

RESEARCH PRE-PROPOSAL: ENVIRONMENTAL PROTECTION AGENCY

Minority Initiations Research Support Program

"THE CHARACTERIZATION OF AIRBORNE PARTICULATES, AND THEIR TOXIC PROPERTIES
IN A PETROLEUM-PETROCHEMICAL INDUSTRIAL ENVIRONMENT"

Submitted by: INSTITUTE FOR ENERGY, ENVIRONMENT, AND BIOMEDICAL SCIENCES
(IEEBS), Catholic University of Puerto Rico in collaboration with CENTER FOR ENERGY AND
ENVIRONMENT RESEARCH.

Project Director: _____

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(CEER), University of Puerto Rico.

Project Director: President, UPR A. Director, CEER

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"THE CHARACTERIZATION OF AIRBORNE PARTICULATES AND THEIR TOXIC PROPERTIES IN A PETROLEUM-PETROCHEMICAL INDUSTRIAL ENVIRONMENT"

Abstract: Selected hydrocarbons, and other air contaminants in particulate matter in a heavily industrialized site in tropical Puerto Rico will be isolated, identified, and characterized, by various chromatographic and spectrometric methods.

Means, a special effort will be dedicated to establishing the size distribution of airborne particulates and to identifying the nitrogen and sulfur-containing polycyclic aromatic heterocompounds, volatile hydrocarbons and potentially toxic trace elements. The mutagenic and teratogenic effects of selected fractions will be studied in an effort to define some toxic properties that could help in predicting potential hazards concerning human health. Knowledge of composition and size distribution of particulate material, chemical transformation of pollutants and its associated toxicological effects will support biomedical studies in Puerto Rico dealing with a very wide spectrum of personal discomfort and illness.

Of particular significance to the study is the fact that (1) major industrial plants in the south coast petroleum-petrochemical complex have reduced operations or closed down temporarily. This could help establish the impact of their respective operations on the overall quality of the region's airborne particulates; and (2) current efforts to obtain a dispensation from having low sulfur content fuel oils on the basis that no further cost to human well-being and environmental health will occur could turn out to be detrimental to the air quality of the region.

Biographical sketch of Key Personnel: Juan J. Rigau, Ph.D., Project Director, Center for Energy and Environment Research, University of Puerto Rico, Institute for Energy, Environment and Biomedical Sciences, Catholic University of Puerto Rico. Richard R. Eckert, Ph.D., Principal Investigator, Institute for Energy, Environment and Biomedical Sciences, Catholic University of Puerto Rico. Arnaldo Carrasquillo, Ph.D., Principal Investigator, Institute for Energy, Environment and Biomedical Sciences, Catholic University of Puerto Rico. Gabriel A. Infante, Ph.D., Principal Investigator, Institute for Energy, Environment and Biomedical Sciences, Catholic University of Puerto Rico. Hilda Lopez Ubpez, Ph.D., Principal Investigator, Center for

Mergy and Environment Research and Medical Sciences Campus, University of Puerto Rico. Gos6 A. Carrasco, Ph.D., is the Principal Investigator for the Center for Energy and Environment Research and Medical Sciences Campus at the University of Puerto Rico.

Juan J. Rigau, B.Sc. MSc, held a previous position at the University of Puerto Rico; Ph.D., Wayne State University; Head of Fossil Fuels Research, Director of Project 60 (Biodegradation of Organic Sulfur Compounds in High Sulfur Crude Oils), and Project 48 (Biodegradation of Hydrocarbons in Venezuelan Extra-Heavy Crude Oils). His research interests include sulfur chemistry in petroleum, petroleum and coal biodegradation, fossil fuel composition, and the environmental impacts of fossil fuel utilization. Secondary interests focus on energy and environment policy formulation, high volume applications of sulfur, and solar energy.

He was the Director of the Office of Petroleum Fuels Affairs, in the Office of the Governor, from 1973 to 1976. He served as an Energy and Environment consultant to the Economic Development

Administration from 1969 to 1973. He was a Research Fellow for sulfur chemistry exploratory research at Wayne State University from 1965 to 1969 and a Research Assistant at the Puerto Rico Nuclear Center from 1960 to 1965.

He has also served as a consultant to several institutions of higher education, and is a former member of the "Senior Energy Advisory Committee", CHER. He is a former president of the College of Chemists of Puerto Rico and a member of Sigma XI, Phi Lambda Upsilon, Who's Who in Government, ACS, and the College of Chemists. He has published over ten papers in refereed journals and has made extensive oral presentations in his research fields of interest.

