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April 13, 1984

M E M O R A N D U M

TO: Dr. Arthur E. Maxwell  
FROM: Yosio Nakamura *YN*  
SUBJECT: Cruise Report - FM-24

The R/V Fred H. Moore cruise FM-24 took place on 20 March through 2 April, 1984. The primary purpose of the cruise was to collect OBS refraction data from five 90-km lines in the western Gulf of Mexico. The experiment was a part of our continuing study of the deep crustal structure in the Gulf of Mexico using large capacity airguns as seismic sources and ocean bottom seismometers as signal detectors, and was conducted in similar fashion as the preceding ones during the Fred H. Moore cruise FM-17, 19, 20-02 and 22. As was the last cruise, this cruise was supported by a single industrial sponsor. In addition to the OBS data, we also acquired multichannel reflection data from a 5-channel streamer and sonobuoys for the same five lines.

The cruise was generally quite successful. Except for a 24-hour delay of the last line due to weather conditions and a reshoot of one of the earlier lines because of instrumental malfunctions, the experiment went smoothly as planned. A total of 26 OBS deployments, including three of a new 3-component unit, were made instead of 21 as originally planned. All were recovered successfully on time, and 22 of them recorded data as programmed. The weather delay and the reshoot added two extra days to the originally planned 11-day cruise, making it a 13-day cruise.

In addition to deploying four vertical component OBS's per line as before, we also deployed a newly developed 3-component OBS with gimbal-mounted 4.5 Hz matched geophones on the three final lines. The data quality from this new instrument appears excellent. In fact, since the data looked so good, we decided to deploy the instrument three times instead of once as originally planned. Another thing we tried for the first time during the cruise was to produce easily interpretable plots of the acquired data on board. A program to plot filtered, static corrected and amplitude gained variable-area record sections in linear distance scale was written during the cruise, and all of the acquired data were plotted before we left the ship in Freeport. The overall quality of the data as seen on these plots looks better than those for the last cruise. This may be due to the difference in the property of sediments in these two areas.

The following personnel participated in the scientific party:

Chief Scientist:	Yosio Nakamura
Deputy Chief Scientist:	Bill O'Brien
OBS Operation:	Phil Roper, Paul McPherson, Mike Butterfield
Navigation:	Dale Sawyer, Kevin MacKenzie, Susan Walker
Multichannel/Electronics:	Ken Griffiths
Airgun Operation:	Oscar Febres-Cordero, George Pearcy
Laboratory Assistants:	Joe Ebeniro, Chris Bennett

As usual, the ship's crew performed admirably. The ship track was maintained excellently; the ship was positioned perfectly for deployment and recovery of OBS's; any problems with ship board equipment were quickly fixed; radio communications with other ships, especially with other seismic ships, were handled cordially; and we had excellent meals on board.

The navigation team, headed by Dale Sawyer with two new members, did an excellent job maintaining ship track and timing for shooting and turning, and to keep good records of navigation data. The OBS team was especially grateful for their consideration in positioning the ship for easier deployment of OBS's from the aft deck in rough seas.

There were some recurring problems with the airguns, but both Oscar and George worked very hard to maintain mostly excellent performance of the guns. I often wondered if Oscar had enough time to sleep because he appeared to be working on those guns all the time.

The OBS team also showed their usual excellence. Despite instrumental malfunctions on some OBS's on earlier lines, they quickly recovered to achieve 100% data acquisition on the last 10 deployments, and only one failure in the last 20 deployments. The success of the experiment was due especially to Phil Roper, who is recuperating from a recent operation but nevertheless decided to participate in the cruise, and to Paul McPherson, who worked hard despite an eye problem that developed during the cruise.

The problem of interference with other seismic ships in the area was greatly reduced this time compared with the last cruise (FM-22). Radio communications with other seismic ships during the planned shooting of the first five lines were smooth and pleasant. This, I believe, was due mainly to the effort of the Institute administration before the cruise to circumvent problems. Only exception was the reshoot of one of the lines, which was not on our original plan. We heard complaints from other seismic ships, but it was too late to do anything but keep shooting though we were asked if we would time share with them.

Most of the problems we encountered during the cruise FM-22 had been solved before this cruise:

- (1) The newly installed filters on the ship's water lines were apparently working very well in providing us with drinking water of much better quality than before. I did not hear any complaints about water quality this time.

