

DISTRIBUTION AND VARIABILITY OF HYDROCARBONS
IN WATER, SEDIMENT AND ORGANISMS FROM
THE EASTERN GULF OF MEXICO

A Technical Proposal
in Response to
Solicitation No. 3016

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March 28, 1983

Suggested reference Pierce RH. 1983. Distribution and
variability of hydrocarbons in water, sediment and organisms from
the eastern Gulf of Mexico. United States Department of Interior
Minerals Management Service. Mote Marine Laboratory Technical
Report no 59a. 42 p. Available from: Mote Marine Laboratory Library.

TABLE OF CONTENTS

<u>TOPIC</u>	<u>PAGE</u>
Supplies and Services	1
I. Introduction	1
A. Relevance	1
B. Objectives	3
C. Scope	3
II. Study Plan	7
A. Task 1: Search and Acquisition	7
B. Task 2: Review and Summary	8
C. Task 3: Synthesis and Preparation of <u>Draft Final Report</u>	9
D. Task 4: <u>Final Report</u>	10
E. Task 5: Publication, Journal, Title, Authors	10
III. Program Management - Personnel	11
A. Activity Monitoring - Personnel	11
- Organizational Chart	14
B. Subcontracts	14
C. Scheduling Plan	14
- Personnel Time-Scheduling Chart	15
D. Contingency Plan	15
IV. Information Research, Interpretation & Synthesis	17
V. Deliverables	18
A. Proposed Schedule	18
B. Bimonthly Progress Reports	18
C. Draft Final Report	18
D. Final Report	19
E. Reprint	19
F. Sections C and F of Solicitation 3016	20
VI. Facilities	23
A. Administrative Facilities & Abilities	23
B. Information Services	24
1. Library	24
2. Data Processing	24
Literature Cited	26
Appendix A	31
Resumes of Key Personnel	32

Supplies and Services

I. Introduction

A. Relevance

Comprehensive environmental surveys relative to gas and oil development in the eastern Gulf of Mexico outer continental shelf (OCS) were initiated by the Bureau of Land Management (BLM) in 1974. Reports submitted to BLM (and recently MMS) resulting from these studies include: SUSIO (1976); Meyers (1976); SUSIO (1977); Dames & Moore (1979); and Woodward-Clyde (1982). In addition to these reports, a synthesis of results from Year-I and Year-II hydrocarbon analysis from the S.W. Florida Shelf Study was prepared for Continental Shelf Associates by Dr. Pierce (1982). A summary of hydrocarbon data obtained from 1974 through 1978 was presented as several different chapters, according to sample matrix, in the report by Dames & Moore (1979). More recent surveys have included samples from the Southwest Florida Shelf. Sediment from the 1980 sampling cruises were analyzed by Dr. Pierce (Principal Investigator for this proposed project). Dr. Pierce has recently completed analysis of sediment collected during 1982 and has been awarded the contract from MMS to analyze hydrocarbons in sediment collected during spring-summer of 1983.

At this time, decisions are being made regarding what future studies are needed within the Eastern Gulf of Mexico OCS. A compilation and

synthesis of hydrocarbon information from the various chapters of the Dames & Moore report, along with the more recent data from the S.W. Florida Shelf, as well as other pertinent data sources, would greatly enhance our understanding of the variability and distribution of hydrocarbons within the Eastern Gulf of Mexico. This information is essential for proper management decisions regarding oil and gas exploration and research directed toward environmental impacts resulting from those activities.

The Principal Investigator (P.I.), Dr. Pierce, has been involved with OCS hydrocarbon studies for over eight years, including a joint EPA-NOAA study of oil drilling muds released into the OCS region of Texas and Louisiana (1979 through 1982), and a recent BLM survey of hydrocarbons in surficial sediment from the West Florida OCS that is presently continuing under the Mineral Management Services. In addition to OCS studies, Dr. Pierce is investigating hydrocarbon distribution in S.W. Florida estuaries (Pierce et al., 1982) which provides valuable insight into hydrocarbons of terrestrial and estuarine origin along the S.W. Florida coastal zone. Through these and related studies (please see resume) he has demonstrated the expertise and ability to direct multidisciplinary research projects providing accurate interpretation and timely presentation of the results.

An outside consultant (Dr. E.S. Van Vleet) will be employed to review reports prepared by the P.I. for accuracy and completeness.

Dr. Van Vleet is a Chemical Oceanographer with over six years experience in studying hydrocarbons in the marine environment. Dr. Van Vleet has performed studies of pelagic tar in the Eastern Gulf and is presently working with Dr. Pierce on an MMS, OCS project. He will co-author the final published report.

B. Objectives

This investigation proposes to review past OCS studies and associated data bases regarding the distribution and variability of hydrocarbons in the water column, surficial sediment and organisms of the Eastern Gulf of Mexico. The overall objective is to review all pertinent literature, and to thoroughly analyze, synthesize and compile the data for publication in a refereed scientific journal. This proposal is in response to Solicitation No. 3016, Scope Item No. 1.

