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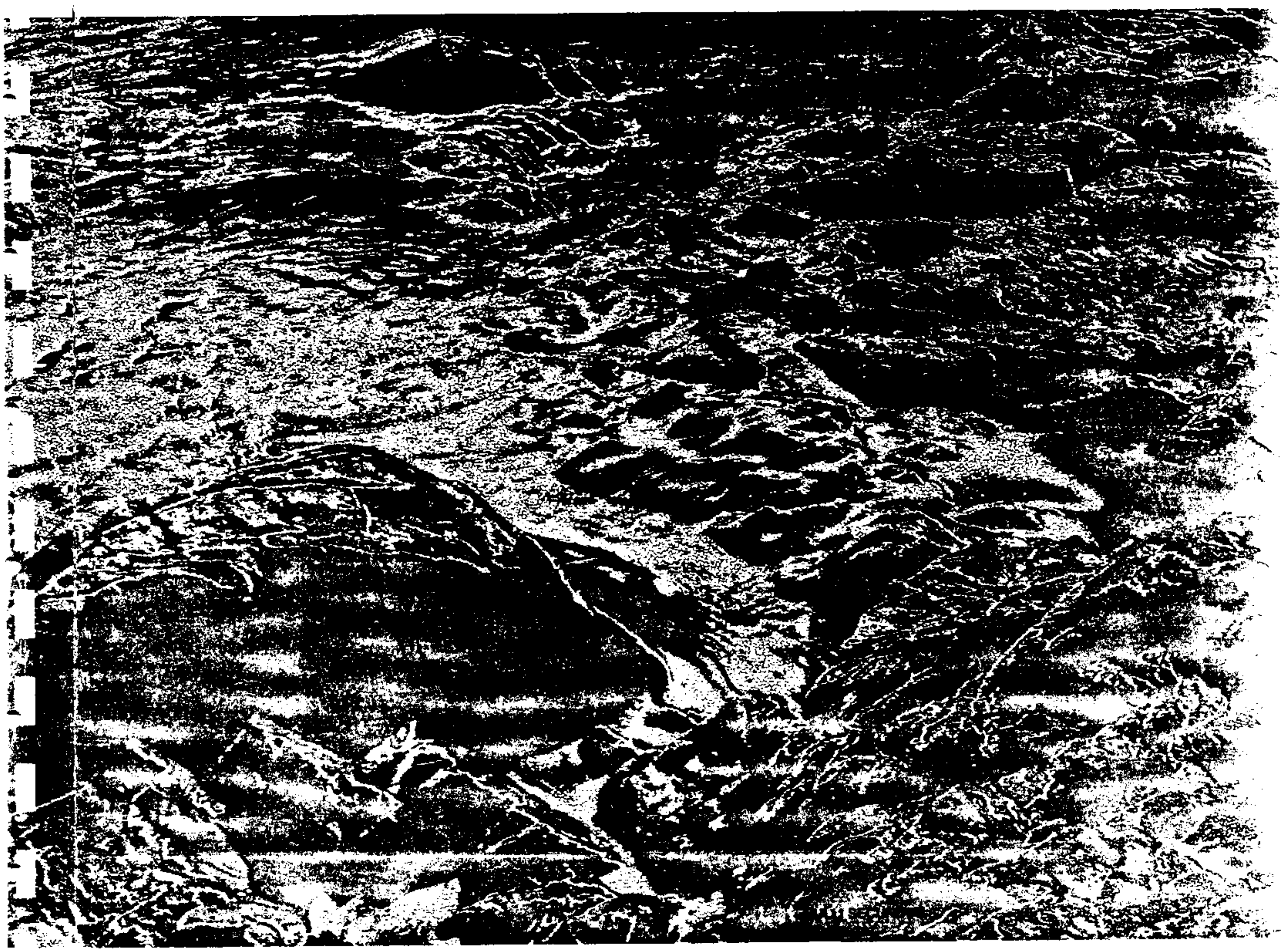
FIELD TEST OF TWO SPILL TREATING AGENTS

Final Report

Submitted to:

Department of the Environment
Conservation and Protection
River Road Env. Tech. Centre
Ottawa



SEAKEM OCEANOGRAPHY LTD SIDNEY, B.C. • DARTMOUTH, N.S. • INUVIK, N.W.T.

FIELD TEST OF TWO SPILL TREATING AGENTS

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Submitted to:

Department of the Environment
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by:

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ABSTRACT

Logistical services in support of a field operation to test the effectiveness of two new oil spill treating agents were provided. The agent Elastol, which imparts a viscoelastic property to oil, and a de-emulsifier (Brand M) were applied to ten test slicks laid midway between Nova Scotia and Sable Island.

Observations of the physical characteristics of the treated slicks and chemical analysis of oil samples taken from the slicks at time intervals ranging from one to six hours indicate that both agents are at least as effective as they have been shown to be in laboratory and large-tank tests. Due to weather conditions at the time of the field trials, it was not possible to determine the effect of the treating agents on the recoverability of the oil.

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2.0 FIELD EXPERIMENT

3.0 RESULTS

ACKNOWLEDGMENTS

This field study was brought to a successful conclusion in spite less than ideal environmental conditions through the coordinated efforts of personnel from a variety of organizations. They were:

Environment Canada:	M. Fingas R. Percy M. Bobra
Materials Management Service:	E. Tennyson L. Hannon
Canadian Coast Guard:	R. Stright R. Carpenter Captain & crew of the CCGS Mary Hichens
General Technology Applications:	E. Tedeschi
Esso Resources Canada	R. Goodman
Canada Centre for Remote Sensing	W. McColl

1.0 INTRODUCTION

To aid in the recovery of petroleum hydrocarbons spilled at sea, two chemical agents to modify the physical properties the spilled oil recently have been introduced. In this study, the effectiveness of these two formulations in modifying oil spill behaviour were tested in the field.

Elastol is a proprietary formulation that comprises a high molecular weight isobutylene polymer coated with a metallic soap. These compounds are insoluble in water, but form solutions in non-polar solvents which exhibit viscoelastic behaviour. Oil slicks floating on water that have been so treated have enhanced cohesive forces and thus should be more easily contained, collected and separated from the water. Small scale laboratory tests of the effect of this material on the physical properties of oil have been undertaken by the manufacturer (Waters and Haderman 1987) as well as by Environment Canada (Bobra et al. 1987) who have also studies these materials in a meso-scale outdoor tank test. The results of these studies show that the elasticity of various oils is indeed enhanced and that tank-confined slicks have significantly modified in their physical characteristics. Consequently, further large-scale ocean tests were recommended.

Certain types of petroleum oils are prone to form water-in-oil emulsions (mousse) which adversely affect such cleanup procedures as mopping, skimming, and pumping (National Research Council 1985). The high water content (30-50% and higher) also inhibits combustion. A surface active agent to break water-in-oil emulsions was also tested as a part of this project. Brand M, a liquid demulsifier/demoussifier, was formulated by Environment Canada and is a modified version of an European-developed emulsion breaker designated Brand S.

2.0 FIELD EXPERIMENT

2.1 Site

The site chosen was 44°15'N 61°50'W which lies about halfway between Halifax and Sable Island and is at least 60 km from the nearest coastline. Environment Canada judged that this site would be unlikely to suffer environmental damage as a result the activities planned. The water depth at this station is 172 m.

2.2 Materials tested

Two petroleum mixtures were used in the field trials: 1) Alberta Sweet Crude Oil (ASCO) (waxes and asphaltenes removed) and 2) a mixture (50:50) of ASCO and Bunker A (Bunker C cut with ca. 20% diesel fuel). The ratio of ASCO to Bunker C actually used was 44.4:55.6 to correct for the diesel fuel content of the Bunker A. To prepare 42.2 bbl of the mixture, the oils were pumped (ASCO first, Bunker A second) into a cylindrical tank (23,000 l) on the dock at Mulgrave. Volumes were determined geometrically from dipstick level measurements (table 2.1). A volume of ASCO of the order of 37 bbl was pumped into a second 23,000 l tank. Both bulk tanks were subsequently secured aboard the Mary Hichens on the aft deck.

Table 2.1 Bulk tank volume vs. depth

Distance from bottom		Volume	
(feet)	(inches)	cu. ft	bbl
3.5	42.0	404.0	72.2
3.4	40.8	389.3	69.5
3.3	39.6	374.7	66.9
3.2	38.4	360.0	64.3
3.1	37.2	345.4	61.7
3.0	36.0	330.8	59.1
2.9	34.8	316.3	56.5
2.8	33.6	301.8	53.9
2.7	32.4	287.5	51.3
2.6	31.2	273.2	48.8
2.5	30.0	259.1	46.3
2.4	28.8	245.0	43.8
2.3	27.6	231.2	41.3
2.2	26.4	217.4	38.8
2.1	25.2	203.9	36.4
2.0	24.0	190.5	34.0
1.9	22.8	177.3	31.7
1.8	21.6	164.3	29.3
1.7	20.4	151.6	27.1
1.6	19.2	139.1	24.8
1.5	18.0	126.9	22.7
1.4	16.8	115.0	20.5
1.3	15.6	103.4	18.5
1.2	14.4	92.2	16.5
1.1	13.2	81.3	14.5
1.0	12.0	70.8	12.6
0.9	10.8	60.7	10.8
0.8	9.6	51.1	9.1
0.7	8.4	42.0	7.5
0.6	7.2	33.5	6.0
0.5	6.0	25.6	4.6
0.4	4.8	18.4	3.3
0.3	3.6	12.0	2.1
0.2	2.4	6.5	1.2
0.1	1.2	2.3	0.4

2.3 Slick laying pattern

For each the demulsifier and elastol trials, five slicks were laid in the following order (see Appendix A for time schedule):

Table 2.2 Order of slicks

DEMULSIFIER (Day 1)	ELASTOL (Day 2)	Notes
Slick #1 (1000 ppm)	Slick # 6 (3000 ppm)	Medium treatment
Slick #2 (250 ppm)	Slick # 7 (1000 ppm)	Low treatment
Slick #3 (0 ppm)	Slick # 8 (0 ppm)	Control
Slick #4 (4000 ppm)*	Slick # 9 (9000 ppm)	High treatment
Slick #5 (1000 ppm)	Slick #10 (3000 ppm)	Medium pre-treatment

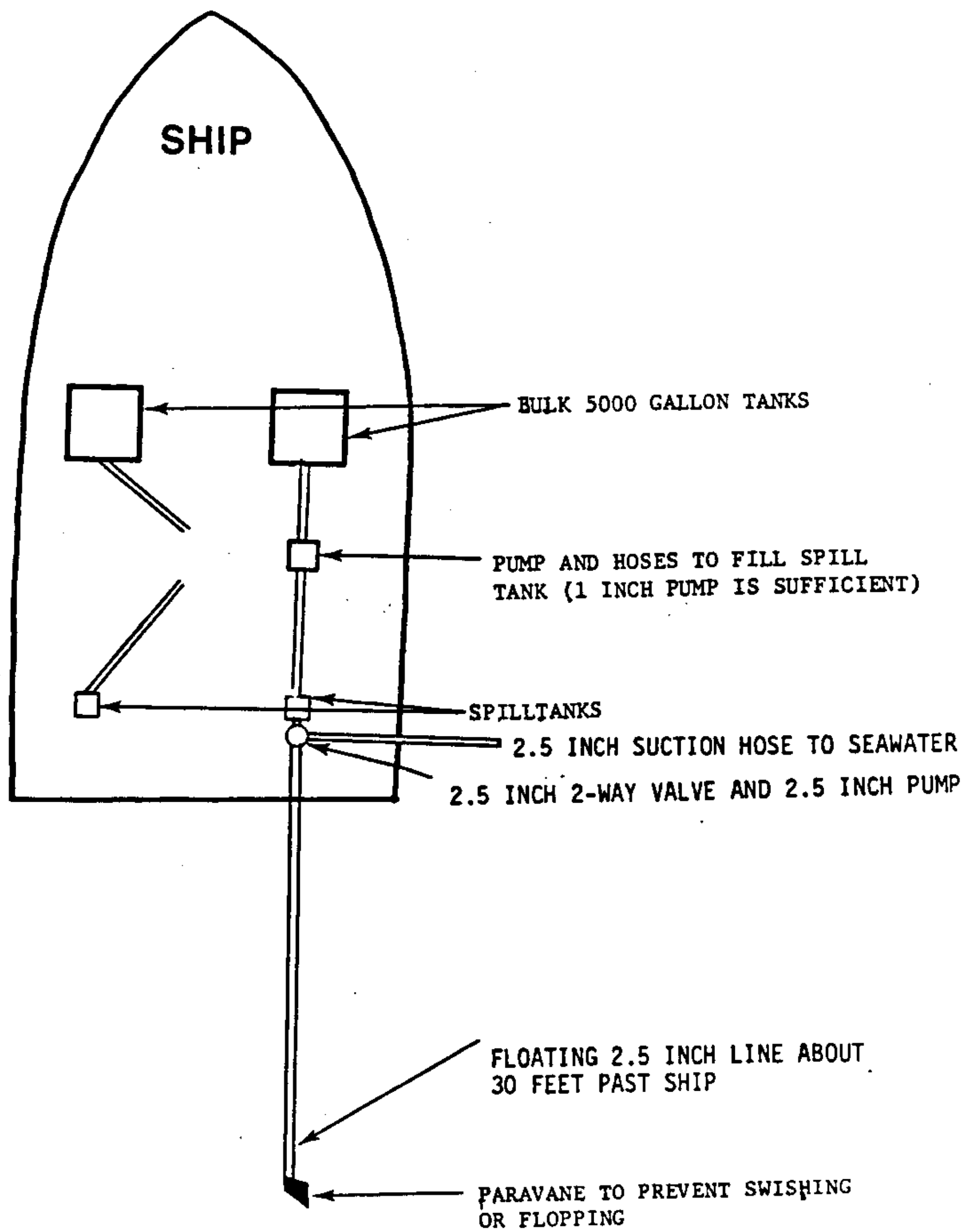
* delayed (6hr) treatment

2.4 Slick laying procedure

The plumbing system that was used to discharge the slicks from the aft deck of the Mary Hichens is shown in figure 2.1. Oil was pumped from the bulk tanks into one of two spill tanks having a capacity of 1000 l. For each spill 5 bbl (800 l, 29" depth) of oil was pumped into the spill tanks as determined by dipstick measurement.

In the case of the demulsifier trial, the spill tanks were discharged via a 2.5" line equipped with flotation along its length and a paravane at the end to prevent flapping or snaking. The end of the discharge line was approximately 10 m from the stern of the Mary Hichens while oil was being pumped. When the contents of the spill tank were completely discharged, a 2-way valve was actuated which allowed seawater to be pumped through the line, thus flushing out the residual oil and minimizing the amount of oil trailed behind the ship as it proceeded to the next spill site.

Figure 2.1 Plumbing for spill laying



During the Elastol trials, the same plumbing arrangement was used to discharge the oil, but the end of the discharge line was fixed near the starboard side of the Mary Hichens about 14 m from the stern. This arrangement was used so that the oil could be treated as is passed under the applicators held by personnel on the aft deck.

2.5 Slick treatment

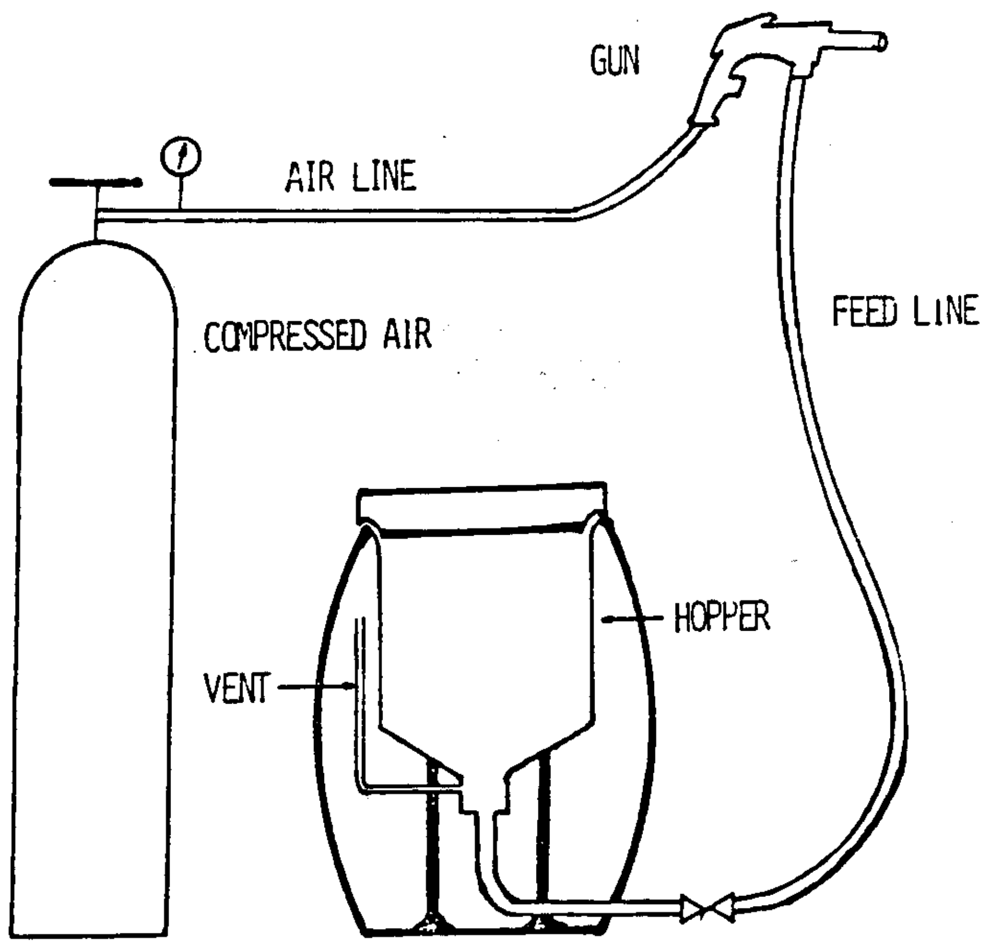
One slick in both the demulsifier and Elastol trials was laid using oil that was treated with the appropriate agent immediately prior to discharge from the spill tank. The agent was added to the spill tank concurrently with the oil being pumped from the bulk tank to ensure that the agent would be well-mixed with the oil.

All other slicks were treated after laying (with the exception of the two control slicks) using specially modified applicators. Campbell-Hausefield Power Blast Model AT1210 (sandblasters) were used to dispense both the demulsifier and Elastol (figure 2.2). This apparatus was chosen by the scientific authority after evaluating several application systems on the basis of their: 1) uniform distribution characteristics, 2) portability and ruggedness, 3) safety and 4) simplicity. Extensive testing of the distribution pattern obtained by use of this applicator was undertaken by Bobra et al. (1987). The applicators used for Elastol were fitted with vented hoppers to ensure continuous flow of the powdered agent. No modification was required for application of the demulsifier.

During the demulsifier trial, the slicks were treated from small sample boats (xx ft Rossboroughs). The procedure that was generally followed was to approach the slick from up wind and spray the slick with the agent while the sample boat traversed the slick in a zig-zag pattern until the downwind side of the slick was reached. This process was repeated until the entire dose of the treating agent had been applied.

During the Elastol trial, heavy seas prevented the use of the sample boats and the slicks were treated directly from the aft deck of the Mary Hichens (as described in section 3.4).

Figure 2.2 Applicators for treating agents



2.6 Sample collection

The samples were obtained with the aid of plastic mesh baskets on the end of aluminum poles. The baskets are of a type commercially available for removing debris from swimming pools. The baskets were swept half-submerged through the slicks and when a sufficient amount of oil had been collected, the plastic mesh was snipped from the frame and allowed to fall into a 5-liter pail which was then labelled and sealed. Care was taken to obtain representative samples of the slicks, i.e. samples were not taken from sheen areas or exclusively in thickly covered areas.

During the demulsifier trial, samples were collected from the small sample boats according to the schedule outlined in Appendix A. For each slick, samples were taken approximately one hour and four hours after the application of the demulsifier. In the case of slick #1, a sample was obtained 24 hours after application. During the collection period, the samples were periodically returned to the laboratory aboard the Mary Hichens to enable prompt analyses for water content and viscosity.

Heavy weather was encountered during the day of the Elastol trial; consequently all sampling was done from the deck of the Mary Hichens. Baskets on extension poles were used to collect the samples, usually from the port side of the ship. All other sampling procedures were the same as in the demulsifier trial.

In neither trial was it possible to collect longer term samples as was originally planned (22-49 hrs after treatment). This was due to the fact that the heavy weather encountered on the second day effectively dispersed the slicks.

3.0 RESULTS

3.1 Cruise plan/ship movements

Figure 3.1 is a graphic summary of the activities of that were undertaken by project staff during the two-day exercise on the Mary Hichens. This information on this figure and in Appendix A was extracted from field notes and the ship's log. The information on the figure can be best understood by reading the chronological list of activities as they appear in Appendix A.

On 10 September, the first activity upon reaching the spill site was to deploy a Datawell surface-following accelerometer buoy (waverider) on a deep water mooring. This buoy transmitted data on wave height and frequency to a DIWAR receiver located on the bridge of the Mary Hichens. The DIWAR received signals from the buoy and converted the signal to a RS232 serial data string which was displayed in real time and logged on floppy disk-both on a Compaq portable computer.

Prior to laying actual oil slicks, a water-soluble dye was used to practice the slick laying technique and the sample collection routine was rehearsed. This practice session was immediately followed by the laying of the first slick. Within 3 hours all five slicks (D1-D5 on Figure 3.1) in the demulsifier series had been laid, treated and sampled according to the schedules given in table 2.2 and Appendix A. The one hour samples were taken by the sample boats at positions which are essentially the identical to those marked as the discharge positions. Approximately four hours after the first slick had been treated, a second sampling sortie was initiated and samples were collected from each of the slicks during the next two hours. The position of the Mary Hichens while the slicks were being sampled from the sample boats the second time are marked on figure 3.1 as Sn' where n is the slick number. These positions do not reflect the true positions that were sampled, but identify the general area where the slicks were sighted, this being southwest of the track where they were originally laid.

An attempt was made to find the slicks D1-D5 approximately 24 hours after the first slick was laid. Oil was found in one area (marked S1'') that could have been the remnants of slick D1 (see section 3.5), but no other surface oil was found that could be identified with the slicks laid the previous day.

Also at this time, the Orion buoys were sighted at the positions marked T3 and T5 on figure 3.1. These buoys were released at the time slicks D3 and D5 were discharged. It is interesting to note that these were found to the northeast of the track while the slicks were apparently found to the southwest. A group of miscellaneous surface tracking buoys that were released at the point between D3 and D4 were found near the same area (indicated by two squares joined by a line).