- (2) The small (11 inch) Versatec printer-plotter for the PDP 11/34 had been fixed. This greatly increased our efficiency in plotting and printing data on board.
- (3) The doppler sonar, which was repaired during the last cruise, but after the completion of our experiment, was in good working order during this cruise. We obtained excellent SATNAV fixes on all of our lines for estimating additional secondary correction factors (ASF's) for LORAN-C TD's for absolute locations. The results are given in Table 4.
- (4) The shortage of support personnel in the lab area was solved by having two graduate students on board this time. Joe Ebeniro was especially helpful in processing the acquired data on board. He was so efficient that the processed data to be delivered to the sponsor were complete before we returned to Freeport. We did not need shore power in the dry dock to complete the processing, though we planned for it.

Two of the problems of the last cruise remained:

- (1) The data logger 'bombed' again. This happened twice during crucial times while we were shooting lines, losing 25 minutes and 44 minutes of valuable navigation data this time. I understand that the problem is in the software. I urge someone to look into this problem immediately.
- (2) The satellite clock on board Fred H. Moore was not only unreliable but out of order most of the time during this cruise. Although the one used for the OBS calibration can substitute for it in certain cases, the OBS operation suffers when it is 'borrowed' for an extended time, as it is at this moment till the Fred H. Moore returns. The unit has been back to the factory several times. This is about the time when we should try something different, such as acquiring a different clock.

A copy of the pre-cruise test plan is attached. All five lines were shot successfully at planned locations. The actual times of execution of each line except the first were slightly readjusted to accommodate a 30-minute increase in turning time between the primary and the reverse lines, and line 8 was delayed by 24 hours for bad weather. Line 7 was reshot after the end of line 8 with four OBS's in the southwestern half of the line. The 3-component OBS was deployed on lines 9 and 7-reshoot in addition to line 8.

A summary of activities during the cruise follows:

#### Tuesday, March 20

15:00	Departed Galveston UTIG pier on schedule
16:30	Conducted a fire drill

#### Wednesday, March 21

##### Line 6 Operation

05:06:53	Deployed OBS No. 1 (see Table 1 for location coordinates and water depth)
06:42:51	Deployed OBS No. 2
09:39:00	Deployed OBS No. 3

11:19:18 Deployed OBS No. 4  
11:49-12:34 Deployed 5-channel streamer  
13:30-14:00 Deployed airguns, slight delay because of trouble with port  
airgun chain  
14:00-41 Started shooting primary line, starting with shot No. 2 and  
about 1/3 mile passed the planned starting point. (see Table  
2 for coordinates and water depths)  
15:30:30 Deployed sonobuoy No. 1 (see Table 3 for location and water  
depth) -died shortly  
15:37:30 Deployed sonobuoy No. 2  
18:06:41 Deployed sonobuoy No. 3  
18:06-18:31 Data logger failed  
20:49:20 Deployed sonobuoy No. 4

Thursday, March 22

00:00:01 Completed primary line shooting on schedule  
01:00:01 Started shooting reverse section 1, still turning and about 3  
miles behind the planned starting point. Apparently, one hour  
for turning was not sufficient; decided to allow 1½ hours for  
later lines  
01:14 Trouble with one compressor - pressure reduced to about 1200 psi  
for both guns  
01:20 Shut down port gun to maintain 2000 psi on starboard gun  
01:27 Compressors back in operation  
04:30:01 Completed reverse section 1, about a mile short of planned end  
point  
04:43-04:52 Retrieved airguns for transit  
07:06-07:22 Redeployed airguns  
07:30:01 Started shooting reverse section 2, about a mile beyond the planned  
starting point  
11:00:01 Completed reverse section 2, about a mile beyond the planned end  
point  
11:01-11:17 Retrieved airguns  
11:30-11:56 Retrieved streamer  
12:26:31 OBS No. 4 surfaced  
12:36:00 Recovered OBS No. 4; data on tape  
14:11:35 OBS No. 3 surfaced  
14:15:15 Recovered OBS No. 3; no data  
17:07:03 OBS No. 2 surfaced  
17:14:40 Recovered OBS No. 2; data on tape  
18:59:35 OBS No. 1 surfaced  
19:05:56 Recovered OBS No. 1; data on tape

Friday, March 23Line 7 Operation

01:04:50 Deployed OBS No. 1  
02:27:52 Deployed OBS No. 2  
06:35:54 Deployed OBS No. 3  
07:57:47 Deployed OBS No. 4  
08:16-08:38 Deployed streamer  
09:34 Deployed airguns  
10:00:01 Started shooting primary line, right on schedule

Friday, March 23 (Cont.)