C. Scope

The distribution and variability of hydrocarbons reflect the major sources and abundance of hydrocarbons for a given area. Classification of hydrocarbons according to source generally includes three major categories: 1) biogenic, recently biosynthesized in marine or terrestrial organisms; 2) petrogenic, crude oil or refined petroleum products; and 3) pyrogenic, resulting from combustion of fossil fuels and forest fires (Blumer, 1970; Farrington and Meyers, 1975; McAuliffe, 1976; Pierce et al., 1975).

Hydrocarbons from marine plankton exhibiting a predominance of odd-carbon-number n-alkanes in the n-C₁₅ to n-C₂₁ region along with specific isoprenoid and cycloalkane compounds have been reported by Blumer (1970), Zsolna (1973), Wade and Quinn (1979), Boehm and Quinn (1978) and Pierce et al. (1982). Terrestrial (vascular) plants also provide an important source of hydrocarbons for the marine environment. The hydrocarbons are characterized by higher molecular weight n-alkanes in the n-C₂₃ to n-C₂₉ range (Farrington, 1974; 1980; Gearing et al., 1976; McAuliffe, 1976; Iliffe and Calder, 1974).

Petroleum hydrocarbons are characterized by continuous n-alkane boiling range with an odd to even carbon preference index (CPI) of one, overlying an unresolved complex of thousands of branched, cyclic and aromatic compounds (Farrington and Meyers, 1975; Van Vleet and Quinn, 1977; 1978; Petrakis et al., 1980; Pierce et al., 1981b; Pierce and Brown, 1982). Refined petroleum products have characteristic changes in the hydrocarbon composition which are complicated by weathering processes that act on petroleum in the marine environment (Iliffe and Calder, 1974; Parker and Menzel, 1974; Brown and Huffman, 1976; Atlas, 1981; Boehm, 1979; Bentz, 1980; Van Vleet and Reinhardt, 1983).

A closer scrutiny of the aromatic hydrocarbon fraction has provided a wealth of information regarding petrogenic and pyrogenic hydrocarbon sources. Petroleum contains alkyl substituted polynuclear aromatic hydrocarbons (PNAHs), the ratios of which can be characteristics of

geographical origin. Hydrocarbons produced during combustion, however, consist primarily of the parent PNAH (Blumer and Sass, 1972; Boehm and Quinn, 1978; Laflamme and Hites, 1978; Farrington, 1980; Wakeman and Farrington, 1980).

In addition to defining hydrocarbon distribution and variability relative to the classes of n-alkane, branched, cyclic and aromatic hydrocarbons, classification according to boiling range must also be considered. Gaseous hydrocarbons (C_1-C_4), volatile low molecular weight liquid hydrocarbons (C_5-C_{13}), and high molecular weight hydrocarbons ($>C_{14}$) represent fractions that require different extraction and analytical techniques (Sackett and Brooks, 1975; Sauer, 1980; Shaw, 1977; McAuliffe, 1977; deLappe and Risebrough, 1977). Throughout the literature review, therefore, considerable attention must be given not only to the classes of compounds reported, but also to the specific sample collection, extraction and analysis procedures used.

The above classifications of hydrocarbons have been studied in the Gulf of Mexico as various physical states: 1) pelagic tar and beach tar (Jeffrey et al., 1974; Romero, 1981; Van Vleet et al., 1983); 2) dissolved and particulate (Ilfie and Calder, 1974; Calder, 1977; Meyers, 1976; Brooks, 1979; Sauer, 1980); and 3) incorporated within sediment and organisms (Ehrhardt, 1972; Chan, 1977; Pierce, 1982; Pierce et al., 1981a; 1982). This project will compile and review literature pertaining to all of the above classifications and physical states.

To accomplish the goals set forth for this project, OCS studies and other pertinent information will be analyzed relative to the distribution and variability of hydrocarbons in the eastern Gulf of Mexico. This information will be prepared and presented for publication through a five phase study plan described in the following sections.

II. Study Plan

The study will be divided into five tasks to be scheduled as follows:

<u>Task</u>	<u>Activity</u>	<u>Duration (Months After Award)</u>
1	Search and acquisition of literature for review including scoping conferences with oceanographers from MMS.	1-4
2	Review of references and preparation of a reference summary report (RSR) for each reference.	2-6
	Synthesis of data from individual RSR for preparation of <u>Draft Final Report</u> for review by MMS personnel.	5-8
	Preparation of <u>Final Report</u> based on MMS review, for submission to refereed journal.	9-10
	Publication of <u>Final Report</u> in refereed journal.	10-20

A detailed description of each task is presented below.

A. Task 1. Search and Acquisition of Literature for Review.

The Principal Investigator maintains a current file on literature pertaining to hydrocarbons in the marine environment as part of his ongoing research efforts in this field. This file will be thoroughly reviewed and updated through computerized literature searches conducted with MML's in-house T.I. Silent 700 data terminal, which accesses the Lockheed Dialog Information System.