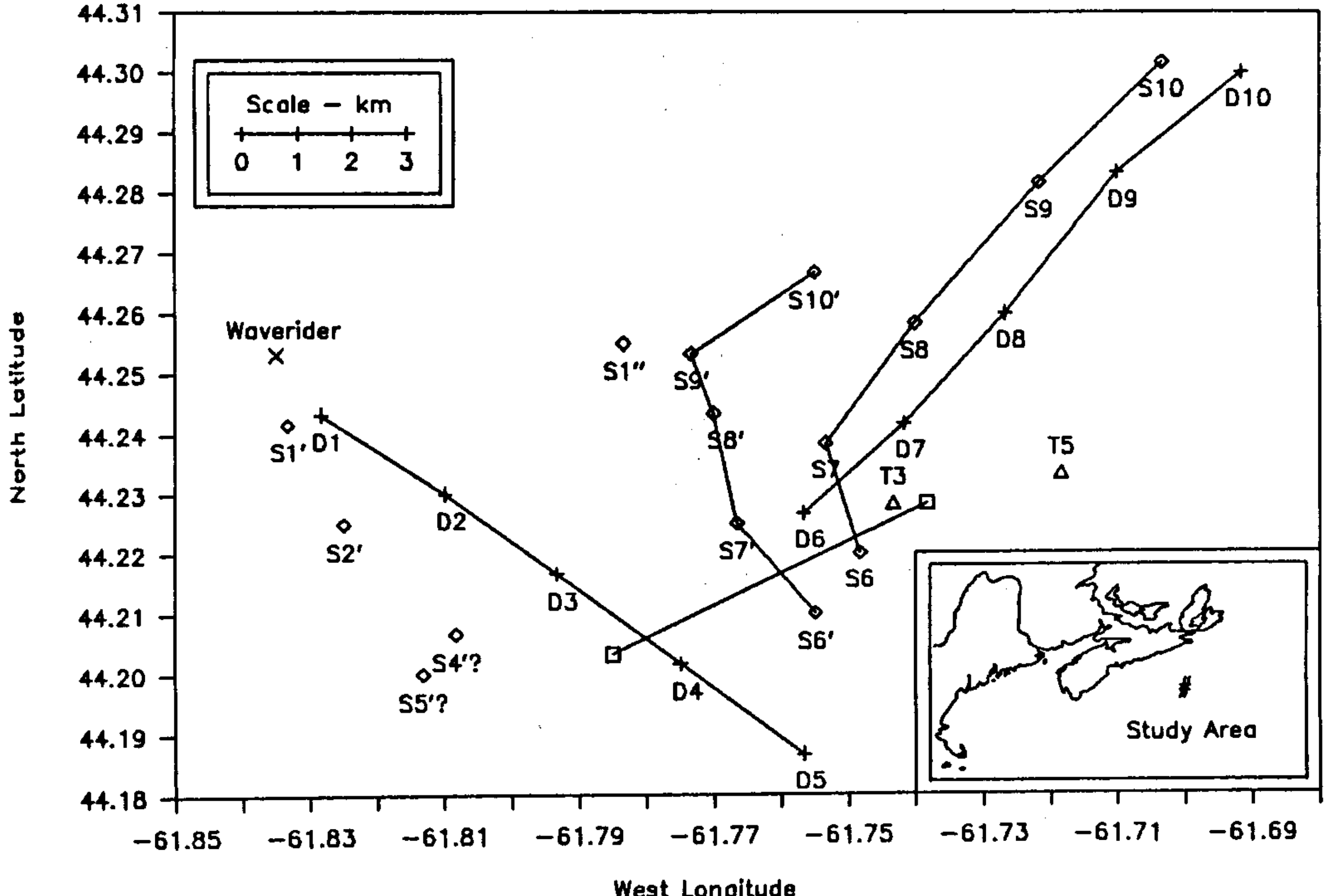
The slick laying and sampling routine followed on 10 September for the Elastol trials was different in that the slicks were treated and sampled directly from the Mary Hichens rather than from the sample boats. Thus slicks D5 through D10 simultaneously were laid and treated in quick succession over a period of about 1.5 hours. The Mary Hichens then proceeded to the site of D6 and the first sample was taken two hours after the time of treatment. Within the next hour the remaining four slicks were sampled and these are indicated on the figure as Sn. Six hours after the D6 was laid, it was sampled again followed by slicks D7 and D8. The positions where this second set of samples were taken in indicated by the track marked Sn'. It was necessary to delay collection of samples from the sites of slicks D9 and D10 by one hour since increasingly high seas made it necessary to recover the waverider buoy.

The track (S6' to S10') along which the second set of samples was collected warrants careful inspection as it may indicate that correct identification of all the samples was not made. For example, samples S8' and S9' may represent the same slick and sample S10' appears to be quite far to the southwest of the slick's original position. The interpretation of the information presented in figure 3.1 should be aided by considering the drift path of the control buoys over the period of the trials (section 3.3).

After the last samples for the Elastol trial were collected, the field trials were at an end. The rough seas were rapidly dispersing the what was left of the slicks and no attempt to recover the oil could be considered.

Figure 3.1 Site plan

Elastol and Demoussifier Field Testing



□ Control Buoys △ Tracker buoys

3.2 Meteorological/oceanographic conditions

Meterological observations (wind speed and direction, temperature, sea state) were taken at regular intervals by the watch keeper on the bridge of the Mary Hichens. These data for the period of the trials are summarized along with sample collection and analysis data in Appendix E.

Wave height and frequency data were also collected by the waverider buoy. The processed data appears in figure 3.2, table 3.1 and Appendix C. It is evident from a quick examination of the significant wave height and maximum heave records (figure 3.2) that the energy of the surface waves increased dramatically between the time the trials began on the morning of 9 Sept. and the evening of 10 Sept. The significant wave height was smaller by a factor of three at the time of the demulsifier trials (ca. 0.5 m) than it was during the Elastol trials (2.5 m).

A better estimate of the wave energy available for mixing can be made through analysis of the energy density spectra presented in Appendix C. Energy transfer from the waves to the slick most likely occurs through the action of breaking waves which are generated by the higher frequency, wind driven waves. The spectra in Appendix C show a bimodal distribution of energy; the lower group of frequencies represent the long period swell and the higher frequencies are the wind driven waves which quite obviously grew in intensity as the trials progressed. It is the latter group which best represent that portion of the wave energy which would be effective in mixing the treating agents with the oil in the slicks. To extract a rough quantitative estimate of this energy, the energy density was integrated over a frequency range of 0.15 to 0.3 Hz to give a value proportional to the square of the significant wave height. The energy available is given by:

$$E = \frac{pgH^2}{8} \qquad (1)$$

where p is the density, g the acceleration of gravity, and H the wave height. It is sufficient for the purpose of comparing wave energies at

Figure 3.2 Processed waverider data

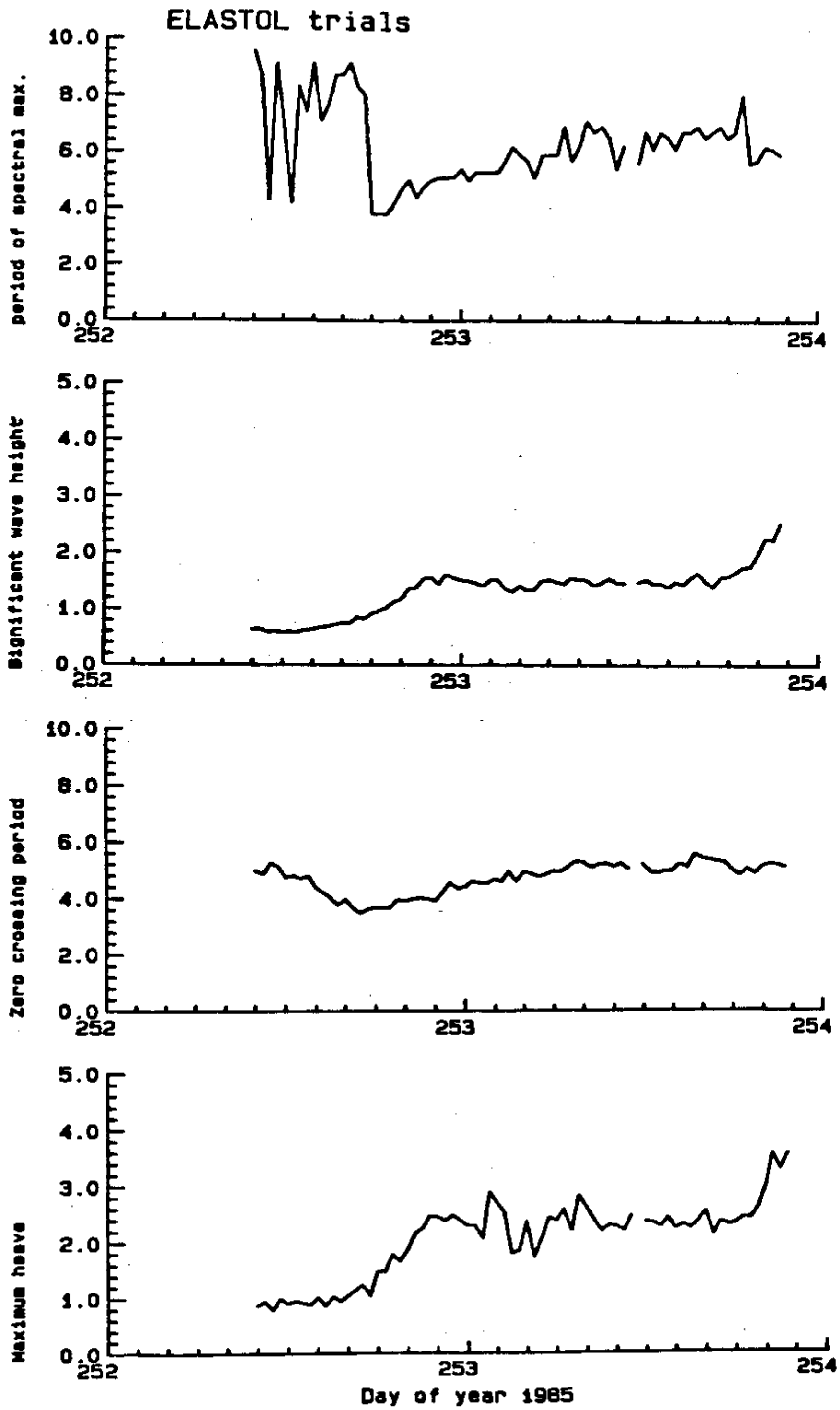


Table 3.1 Relative wave energy

Day/Time		Relative wave energy
09/09/88	1400	1.0
	1800	2.2
	2200	7.7
10/09/88	0400	4.7
	0800	7.0
	1600	6.7

different times during our experiment to allow that the energy is proportional to the square of the wave height. As table 3.1 shows, the relative wave energy increased by a factor of seven over the period of the trials.

3.3 Control buoy movements

§Data not yet available from L. Hannon of MMS.†

3.4 Physical behaviour of slicks

As was discussed in section 3.1, the period over which the trials were run was characterized by high wave energy and this tended to disperse the test slicks only a relatively short time after they were laid. While the long-term effects of the treating agents can not be assessed from the data collected during this study, observations were made on the physical behaviour of the slicks over a four to six hour period after the treatment agents were applied:

- Formation of water-in-oil emulsions appeared to be inhibited in the treated slicks compared to the control slick and the slick treated at the four-hour time period;

- direct application of the demulsifier to patches of mousse in the untreated slicks had the immediate effect of breaking up the emulsion (10-15 seconds);

- mousse in areas of the slick not directly sprayed appeared to break up when the agent migrated from sprayed areas (ca. 10 minutes);

- Elastol had the desired effect of increasing the viscoelasticity of the oil (as measured in the laboratory on board the ship - section 3.4) but due to the high mixing energy present at the surface, did not result in a particularly cohesive slick;

- The means in which the agents were applied did not seem to particularly critical, i.e. if the agents were applied in a non-uniform manner, they appeared to migrate to all portions of the slick through the mixing action of the waves.

3.5 Physico/chemical properties of treated oil

Oil samples taken from the slicks were processed as soon as possible on board the Mary Hichens where the following determinations were made: water content (spectrophotometry), viscosity (Brookfield), and elasticity (die swell). Subsamples were taken from each sample and returned to Seakem's laboratory for analysis by gas chromatography (GC-FID) in order to determine the extent of weathering oil had experienced.

The data obtained aboard the shipboard laboratory are given in two tables and two figures in Appendix E. Elastol was found to impart as much or greater elasticity to the oil as was found in laboratory tests (Bobra et al. 1987). The high mixing energy available during the field trials are probably responsible for the high level of performance of Elastol. Viscosity measurements also were in the expected range, showing a large increase vs. dose for the Elastol-treated oil while the demulsifier demonstrated the tendency to decrease the viscosity of the treated oil. Water content measurements were also made in the case of the samples taken during the demulsifier trials, but this quantity did not correlate well with the presence of water-in-oil emulsions in the samples. All slicks had a high water content (78-90%) regardless of the amount of mousse observed.

Figure 3.3 and table 3.1 are summarized GC-FID data (chromatograms for each sample can be found in Appendix B). The amount of weathering undergone by the oil was estimated by integrating the area under the peaks in the area of C7 to C14 in the GC chromatograms. These areas have been normalized to the same quantity determined for the original oils. As is obvious from an examination of these data, the oils progressively lost light hydrocarbons over the 4 to 6 hour period they were on the surface. In the case of the emulsifying mixture, the effect was less severe, as would be expected from its content of relatively heavy bunker A.

Figure 3.3 Weathering by GC-FID

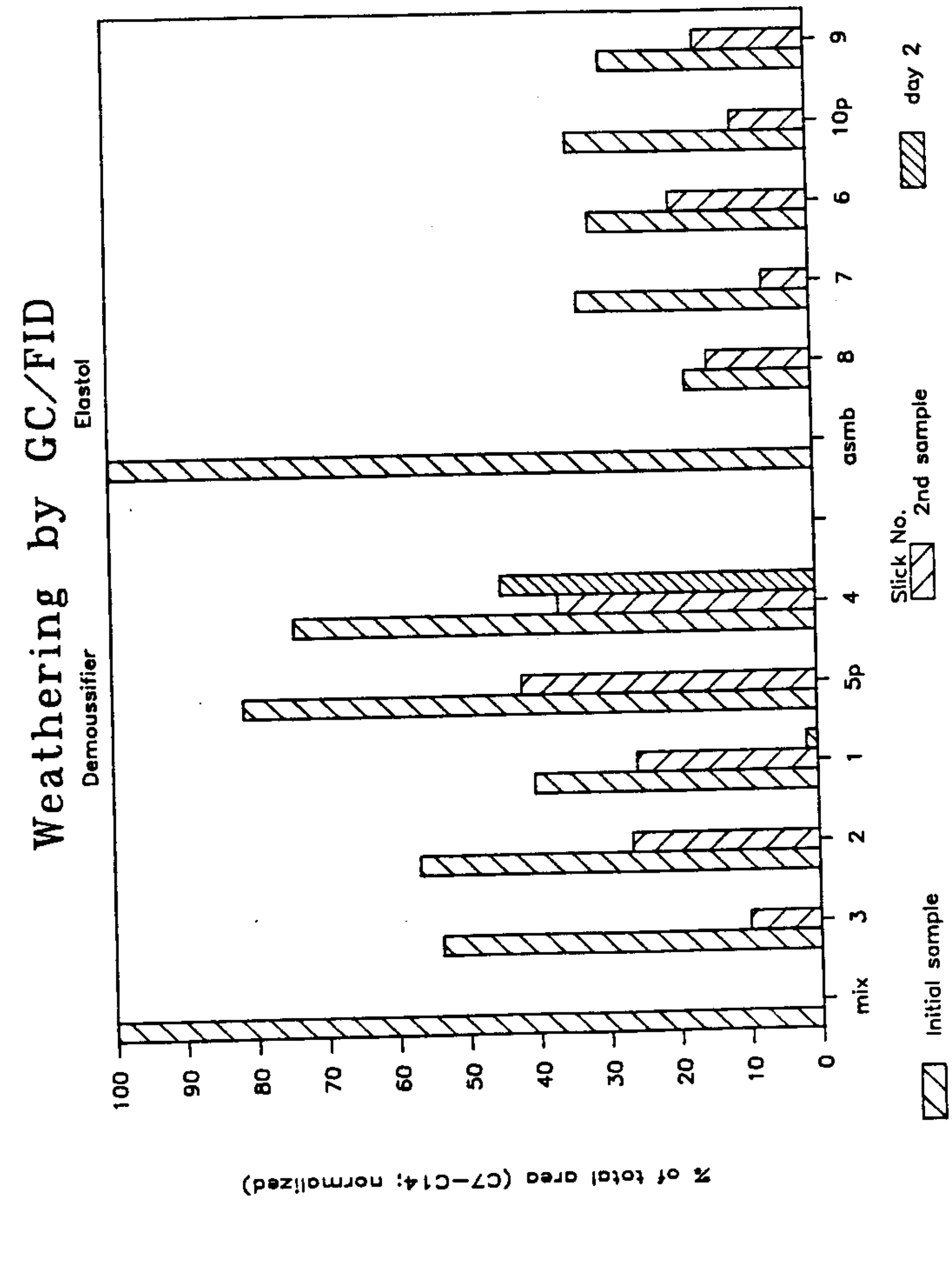


Figure 3.4 Weathering vs. demulsifier concentration

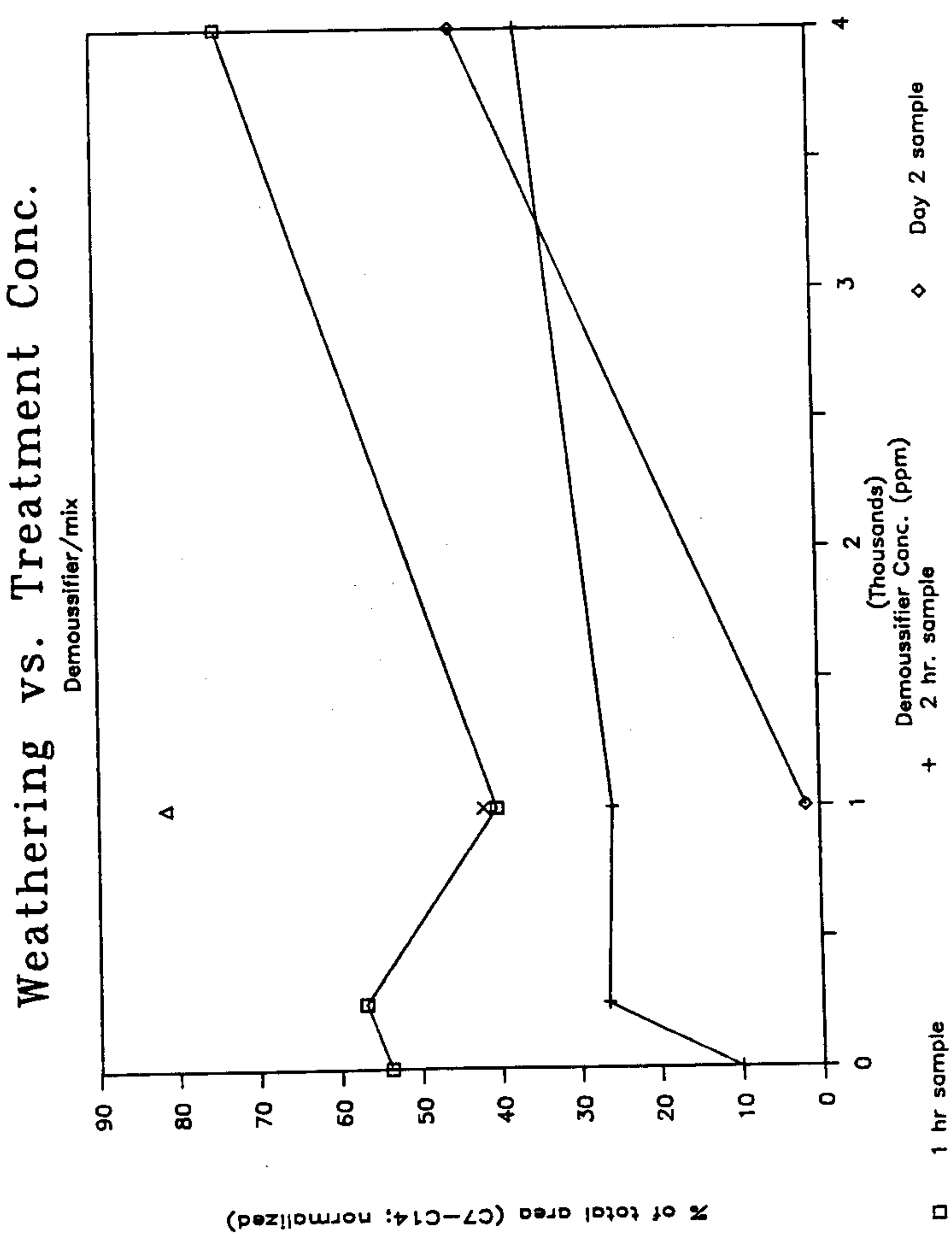


Figure 3.5 Weathering vs. Elastol concentration

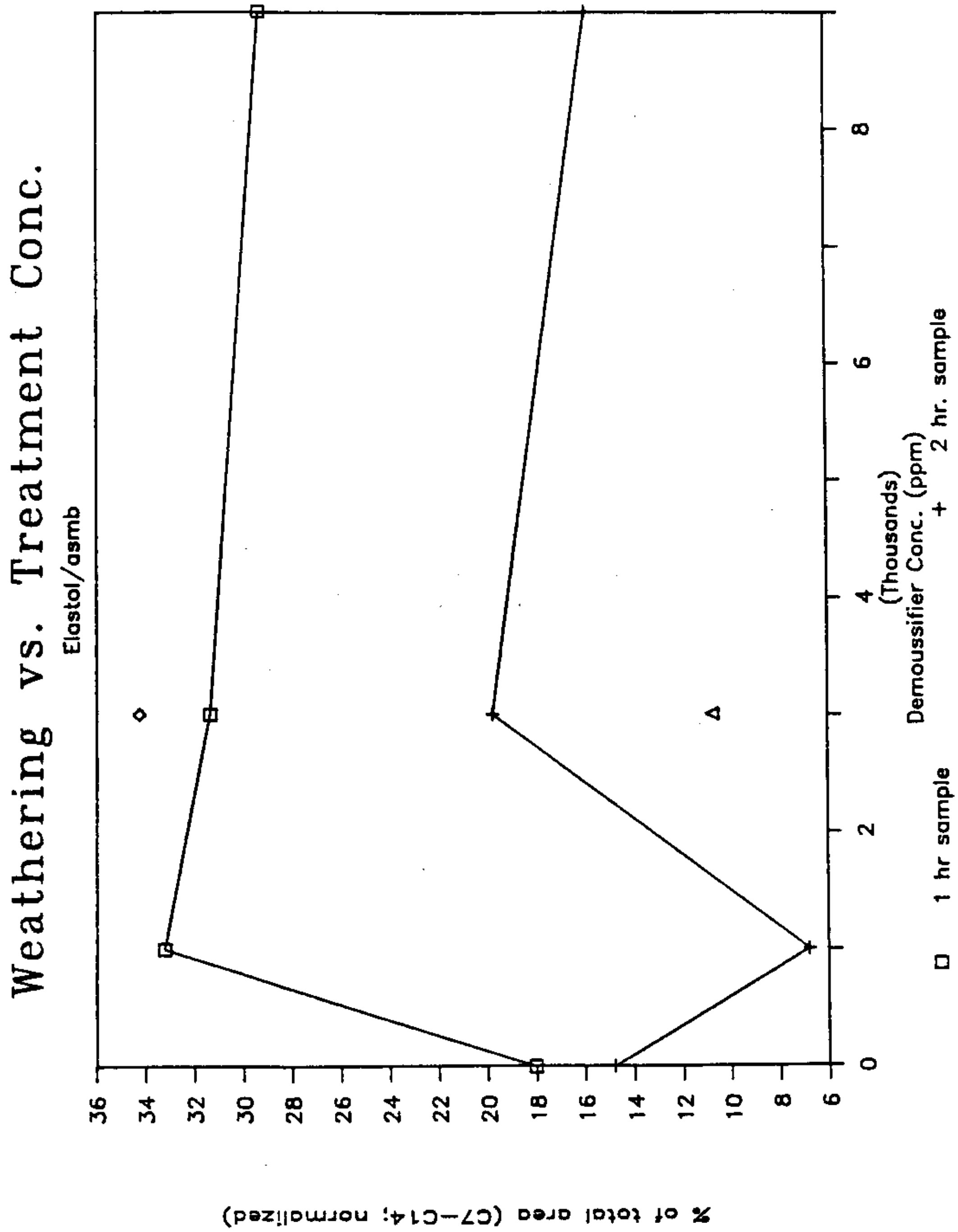


Table 3.1 Weathering by GC/FID

C7 - C14 (% of total area)					Normalized		
Brand M Demulsifier							
Treatment Conc (ppm)	Slick	Initial	2nd	3rd	Initial	2nd	3rd
-	mix	35.7	-	-	100.0	-	-
0	3	19.2	3.6	-	53.8	10.1	-
250	2	20.3	9.5	-	56.9	26.6	-
1000	1	14.4	9.2	0.6*	40.3	25.8	1.7
1000	5p	29.1	15.0	-	81.5	42.0	-
4000	4	26.5	13.1	16.0	74.2	36.7	44.8
ELASTOL							
-	asco	58.7	-	-	100.0	-	-
0	8	10.6	8.7	-	18.1	14.8	-
1000	7	19.5	4.0	-	33.2	6.8	-
3000	6	18.4	11.6	-	31.3	19.8	-
3000	10p	20.1	6.3	-	34.2	10.7	-
9000	9	17.2	9.3	-	29.3	15.8	-

* Sampled 10 September, Day 2

When the degree of weathering is plotted against the concentration of agent used in treating the slick for the demulsifier trial (figure 3.4), a very weak tendency for weathering to be inhibited with increasing treatment concentration might be discernible. The samples pretreated at 1000 ppm (indicated by the diamond-1st sample, and the triangle-2nd sample) are distinctly less weathered, however.