Curriculum Vitae: Richard R. Rokert

Age: 36 years

Marital Status: Married, 1 daughter

Education: PhD, University of Kansas, Kansas, Physics, 1971

M.S., University of Kansas, Kansas, Physics, 1965

B.S., Case Institute of Technology, Cleveland, Physics, 1964

Position: Professor of Physics, Catholic University of Puerto Rico since 1978, with tenure granted in 1976. He was an Associate Professor from 1973 to 1978 at CUPR and an Assistant Professor from 1971 to 1973 at UCPR.

Publications: He has published about

15 papers in the areas of Physics, air pollution, and computer models by Richard Eckert, 1979, titled "Particulate Contamination in Puerto Rico." Published in Physics Researcher, \$1, pages 32-32. Presentations: about 20 oral presentations in the same fields. Services: President, Puerto Rico Chapter of American Association of Physics Teachers, 1978-1979. Principal Investigator for NIU-MES Grant No. 34606-RR-08067-0851, "Atmospheric Particulate as a Public Health Hazard." Catholic University representative on the Puerto Rico Council for Higher Education, Accreditation Committee for Electronic Data Processing Colleges.

Arnaldo Carrasquillo

Birth Date: December 7, 1937

U.S. citizen

Education: Ph.D. Organic Chemistry, Ohio State University, Columbus, 1971

M.S. Organic Chemistry, University of Puerto Rico, Rio Piedras, 1966

B.S. Organic Chemistry, University of Puerto Rico, Rio Piedras, 1959

Positions: Professor of Chemistry, Catholic University of PR, 1979 - present (Tenure granted in 1976)

Biomedical Research Program Director, 1976-1978, CURR. Associate Professor, CUPR, 1973-1978

Assistant Professor, CURR, 1971~1973

President, Puerto Rico Section, American Chemical Society

Research Areas: Organic Chemistry, Natural Products Chemistry, Photochemistry, Environmental Chemistry

Research Grants: Biomedical Research Grant from MAS Program, U.S. National Institute of Health.

Publications: About ten (10) publications in organic chemistry About thirty (30) oral presentations in the same areas.

BRIEF CURRICULUM VITAE

Gabriel A. Infante

Birth Date: November 3, 1945

Address: Department of Chemistry

Place: Havana, Cuba

Catholic University of PR

Citizenship: United States

Ponce, PR 00731

Education: B.S. Chemistry, 1967, Catholic University of P.R.

M.S. Chemistry, 1969, University of Puerto Rico, Mayaguez

Ph.D. Chemistry, 1973, Texas A&M University, Texas

Post-Doctoral: Radiation Chemistry, 1974, Carnegie Mellon University, Pittsburgh

Undergraduate: Medals Analytical, Organic Physical and Industrial chemistry

Graduate:

Graduation: Graduated with outstanding grades from Texas A&M University, 1973.

Professional Achievements:

- Recognized as the Outstanding Educator of America, 1975.
- Featured in *Who's Who of South and South West*, 1976.
- Served as Chairman of the American Chemical Society, Puerto Rico, 1977.
- General Chairman of the IX Caribbean Chemical Conference, December 1977.
- Chaired the Advisory Committee on Chemistry 1977-1978.

Positions Held:

- Associate Professor with Tenure, Department of Chemistry, Catholic University of Puerto Rico, 1976 to date.
- Director of Biomedical Research Program, Catholic University of Puerto Rico, 1978 to date.
- Associate Scientist, Center for Energy and Environment Research.

Research Areas:

- Radiation Chemistry.
- Cancer Research.
- Micellar Chemistry.
- Environmental Chemistry and Pollution.

Grants:

- Received Biomedical Research Support Grant from WS Program and National Cancer Institute, U.S. National Institute of Health, and U.S. Energy Office through the Puerto Rico Center for Energy and Environment Research.

Publications and Presentations:

- Published about forty (40) articles in scientific journals, mainly in the areas of Radiation

Chemistry, Micellar Chemistry, and Pollution.

- Delivered approximately sixty (60) oral presentations in scientific meetings and conferences in the same areas described above.

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About Wida Tepen-Lopez, B.Sc., M.Sc., Ph.D. - University of Puerto Rico:

Positions Held:

- Assistant Professor, Department of Anatomy, School of Medicine, University of Puerto Rico.

Primary area of interest: Embryology.

- Guest lecturer at Daron Medicine, Catholic University of P.R, 1977-1978, while on leave of absence from the University of Puerto Rico.

- Assistant Professor, School of Medicine, University of P.R., 1976.

- Instructor, University of P.R., 1965-1975.