In addition to the literature search, the P.I. will contact MMS oceanographers from the Environmental Assessment Division in Metairie, Louisiana, and will contact the Offshore Studies Division in Washington, D.C. to scope out specific departmental needs and to obtain information regarding pertinent BLM technical reports. Related studies funded by other agencies (e.g., NOAA, EPA) also will be considered.

As the references are received, each will be logged and indexed according to key word topics along with a brief abstract on an Apple II Plus Computer using a PFS file index. References will be cross indexed according to geographical area and hydrocarbon type so that these data can be retrieved simultaneously.

Copies of each reference will be filed alphabetically according to the last name of the first author, subsequent authors and then chronologically. All other cross indexing by topic, geographical region and hydrocarbon type will be stored on floppy disc for the above-described computer system.

B. Task 2. Review of References and Preparation of Reference Summary Reports (RSR).

Each reference will be thoroughly reviewed and summarized in the following manner:

- a) Geographical location;
- b) Sample type (water, sediment, organism);
- c) Validity of sample collection and analysis techniques;

- d) Specific types and concentrations of hydrocarbons analyzed (gaseous, volatile liquid and high molecular weight);
- e) Probable or suggested hydrocarbon sources;
- f) Summary and tabulation of data;
- g) Consultant review of summary.

Information from each reference will be summarized and reduced to tabular form for storage on floppy discs. Any biased or invalid data obtained through improper collection or analysis procedures will be noted and evaluated with a recommendation for partial or complete omission of that data set.

Each reference summary and evaluation will be sent to the consultant to check for completeness and accuracy. Upon satisfactory completion, each reference summary will be returned to the P.I. for Task 3.

C. Task 3. Synthesis of Data from Individual RSR for Preparation of Draft Final Report for Review by MMS Personnel.

The distribution and variability of hydrocarbons throughout the eastern Gulf of Mexico will be established, according to available information, by comparison of the major types and amounts of hydrocarbons reported for water column surficial sediments and organisms. Comparisons will be made regarding seasonal changes and relative concentrations of biogenic, petrogenic and pyrogenic components as described above in the Scope section. Conflicting results and data gaps will be identified and reported.

Preliminary reports will be prepared as a compilation of RSR for the four major sample matrices: 1) dissolved and particulate hydrocarbons in the water column; 2) hydrocarbons in surficial sediment; 3) hydrocarbons in organisms; and 4) tar. These four reports will then be synthesized into one overall draft report. The draft report, along with the four preliminary reports, will be reviewed by the consultant and returned to the P.I. for preparation of the Draft Final Report.

The Draft Final Report will be submitted to the MMS COR within eight months of contract award, in appropriate format for publication in the journal, Marine Pollution Bulletin. Format and numbers of copies will follow the guidelines set forth in Section C of the Solicitation (please see below).

D. Task 4. Preparation of Final Report for Submission to Refereed Journal.

MMS review and comments of the Draft Final Report will be returned to the P.I. within 30 days after it is received. The P.I. will incorporate suggestions by the MMS review into the Final Report will be reviewed by the outside consultant and then submitted to the COR with 30 days of receipt of the Draft Final Report review.

E. Task 5. Publication of Final Report in Refereed Scientific Journal.

The final manuscript of the Final Report will be submitted to Marine Pollution Bulletin for peer review and publication by the journal

after the Final Report has been approved by the COR. A suggested title for the paper is "Hydrocarbon Distribution and Variability in the Eastern Gulf of Mexico". The authors will be R.H. Pierce and E.S. Van Vleet.

III. Program Management - Personnel

A. Activity Monitoring - Personnel

Accomplishment of each task will be considered a milestone by which to monitor progress of proposed activities. Bimonthly progress reports including a detailed description of the tasks accomplished to date will serve as the vehicle by which the P.I. will communicate continuing activity progress to the COR. Tasks accomplished can be compared with those proposed to ensure timely compliance. Copies of each progress report will be provided for QC to Dr. W.H. Taft, President of MML, who will review them for compliance with proposed time tables. He will report any discrepancies to the COR and P.I. The P.I. will then provide a plan for correcting the deficiencies.

The project will be managed by the P.I., Dr. Richard Pierce, a Chemical Oceanographer with extensive experience in the study of hydrocarbons in the marine environment. His investigations include studies of hydrocarbon distribution and variability resulting from oil spills (Traxler and Pierce, 1974; Pierce et al., 1975; 1981a), OCS oil drilling operations (Pierce, 1980; Pierce et al., 1981a) and identification of petrogenic, pyrogenic and biogenic hydrocarbons in the OCS (Pierce et al., 1981b) and estuarine (Pierce, 1982a; Pierce et al., 1982) environments. In addition to the above studies, Dr. Pierce has been involved in several workshops and symposia regarding oil pollution including: International

Marine Pollution Monitoring (Petroleum) NBS (1974); National Response Team, Oil Spill Scientific Response Workshop for the Gulf of Mexico (1977); and the IXTOX-1 Symposium, Miami (1980).