The same plot for the Elastol trial (figure 3.5) shows a similar trend, i.e. the slicks with the higher treatment concentrations show decreased weathering. While the first sample (diamond) from the slick pre-treated at 3000 ppm shows less weathering and is consistent with the trend noted above for the demulsifier, the second sample (triangle) is distinctly more weathered.

However, as was noted in section 3.1, there may be some confusion as to the identity of these samples (S6' - S10'). Indeed, if samples S8' (control) and S9' (9000 ppm) are representative of the same slick (e.g. slick 9) the first point on the line indicated by "+" on figure 3.5 would be moved to 9000 ppm on the x-axis which appears to be a more consistent interpretation of the data. Again, the correct identity of the samples may be aided by an analysis of the surface current regime at the time of our sampling exercise.

One other interesting feature of the GC data is the chromatogram for the sample purported to be the 24 sample from slick 1 of the demulsifier trial (Appendix B). This chromatogram shows that this sample is the most weathered of any that was collected, which might be expected as a result of a long (24 hr) exposure time. However, the large unresolved envelope may be indicative of oil from another source as a component of the sample. This sample also had an anomolously high viscosity (592,000 cp).

3.6 Remote sensing

Overflights by Falcon Fan-Jet aircraft operated by the Canada Centre for Remote Sensing were to be used to collect data on slick positions by IR/UV scanning. Unfortunately, bad weather conditions severely curtailed the planned schedule of flights. On the flights that did take place, visibility conditions were such that no oil was detected in the area of the trials.

Flight data to com.

4.0 CONCLUSIONS

Several conclusions can be made concerning the performance of the spill treating agents Elastol and Brand M demulsifier during the field trials. The most important of these are:

- Both agents did what they had been demonstrated to do in smaller scale tests; in the case of Elastol - increase the viscoelasticity and in the case of the demulsifier -break up water-in-oil emulsions.

- It is advantageous and economical that both agents work at quite low concentrations when compared to traditional spill treating agents such as dispersants.

- A potential problem that could have arisen from trying to uniformly distribute a small dose of agent over a large slick did not materialize. The agents apparently are distributed more or less uniformly throughout the slick when applied initially to only a small area. Application of these agents by aircraft may thus be feasible.

5.0 REFERENCES

Bobra, M.A., P.I. Kawamura, M. Fingas and D. Velicogna. 1987. Laboratory and tank test evaluation of Elastol. Proceedings of the tenth Arctic Marine Oilspill Program Technical Seminar, Edmonton, Alta., June 9-11, 1987, pp. 223-241.

Bobra, M.A., P.I. Kawamura, M. Fingas and D. Velicogna. 1987. Mesoscale application and testing of an oil spill demulsifying agent and Elastol. Preprint prepared for U.S. Minerals Management Service, September, 1987.

National Research Council. 1985. Oil In the Sea: Inputs, Fates and Effects, National Academy Press, Washington, D.C., pp. 279, 281.

Waters, P. and A.F. Haderman. 1987. The efficiency of elastomers in oil spill cleanup. 1987 Oil Spill Conference, Los Angeles, CA, 1987, pp. 231-233.

APPENDIX A - FIELD NOTES

Tuesday, 08 Sept 1987

0800 ADT CCGS Mary Hichens secured at Mulgrave dock; loading Equipment for field trial.

2000 All clear Mulgrave Dock.

Wednesday, 09 Sept 1987

0640 Deployed waverider buoy;
44°15.2'N 61°50.1'W; l/c 13768.8 29350.4;
Depth 152 m.

0700 Sample boats 1 & 2 in water; conduct trial exercise with dye.

0732 Sample boats onboard.

0850 Sample boats away.

0909 Discharging slick #1;
44°14.6'N 61°49.7'W; l/c 13765.9 29345.9;
tracking buoy #1 in water.

0924 Discharging slick #2;
44°13.8'N 61°48.6'W; l/c 13761.3 29337.0

0939 Discharging slick #3;
44°13.0'N 61°47.6'W; l/c 13756.9 29328.0;
tracking buoy #3 in water.

0955 Dropped six control buoys;
44°12.2'N 61'47.1'.

1024 Slick #2 sampled; bt. #2 same pos'n. as 0924 ADT.

1105 Slick #1 sampled; bt. #1 same pos'n. as 0909 ADT.

1125 Slick #3 sampled; bt. #1 same pos'n. as 0939 ADT.

1126 Discharging slick #4;
44°12.1'N 61°46.5'W; l/c 13752.2 29319.1;
slick not treated.

1140 Slick #4 sampled; bts. #1&2 same pos'n. as 1126 ADT.

1141 Discharging pretreated slick #5;
44°11.2'N 61°45.4'W; l/c 13747.8 29310.5;
tracking buoy #4 in water.

1155 Slick #5 sampled; bt. #1 same pos'n. as 1141 ADT.

1217 Sample Boats on board.

1408 Sample Boats away; slick #1 pos'n.

1420 Slicks #1 and #2 sampled;
slick 1, bt. #1: 44°14.2'N 61°50.0'W; l/c 13762 29345;
slick 2, bt. #2: 44°13.5'N 61°49.5'W; l/c 13757 29341.

1425 Boat #2 delivers slick #2 sample.

1435 Boat #1 delivers slick #1 sample.

1500 Slick #3 sampled; bt. #1: pos'n?

1508 Boats & ship to slick #3.

1522 Boats & ship to slick #4.

1531 Slick #4 sampled then treated;
44°12.2'N 61°48.2'W; l/c 13750 29332.

1606 Slick #4 sampled - post treatment; same pos'n as 1531 ADT.

1612 Boats & ship to slick #5.

1615 Slick #5 sampled;
44°12.0'N 61°48.8'W; l/c 13748 29334.

1648 Boats on board and samples delivered.

<u>Thursday, 10 September 1987</u>

0915 Sample slick #1 from Mary Hichens;
44°15.3'N 61°47.0'W

1047 Alongside tracker buoy #3;
44°13.7'N 61°44.6'W; no slick.

1050 Sighted 3 control buoys;
44°13.7'N 61°44.3'W; no slick.

1101 Alongside tracker buoy #4;
44°14.0'N 61°43.1'W; no slick.

1248 Discharging slick #6;
44°13.5'N 61°45.4'W; l/c 13758, 29309.

1249 Tracker buoy #4 away.

1253 Completed discharge, slick #6;
l/c 13759, 29307.

1306 Discharging slick #7;
44°14.5'N 61°44.5'W; l/c 13764, 29303.

1311 Completed discharge, slick #7;
l/c 13765, 29301.

1323 Discharging slick #8;
44°15.6'N 61°43.6'W; l/c 13771, 29297.

1325 Tracker buoy #5 away;
l/c 13772, 29296.

1327 Completed discharge, slick #8.

1348 Discharging slick #9;
44°17.0'N 61°42.6'W; l/c 13779, 29290.

1359 Completed discharge, slick #9;
l/c 13780, 29289.

1414 Discharging slick #10;
44°18.0'N 61°41.5'W; l/c 13785, 29283.

1416 Tracker buoy away.

1500 Slick #6 sampled from Mary Hichens;
44°13.2'N 61°44.9'W; l/c 13756, 29304.

1527 Slick #7 sampled from Mary Hichens;
44°14.3'N 61°45.2'W; l/c 13763, 29308.

1537 Slick #8 sampled from Mary Hichens;
44°15.5'N 61°44.4'W; l/c 13770, 29304.

1548 Slick #9 sampled from Mary Hichens;
44°16.9'N 61°43.3'W; l/c 13778, 29294.

1603 Slick #10 sampled from Mary Hichens;
44°18.1'N 61°42.2'W; l/c 13785, 29287.

1715 Slick #6 sampled from Mary Hichens; 44°12.6'N 61°45.3'W; l/c 13753, 29313.

1800 Slick #7 sampled from Mary Hichens; 44°13.5'N 61°46.6'W; l/c 13758, 29319.

1815 Slick #8 sampled from Mary Hichens; 44°14.6'N 61°46.2'W.

1840 Recovered waverider buoy.

1851 Recovered subsurface buoy; abandoned mooring due to heavy weather.

1915 Slick #9 sampled from Mary Hichens; 44°15.2'N 61°46.4'W.

1926 Slick #10 sampled from Mary Hichens; 44°16.0'N 61°45.3'W.

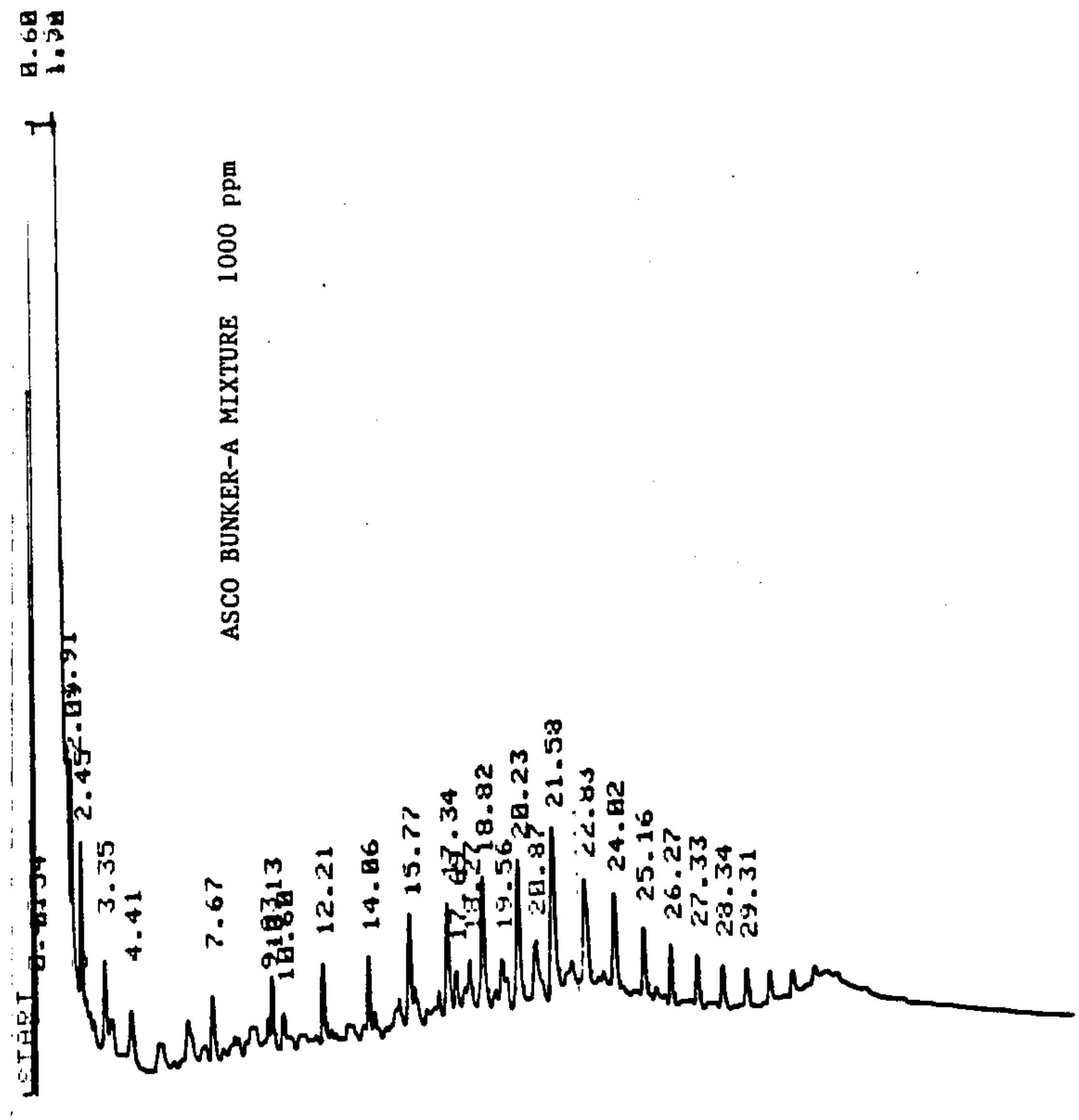
1935 Proceeding to Mulgrave due to heavy sea.

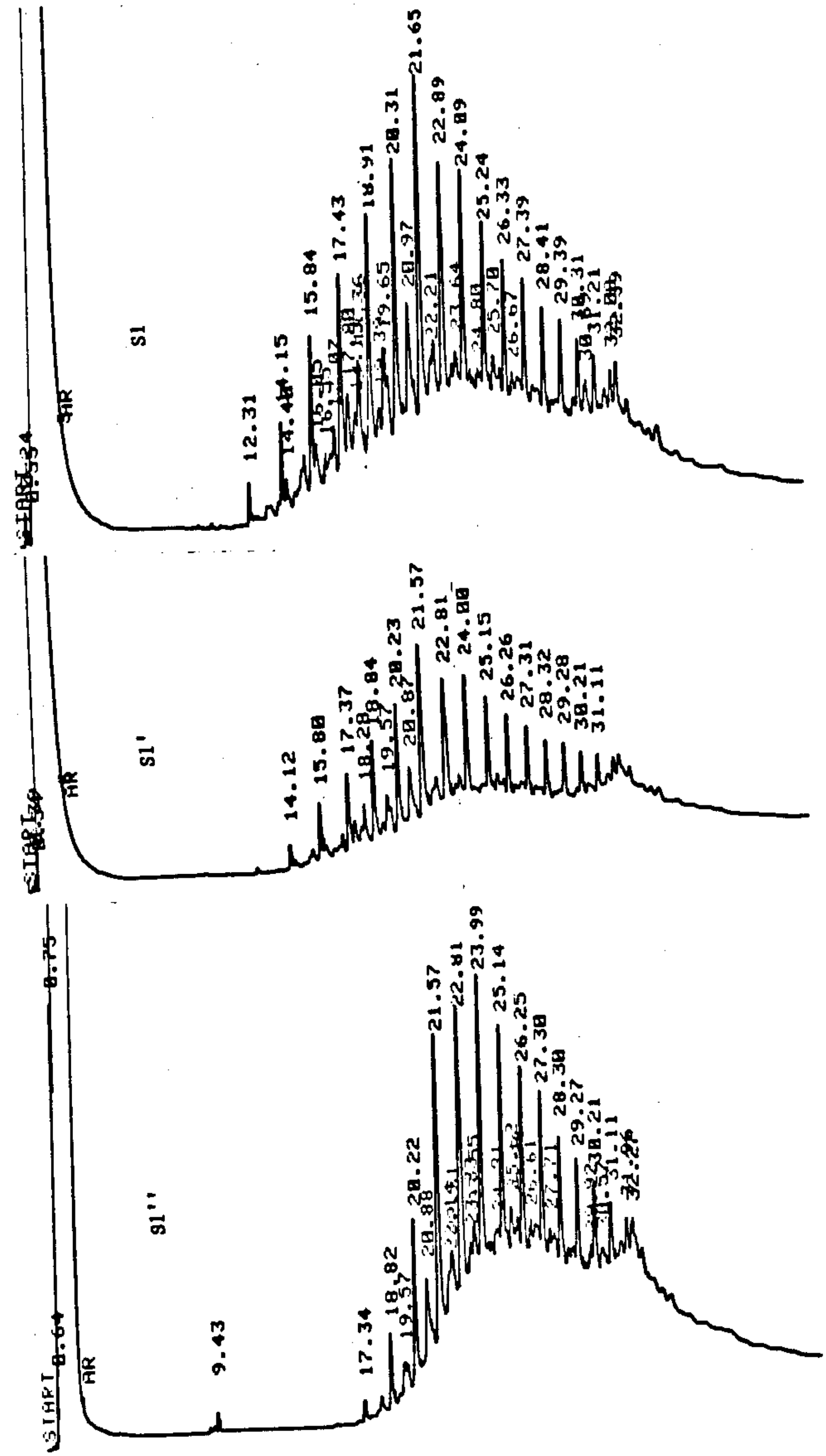
Friday, 11 September 1987

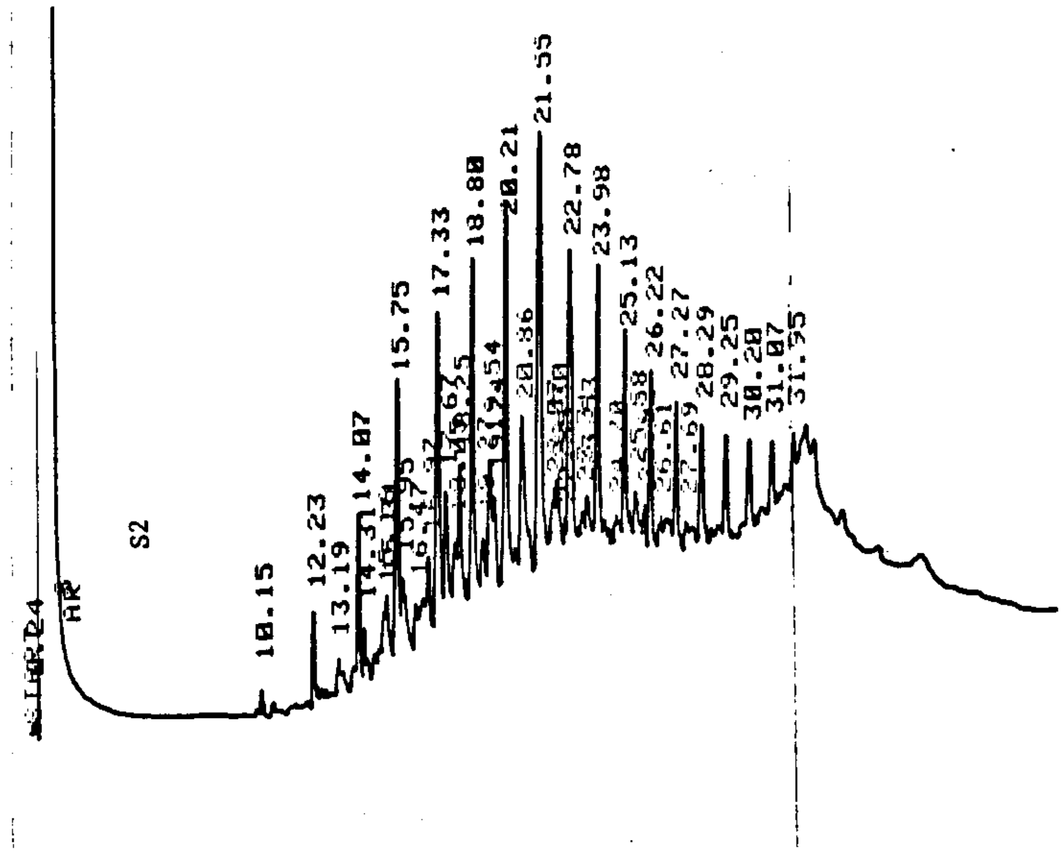
0646 Secured alongside Mulgrave dock.

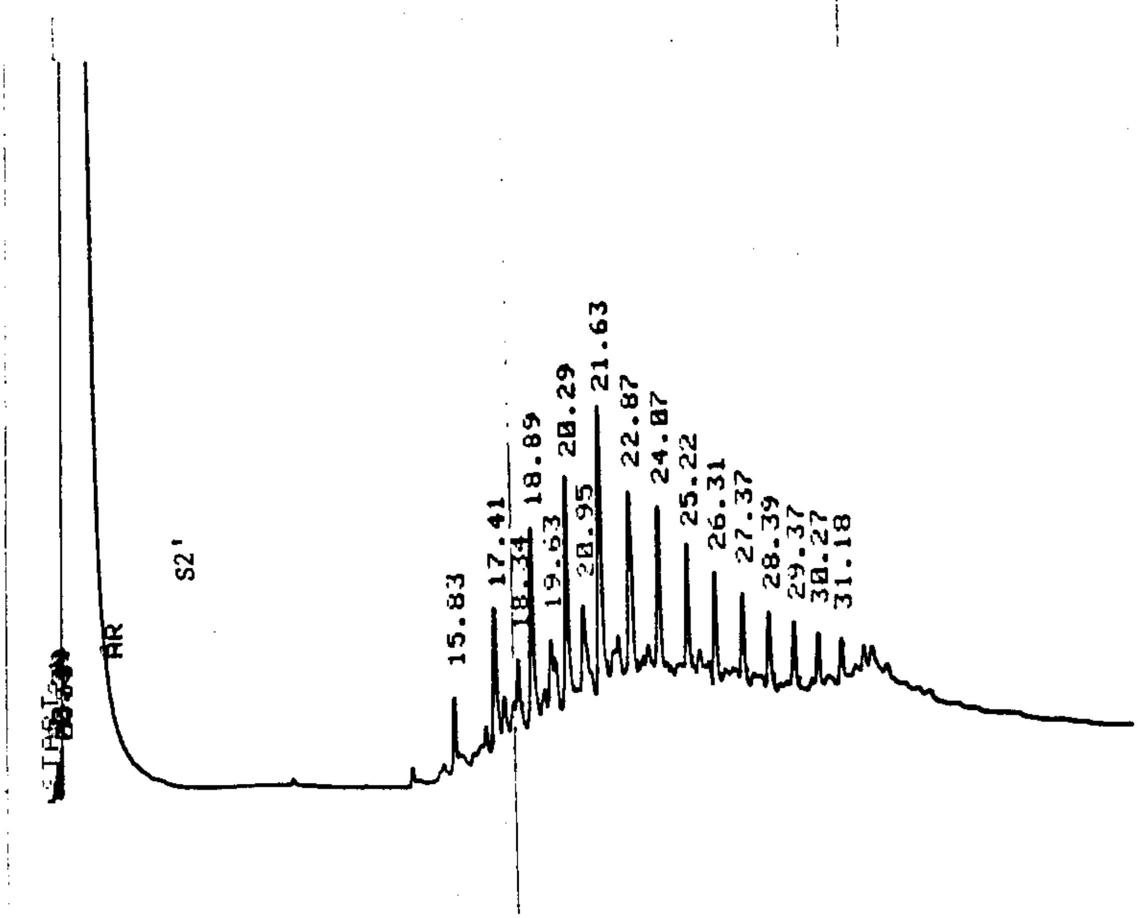
APPENDIX B - GC CHROMATOGRAMS OF SLICK SAMPLES