11:25	Deployed sonobuoy No. 5; dead
11:33	Deployed sonobuoy No. 6
14:09:20	Deployed sonobuoy No. 7; dead
14:17:30	Deployed sonobuoy No. 8; dead
14:25:30	Deployed sonobuoy No. 9; dead
14:32:30	Deployed sonobuoy No. 10; dead
14:42	Deployed sonobuoy No. 11; alive!!
16:55	Deployed sonobuoy No. 12
20:00:01	Completed primary line, 0.4 mile short of scheduled end point
21:30:01	Started reverse section 1 on schedule

Saturday, March 24

01:00:01	Completed reverse section 1, 0.2 mile beyond the planned end point
01:04-01:15	Retrieved airguns
03:35-03:40	Redeployed airguns
04:00:01	Started reverse section 2 on schedule
07:30:01	Completed reverse section 2, 0.6 mile beyond the planned end point
07:34-07:49	Retrieved airguns
08:10-08:38	Retrieved streamer
08:56:10	OBS No. 4 surfaced
09:13:30	Recovered OBS No. 4; data on tape
10:38:35	OBS No. 3 surfaced
10:43:20	Recovered OBS No. 3; data on tape
13:56:50	OBS No. 2 surfaced; late
14:02:34	Recovered OBS No. 2; no data
15:58:56	OBS No. 1 surfaced; late
16:04:45	Recovered OBS No. 1; no data

Line 10 Operation

21:17:04	Deployed OBS No. 1
22:46:26	Deployed OBS No. 2

Sunday, March 25

01:30:35	Deployed OBS No. 3
02:56:00	Deployed OBS No. 4
04:26-04:49	Deployed streamer
05:44-05:52	Deployed airguns
06:00:01	Started shooting primary line on schedule
07:30:30	Deployed sonobuoy No. 13
10:19:26	Deployed sonobuoy No. 14
12:36:19	Deployed sonobuoy No. 15; short lived
16:00:01	Completed primary line, 1/4 mile short of planned end point
17:30:01	Started reverse section 1, 1/3 mile inside of planned start point
18:45-19:29	Data logger out of order
19:15	Port gun retrieved for service
20:24	New port gun deployed
21:00:01	Completed reverse section 1, 2/3 mile beyond planned end point
21:03-21:15	Retrieved airguns
23:28-23:37	Redeployed airguns
23:51	Retrieved port gun for service

Monday, March 26

00:00:01 Started reverse section 2 with one airgun,  $\frac{1}{2}$  mile behind schedule  
00:41:31 Both guns in operation  
01:20-01:50 Port gun out of service for solenoid replacement  
03:29:31 Completed reverse section 2, 1.8 miles short of planned end point  
03:31 Retrieved airguns  
04:06-04:32 Retrieved streamer  
05:05:52 OBS No. 4 surfaced  
05:12:35 Recovered OBS No. 4; data on tape  
06:49:44 OBS No. 3 surfaced  
06:54:52 Recovered OBS No. 3; data on tape  
09:55:34 OBS No. 2 surfaced  
10:00:52 Recovered OBS No. 2; data on tape  
11:43:00 OBS No. 1 surfaced  
11:50:15 Recovered OBS No. 1; data on tape

Line 9 Operation

16:58:16 Deployed OBS No. 1  
18:25:31 Deployed OBS No. 2  
21:18:14 Deployed OBS No. 3A, 3-component  
21:21:10 Deployed OBS No. 3  
22:55:46 Deployed OBS No. 4

Tuesday, March 27

01:05-01:27 Deployed streamer  
02:30 Deployed airgun  
03:00:01 Started shooting primary line,  $\frac{1}{3}$  mile behind schedule  
03:49-04:19 One compressor out of order; shot with one gun only  
04:38:11 Deployed sonobuoy No. 16; dead  
06:10-06:45 Starboard gun retrieved for service  
07:35 Port gun retrieved for service  
08:07 Deployed sonobuoy No. 17  
09:56 Port gun back in operation  
10:26 Retrieved starboard gun for service  
12:49 Starboard gun back in operation  
13:00:01 Completed primary line on schedule; the ship speed during this line was quite irregular because of frequent airgun service  
14:30:01 Started reverse section 1,  $\frac{1}{3}$  mile behind schedule  
18:00:01 Completed reverse section 1,  $\frac{1}{4}$  mile behind schedule  
18:14-18:24 Retrieved airguns for transit  
20:42-20:50 Redeployed airguns  
21:00:00 Started reverse section 2 on schedule  
22:06-22:10 Shot with one gun only for compressor repair