Dr. Pierce's responsibilities for this project include technical and administrative management of the project. He will personally review and evaluate each reference and will prepare the Draft Final Report and Final Report manuscript for publication with assistance from the outside consultant. Dr. Pierce will allot 250 hours to this project.

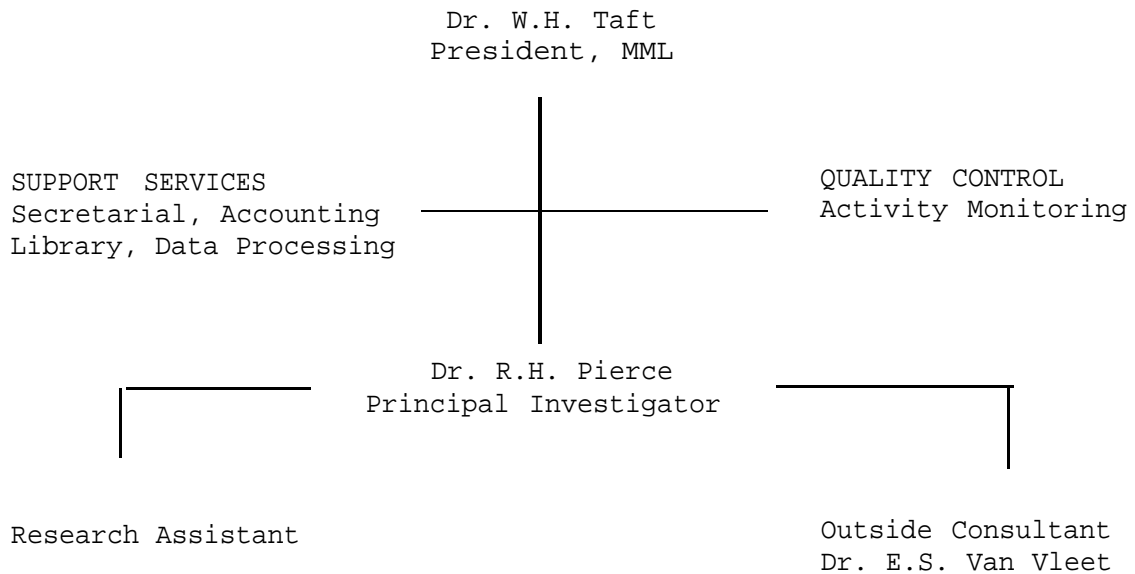
The outside consultant, Dr. Edward S. Van Vleet, is an Assistant Professor in the Department of Marine Science at the University of South Florida, St. Petersburg, Florida. He is a chemical oceanographer with extensive experience regarding hydrocarbons in the marine environment. Dr. Van Vleet has studied hydrocarbons in OCS regions (Van Fleet et al., 1976; Van Vleet et al., 1983), estuarine environments (Van Vleet and Quinn, 1977; Van Vleet, 1978; Van Vleet and Quinn, 1978; Van Vleet and Reinhardt, 1983) and pelagic tar (Van Vleet et al., 1983).

Dr. Van Vleet's responsibilities will be to review for completeness and accuracy the summary references (Task 2), the Draft Final Report (Task 3) and Final Report (Task 4). He will allot approximately 60 hours consulting for this project.

A Research Assistant (R.A.) will be required in addition to the professional chemical oceanographers described above. The R.A. will

assist the P.I. with obtaining reference material and will be responsible for maintaining the computerized data processing and retrieval system. During preparation of the manuscript, the R.A. will provide drafting assistance. Approximately 208 hours will be required by the R.A. for this project.

MML Project Management Organizational Chart



B. Subcontracts

No subcontracts will be required for this project. The outside expert used to review reports will be employed on a consultant basis. The consultant will work directly with the P.I., responding directly to specific reports. Timely completion reviews by the consultant will be monitored by the P.I. and the QC coordinator, Dr. Taft.

C. Scheduling Plan

The project shall be performed in accordance with the schedule of deliverables outlined in Section F of the Solicitation. Specific work

tasks have been identified. The duration of each task, deliverables and personnel time required are outlined below:

Personnel Time-Scheduling Chart

Month (After Award)	Deliverable	Task No.	Personnel Time (hours)			
			P.I.	R.A.	Typist	Consultant
1		1	24	16	0	
2		1,2	24	16	6	
3	1st Progress Report	1,2	24	24	6	8
4		1,2	24	24	8	8
5	2nd Progress Report	2,3	24	32	8	8
6		2,3	30	32	8	8
7	3rd Progress Report	3	32	32	8	8
8	Draft Final Report	3	36	32	24	12
9		4	8	0	0	
10	Final Report	4	24	0	12	8
↓						
20	Reprint	5				
	Total Hours		250	208	80	60

Total personnel time allotted for this project is 598 hours, or approximately 3.5 months.

D. Contingency Plan

Due to the nature of this project which involves literature review and evaluation, no problems are anticipated that would inhibit timely completion of the work. Back-up computer, word processing and reference acquisition facilities are readily available to MML staff so that downtime on any such equipment will not delay the project.