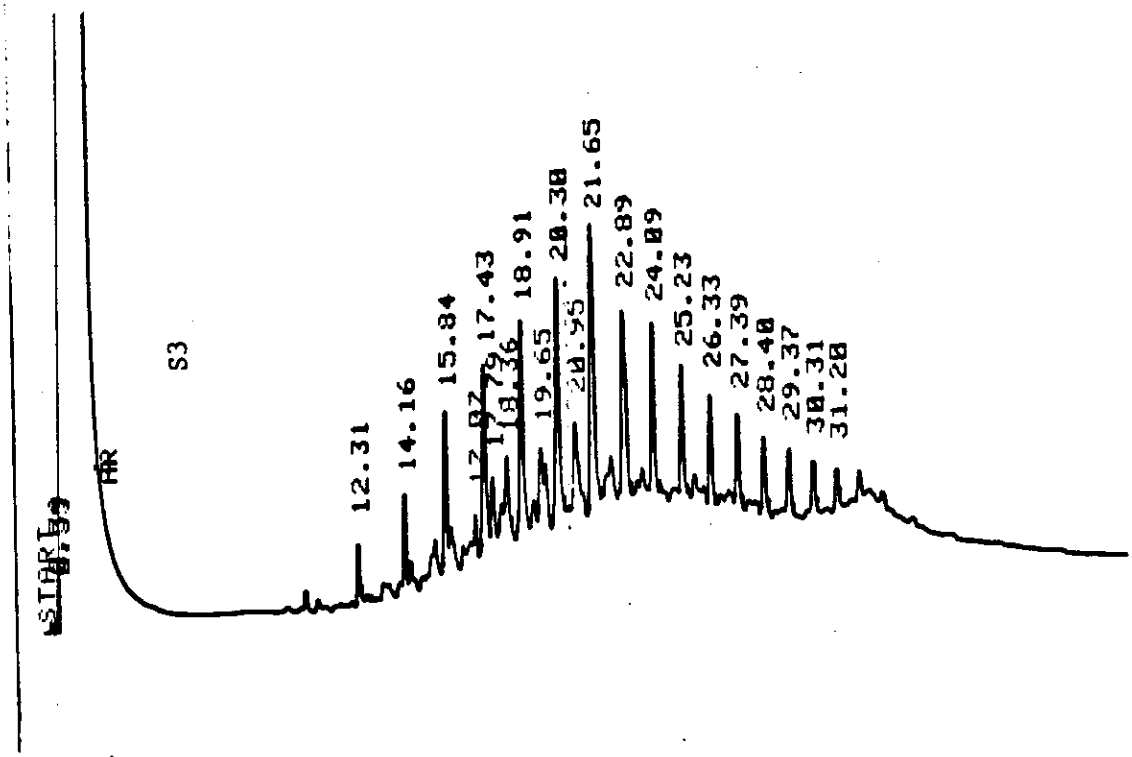
DEMULSIFIER TRIAL

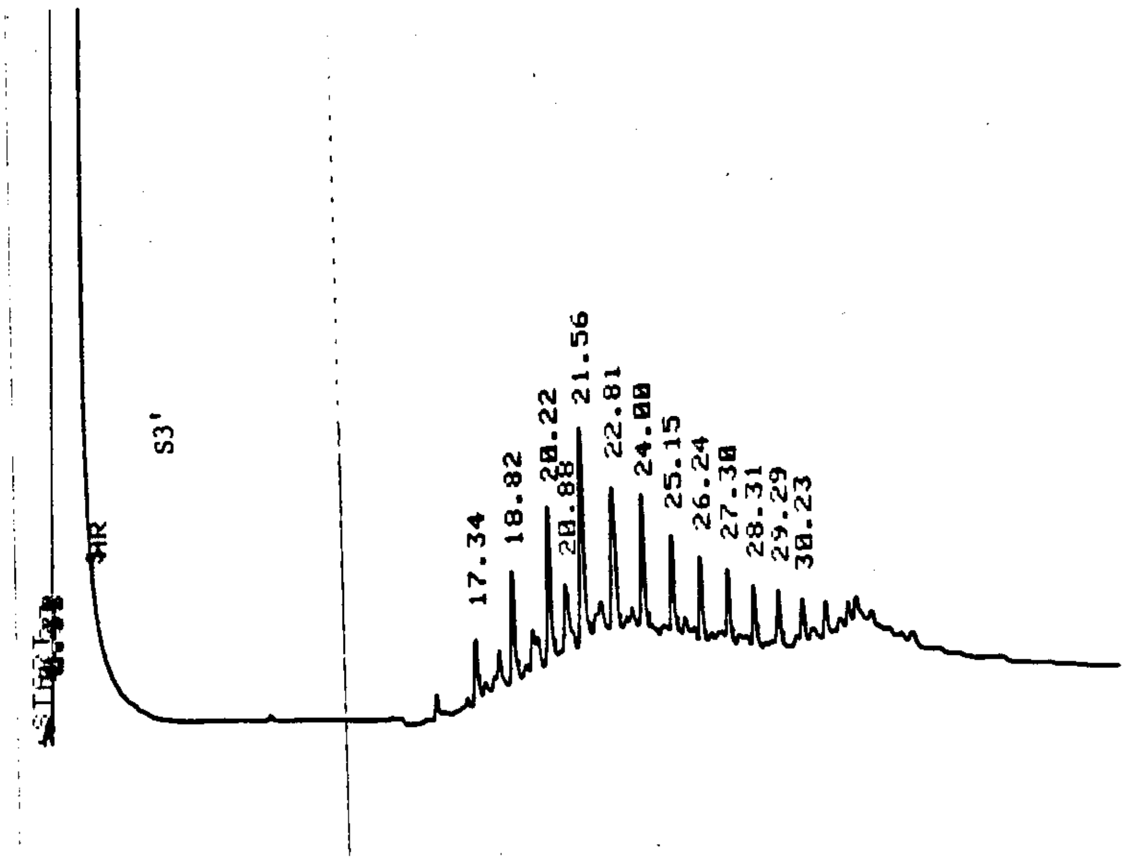


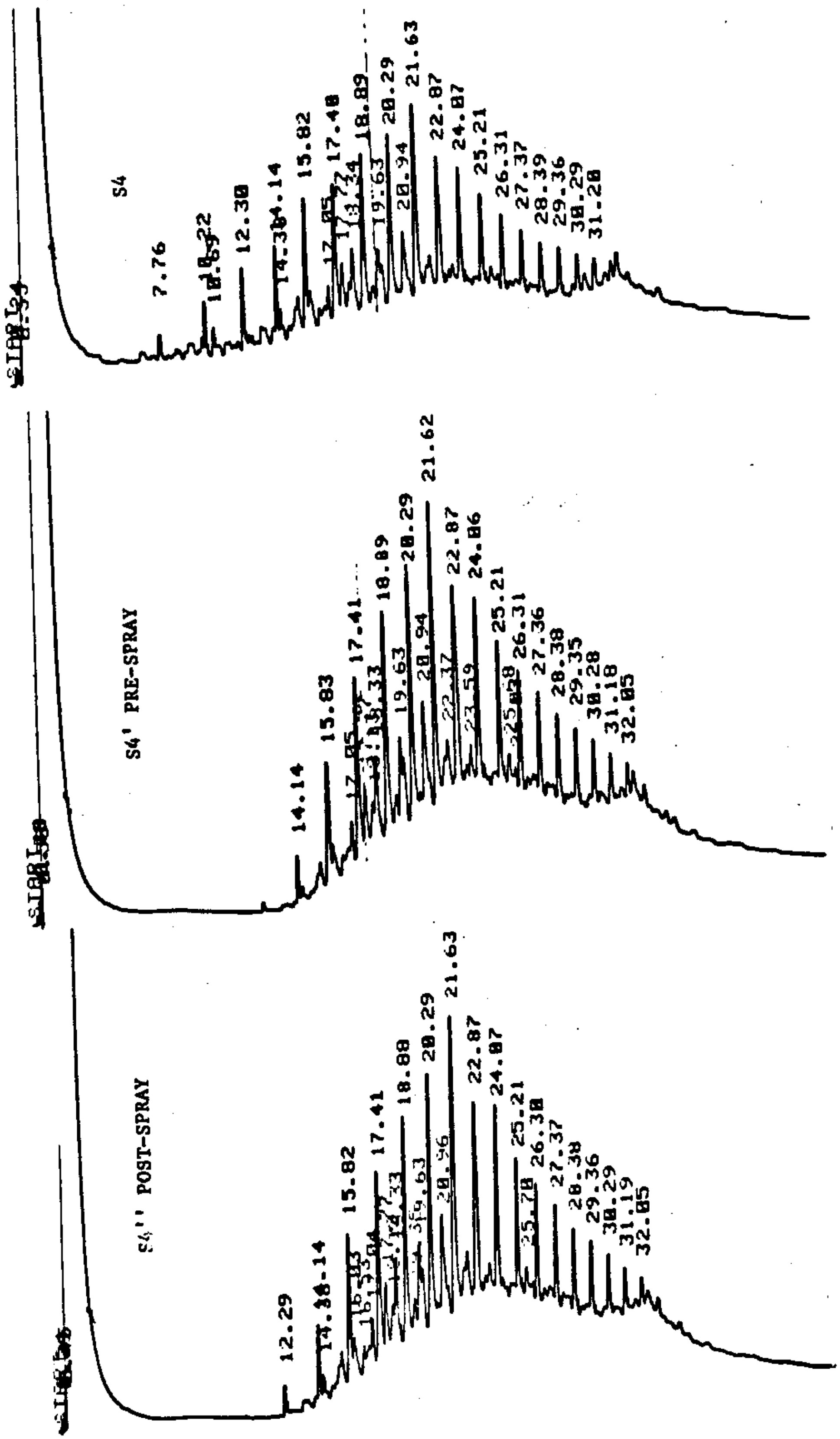

S1
START
AR
12.31
14.15
15.84
17.43
18.91
20.31
21.65
22.89
24.89
25.24
26.33
27.39
28.41
29.39
S1'
START
AR
14.12
15.80
17.37
18.84
20.23
21.57
22.81
24.00
25.15
26.26
27.31
28.32
29.28
30.21
31.11
S1''
START
AR
8.64
8.75
9.43
17.34
18.82
19.57
20.88
20.22
21.57
22.81
23.99
25.14
26.25
27.30
28.30
29.27
30.21
31.11

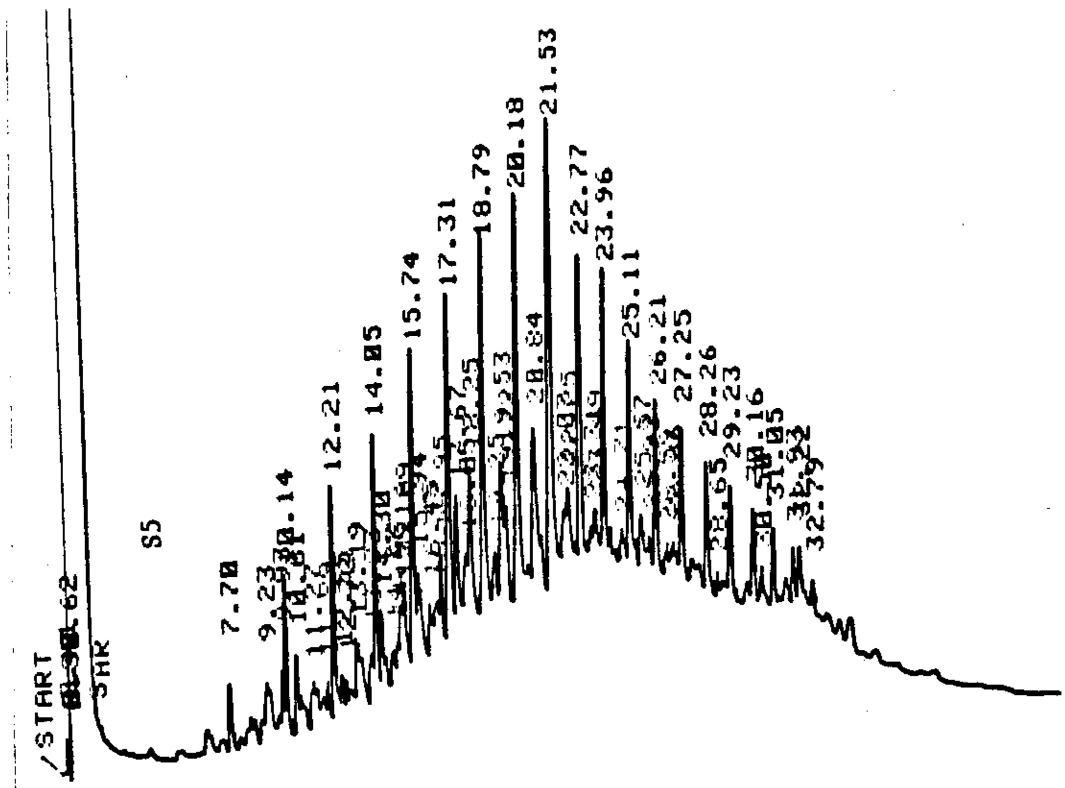

S2
10.15
12.23
13.19
14.07
15.75
17.33
18.80
20.21
20.86
21.55
22.78
23.98
25.13
26.22
27.27
28.29
29.25
30.20
31.07
31.35

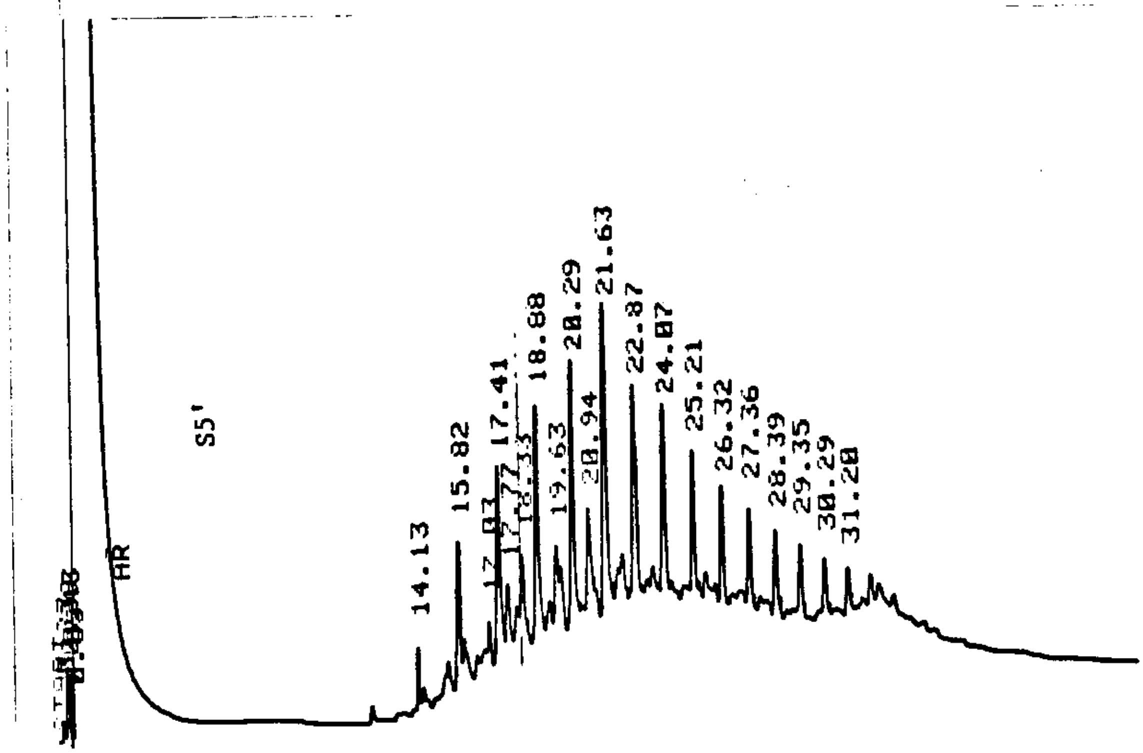

S2'
15.83
17.41
18.34
18.89
19.63
20.29
20.95
21.63
22.87
24.07
25.22
26.31
27.37
28.39
29.37
30.27
31.18


S3
HR
12.31
14.16
15.84
17.43
18.91
19.65
21.65
22.89
25.23
26.33
27.39
29.37
31.28

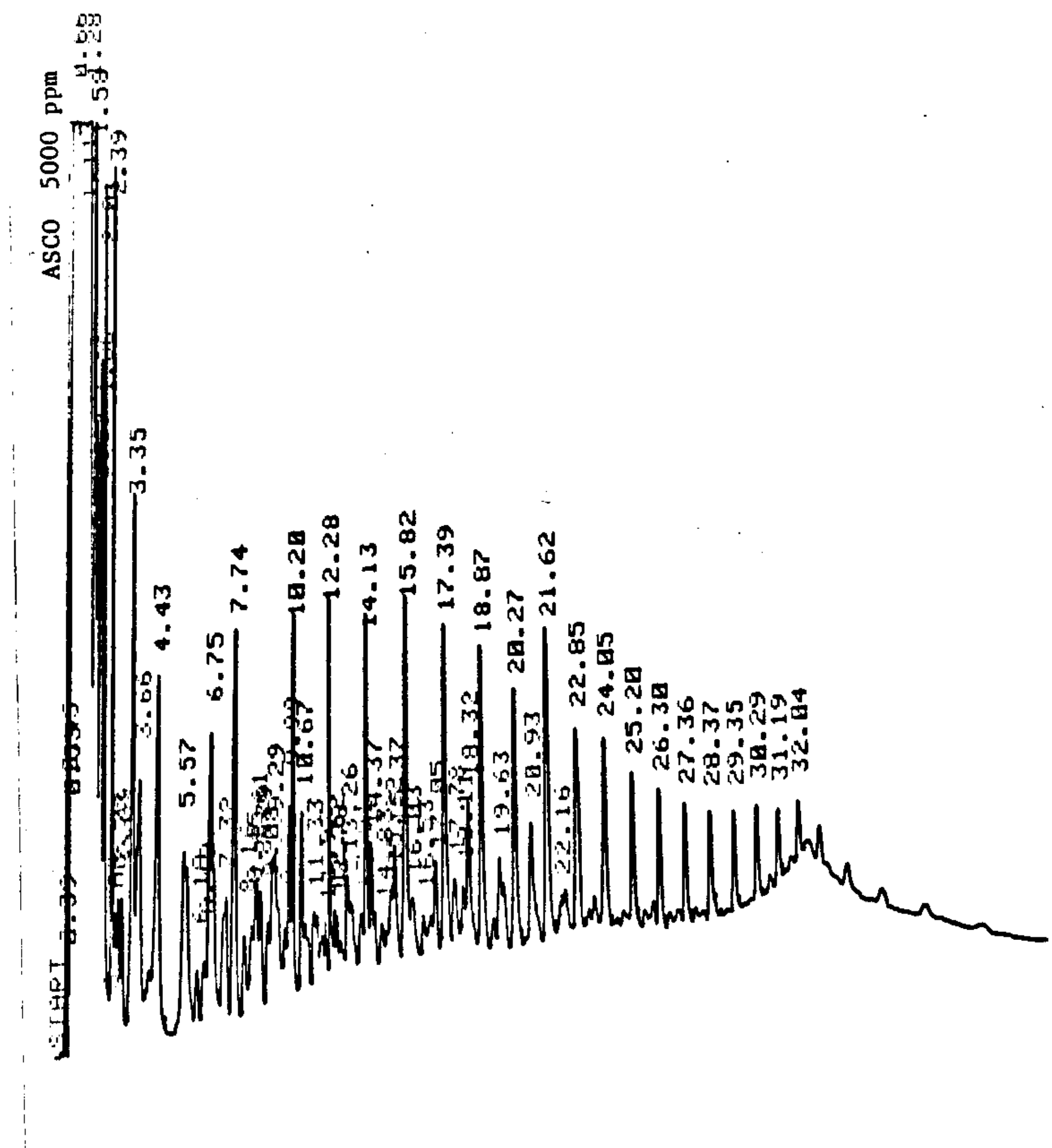

S3'
HR
17.34
18.82
21.56
22.81
25.15
26.24
28.31
29.29

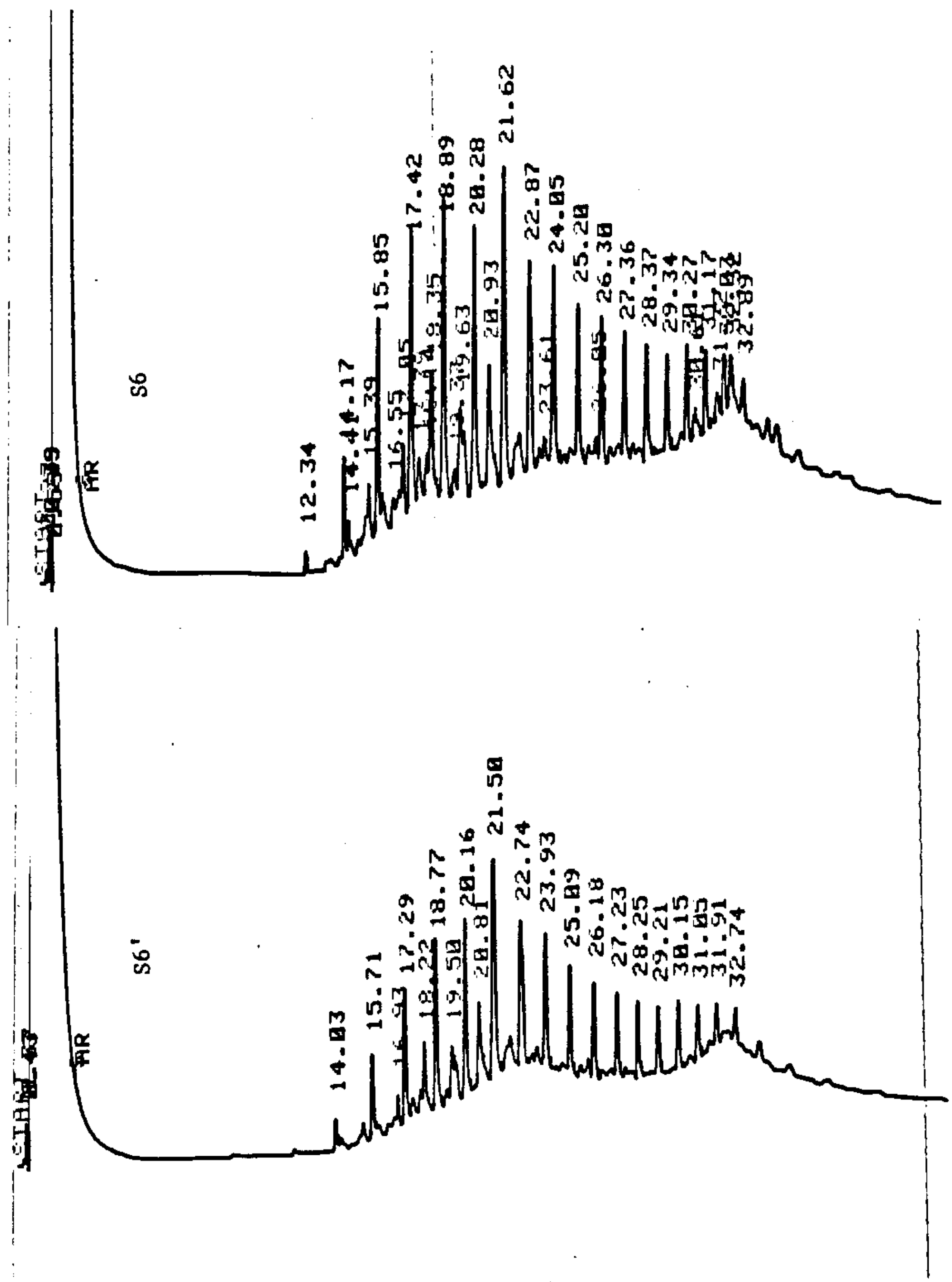

S4
7.76
12.30
14.14
15.82
17.48
18.89
20.29
20.94
21.63
22.87
24.87
25.21
26.31
27.37
28.39
29.36
30.29
31.20
S4' PRE-SPRAY
14.14
15.83
17.41
18.89
19.63
20.29
20.94
21.62
22.87
24.86
25.21
26.31
27.36
28.38
29.35
30.28
31.18
32.85
S4'' POST-SPRAY
12.29
15.82
17.41
18.88
20.29
21.63
22.87
24.87
25.21
26.30
27.37
28.38
29.36
30.29
31.19
32.85