Wednesday, March 28

00:30:01 Completed reverse section 2 on schedule  
00:35-00:53 Retrieved airguns  
00:55-01:43 Retrieved streamers; winds were picking up and waves were getting higher, making operations increasingly difficult  
01:57:38 OBS No. 4 surfaced  
02:20:05 Recovered OBS No. 4; data on tape  
03:42:12 OBS No. 3 surfaced  
03:50:00 Recovered OBS No. 3; no data

Wednesday, March 28 (Cont.)

04:11:20 OBS No. 3A surfaced  
04:21:01 Recovered OBS No. 3A; data on tape  
07:17:31 OBS No. 2 surfaced  
07:41 OBS No. 2 recovery delayed because of repair on stuck rudder  
08:05:43 Recovered OBS No. 2; data on tape  
08:59 OBS No. 1 surfaced  
09:28:33 Recovered OBS No. 1; data on tape: the sea had increased to 14-15 feet and worsening conditions were forecast; decided to delay the line 8 operation; meanwhile, surveyed depth variations along line 8 for better OBS deployment sites

Thursday, March 29Line 8 Operation

13:19:25 Deployed OBS No. 1, after 24-hour delay from original schedule  
14:48:00 Deployed OBS No. 2  
17:30:20 Deployed OBS No. 3A - 3-component  
17:39:05 Deployed OBS No. 3  
19:33:45 Deployed OBS No. 4  
20:25-20:42 Deployed streamer  
22:36-22:44 Deployed airguns  
23:00:01 Started shooting primary line,  $\frac{1}{2}$  mile behind schedule

Friday, March 30

00:48 Deployed sonobuoy No. 18; died after 5 minutes  
01:04 Deployed sonobuoy No. 19  
05:38:30 Deployed sonobuoy No. 20  
07:36 Deployed sonobuoy No. 21  
09:00:01 Completed primary line, one mile passed the planned end point  
10:30:01 Started reverse section 1,  $1\frac{1}{2}$  miles behind schedule  
14:00:01 Completed reverse section 1,  $\frac{1}{2}$  mile ahead of schedule  
14:08 Retrieved airguns for transit  
16:48-16:58 Redeployed airguns  
17:11:01 Started reverse section 2, with 11-minute delay and  $\frac{1}{2}$  mile behind schedule  
20:30:01 Completed reverse section 2, one mile passed the planned end point  
20:33-20:45 Retrieved airguns  
21:05-21:49 Retrieved streamers  
22:28:01 OBS No. 4 surfaced  
22:35:58 Recovered OBS No. 4; data on tape

Saturday, March 31

00:13:15 OBS No. 3 surfaced  
00:21:20 Recovered OBS No. 3; data on tape  
00:40:20 OBS No. 3A surfaced  
00:50:40 Recovered OBS No. 3A; data on tape  
03:42:16 Surfaced  
03:47:45 Recovered OBS No. 2; data on tape  
05:24:40 OBS No. 1 surfaced  
05:32:19 Recovered OBS No. 1; data on tape

Saturday, March 31 (Cont.)Line 7 Reshoot Operation

13:52:50	Deployed OBS No. 7A, 3-component, near the OBS 2 site of the original line 7
13:55:14	Deployed OBS No. 7
16:09:50	Deployed OBS No. 6, 2.25 km SW of the OBS 1 site of the original line 7 to avoid proximity to salt dome
16:11:45	Deployed OBS No. 5
18:14-18:25	Deployed airguns
19:00:01	Started shooting primary line

Sunday, April 1

05:00:01	Completed primary line on schedule
06:30:01	Started reverse section, 1.7 miles behind schedule; shooting out of sync. until 06:36
10:00:01	Completed reverse section
10:00-10:11	Retrieved airguns
12:30:54	OBS No. 7A surfaced
12:34:00	Recovered OBS No. 7A; data on tape
12:58:25	OBS No. 7 surfaced
13:03:45	Recovered OBS No. 7; data on tape
14:59:40	OBS No. 6 surfaced
15:07:45	Recovered OBS No. 6; data on tape
15:30:32	OBS No. 5 surfaced
15:36:15	Recovered OBS No. 5; data on tape