Timely completion of tasks will be monitored through bimonthly reports from the P.I. to the MMS COR and the Mote Marine Laboratory

President, Dr. Taft, who will provide quality control for activity monitoring. Any delays would be readily observable by comparison of progress reports with the proposed scheduling plan. In this event, the P.I. will respond in writing to the COR explaining the delay and providing a description of how the project will be brought back on schedule.

IV. Information Research, Interpretation and Synthesis

Location of research material (Task 1) regarding hydrocarbons in the marine environment is a continuing part of the P.I.'s on-going research. Reports relative to MMS- (and previously BLM-) sponsored projects have been obtained from the NTIS and by loan from the MMS library in Metairie, Louisiana. Other sources will be obtained through computer data base searches, from references cited in articles obtained and from contacting MMS personnel.

Interpretation of data from each reference and synthesis of these data into the Draft and Final Reports are described above within the Scope and Study Plan, Tasks 2 through 4.

V. Deliverables

A. Proposed Schedule

The Proposed Scheduling for task completion is as follows:

TASK 1: Complete within four (4) months after award.

TASK 2: Complete within six (6) months after award.

TASK 3: Draft Final Report complete within eight (8) months after award.

TASK 4: Final Report complete within thirty (30) days of receipt of MMS review, approximately ten (10) months after award.

TASK 5: Complete upon acceptance of Final Report for publication, within twenty (20) months after award.

B. Bimonthly Progress Reports

Bimonthly Progress Reports will be submitted detailing progress, accomplishments of milestones (Tasks), effort expended and problems which have arisen over the preceding two months. This report, along with examples of completed reviews, shall be submitted to the COR by the tenth (10th) day of alternate months beginning with the third (3rd) full month following signing of the contract award.

C. Draft Final Report

The Draft Final Report will be submitted to the COR in appropriate format for publication in the journal, Marine Pollution Bulletin. This report will be submitted on or before the end of the eighth month of the contract.

D. Final Report

The Final Report will be a copy of the scientific article that has been reviewed by MMS and is ready to be submitted to Marine Pollution Bulletin. A copy of the Final Report will be sent to COR within one month following receipt of MMS comments on the Draft Final Report.

E. Reprint

The reprint will be a copy of the article published in Marine Pollution Bulletin. This article will be submitted to the COR when available, depending on revisions required, lag time between acceptance and publication and receipt of reprints from the journal.

The organization and format of Draft and Final Reports will be as described in Section C (p. 7) of Solicitation No. 3016 (provided below). The number of copies and scheduling of deliverables will be as described in Section F (p. 9) of Solicitation No. 3016 (provided below).

F. Sections C and F of Solicitation No. 3016.

Section C: Specifications for Organization and
Format of Draft and Final Report

Section F: Schedule for Deliverables/Performance

**SECTION C
SPECIFICATIONS**

Specification for Organization and Format of Draft and Final Reports

I. General Organization

The organization of the draft and final reports shall follow the format required to meet the specifications of the scientific refereed journal where the article will be submitted.

A. Disclaimer Page

This is the first printed page of the report and must bear the following disclaimer:

For the Draft Final Report: "This draft report has not been reviewed by the Minerals Management Service, nor has it been approved for publication. Approval, when given, does not signify that the contents necessarily reflect the views and policies of the Service, nor does mention of trade names or commercial products constitute endorsement or recommendation for use."

For the Final Report: "This report has been reviewed by the Minerals Management Service and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Service, nor does mention of trade names or commercial products constitute endorsement or recommendation for use."

B. Acknowledgements

This section must acknowledge the support of the Minerals Management Service (MM) in funding the preparation and publication of article and any other support provided by the Department of the Interior through the Outer Continental Shelf- (OCS) Environmental Studies Program in funding the original studies that were used in developing the article.

The Contractor shall make corrections (i.e., typographical or grammatical in nature) to the draft final report as specified by MMS. Additions or revisions affecting the Contractor's interpretations, recommendations, or judgments shall be changed as mutually agreed upon. The MMS will have a total of 30 days for review of the draft final report.

SECTION F
DELIVERIES/ PERFORMANCE

I. Deliverables.

Deliverable products shall be submitted In accordance with the schedule provided hereunder:

Item 4.C. Bimonthly Progress Reports. Submit to:

MMS, Chief, Branch of Offshore Studies (644) One copy;
MMS, COR, Offshore Studies (644) Three copies; and
MMS, Contracting Officer (635) One copy

Due on or before: No later than the tenth day of every other month, beginning with the third month following the month of contract award, and continuing until submission of the draft final report.

Item 4.C. Draft Final Report. Submit to:

MMS, Chief, Branch of Offshore Studies (644) One copy;
MMS, COR, Offshore Studies (644) Three copies, and
MMS, Contracting Officer (635) Copy of cover letter only

Due on or before: Eight months following contract award. The MMS shall have thirty (30) days to review the report and notify the Contractor of the required changes, corrections, or additions.