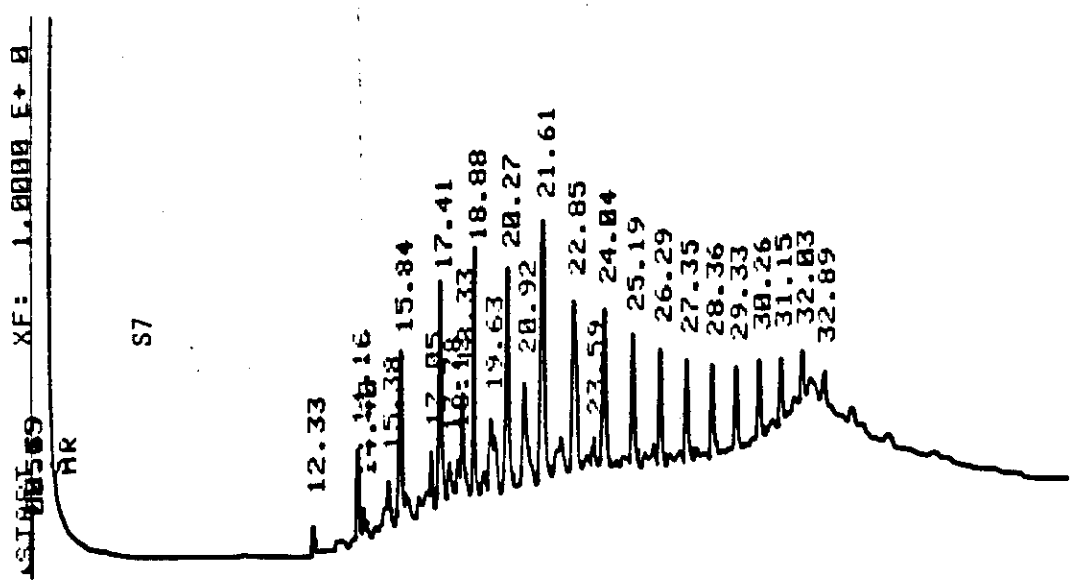

S5

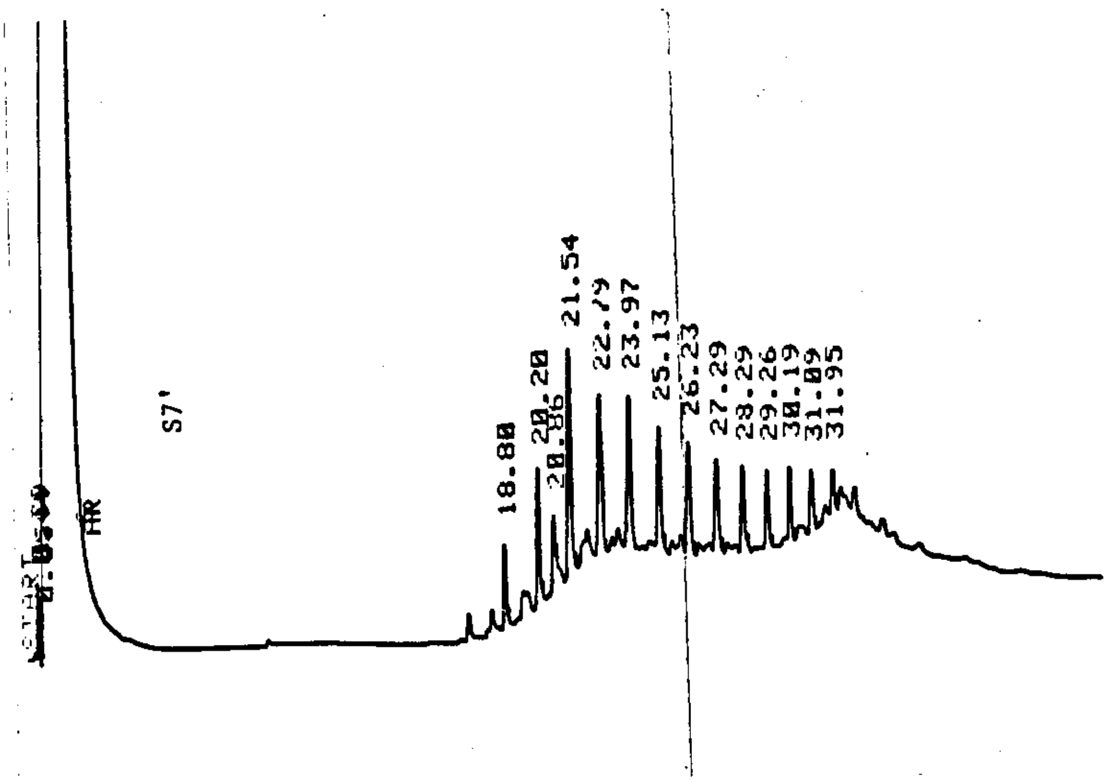

S5'

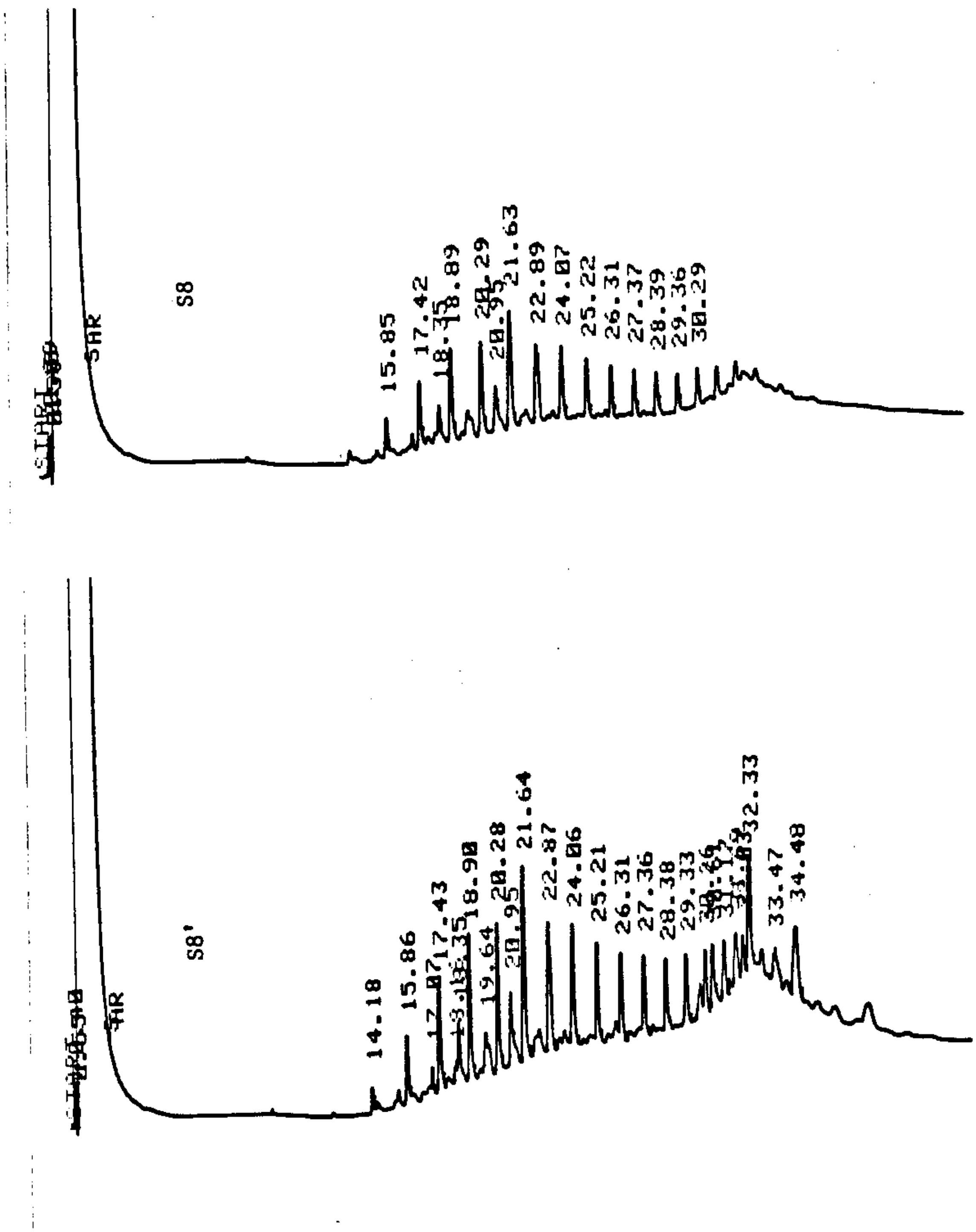
Elastol trial

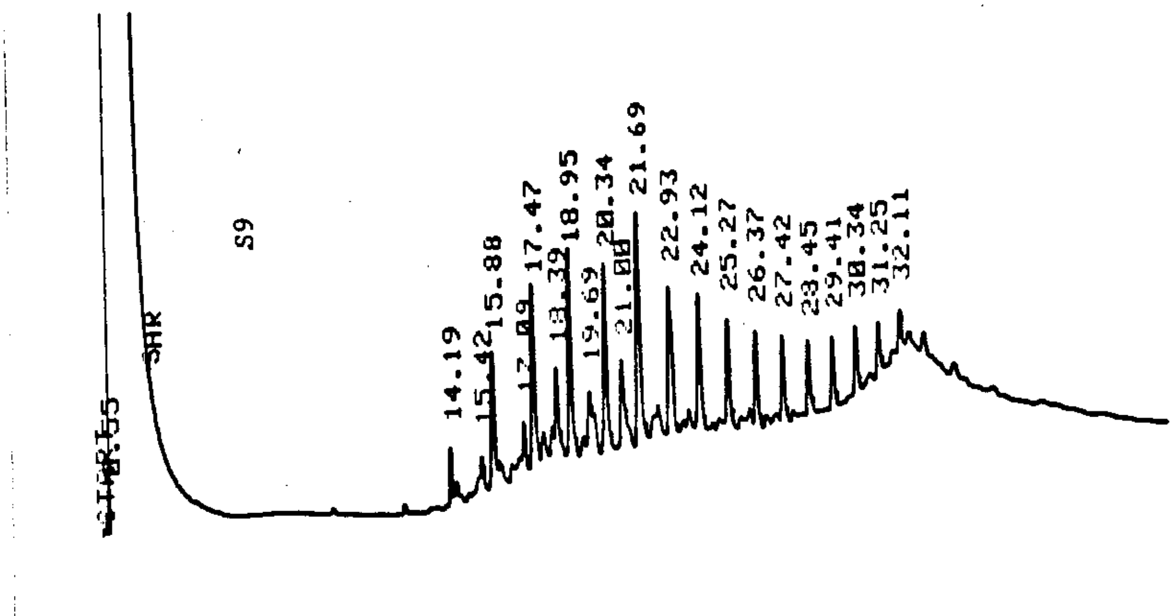


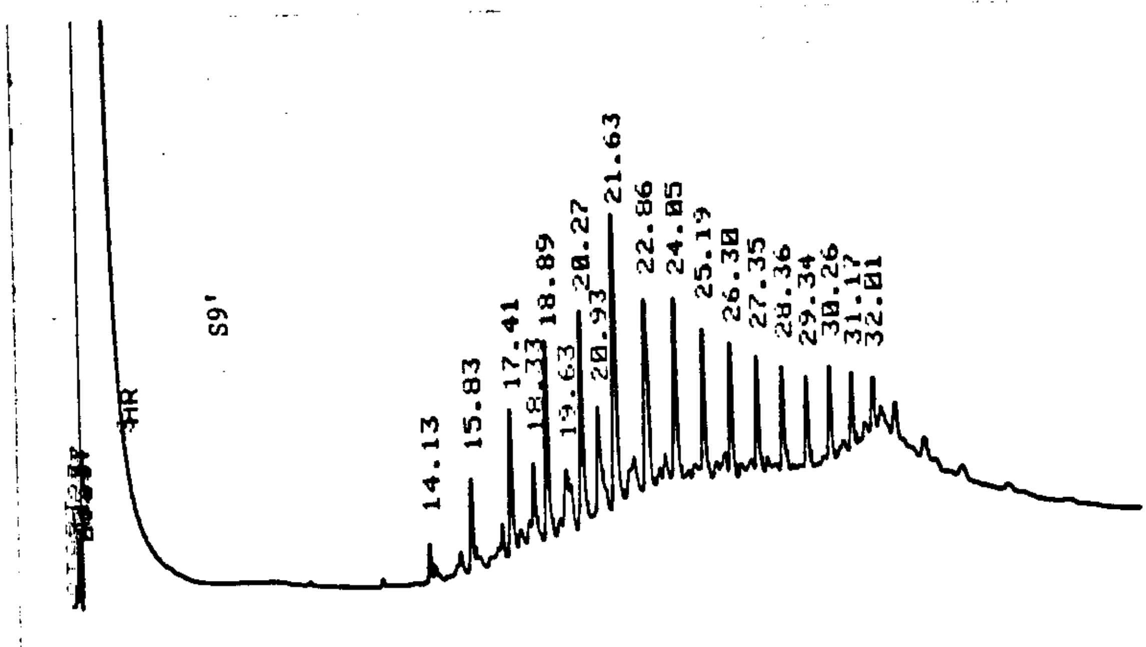

S6
12.34
15.85
17.42
18.89
20.28
21.62
22.87
24.05
25.20
26.30
27.36
28.37
29.34
30.27
31.17
S6'
14.03
15.71
17.29
18.77
20.16
21.50
22.74
23.93
25.09
26.18
27.23
28.25
29.21
30.15
31.05
31.91
32.74

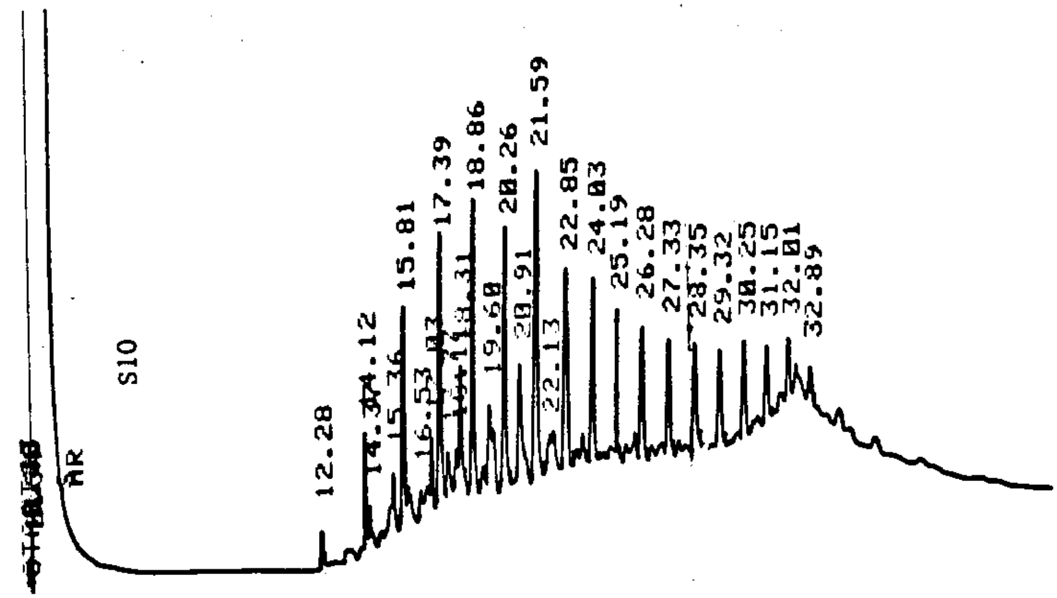

S7

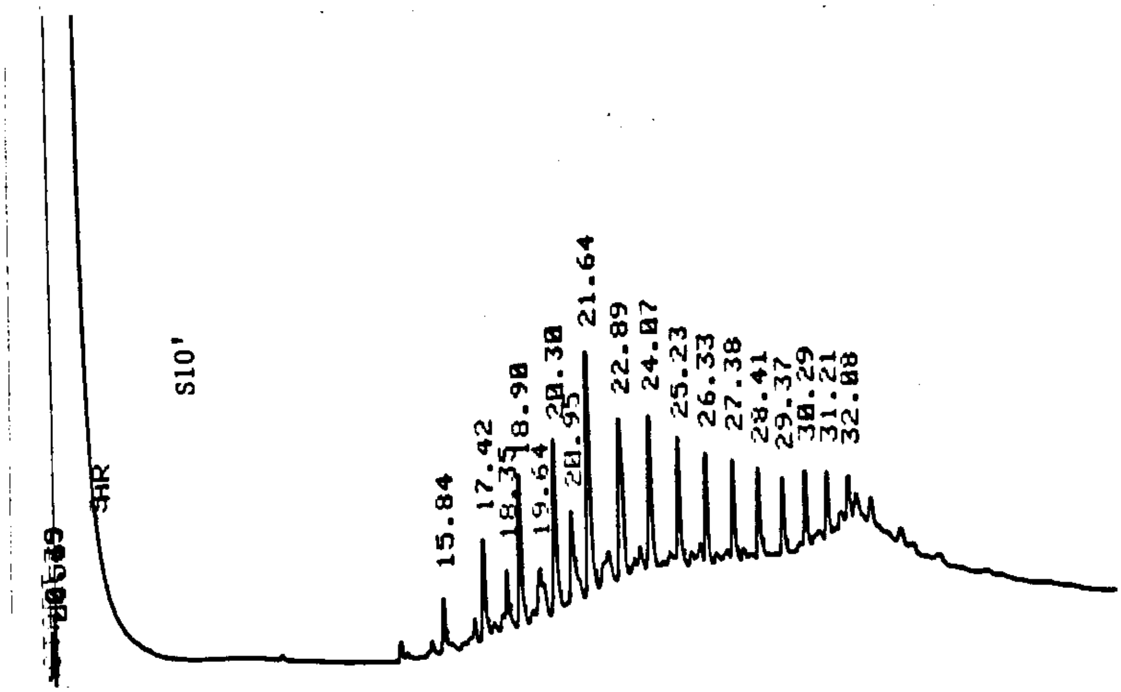

S7'


S8
AR
15.85
17.42
18.35
18.89
20.29
20.95
21.63
22.89
24.07
25.22
26.31
27.37
28.39
29.36
30.29
S8'
AR
14.18
15.86
17.43
18.90
19.64
20.28
20.95
21.64
22.87
24.06
25.21
26.31
27.36
28.38
29.33
32.33
33.47
34.48

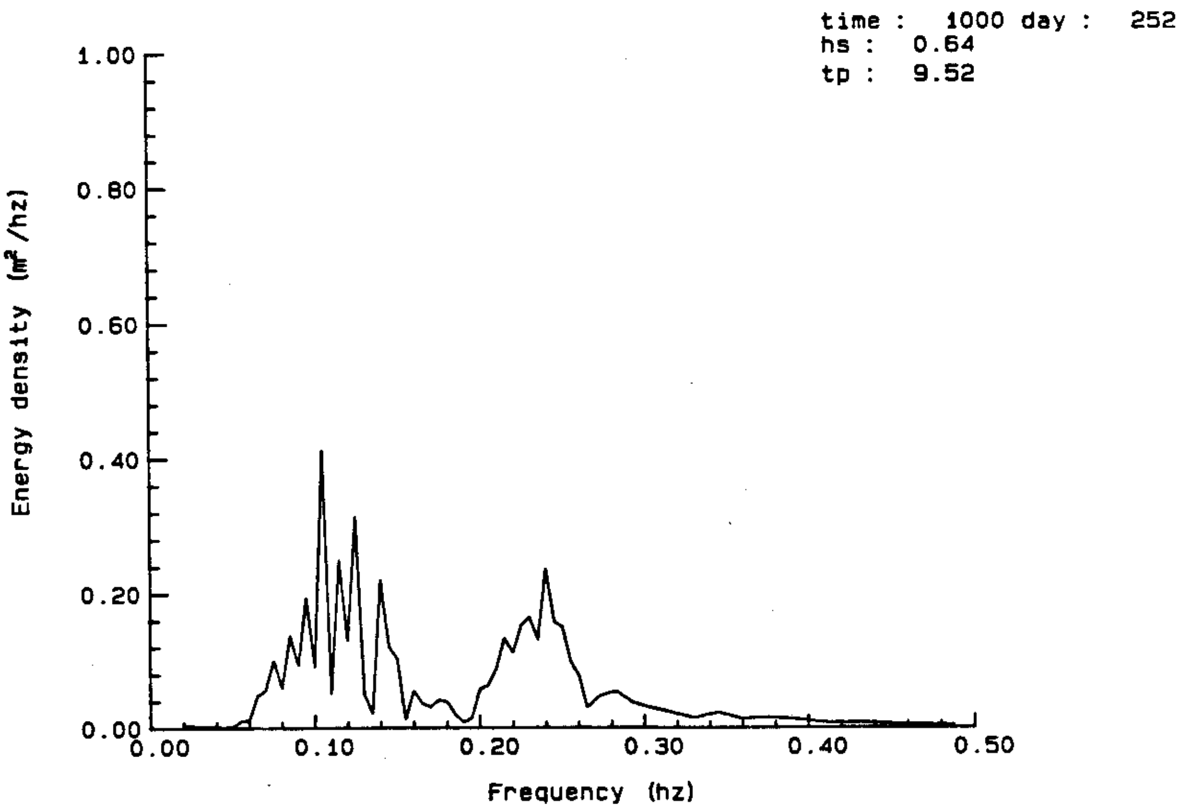

S9
14.19
15.42
15.88
17.47
18.39
18.95
19.69
20.34
21.00
21.69
22.93
24.12
25.27
26.37
27.42
28.45
29.41
30.34
31.25
32.11