Monday, April 2

06:00	Arrived at Swiftships Shipyard in Freeport for new transducer installation
07:27	Completed on-board data processing



Table 1. OBS Deployment(D) and Recovery(R) Locations

Line	OBS	D&L Recv.	Latitude deg,min N	Longitude deg,min W	Loran-C		Water Depth fm
					TDW	TDX	
6	1	D	27 53.07	95 35.62	11112.2	24771.3	33
		R	27 53.11	95 35.59	11112.1	24771.8	33
	2	D	27 46.48	95 45.51	11114.5	24638.4	37
		R	27 46.55	95 45.56	11114.5	24638.5	36
	3	D	27 31.29	96 06.90	11120.6	24344.8	77
		R	27 31.30	96 07.04	11120.6	24343.6	76
	4	D	27 24.58	96 16.64	11122.8	24212.5	72
		R	27 24.57	96 16.68	11122.8	24211.7	73
7	1	D	27 11.91	95 25.95	11178.4	24659.3	664
		R	27 11.87	95 25.91	11178.3	24659.8	678
	2	D	27 17.36	95 15.33	11179.7	24792.7	630
		R	27 17.18	95 15.25	11179.9	24792.6	630
	3	D	27 29.31	94 51.58	11183.4	25089.5	465
		R	27 29.12	94 51.65	11183.5	25087.9	464
	4	D	27 34.73	94 40.86	11185.2	25223.7	413
		R	27 34.45	94 40.94	11185.5	25221.5	420
10	1	D	26 45.32	96 13.83	11175.3	24055.3	240
		R	26 45.21	96 13.74	11175.7	24056.1	233
	2	D	26 34.77	96 17.32	11186.7	23984.2	252
		R	26 34.81	96 17.19	11186.9	23985.7	257
	3	D	26 11.55	96 25.18	11211.1	23852.5	37
		R	26 11.71	96 25.15	11211.0	23852.2	37
	4	D	26 01.21	96 28.72	11221.8	23806.8	33
		R	26 01.21	96 28.67	11221.7	23807.1	33
9	1	D	26 00.57	95 47.99	11263.0	24217.2	494
		R	26 00.20	95 48.17	11263.4	24214.8	429
	2	D	26 06.81	95 37.92	11264.9	24329.9	668
		R	26 06.67	95 38.06	11264.9	24328.1	660
	3A	D	26 20.50	95 15.54	11269.4	24590.1	739
		R	26 20.50	95 15.53	11269.4	24590.1	739
	3	D	26 20.61	95 15.51	11269.3	24590.6	739
		R	26 20.59	95 15.51	11269.3	24590.3	742
	4	D	26 26.62	95 05.39	11271.7	24711.2	917
		R	26 26.47	95 05.13	11272.3	24713.7	917
	8	D	25 59.90	95 09.81	11309.5	24603.9	903
		R	26 00.07	95 09.85	11309.2	24603.6	916
8	2	D	26 00.11	94 57.61	11325.6	24728.2	1455
		R	26 00.17	94 57.61	11325.4	24728.3	1461
	3A	D	26 00.40	94 30.70	11364.5	25002.0	1615
		R	26 00.15	94 30.32	11365.4	25005.0	1614
	3	D	26 00.32	94 30.71	11364.6	25001.5	1615
		R	26 00.15	94 30.38	11365.3	25004.5	1615
	4	D	26 00.45	94 18.58	11383.8	25124.6	1606
		R	26 00.02	94 18.00	11385.6	25129.5	1609
	7R	D	27 17.27	95 15.40	11179.7	24791.5	630
		R	27 17.39	95 15.35	11179.6	24792.6	629
	7	D	27 17.22	95 15.39	11179.8	24791.5	630
		R	27 17.38	95 15.35	11179.6	24792.4	629
	6	D	27 11.24	95 27.36	11178.0	24642.2	659
		R	27 11.52	95 27.34	11177.5	24643.5	661
	5	D	27 11.21	95 27.36	11178.0	24642.1	659
		R	27 11.51	95 27.36	11177.5	24643.2	661

Coordinates and TD values are from Northstar 6000; thus are preliminary.