Item 4.C. Final Report. Submit to:

MMS. Chief, Branch of Offshore Studies (644) One copy;
MMS, COR, Offshore Studies (644) Five copies; and
MMS, Contracting Officer (635) One copy

Due on or before: Thirty (30) days following receipt of MMS review comments.

Item 4.C. Reprints. Submit to:

MMS, Chief, Branch of Offshore Studies (644) One copy;
MMS, COR, Offshore Studies (644) Fifty copies; and
MMS, Contracting Officer (635) Copy of cover letter only

Due upon publication In journal

VI. Facilities

Mote Marine Laboratory (MML) is a private, nonprofit organization dedicated to research in marine science. It is located on City Island in Sarasota, Florida on a six-acre site fronting on both Sarasota Bay and New Pass to the Gulf of Mexico. The newly constructed research building of 18,000 square feet houses: a library of 2,750 volumes, 280 serials and 15,000 reprints; water chemistry, pesticide residue, bioacoustic, bioassay and environmental ecology laboratories; six general laboratories; collection room; five controlled environmental rooms; five administrative offices; an archives room; and a large conference/seminar hall. A separate 1,200 square foot building at dockside serves as the ship and boat maintenance facility, machine shop and carpentry shop. In addition, four well-equipped, air conditioned trailer laboratories house biomedical, microbiological, bioassay and toxic organic substance research programs, and two constant temperature rooms. Experimental tanks, all supplied with filtered seawater drawn from New Pass, include eight water tables (six environmentally controlled) and two 16-foot diameter circular pools. A tidally fed lagoon is used to maintain large experimental animals. A variety of boats and ships (total of 12) are available, ranging in size from 12 to 48 feet.

A. Administrative Facilities and Abilities

MML is staffed with adequate administrative personnel to ensure proper accounting and financial management of projects. As evidenced by

the Laboratory's research record and current projects, MML is familiar with federal accounting, procurement, quality assurance and reporting procedures. Typing, photocopying, and duplicating facilities are also available. Administrative and financial data are managed using an Apple II Plus Computer, telecom long-distance telephone logging, and other automatic systems. The existing administrative configuration is capable of managing a staff of 80 persons and the operations of approximately thirty grants and contracts. Independent audits of MML records are conducted each year and are available for inspection.

B. Information Services

1. Library

MML's library is well equipped to handle the literature requirements of this project. A librarian supervises all circulating, research, and archival materials, transmits interlibrary loan requests, and manages all information procurement. Computerized literature searches are conducted with the Laboratory's T.I. Silent 700 portable data terminal, which accesses the Lockheed Dialog Information System. The library is also equipped with a 3-M Model Microfiche reader and printer. The MML Librarian is an active member of the International Marine Laboratory Library Association.

2. Data Processing

MML owns a Heath H-8 computer with disc systems, video terminal and IDS 560 printer; three Apple II Plus Computers, each with two floppy disc drives, high-resolution terminals, and two printers; a Wang 300

Programmable Calculator; a Varian Vista 401 Chromatography Data System with CRT and disc drive for manipulation and storage of chromatographic analyses; and access to the Computer Facilities of the University of South Florida (IBM 370), and University of Florida (IBM 3033). The Apple computers are available for transmission of: 1) data (binary or report formats); 2) text (reports or direct communications); and 3) graphics (Versawriter Graphics Tablet).

LITERATURE CITED

- Atlas, R.M. 1981. Fate of Oil from two Major Oil Spills: Role of Microbial Degradation in Removing Oil from the Amoco Cadiz and IXTOC-1 Spills. Environ. Int. 5 :33-38.
- Bentz, A.T. 1980. Oil Spill Identification and Remote Sensing, In: Petroleum in the Marine Environment, L. Petrakis and F. Weiss, Eds., Adv. in Chem. Series, 185. ACS, Washington, D.C. pp. 55-86.
- Blumer, M. 1970. Dissolved Organic Compounds in Seawater: Saturated and olefinic hydrocarbons and singly branched fatty acids. W. Hood, Ed., Symposium of Organic Matter in Natural Waters, University of Alaska Press. pp 153-167.
- Blumer, M. and J. Sass. 1972. Indegenous and Petroleum-derived Hydrocarbons in and Oil Polluted Sediment, Mar. Poll. Bull. 6 :92-93.
- Boehm, P.D. 1979. Interpretation of Sediment Hydrocarbon Data, Vol. II, Chapter 10. Final Report for BLM-MAFLA Study, 1977/1978 project period. OCS Environmental Baseline Survey. pp. 572-607.
- Boehm, P.D. and J.G. Quinn. 1978. Benthic Hydrocarbons of Rhode Island Sound. Estuarine and Coastal Marine Science. 6 :471-494.
- Brooks, J_TM. 1979. Sources and distributions of petroleum hydrocarbons in the Gulf of Mexico: Summary of Existing Knowledge. Technical Report to NOAA, AOML, Miami, Florida. 55 pp.
- Brown, R.A. and L.H. Huffman, Jr. 1976. Hydrocarbons in Open Ocean Waters. Science. 191 :847-849.
- Calder, J.A. 1977. Seasonal variations of hydrocarbons in the water column of the MAFLA lease area, In: Fate and Effects of Petroleum Hydrocarbons in Marine Ecosystems and Organisms. D.A. Wolfe, Ed., Pergamon Press, New York. pp. 200-209.
- Chan, E.I. 1977. Oil Pollution and Tropical Littoral Communities: biological effects of the 1975 Florida Keys oil spill, Proceedings, 1977 Oil Spill Conference, NOAA, Washington, D.C. pp. 539-542.
- Dames & Moore. 1979. Mississippi, Alabama, Florida, OCS baseline environmental survey, 1977-1978. Report submitted to Bureau of Land Management, U.S. Dept. of Interior, Washington, D.C.