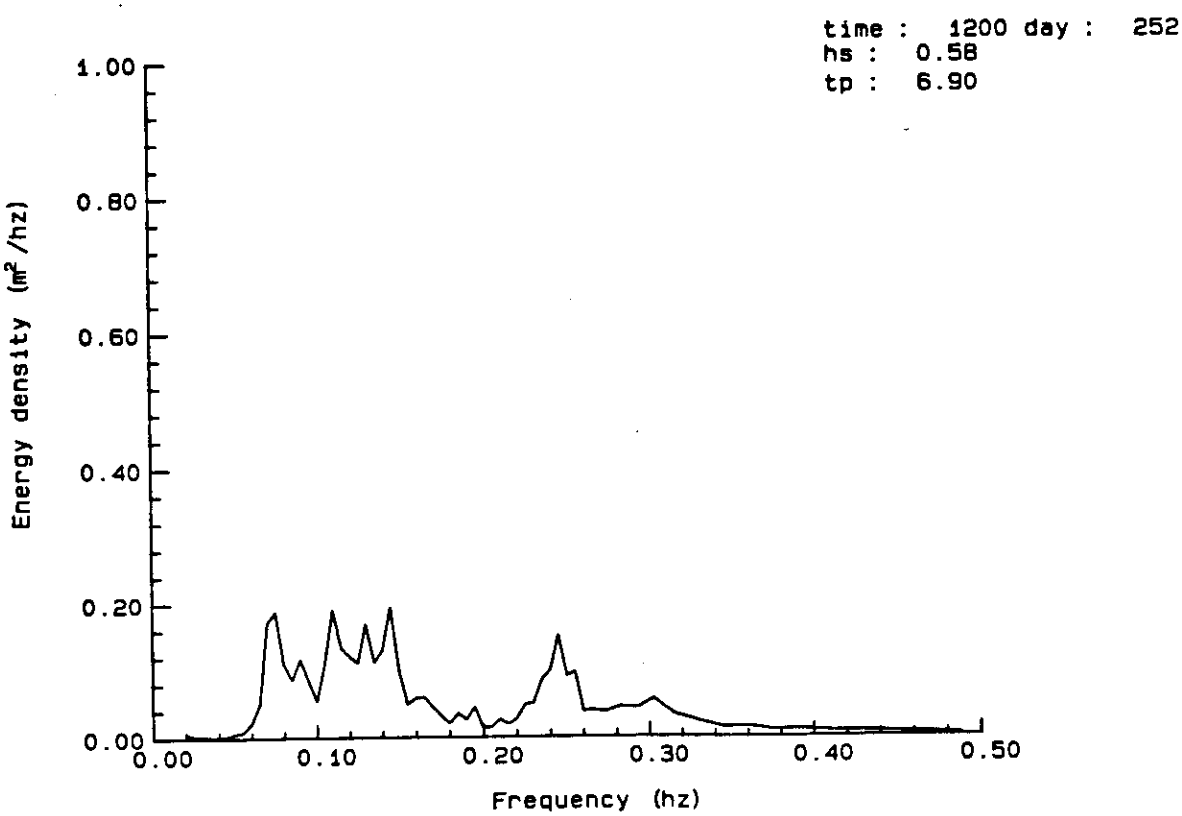

S9'
14.13
15.83
17.41
18.33
18.89
19.63
20.27
20.93
21.63
22.86
24.05
25.19
26.30
27.35
28.36
29.34
30.26
31.17
32.01

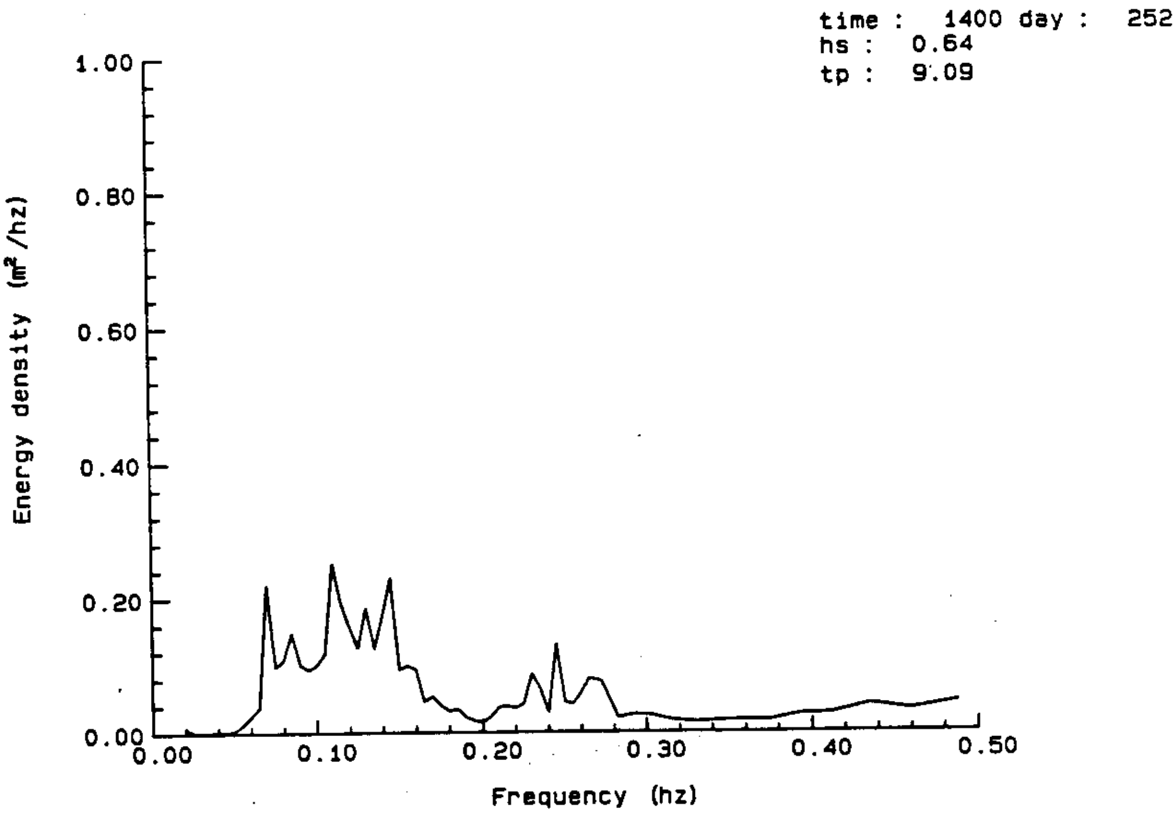

S10
AR
12.28
14.12
15.81
17.39
18.86
20.26
21.59
22.85
24.03
25.19
26.28
27.33
28.35
29.32
30.25
31.15
32.01
32.89

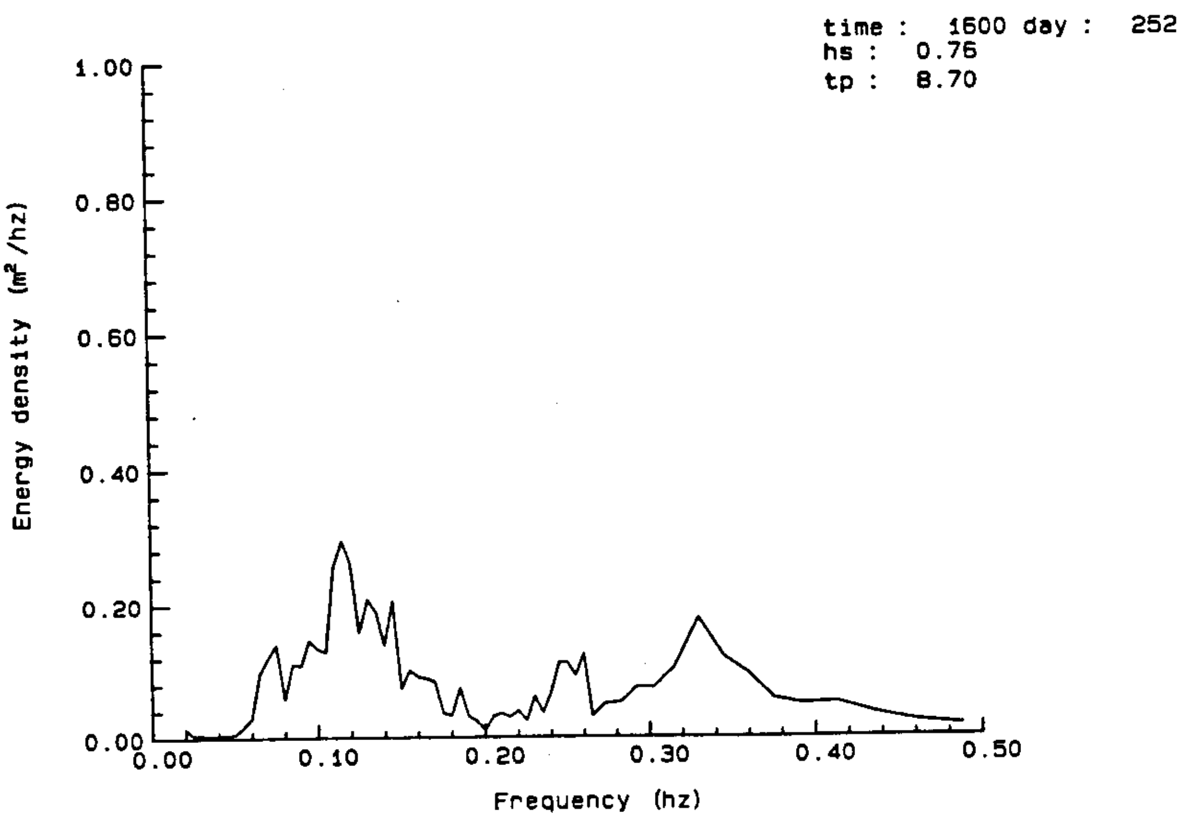

S10'
AR
15.84
17.42
18.35
18.90
19.64
20.30
20.95
21.64
22.89
24.07
25.23
26.33
27.38
28.41
29.37
30.29
31.21
32.08

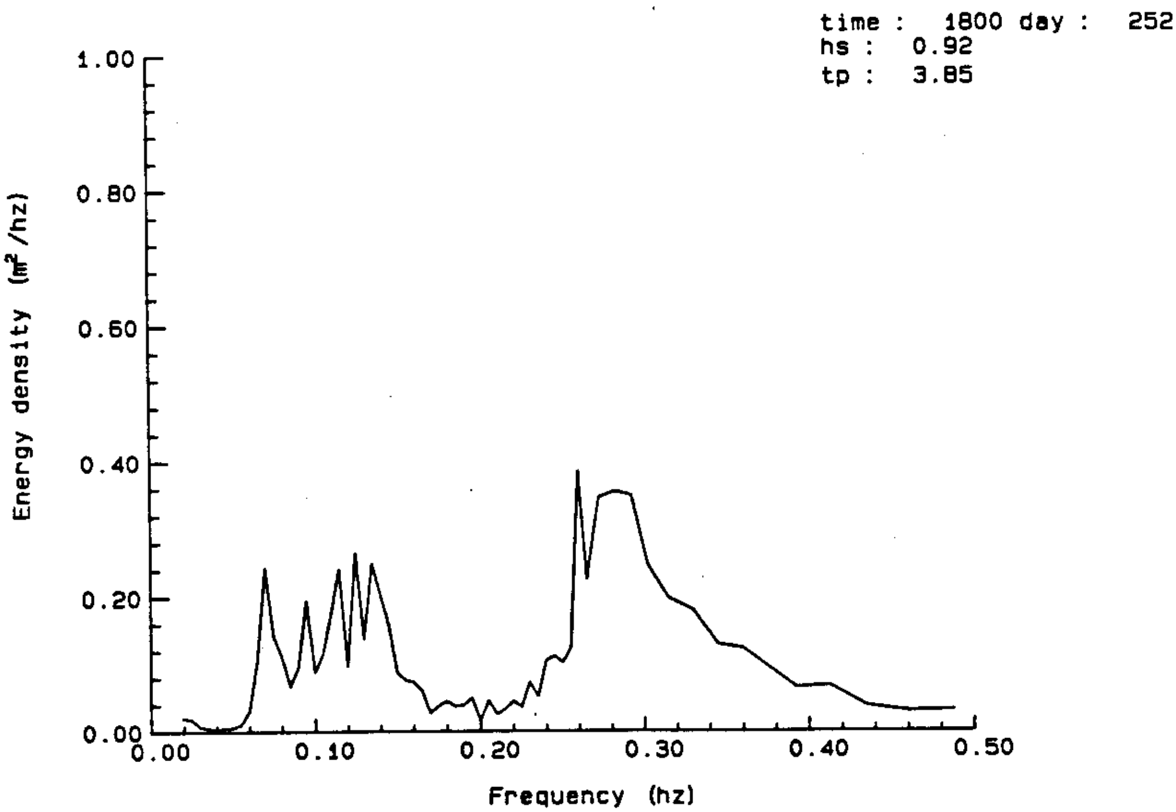
APPENDIX C - WAVERIDER DATA

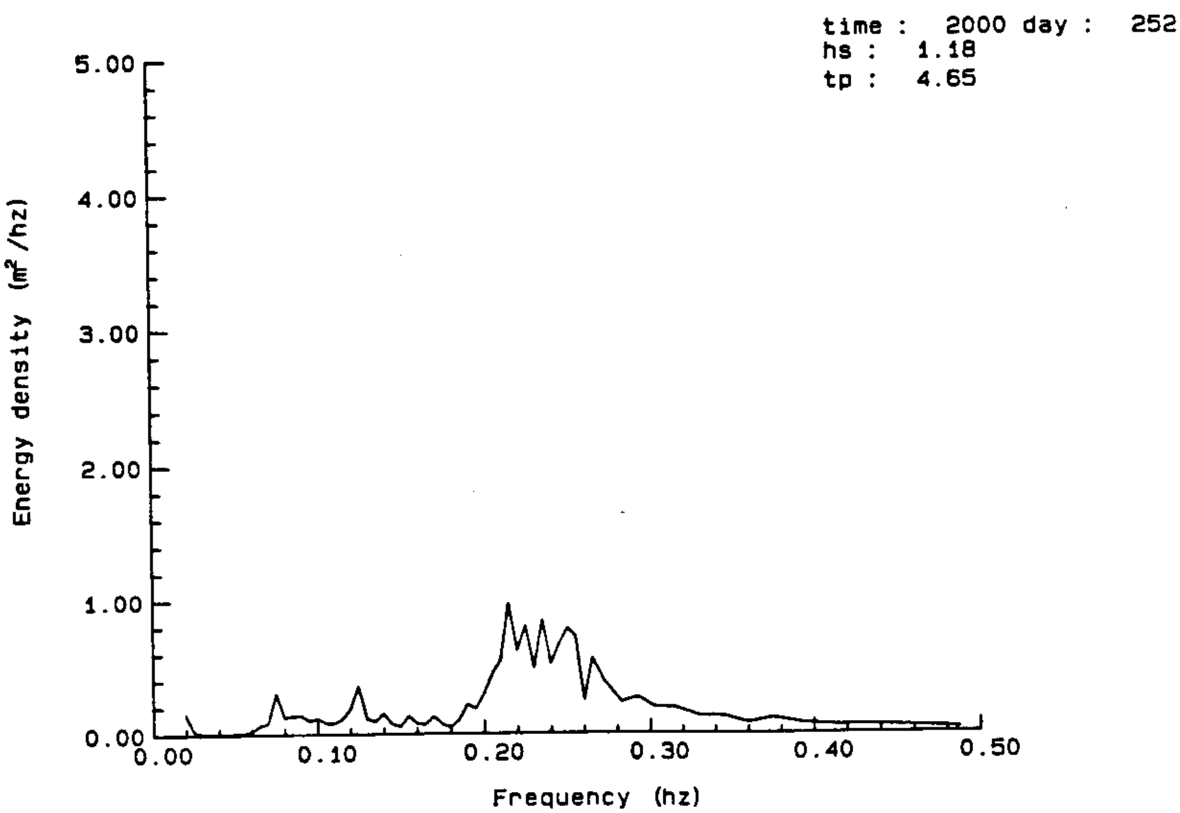

time : 1000 day : 252
hs : 0.64
tp : 9.52
Energy density (m²/hz)
1.00
0.80
0.60
0.40
0.20
0.00
0.00
0.10
0.20
0.30
0.40
0.50
Frequency (hz)

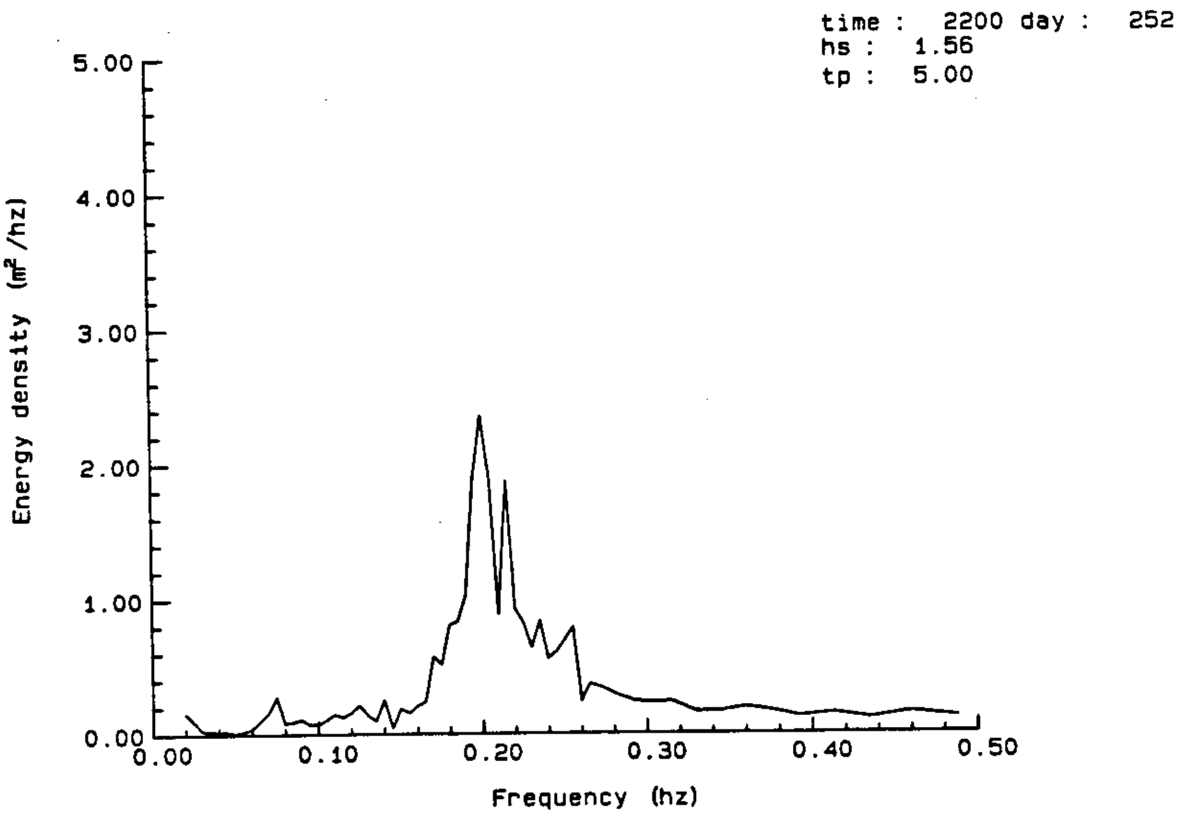

time : 1200 day : 252
hs : 0.58
tp : 6.90
Energy density (m²/hz)
1.00
0.80
0.60
0.40
0.20
0.00
0.00
0.10
0.20
0.30
0.40
0.50
Frequency (hz)

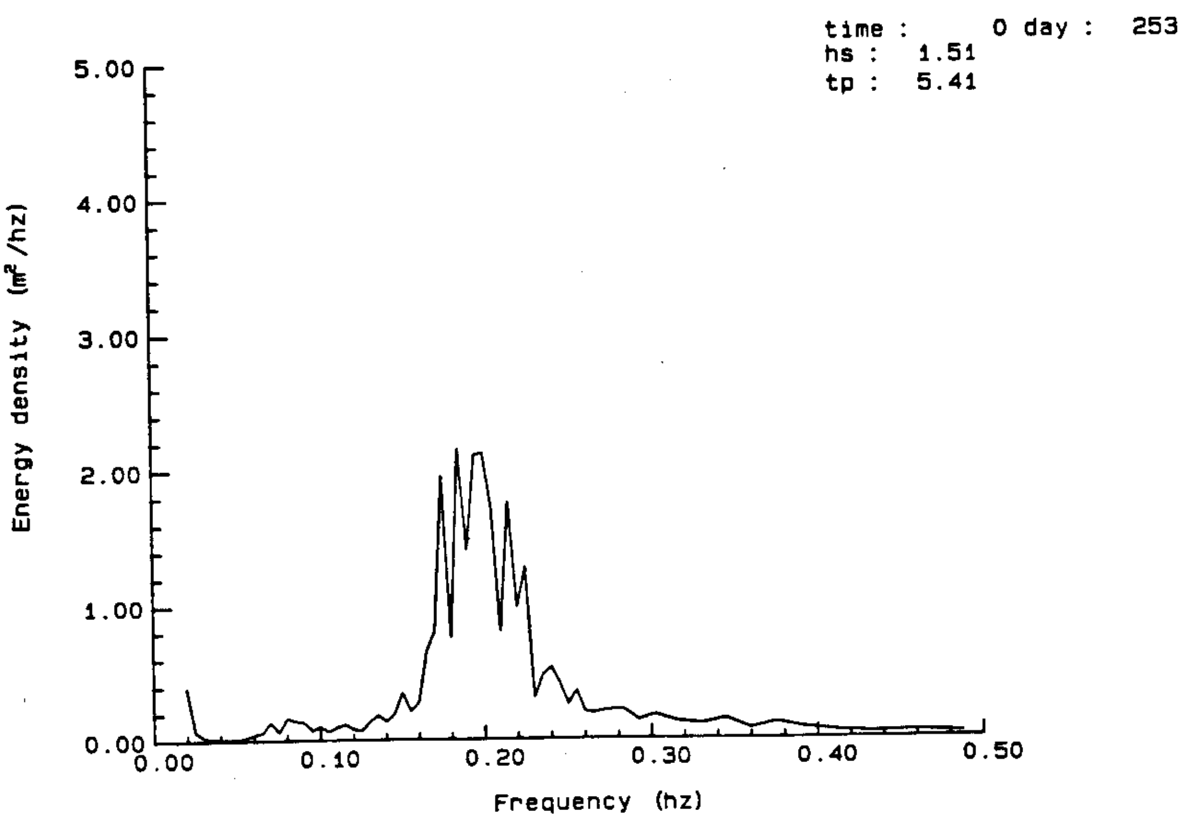

time : 1400 day : 252
hs : 0.64
tp : 9.09
1.00
0.80
0.60
0.40
0.20
0.00
Energy density (m²/hz)
0.00
0.10
0.20
0.30
0.40
0.50
Frequency (hz)

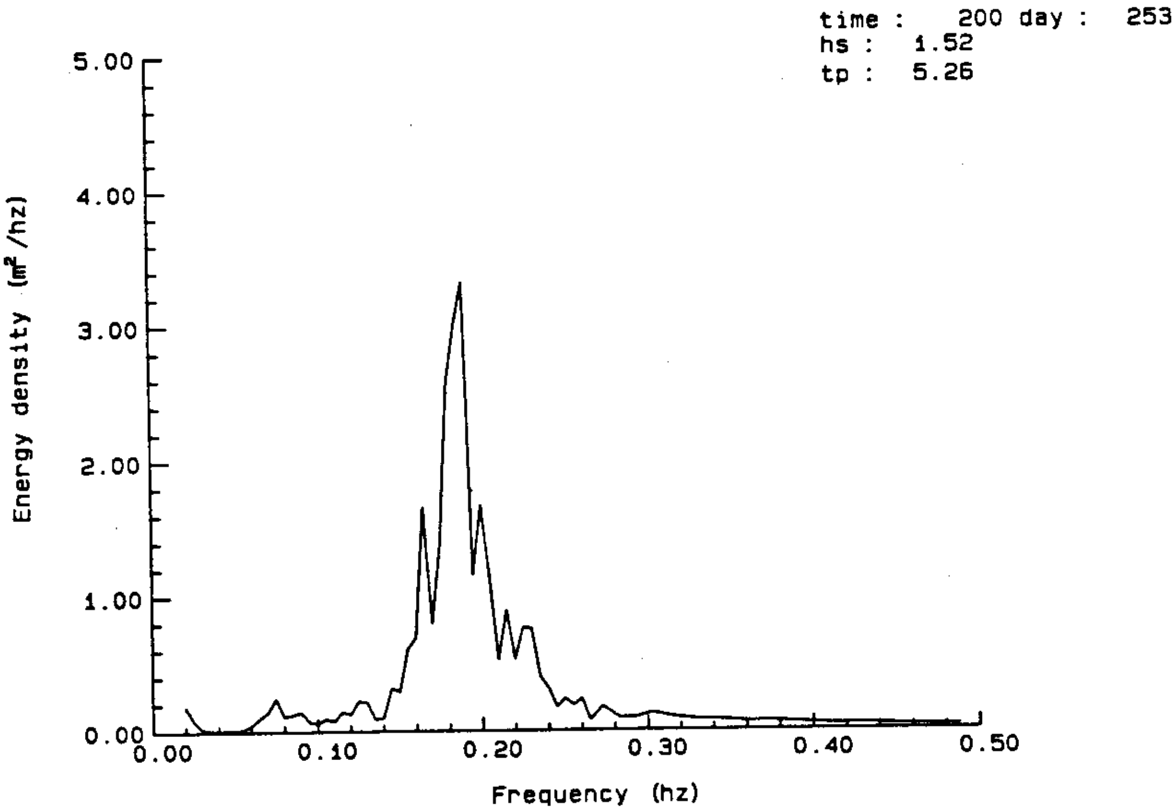

time : 1600 day : 252
hs : 0.76
tp : 8.70
1.00
0.80
0.60
0.40
0.20
0.00
Energy density (m²/hz)
0.00
0.10
0.20
0.30
0.40
0.50
Frequency (hz)