Table 2. End Points of Shooting Lines

Line	Shot No.	Latitude deg,min N	Longitude deg,min W	Loran-C		Water Depth fm
				TDW	TDX	
6	2	27 24.09	96 17.38	11123.0	24202.4	72
	901	27 53.98	95 34.50	11111.7	24787.4	32
	902	27 55.37	95 32.13	11111.4	24818.0	32
	1322	27 44.31	95 48.79	11115.4	24594.4	40
	1323	17 33.96	96 03.39	11119.4	24394.0	75
	1743	27 22.98	96 18.69	11123.5	24183.1	71
7	1	27 35.40	94 39.61	11185.3	25239.4	396
	901	27 11.49	95 26.75	11178.1	24649.5	662
	902	27 11.46	95 27.19	11177.8	24644.8	662
	1322	27 19.89	95 10.34	11180.3	24855.1	607
	1323	27 26.87	94 56.41	11182.5	25029.1	518
	1743	27 35.56	94 39.00	11185.6	25246.4	386
10	1	25 59.79	96 28.99	11223.3	23803.3	35
	901	26 46.32	96 13.58	11174.3	24061.8	267
	902	26 46.23	96 13.38	11174.6	24063.4	265
	1322	26 29.57	96 19.15	11192.2	23950.5	155
	1323	26 16.69	96 23.49	11205.7	23877.6	40
	1743	26 01.55	96 28.39	11221.5	23810.3	35
9	1	26 27.35	95 03.99	11272.3	24727.8	896
	901	25 59.84	95 49.11	11262.8	24204.8	444
	902	25 59.82	95 49.45	11262.5	24201.3	445
	1322	26 09.42	95 33.68	11265.6	24378.3	806
	1323	26 17.89	95 20.03	11268.2	24537.2	855
	1743	26 27.02	95 04.37	11272.3	24723.0	909
8	1	26 00.15	94 16.75	11386.7	25143.0	1590
	901	25 59.97	95 12.46	11305.9	24577.0	951
	902	25 59.97	95 12.99	11305.3	24571.7	932
	1322	26 00.08	94 51.63	11333.8	24788.8	1537
	1345	26 00.68	94 35.46	11356.6	24954.3	1640
	1743	26 00.63	94 16.20	11387.4	25149.1	1594
7R	1	27 10.93	95 27.98	11177.9	24634.6	661
	901	27 35.19	94 39.69	11185.6	25237.8	396
	902	27 35.94	94 38.10	11185.9	25257.2	380
	1322	27 26.76	94 56.85	11182.3	25023.9	527

Coordinates and TD values are from Northstar 6000; thus are preliminary.

Shot Nos. 1, 901, 902, 1322, 1323 and 1743 represent beginning and end of primary, first reverse and second reverse sections, respectively.

Table 3. Active Sonobuoy Deployment Locations

Line	Sonobuoy No.	Latitude deg,min N	Longitude deg,min W	Loran-C		Water Depth fm
				TDW	TDX	
6	2	27 29.03	96 10.71	11121.0	24294.1	75
	3	27 35.94	96 00.64	11118.7	24432.1	74
	4	27 43.89	95 49.05	11115.9	24589.0	41
7	6	27 31.45	94 47.26	11184.2	25144.2	451
	11	27 23.68	94 02.41	11181.9	24953.6	599
	12	27 18.62	95 12.92	11179.9	24823.3	621
10	13	26 07.23	96 26.72	11215.4	23833.0	36
	14	26 20.51	96 22.15	11201.7	23898.6	44
	15	26 31.09	96 18.66	11190.6	23959.7	192
9	17	26 11.27	95 25.50	11267.5	24422.3	833
8	19	26 00.34	94 28.56	11367.8	25023.0	1605
	20	26 00.20	95 53.80	11330.6	24766.9	1504
	21	26 00.13	94 04.71	11315.8	24656.1	1308

Coordinates and TD values are from Northstar 6000; thus are preliminary.

Sonobuoy Nos. 1, 5, 7, 8, 9, 10, 16 and 18 were duds.