- deLappe, B.W. and R.W. Risebrough. 1977. Development of Methodologies for the in situ Extraction of Petroleum Compounds from Seawater. Unpublished Report, BLM, Dept. of Interior. p. 165.
- Erhardt, M. 1972. Petroleum hydrocarbons in oysters from Galveston Bay, Environ. Pollut. (3):357-271.
- Farrington, J.W. 1974. Some Problems Associated with the Collection of Marine Samples and Analysis of Hydrocarbons. Conference/Workshop on Marine Environmental Implications of Offshore Drilling in the Eastern Gulf of Mexico. USF, St. Petersburg, Florida.
- Farrington, J.W. and P.A. Meyers. 1975. Hydrocarbons in the marine environment. Chapter 5, In: Environmental Chemistry Vol. I. G. Eglinton, Ed., Specialists Periodical Report. The Chemical Society, London. pp. 109-136.
- Farrington, J.W. 1980. An Overview of the Biogeochemistry of Fossil Fuel Hydrocarbons in the Marine Environment, In: "Petroleum in the Marine Environment", L. Petrakis and F. Weiss, Eds., Adv. In Chem. Series No. 185, ACS. pp. 1-22.
- Gearing, P., J. Gearing, T.F. Lytle and J.S. Lytle. 1976. Hydrocarbons in 60 Northeast Gulf of Mexico Sediments: A preliminary survey. Geochim. et Cosmochim. Acta. 40 :1005-1007.
- Iliffe, T. and J.A. Calder. 1974. Dissolved Hydrocarbons in the Eastern Gulf of Mexico Loop Current and Caribbean Sea. Deep Sea Research. 21 :481-488.
- Jeffrey, L.M., W.E. Pequegnat, E.A. Kennedy, A. Vos and B.M. James. 1974. Pelagic tar in the Gulf of Mexico and Caribbean Sea, NBS Special Publication, 409, Marine Pollution Monitoring. pp. 233-235.
- Laflemme, R.E. and R.A. Hites. 1978. The Global Distribution of Polycyclic Aromatics in Recent Sediments. Geochim. Cosmochim. Acta. 42 :280-303.
- McAuliffe, C.D. 1976. Surveillance of the marine environment for hydrocarbons. Mar. Sci. Commun. 3 :13-42.
- McAuliffe, C.D. 1977. Evaporation and solution of C₂ to C₁₀ hydrocarbons from crude oils in the sea surface. In: D.A. Wolfe, Ed., Fate and Effects of Petroleum Hydrocarbons in Marine Organisms and Ecosystems. Pergamon Press, New York. pp. 363-372.
- Meyers, P.A. 1976. An Extension of the baseline compositions of hydrocarbons in benthic epifauna of the OCS of the Eastern Gulf of Mexico. Report submitted to Bureau of Land Mgmt., U.S. Dept. of Interior, Washington, D.C.

- Parker, P.L. and D. Mensel. 1974. Effects of Pollutants on Marine Organisms. Nat. Sci. Foun. IDOE. Washington, D.C. p. 46.
- Petrakis, L., D.M. Jewell and W.F. Benusa. 1980. Analytical Chemistry of Petroleum: An Overview of Practices in Petroleum Industry Laboratories with Emphasis on Biodegradation. In: "Petroleum in the Marine Environment", Adv. in Chem. Ser. No. 185, ACS, Washington, D,C. pp. 23-54.
- Pierce, R.H., Jr., A.M. Cundell and R.W. Traxler. 1975. Persistence and Biodegradation of Spilled Residual Fuel Oil on an Estuarine Beach. Applied Micro. 29 (5):646-707.
- Pierce, R.H. 1980. Petroleum Associated with Spent Drilling Fluid. Paper presented at the American Chemical Society SE/SW Regional Meeting, New Orleans, La. Dec. 10-13.
- Pierce, R.H., Jr., D.C. Anne', F.I. Saksa and B.A. Weichert. 1984. The Fate of Select Organics from Spent Drilling Fluid Discharged to the Marine Environment. Proceedings, Third International Ocean Disposal Symposium, Woods Hole, Massachusetts. I.W. Duedall, Ed. In Press.
- Pierce, R.H. Jr., B. Weichert and G. Miller. 1981. Hydrocarbon Analysis of Surficial Sediment from the West Florida Shelf. Final Report to the Bureau of Land Management, D.O.I., Southwest Florida OCS Study.
- Pierce, R.H. and R.C. Brown. 1982. Analysis and Characterization of Tar Collected in New Pass, Sarasota Bay, Florida. Special Report to the County of Sarasota, Environmental Services. 8 pp. Unpublished document.
- Pierce, R.H., R.C. Brown and E.S. Van Vleet. 1982. Study of Hydrocarbons in the Recent Sediment of Charlotte Harbor, Six-month Final Report to Florida Dept. of Natural Resources. 104 pp.
- Pierce, R.H. 1982. Synthesis of Results, Year-I and Year-II: Hydrocarbon Analysis of Surficial Sediment, Southwest Florida Shelf study. Report submitted to Continental Shelf Associates, Tequesta, Florida.
- Romero, G.C., G.R. Harvey and D.K. Atwood. 1981. Stranded Tar on Florida Beaches: September 1979-October, 1980. Marine Pollution Bulletin. 12(8):280-284.
- Sackett, W.M. and T.M. Brooks. 1975. Origin and distribution of low-molecular-weight hydrocarbons in Gulf of Mexico coastal waters, In: Marine Chemistry of the Coastal Environment, T.M. Church, Ed., Am. Chem. Soc. Symposium Series 18. pp. 211-230.