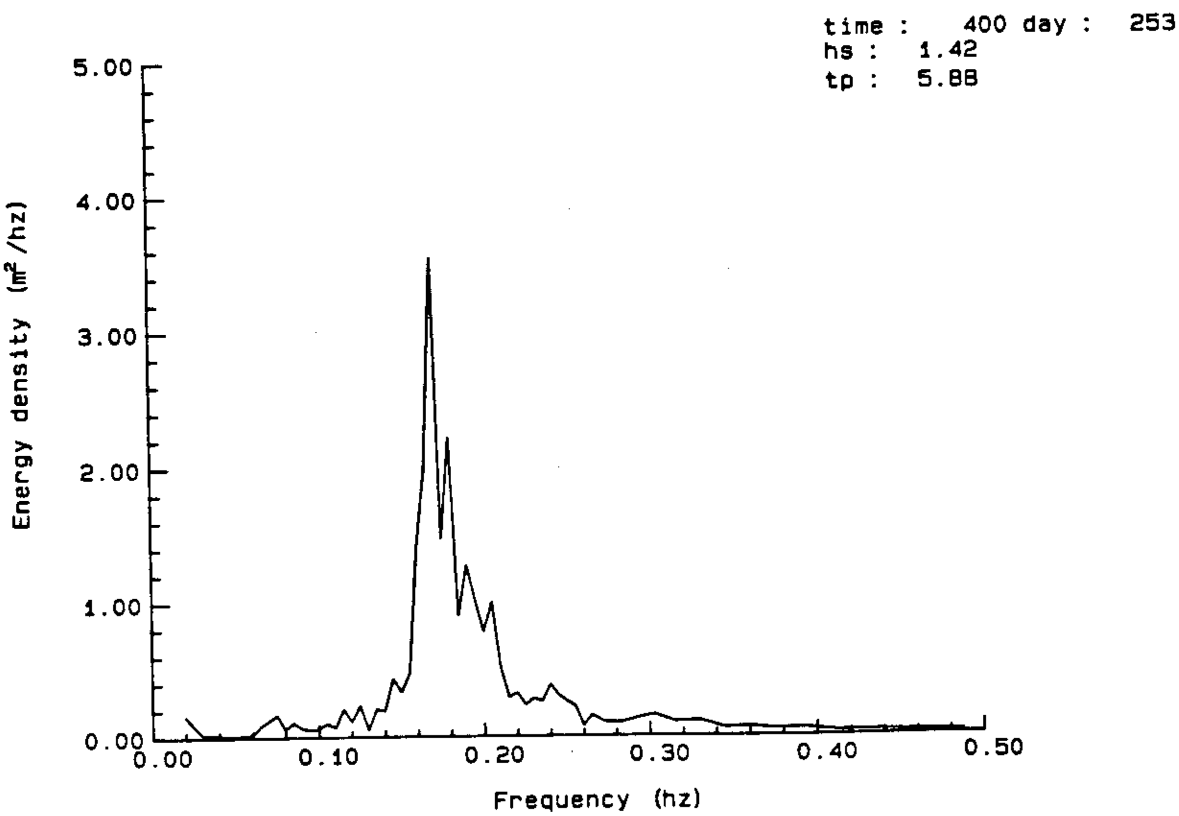

time : 1800 day : 252
hs : 0.92
tp : 3.85
Energy density (m²/hz)
1.00
0.80
0.60
0.40
0.20
0.00
0.00
0.10
0.20
0.30
0.40
0.50
Frequency (hz)


time : 2000 day : 252
hs : 1.18
tp : 4.65
Energy density (m²/hz)
5.00
4.00
3.00
2.00
1.00
0.00
0.00
0.10
0.20
0.30
0.40
0.50
Frequency (hz)


time : 2200 day : 252
hs : 1.56
tp : 5.00
5.00
4.00
3.00
2.00
1.00
0.00
Energy density (m²/hz)
0.00
0.10
0.20
0.30
0.40
0.50
Frequency (hz)


time : 0 day : 253
hs : 1.51
tp : 5.41
5.00
4.00
3.00
2.00
1.00
0.00
Energy density (m²/hz)
0.00
0.10
0.20
0.30
0.40
0.50
Frequency (hz)


time : 200 day : 253
hs : 1.52
tp : 5.26
5.00
4.00
3.00
2.00
1.00
0.00
Energy density (m²/hz)
0.00
0.10
0.20
0.30
0.40
0.50
Frequency (hz)


time : 400 day : 253
hs : 1.42
tp : 5.88
5.00
4.00
3.00
2.00
1.00
0.00
Energy density (m²/hz)
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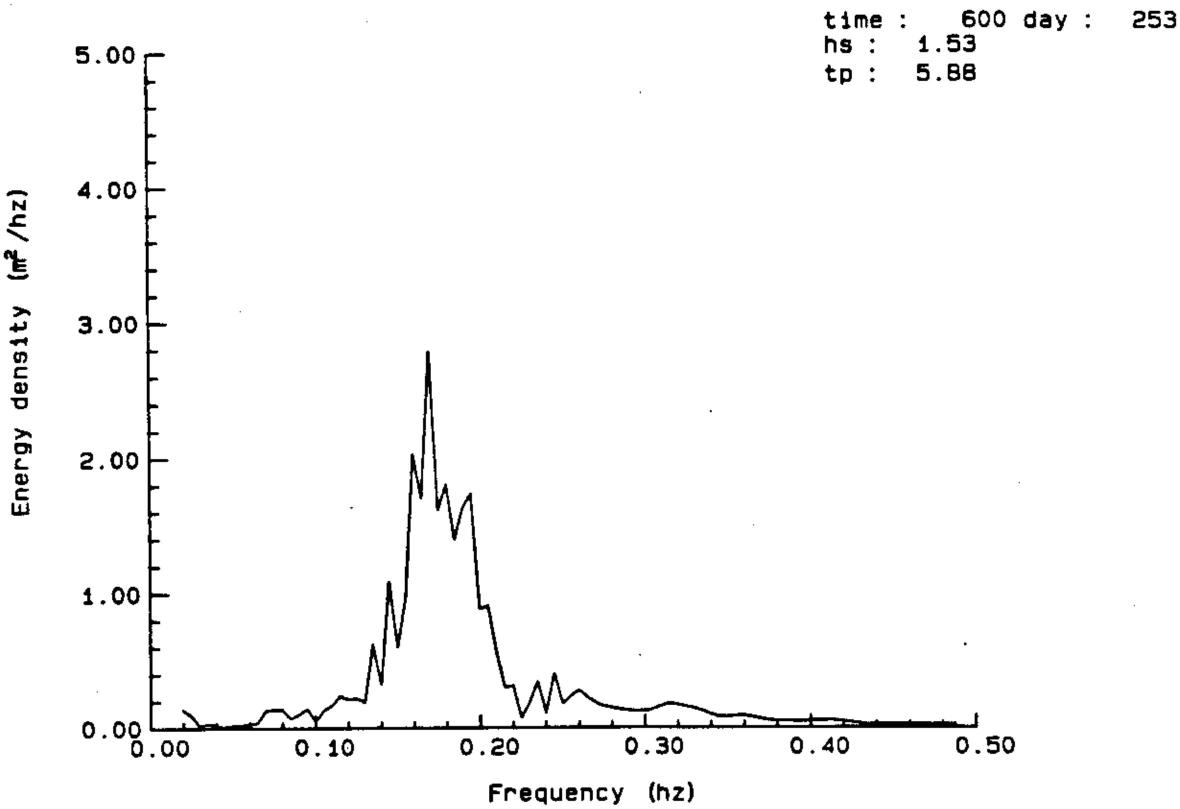
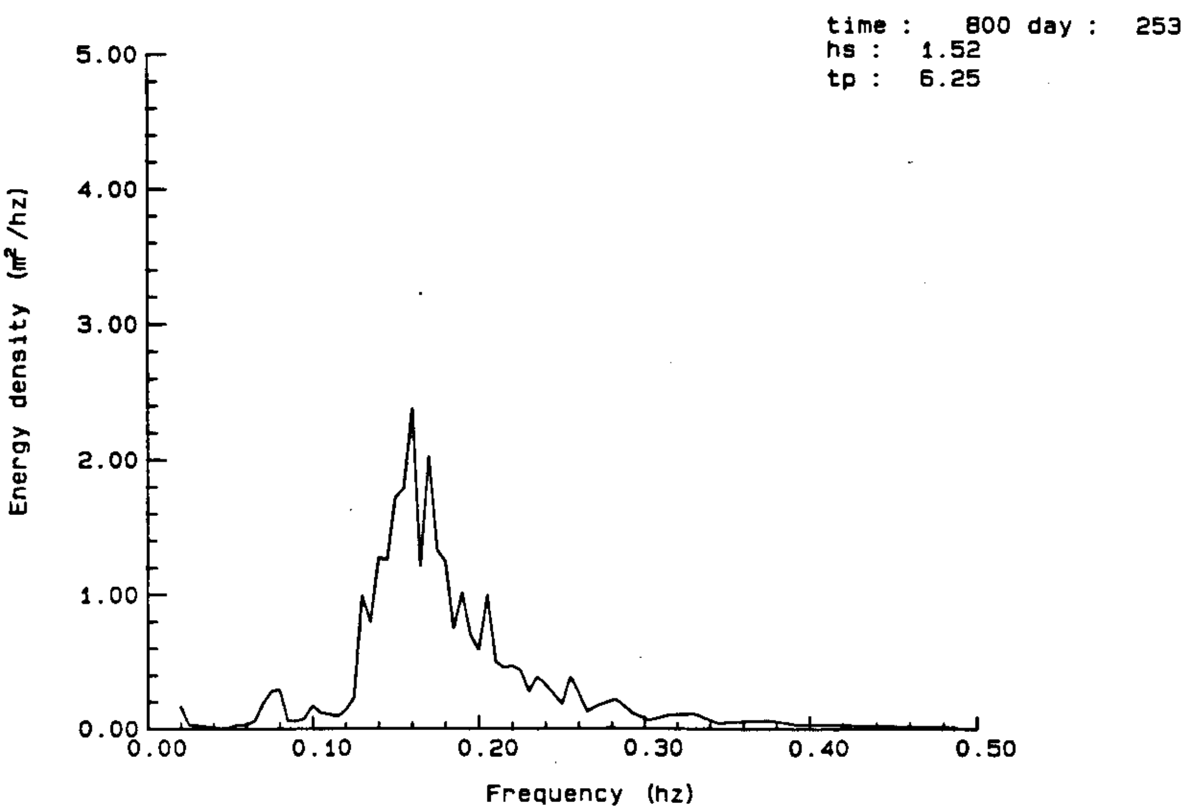
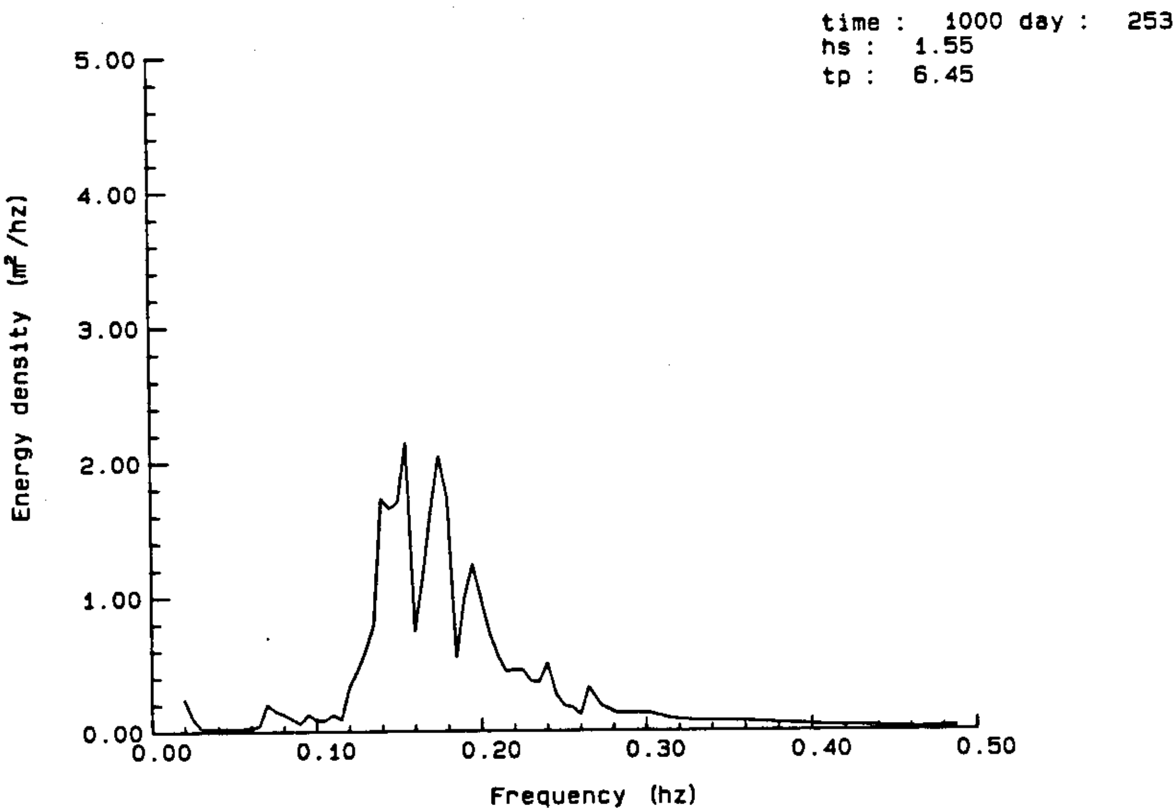
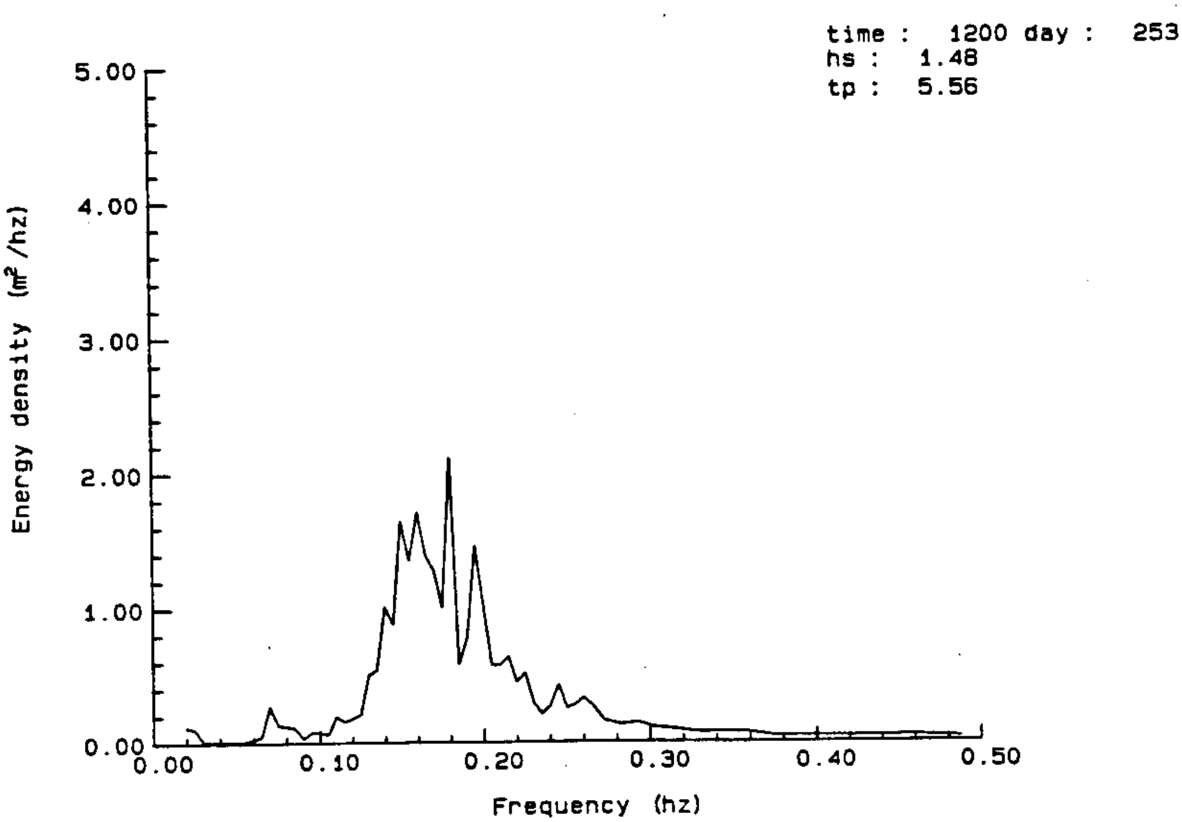
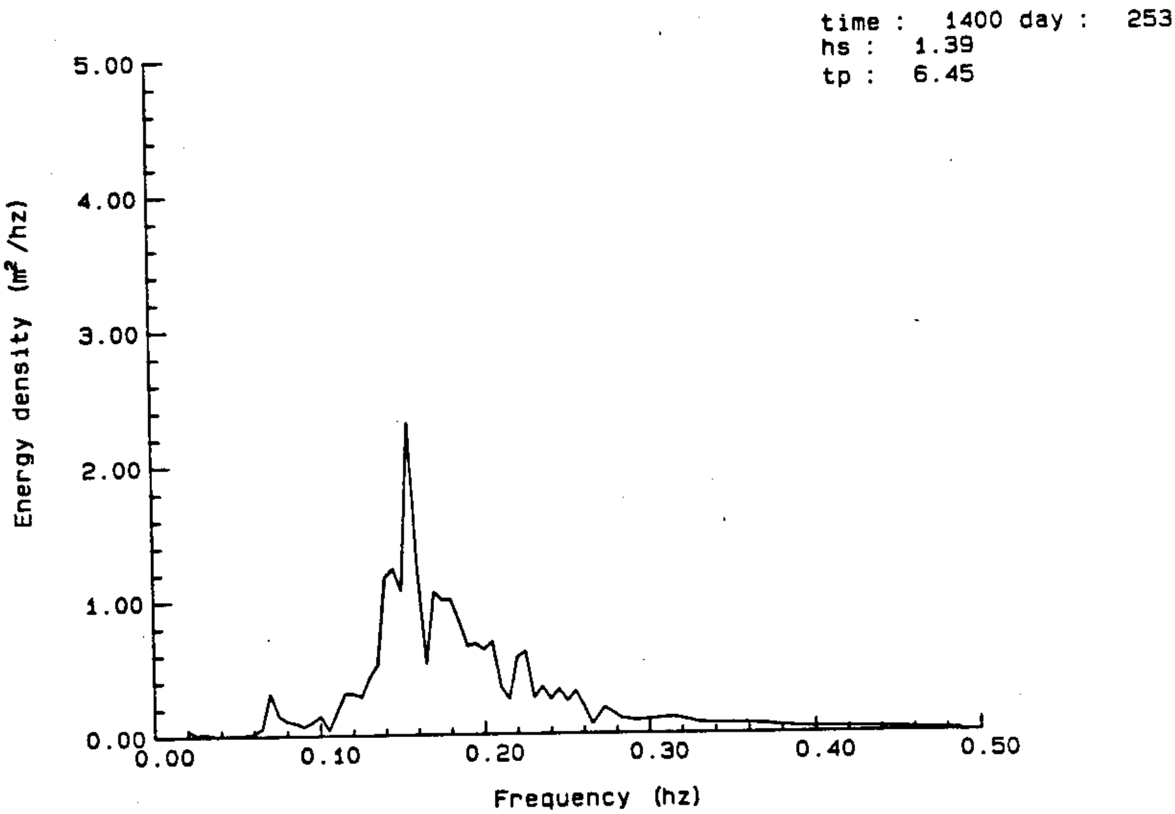
0.10
0.20
0.30
0.40
0.50
Frequency (hz)

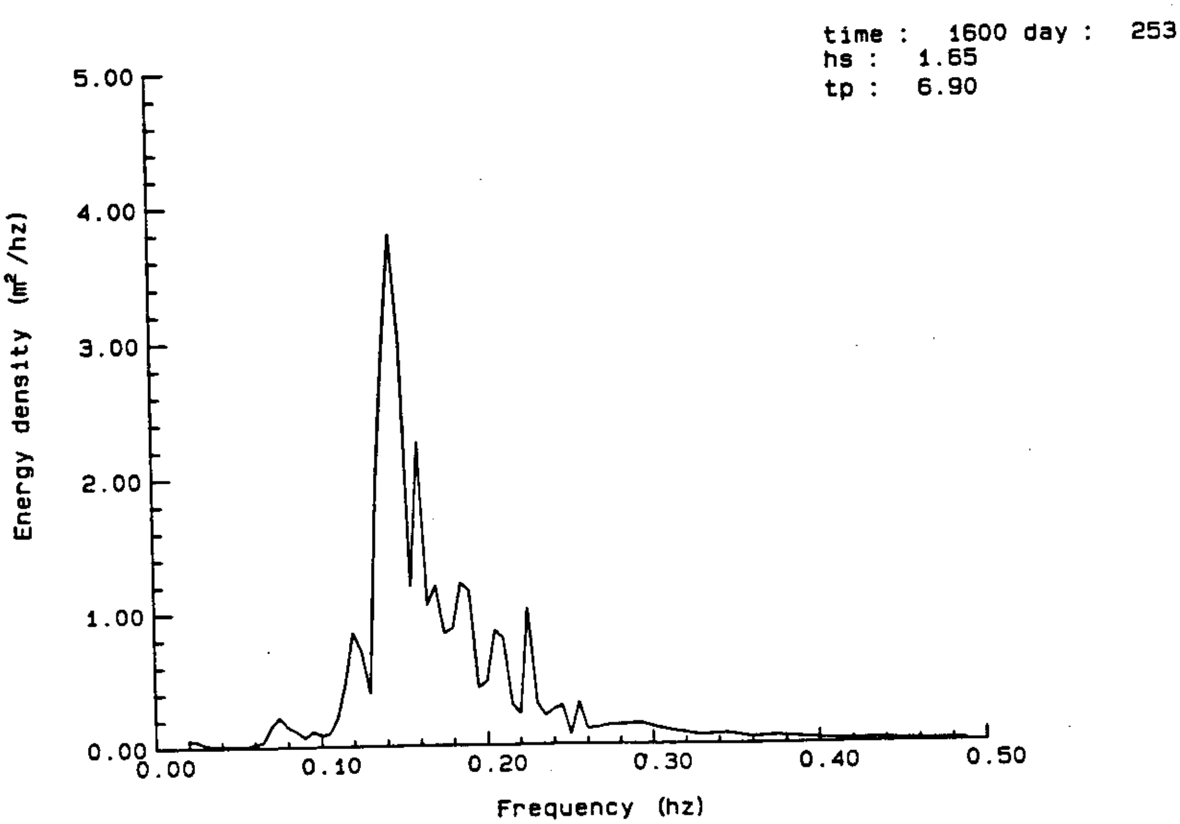

time : 600 day : 253
hs : 1.53
tp : 5.88
Energy density (m²/hz)
5.00
4.00
3.00
2.00
1.00
0.00
0.00
0.10
0.20
0.30
0.40
0.50
Frequency (hz)

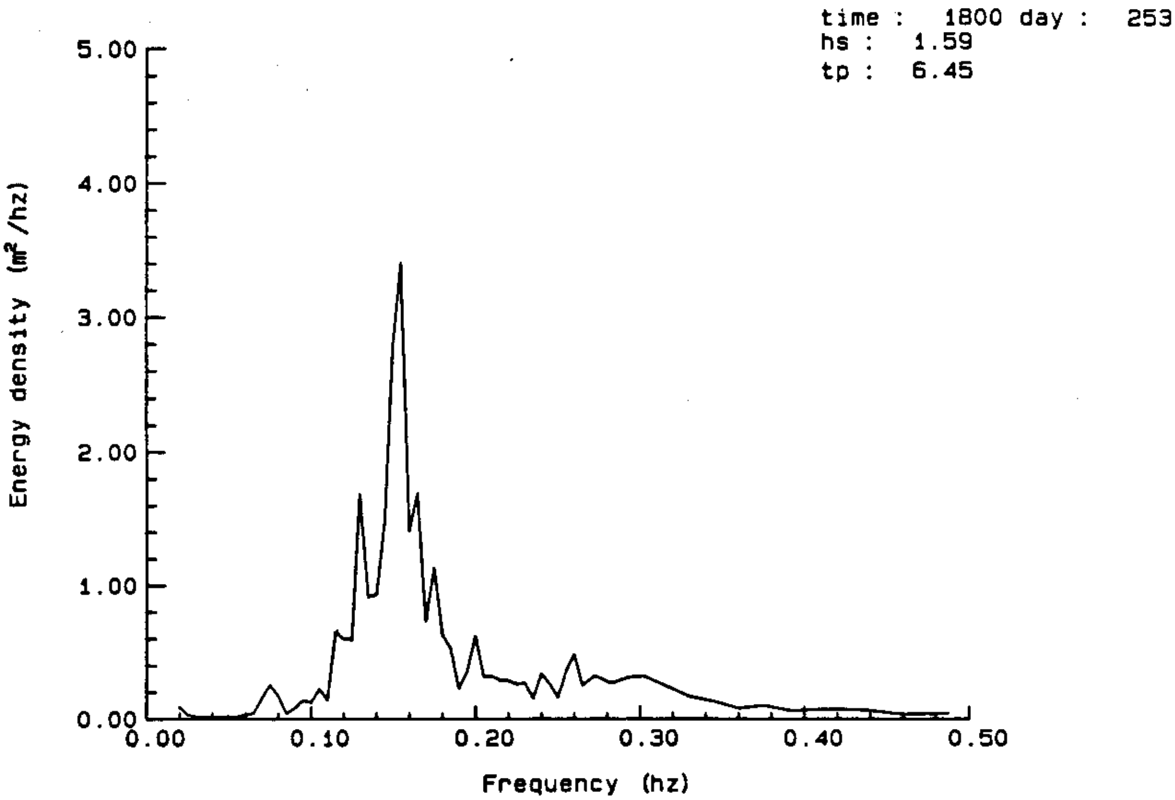

time : 800 day : 253
hs : 1.52
tp : 6.25
Energy density (m²/hz)
5.00
4.00
3.00
2.00
1.00
0.00
0.00
0.10
0.20
0.30
0.40
0.50
Frequency (hz)