Table 4. Estimates of Loran-C Additional Secondary Corrections (ASF's) Based on Satellite Navigation Fixes

Line	W-ASF		X-ASF	
	$\mu\text{sec}$		$\mu\text{sec}$	
6	1.19	+0.02 (0.3)	1.2	+0.2 (0.8)
7	0.87	+0.04 (0.1)	0.6	+0.2 (0.6)
8	0.31	+0.03 (0.0)	0.9	+0.2 (0.2)
9	0.45	+0.07 (0.0)	1.1	+0.5 (0.3)
10	0.54	+0.03 (0.1)	0.5	+0.1 (0.4)

The values in parentheses are those published in the Loran-C Correction Table, 1981.

Northstar 6000 uses 0.6  $\mu\text{s}$  and 0.3  $\mu\text{s}$  for W-ASF and X-ASF, respectively, regardless of location.

## OFFSHORE TEXAS OBS REFRACTION EXPERIMENT PLAN

Rev. 03/15/84

Dates: March 20-30, 1984 (Tuesday-Friday)

Lines: Line 6: 27 24.05'N, 96 17.78'W to 27 54.20'N, 95 34.50'W  
 Line 7: 27 11.50'N, 95 27.39'W to 27 35.51'N, 94 39.70'W  
 Line 8: 26 00.26'N, 95 11.51'W to 26 00.75'N, 94 17.32'W  
 Line 9: 26 00.21'N, 95 49.20'W to 26 27.57'N, 95 04.38'W  
 Line 10: 26 00.20'N, 96 29.09'W to 26 47.04'N, 96 13.49'W

Each line is approximately 90 km (48.6 nm) long

Signal Source: Two 2000 cubic inch 2000 psi air guns

Detectors: (1) OBS's: Four OBS's, each with a 4.5 Hz vertical geophone, at 2.2, 22.5, 67.5 and 87.8 km (1.2, 12.1, 36.4 and 47.4 nm) from the starting point of each line, plus one with a 4.5 Hz 3-component geophone at 67.5 km on line 8  
 (2) Streamer: 600 m, 5 channels  
 (3) Sonobuoys: At 13.5, 36.0 and 58.5 km (7.3, 19.4 and 31.6 nm) from another end of each line

Ship Schedule: (R/V Fred H. Moore)

Tues.	March 20	15:00	Sail from Galveston	
Wed.	March 21	05:00	Start line 6	(99 nm from seabuoy)
Thurs.	March 22	19:30	End line 6	
Fri.	March 23	01:00	Start line 7	(42 nm from line 6)
Sat.	March 24	15:30	End line 7	
		21:00	Start line 10	(50 nm from line 7)
Mon.	March 26	11:30	End line 10	
		17:00	Start line 9	(50 nm from line 10)
Wed.	March 28	07:30	End line 9	
		12:30	Start line 8	(34 nm from line 9)
Fri.	March 30	04:00	End line 8	
		23:00	Arrive at Freeport	(173 nm to seabuoy)

Detailed Schedule for Each Line: (Ref. time = 33 hrs before shooting start)

Lines 6,7,10&9	Line 8	Activity
01/00:00-00:30	00/23:30-24:00	Deploy OBS #1
01/01:45-02:15	01/01:15-01:45	Deploy OBS #2
	01/04:15-04:45	Deploy OBS #3a
01/04:45-05:15	:	Deploy OBS #3
01/06:30-07:00	:	Deploy OBS #4
01/07:00-09:00	:	Deploy streamer and air guns
01/09:00	:	Commence primary shooting
01/10:30	Same	Deploy sonobuoy #1
01/13:00	as	Deploy sonobuoy #2
01/15:30	Other	Deploy sonobuoy #3
01/19:00	Lines	End primary shooting
01/20:00-23:30	:	Shoot reverse section 1
02/02:30-06:00	:	Shoot reverse section 2
02/06:00-07:30	:	Retrieve air guns and streamer
02/07:30-08:00	:	Recover OBS #4
02/09:15-09:45	:	Recover OBS #3
	02/09:45-10:15	Recover OBS #3a
02/12:15-12:45	02/12:45-13:15	Recover OBS #2
02/14:00-14:30	02/14:30-15:00	Recover OBS #1

Ship speed while shooting: 4.9 knots

# Shooting Schedule:

Shot Nos.	From	To	Interval
1- 901	01/09:00:01	01-19:00:01	40 sec
902-1322	01/20:00:01	01-23:30:01	30
1323-1743	02/02:30:01	01-06:00:01	30

# Recording Schedule:

Sampling Interval:	10.008 msec
Record Length: OBS # 1-4:	20.416 sec
OBS # 3a:	13.611 sec