- Sauer, T.C., Jr. 1980. Volatile Liquid Hydrocarbons in Waters of the Gulf of Mexico and Caribbean Sea. *Limnol. Oceanogr.* 25(2):338-351.
- Shaw, D.G. 1977. Hydrocarbons in the Water Column. In: *Fate and Effects of Petroleum Hydrocarbons in Marine Organisms and Ecosystems*, D.A. Wolfe, Ed., Pergamon Press, New York. pp. 8-18.
- SUSIO. 1976. Baseline Environmental Survey of the MAFLA Lease Areas CY, 1974; State University System of Florida Institute of Oceanography. Report submitted to Bureau of Land Management, U.S. Department of the Interior, Washington, D.C.
- SUSIO. 1977. Baseline Monitoring Studies, Mississippi, Alabama, Florida, OCS, 1975-1976, Volumes I-VI. State University System of Florida Institute of Oceanography. Report submitted to Bureau of Land Mgmt., U.S. Dept. of Interior, Washington, D.C.
- Traxler, R.W. and R.H. Pierce, Jr. 1974. Standards and Intercomparison Criteria: Tar Balls and Particulate Matter, Proceedings of the International Marine Pollution Monitoring (Petroleum) Symposium and Workshop, May 1974, U.S. Department of Commerce, National Bureau of Standards, Washington, D.C. pp. 161-162.
- Van Vleet, E.S., T.L. Wade and J.G. Quinn. 1976. Draft Environmental Statement, Outer Continental Shelf Sale No. 42 - Hydrocarbon Review. In: *Review of the Draft Environmental Impact Statement*. Prepared for the New England Regional Commission at the Coastal Resources Center, Graduate School of Oceanography, University of Rhode Island. Nov. 3.
- Van Vleet, E.S. and J.G. Quinn. 1977. Input and fate of petroleum hydrocarbons entering the Providence River and Upper Narragansett Bay from wastewater effluents. *Environ. Sci. Technol.* 11:1086-1092.
- Van Vleet, E.S. 1978. Diagenesis of Hydrocarbons, Fatty Acids, and Isoprenoid Alcohols in Marine Sediments. Ph.D. Thesis, Univ. of R.I. 232 pp.
- Van Vleet, E.S. and J.G. Quinn. 1978. The contribution of chronic petroleum inputs to Narragansett Bay and Rhode Island Sound sediments. *J. Fish. Res. Bd. of Can.* 35:536-543.
- Van Vleet, E.S., W.M. Sackett, F.F. Weber, Jr. and S.B. Reinhardt. 1983. Spatial and temporal variation of pelagic tar in the Eastern Gulf of Mexico. *Advances in Organic Geochemistry*. In Press.

- Van Vleet, E.S. and S.B. Reinhardt. 1983. Inputs and Fates of Hydrocarbons in a Subtropical Marine Estuary, *Oceanography International*. In Press.
- Wade, R.L. and J.G. Quinn. 1979. Geochemical distribution of hydrocarbons in sediments from mid-Narragansett Bay, Rhode Island. *Org. Geochem.* 1 :157-167.
- Wakeham, S.G. and J.W. Farrington. 1980. Hydrocarbons in Contemporary Aquatic Sediments, In: *Contaminants and Sediments*, Vol. 1, R.A. Baker, Ed., Ann Arbor Science, Ann Arbor, Mich. pp. 3-32.
- Woodward-Clyde Consultants. 1982. Southwest Florida Shelf Ecosystems study, Year-I. Report submitted to Minerals Management Service, U.S. Dept. of Interior, Metairie, Louisiana.
- Zsolna, A. 1973. Hydrocarbon and Chlorophyll: A Correlation in the Upwelling Region off West Africa. *Deep Sea Research.* 20 :923-925.