- Research Assistant, University of P.R., 1964-1965.

Additional Interests:

- Director of the Embryology and the Musculo-skeletal courses of Human Biology I for Medical students.

- Director of the Histology course for Dental students.

- Thesis Advisor for graduate students in the Department of Biology, University of P.R.

- Thesis Advisor for graduate students in the Department of Anatomy, School of Medicine.

"Cine, University of P. Rez, member of the Human Biology I Committee, member of the Cardiorespiratory, and the Renal and Urogenital sub-committees of Human Biology I; Member of Beta, Beta, Beta Honorary Society. Has worked in three investigations (in preparation for publication) and made several oral presentations on her research findings on cytological changes in the pars distalis of the hypophysis of Anoline lizards under various conditions.

A. Carrasco-Canales, B.Sc, M.T., M.S, Ph.D., Assistant Professor, Department of Microbiology and Medical Zoology, School of Medicine, University of Puerto Rico. Previous position: collateral interest. Primary area of interest: Mycology, Molecular Genetics and Mutagenicity of carcinogens on Bacteria. Secondary interest in Microbial Physiology and Immunology. Instructor in Microbiology, Dept. of Microbiology, School of Medicine of the University of Puerto Rico from 1963-1974; Assistant in Mycology, Dept. of Microbiology, School of Medicine of the University of Puerto Rico from 1962-1963. Director of the Infectious Diseases Block for 2nd year Medical Students, member of the Human Biology II Committee. Member of the Promotions Committee for 2nd year Medical students, member of the Awards' Committee of the University of Puerto Rico School of Medicine. Has worked on investigations in Mycology and Molecular Genetics leading to four publications and one more in progress.

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"Inotashoomisa-HnatoUiaE V NI SatdmEdond Oixol NISL aNY Sauwtinotiave Anyomety Jo

Nolewzthblowavhd SIL" is not clear and cannot be corrected without context.

1. Objective of this project: This proposal attempts to develop an interdisciplinary cooperative program involving the recently created Institute for Energy, Environment, and Biomedical Sciences of the Catholic University of Puerto Rico and the Center for Energy and Environment Research of the University of Puerto Rico. The program aims to carry out the following objectives:

Principal objectives:

1. Initiate a systematic effort to characterize potentially toxic trace elements and organic constituents (especially sulfur and nitrogen derivatives) downwind and upwind of the neighborhood of a petroleum-petrochemical complex. It also aims to correlate the structure of the molecules detected with their possible mutagenic and teratogenic effects. Extracts from particulate matter of various sizes will be obtained and evaluated for biological activity.

2. Improve our knowledge of sources of toxic substances by studying airborne particulate composition with an orientation to establish (a) if the particulate matter in the south coast industrial complex is responsible for impacting the atmosphere from neighboring cities downwind from the complex and (b) if the particles bearing these contaminants are small enough to be deposited efficiently in human lungs.

Subordinate objectives:

1. Study the transformation of individual reactive chemicals and that of their primary conversion products by exposing them to filtered air from the region of interest and/or to specific major contaminants.
2. Employ air pollution computer simulation methods to correlate the chemical nature of the contaminants with the prevailing meteorology of the region.
3. Conduct research in areas remote from immediate sources of pollution to provide background values in areas directly unaffected by point source emissions.
4. Train research scientists and students in environmental health research by developing an interdisciplinary research program.

To increase our knowledge of toxic substances in the environment.

C. Statement of Problem

In the last three decades, Puerto Rico has experienced highly significant economic development, based on the industrial sector (Appendix 1, Table I). A considerable number of industries are established annually. They exploit petroleum derivatives both as raw material and as energy sources directly and indirectly (Appendix I, Table XII) and generate environmental impacts of concern to the general population.

Appendix I, Figure 1a shows some chemical considerations relevant to the sulfur and nitrogen derivatives present in crude oil. Knowledge of crude oil composition is necessary to better

understand the complexity of the stack emissions in a refining-petrochemical complex.

Both with respect to point and area sources, the industrial areas comprising the Cataño and Guayanilla-Peñuelas municipalities (Appendix I, Figure 2) bear the brunt of the pollutants emitted in Puerto Rico. Therefore, because of its proximity to the Catholic University of Puerto Rico research facilities, and the fact that the petroleum-petrochemical complex has been the subject of numerous citizens' complaints because of its emitted pollutants, we have selected the Guayanilla-Peñuelas area as the subject of this proposal, with a long-range objective of studying other sites and the effects of air pollutants on human health in Puerto Rico.