OBS #	Shot Nos.	From	To	Interval	Blocks
1	1- 540	01/09:00:10	14:59:30	40	1
	541- 901	01/15:00:10	18:59:58	40-2/60	1
	1323-1743	02/02:30:10	06:00:17	30+1/60	1
2	1- 360	01/09:00:10	12:59:30	40	1
	361- 720	01/13:00:10	16:59:18	40-2/60	1
	721- 901	01/17:00:00	19:00:06	40+2/60	1
	1323-1743	02/02:30:10	06:00:10	30	1
3	1- 270	01/09:00:00	11:59:20	40	1
	271- 570	01/12:00:00	15:19:30	40+2/60	1
	571- 901	01/15:20:10	19:00:15.5	40+1/60	1
	902-1322	01/20:00:10	23:30:10	30	1
4	1- 60	01/09:00:00	09:39:20	40	1
	61- 360	01/09:40:00	12:59:30	40+2/60	1
	361- 901	01/13:00:10	19:00:19	40+1/60	1
	902-1322	01/20:00:10	23:30:10	30	1
3a	211- 270	01/11:20:00	11:59:20	40	2
	271- 570	01/12:00:00	15:19:30	40+2/60	2
	571- 901	01/15:20:10	19:00:15.5	40+1/60	2

# Scientific Party:

Chief Scientist:	Yosio Nakamura
Deputy Chief Scientist:	Bill O'Brien
OBS:	Phil Roper, Paul McPherson, Mike Butterfield
Navigation:	Dale Sawyer, Kevin MacKenzie, Susan Walker
Laboratory Assistants:	Joe Ebeniro, Chris Bennett
Multichannel/Electronics:	Ken Griffiths
Air Gun:	Oscar Febres-Cordero, George Pearcey

OBS: #1

#2

#3  
(3a)

#4

Deployment:

Primary  
Shooting:

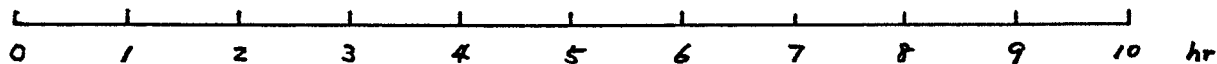
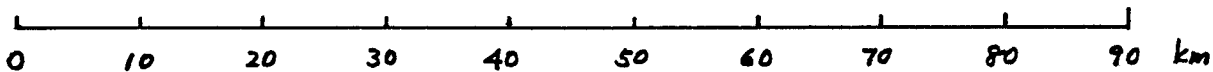
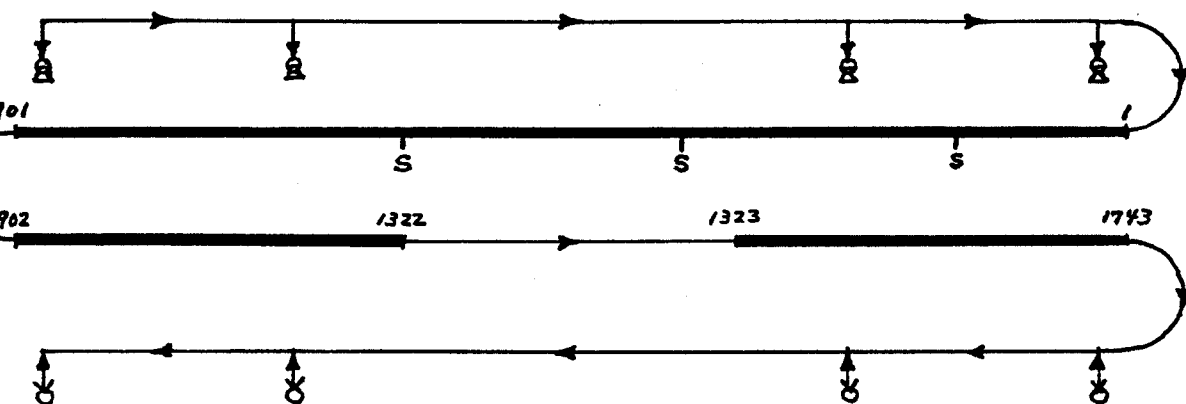
Reverse  
Shooting:

Recovery:

Distance:

Time

at 49 knots:



surface wells and wells submerged 11  
more: aids to navigation and safety  
u oil fields  
wells may be marked by lighted or un-