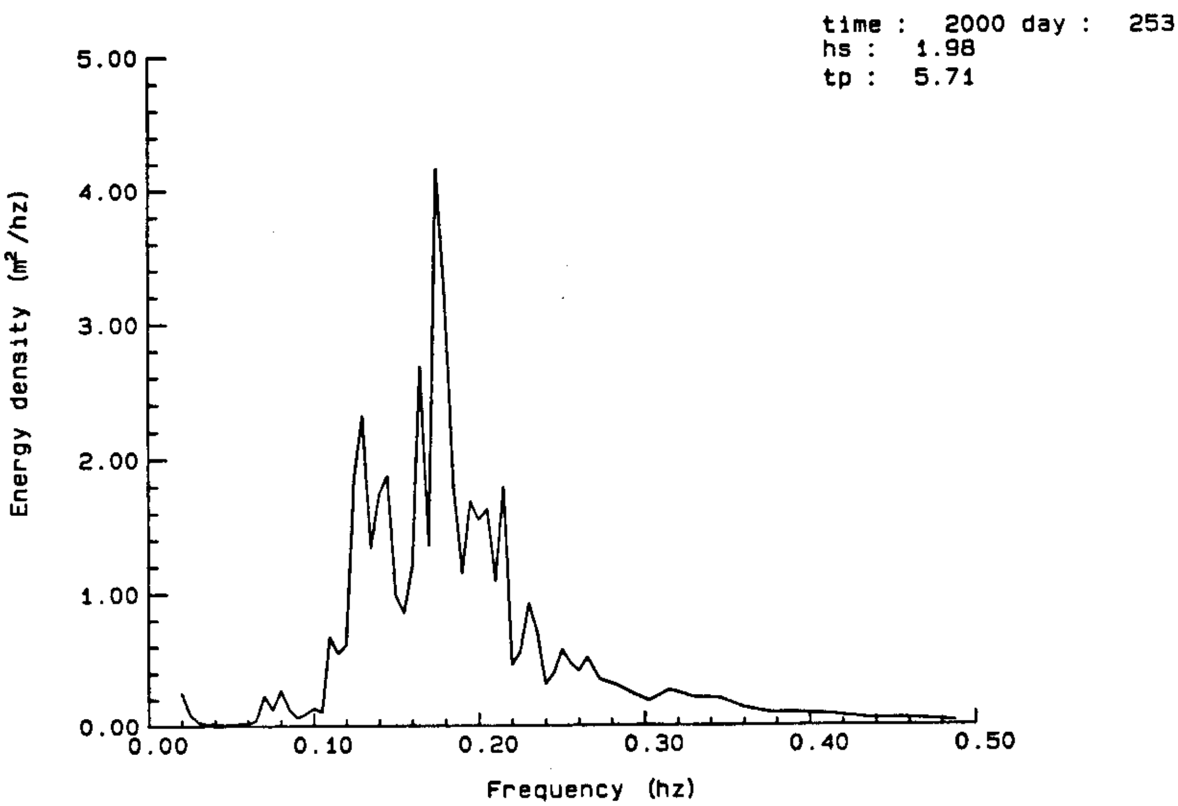

time : 1000 day : 253
hs : 1.55
tp : 6.45
Energy density (m²/hz)
5.00
4.00
3.00
2.00
1.00
0.00
0.00
0.10
0.20
0.30
0.40
0.50
Frequency (hz)


time : 1200 day : 253
hs : 1.48
tp : 5.56
Energy density (m²/hz)
5.00
4.00
3.00
2.00
1.00
0.00
0.00
0.10
0.20
0.30
0.40
0.50
Frequency (hz)


time : 1400 day : 253
hs : 1.39
tp : 6.45
5.00
4.00
3.00
2.00
1.00
0.00
Energy density (m²/hz)
0.00
0.10
0.20
0.30
0.40
0.50
Frequency (hz)


time : 1600 day : 253
hs : 1.65
tp : 6.90
5.00
4.00
3.00
2.00
1.00
0.00
Energy density (m²/hz)
0.00
0.10
0.20
0.30
0.40
0.50
Frequency (hz)


time : 1800 day : 253
hs : 1.59
tp : 6.45
Energy density (m²/hz)
5.00
4.00
3.00
2.00
1.00
0.00
0.00
0.10
0.20
0.30
0.40
0.50
Frequency (hz)


time : 2000 day : 253
hs : 1.98
tp : 5.71
Energy density (m²/hz)
5.00
4.00
3.00
2.00
1.00
0.00
0.00
0.10
0.20
0.30
0.40
0.50
Frequency (hz)

APPENDIX D - DUMPING PERMIT

DEPARTMENT OF THE ENVIRONMENT

OCEAN DUMPING CONTROL ACT

Pursuant to the provisions of the Ocean Dumping Control Act, the following permit is approved:

PERMIT NO. 4543-2-02238: Mulgrave (Elastol) #1,
Guysborough Co., Nova Scotia

1. PERMITTEE

Environment Canada, River Road Environmental Technology Centre, Ottawa, Ontario

2. TYPE OF PERMIT

Experimintal oil spill to test the capability and utility of Elastol and demousifier as spill testing agents.

3. TERM OF PERMIT

Permit valid from September 1, 1987
to October 1, 1987.

4. LOAD SITE

45°36.50' N; 61°23.50' W

5. DUMP SITE

44°15.00'N; 61°50.00'W at a depth of 172 m.

6. ROUTE TO DUMP SITE

Most direct navigational route from loading site to dump site.

7. EQUIPMENT

Oil tank, pumps and hose, skimmers, sorbent pads and discs.

8. METHOD OF DISCHARGE

Oil will be discharged at the dump site to simulate real spill situations. 0.8 cu m of oil will be used for each discharge. A total of 15 diacharges will be conducted.

.../2

9.. TOTAL QUANTITY TO BE DUMPED
Not to exceed 12 cu. m. (75 barrels) of oil.

10. MATERIAL TO BE DUMPED

Alberta Sweet Mixed Blend crude oil, Light Bunker C Oil, Elastol, Demousifier.

11. MONITORING REQUIREMENTS AND DUMPING RESTRICTIONS

11.1 The Permittee shall provide the Regional Director, Environmental Protection, Atlantic Region, with a tentative schedule for the experimental discharge at least 7 days prior to the start of the experimental program. This schedule shall be confirmed or revised by telex or telephone at least 24 hours prior to commencing the experiment.

11.2 A report outlining the following shall be submitted to the Regional Director, Environmental Protection, Atlantic Region, within 30 days of the expiring of this permit:

i) quantity of material discharged;
ii) dates on which each discharge occurred;
iii) precise location (Lat/Long) of each discharge;
iv) amount of oil reclaimed through cleanup measures;
v) the extent of the area affected by each discharge.

11.3 The Permittee shall employ the available technology for the cleanup of oil remaining after each experiment and shall ensure that, to the best of his/her ability and to the satisfaction of the ODCA Inspector, no oil remains in a quantity or concentration which can result in adverse environmental effects. The onus for additional cleanup measures, if required, rests with the Permittee.

11.4 The operation shall not be undertaken if it appears that environmental conditions exist which are likely to transport oil to shore.

11.5 Five copies of the final report describing the experiments, the ultimate fate of the disposed oil, and the results of the experiments shall be provided to the Regional Director, Environmental Protection, Dartmouth, upon completion of the operations.

.../3

11.6 The Permittee shall monitor the test areas daily throughout the operation. If the spill causes significant wildlife stress, the experiments shall be discontinued.

11.7 The Permittee shall ensure that space for an ODCA Inspector is made available on either surveillance aircraft or working vessels.

11.8 No dumping shall be permitted unless an ODCA Inspector is present at the site.

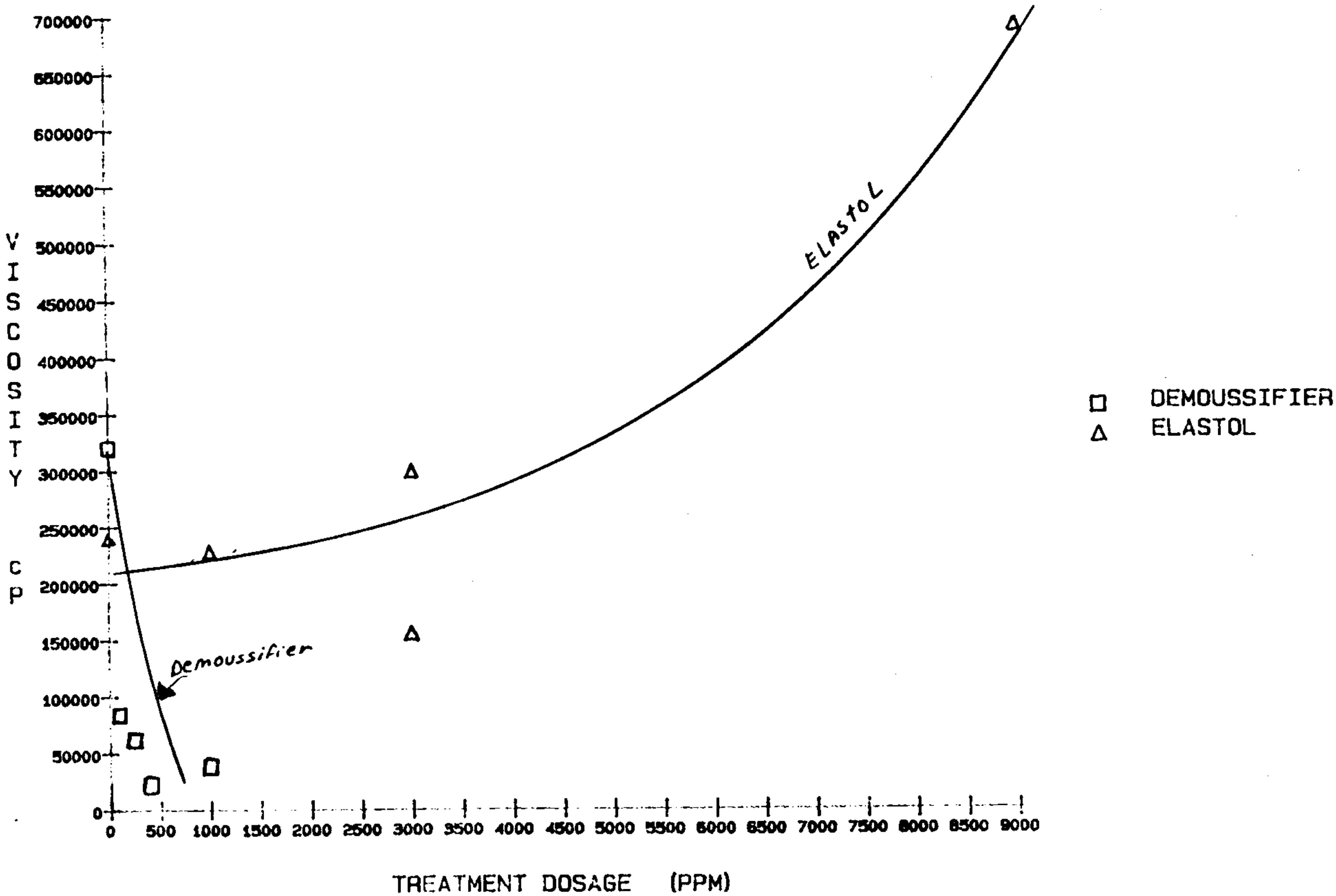
11.9 The Permittee will be required to terminate the operations immediately if the operations are not carried out according to the terms and conditions of this Permit.

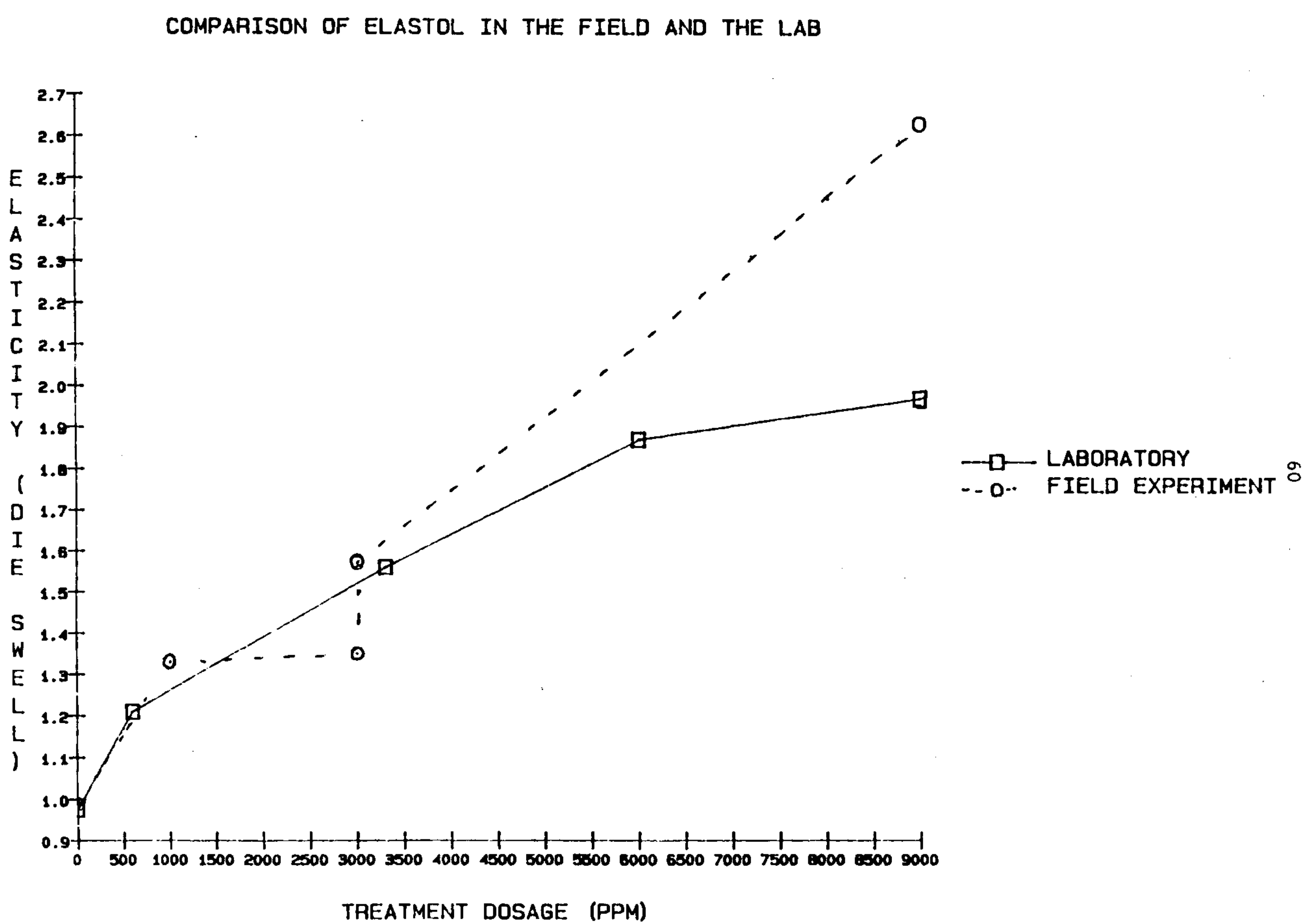
E. J. NORRENA

REGIONAL DIRECTOR
ENVIRONMENTAL PROTECTION
ENVIRONMENT CANADA
ATLANTIC REGION
FOR THE MINISTER OF ENVIRONMENT

APPENDIX E - SHIPBOARD DATA

VISCOSITY OF ALL SLICKS AFTER 5 HOURS




COMPARISON OF ELASTOL IN THE FIELD AND THE LAB
ELASTICITY (DIE SWELL)
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
8000
8500
9000
TREATMENT DOSAGE (PPM)
LABORATORY
FIELD EXPERIMENT

DEMOUSSIFIER TRIALS

SLICK	TREATMENT	SAMPLE 1 TIME	VISCOSITY	WATER CONTENT	COMMENTS	SAMPLE 2 TIME	VISCOSITY	WATER CONTENT	COMMENTS
1	1000-PPM	60	10000	84%	NO MOUSSE FORMED	300	84250	90%	NO MOUSSE NOTED
2	250-PPM	60	2700	54%	NO MOUSSE FORMED	300	62250	93%	NO MOUSSE NOTED
3	CONTROL	60	6350	88%	HEAVY MOUSSE	270	320000	95%	HEAVY MOUSSE
4	POST-4000PPM	60	2200	72%	MODERATE MOUSSE	PRE-240	105000	90%	HEAVY MOUSSE
						POST-270	22600	78%	TREATMENT BROKE MOUSSE
5	PRE-1000PPM	15	970	32%	NO MOUSSE OBSERVED	280	38500	80%	NO MOUSSE FORMED

ELASTOL TRIALS

SLICK	TREATMENT	SAMPLE 1 TIME	VISCOSITY	ELASTICITY	COMMENTS	SAMPLE 2 TIME	VISCOSITY	ELASTICITY	COMMENTS
6	3000-PPM	130	29300	1.33	MODERATELY ELASTIC	280	300000	1.35	HIGHLY ELASTIC
7	1000-PPM	145	32250	1.28	LOW ELASTICITY	280	228000	1.33	MODERATLEY ELASTIC
8	CONTROL	135	187000	0.99	NO ELASTICITY,WIDESPREAD	290	242000	0.99	NO ELASTICITY,WIDESPREA
9	9000-PPM	120	93000	1.99	HIGH ELASTICITY	330	696000	2.63	SUPER ELASTIC
10	PRE-3000PPM	115	170500	1.35	MODERATE ELASTICITY	315	156000	1.57	HIGHLY ELASTIC

DAY 1 SEPTEMBER 9 DEMOUSSIFIER TRIAL

SLICK	TREATMENT	SLICK LAYING TIME LAID	POSITION LAID	PUMP ON TIME	WIND DIRECTION	WIND SPEED	AIR TEMP	SWELL HEIGHT	CHOP HEIGHT	OTHER WEATHER OBSERVATIONS	SAMPLE 1 SAMPLE TIME	ELAPSED TIME	SLICK POSITION
1	1000-PPM	9.09	44:14:36 61:49:41	9	110	6	19	0.1	0.02	FOGGY	10:09	60	SAME
2	250-PPM	9:23	44:13:46 61:48:38	5	110	6	19	0.1	0.02	FOG	10:23	60	SAME
3	CONTROL	9:39	44:12:70 61:47:32	5	110	6	19	0.1	0.02	FOG	10:39	60	SAME
4	POST-4000PPM	11:25	44:12:02 61:46:24	4	120	10	18	0.2	0.04	FOGGY	12:25	60	SAME
5	PRE-1000PPM	11:40	44:11:11 61:45:21	3	120	10	18	0.2	0.04	FOGGY	11:50	15	SAME

DAY 2 SEPTEMBER 10 ELASTOL TRIALS

SLICK	TREATMENT	SLICK LAYING TIME LAID	POSITION LAID	PUMP ON TIME	WIND DIRECTION	WIND SPEED	AIR TEMP	SWELL HEIGHT	CHOP HEIGHT	OTHER WEATHER OBSERVATIONS	SAMPLE 1 SAMPLE TIME	ELAPSED TIME	SLICK POSITION
6	3000-PPM	12:48	44:13:03 61:45:05	5	290	12	17	2	0.03	FOGGY	15:04	130	44:12:51 61:44:70
7	1000-PPM	13:05	44:14:01 61:44:20	5	305	8	17	2	0.03	FOGGY	15:29	145	44:13:96 61:44:83
8	CONTROL	13:22	44:15:16 61:43:34	4	305	10	17	2	0.03	FOGGY	15:37	135	44:15:14 61:44:30
9	9000-PPM	13:47	44:14:40 61:42:38	5	305	10	17	2	0.03	FOGGY	15:49	120	44:16:19 61:43:19
10	PRE-3000PPM	14:13	44:17:51 61:41:33	4	305	10	17	2	0.03	FOGGY	15:59	115	44:17:13 61:42:04

NOTES ALL DATA ARE OBSERVATIONS FROM THE BRIDGE OR FROM ON-BOARD ANALYSIS WAVE INFORMATION WILL CHANGE WHEN WAVERIDER DATA IS ANALYZED
PURPOSE OF THIS TABLE IS TO PROVIDE ALL BRIDGE AND ANALYTICAL DATA TO THE REPORT WRITERS AND TO THE EXPERIMENTS SO THAT THEY HAVE IMMEDIATE DATA -

SAMPLING DURATION	WIND DIRECTION	WIND SPEED	AIR TEMP	SWELL HEIGHT	CHOP HEIGHT	OTHER WEATHER OBSERVATIONS	ANALYSIS TIME	VISCOSITY	WATER CONTENT	OBSERVATIONS	SAMPLE 2 SAMPLE TIME	ELAPSED TIME
?	115	8	18	0.1	0.02	FOG	11:05	10000	84%	NO MOUSSE NOTED	13:56	300
											SAMPLE 3 SEPTEMBER 9:45	1475
?	115	8	18	0.1	0.02	FOG	10:24	2700	54%	NO MOUSSE NOTED	14:13	300
											SAMPLE 3 SEPTEMBER 9:48	1460
?	115	8	18	0.1	0.02	FOG	11:25	6350	88%	LARGELY MOUSSE	14:46	270
											SAMPLE 3 SEPTEMBER 10:00	1460
?	130	13	18	0.4	0.05	FOGGY	11:40	2200	72%	MOUSSE PATCHES	15:24	240
											16:05	270
?	130	13	18	0.4	0.05	FOGGY	11:55	970	32%	NO MOUSSE NOTED	16:20	280

SAMPLING DURATION	WIND DIRECTION	WIND SPEED	AIR TEMP	SWELL HEIGHT	CHOP HEIGHT	OTHER WEATHER OBSERVATIONS	ANALYSIS TIME	VISCOSITY	ELASTICITY DIE-SWELL	OBSERVATIONS	SAMPLE 2 SAMPLE TIME	ELAPSED TIME
8	305	12	17	2	0.02	FOGGY	15:20	29300	1.33	MODERATELY ELASTIC	17:36	280
?	305	20	17	2.5	0.08	FOGGY	15:39	32250	1.28	MODERATELY ELASTIC	17:36	280
3	305	20	17	2.5	0.08	FOGGY	15:47	187000	0.99	SOME MOUSSE	18:11	290
10	305	25	17	2.5	0.08	FOGGY	16:10	93000	1.99	HIGHLY ELASTIC	19:16	330
?	305	25	17	2.5	0.08	FOGGY	16:20	170500	1.35	MODERATELY ELASTIC	19:28	315

TIME IS IN MINUTES VISCOSITY IS IN cP TIME OF SAMPLING AND PUMPING ARE TAKEN FROM BRIDGE OBSERVATIONS AND MAY NOT BE ACCURATE NOTE THAT FOR THE
PLEASE NOTE THE UPDATES THAT WILL BE MADE FROM OTHER SOURCES

SLICK POSITION	SAMPLING DURATION	WIND DIRECTION	WIND SPEED	AIR TEMP	SWELL HEIGHT	CHOP HEIGHT	OTHER WEATHER OBSERVATIONS	ANALYSIS TIME	VISCOSITY cP	WATER CONTENT	OBSERVATIONS
13760 29342	18	130	13	18	0.2	0.04	FOG	14:20	84250	90%	NO MOUSSE EVIDENT
10											
44:15:21 61:46:58	3	290	12	17	3	0.03	FOG	9:45	592000	?	PROB. BILGE WASTE
44:12:54 61:49:13	?	130	13	18	0.2	0.04	FOG	14:20	62250	93%	NOT MOUSSE
10											
44:14:41 61:46:24	NONE	290	12	17	3	0.03	FOG	NONE	NONE	NOT DONE	SHEEN ONLY IN AREA
44:12:27 61:49:10	?	130	13	18	0.2	0.04	FOGGY	15:00	320000	95%	STABLE MOUSSE
10											
44:13:44 61:44:14	NONE	290	12	17	3	0.03	FOG	NONE	NONE	NOT DONE	BUOYS ONLY FOUND
44:11:56 61:48:12	?	130	13	18	0.2	0.03	FOGGY MOUSSE	15:31	105000	90%	PRE-TREATMENT
	?						AFTER TREATMENT	16:00	22600	78%	POST-TREATMENT
44:11:28 61:48:21	?	130	18	16	0.6	0.08	FOGGY	16:15	38500	80%	NO MOUSSE NOTED

SLICK POSITION	SAMPLING DURATION	WIND DIRECTION	WIND SPEED	AIR TEMP	SWELL HEIGHT	CHOP HEIGHT	OTHER WEATHER OBSERVATIONS	ANALYSIS TIME	VISCOSITY cP	ELASTICITY DIE SWELL	OBSERVATIONS
44:12:23 61:45:07	14	45	25	16	3	0.2	HIGH SEAS	17:60	300000	1.35	HIGHLY ELASTIC
44:13:09 61:46:33	5	45	25	16	3	0.2	HIGH SEAS	18:00	228000	1.33	MODERATELY ELASTIC
44:14:56 61:46:16	5	45	25	16	3	0.2	HIGH SEAS	18:20	242000	0.99	NOT ELASTIC,WIDESPREAD
44:15:24 61:46:42	4	45	28	16	3.5	0.2	BEAUFORT 6	9:15 ND	696000	2.63	SUPER ELASTIC
44:15:96 61:45:31	6	45	28	16	3.5	0.2	BEAUFORT 6	9:45 ND	156000	1.57	HIGHLY ELASTIC

WIND DIRECTIONS AND SPEEDS ARE FROM THE SHIPS LOG AND ARE INTERPOLATED   ND= NEXT DAY

DEMOUSSIFIER TRIALS . SAMPLING WAS ATTEMPTED ON THE SECOND DAY AND THIS DAY IS ROLLED IN WITH SAMPLE 2 DATA