Figure 2 shows some major air pollution related issues. South coast residents living close to or downwind from the Guayanilla-Peñuelas industrial site are potentially exposed to

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Square mile. In general, the major pollutants of concern in the Guayanilla-Peñuelas area are those associated with fossil fuel combustion (Appendix I, Table 12) and those related to petroleum-petrochemical operations (Appendix I, Figure 3). The production and subsequent reactivity or degradation of these emission constituents, in combination with particular meteorological conditions, have led to photochemical oxidants, chemical carcinogens, and particulate materials. These particles are heterogeneous in size, shape, chemical contents, etc., depending on the type of process and other parameters. All the polynuclear aromatic hydrocarbons

(PAH) are contained in the particulate emissions, and some of them are the most potent carcinogens known. The pollution attributed to particulate matter, which contains the carcinogenic PAH, was estimated at 98,123 tons in 1970, which were generated in the Guayanilla-Penuelas area.

Unfortunately, the text provided in this section is not clear and seems to contain non-English words and phrases.

The damages associated with air pollution include the costs associated with damage to human health, the costs of pollution-related cleaning and maintenance activities, the costs of inhibited growth and destruction of plant and animal life, and the reduction in property values. For instance, sulfur dioxide, an acidic, corrosive, poisonous gas produced almost entirely by the burning of fuel containing sulfur as an impurity, can cause temporary or permanent injury to the respiratory system.

System. When particulate matter is inhaled with adsorbed sulfur dioxide, health damage may significantly increase. Sulfur dioxide can irritate the upper respiratory tract. Carried into the lungs on particles, it can injure delicate tissue. It has been known that some of the mechanisms for the transformation of sulfur dioxide to sulfate involve homogeneous, photochemical, gas phase conversion to particles. Other mechanisms involve heterogeneous reactions in liquid droplets or in liquid films on the surface of solid particles. It is entirely possible that more than one of these mechanisms may contribute concurrently to the conversion of sulfur dioxide to sulfate in the atmosphere.

On the other hand, hydrocarbons represent unburned and wasted fuel. Normally, the gaseous hydrocarbons at concentrations found in the atmosphere are not toxic, but they are a major pollutant because of their role in forming photochemical smog. Particulate matter, derived from fuel combustion such as power plants (Appendix, Table II) and automobiles, containing metallic, polynuclear aromatic hydrocarbons, sulfurated, nitrogenated, and oxygenated substances have been shown to exhibit carcinogenic and co-carcinogenic properties in experimental animals and have been associated with the incidence of various types of cancer in humans.

Although great efforts are underway to study the isolation, identification, and reactivity of these compounds in other parts of the world, very little or no information is available for Puerto Rico. Guayanilla's air, containing one of the highest pollution levels in Puerto Rico, is the source of numerous resident complaints of pollution-related health problems. Two medical studies have found evidence to back their allegations. In Guayanilla, residential neighborhoods lie several miles downwind from a highly integrated petroleum-petrochemical complex with the combined smokestacks of PPG, the Commonwealth Oil Refining Co., Union Carbide Water Resources Authority.

Puerto Rico's power plants and other factories have been a source of pollution. Over the past three years, residents from various neighborhoods, including Villa El Rio, Guayanilla Beach, and Magas, have united to form anti-pollution committees. The size distribution of elements and organic compounds in particulates has significant implications for environmental health. It has been found that contaminants are most effectively extracted into the human bloodstream from small particles.

Particles less than about one micrometer in equivalent aerodynamic diameter predominantly deposit in the alveolar regions of the lungs where the absorption efficiency for most trace elements is 60 to 80 percent. Larger particles, on the other hand, deposit in the nasal, pharyngeal, and bronchial regions of the respiratory system and are removed by ciliary action to the stomach where absorption efficiency is commonly only 5 to 15 percent for most trace elements. The lung is therefore the major gateway to the bloodstream for toxic elements present in airborne particles.

More recent results show that over 90% of polycyclic aromatic hydrocarbons are found on particles smaller than one micrometer. About 75% of the benzo(4)pyrene and 85% of the coronene are associated with particles of an aerodynamic diameter less than 0.26 micrometers. Almost half of the total mass of both polynuclear hydrocarbons are associated with aerosols in a very narrow size range (0.075 - 0.12 micrometers). The available evidence suggests that polynuclear aromatic hydrocarbons mainly contribute to the smaller size particles, which have a high probability of being absorbed in the pulmonary region of the respiratory tract.

A recent Health Department Report found that more than 30 percent of all patients admitted into emergency rooms in Cataño and Guayanilla during 1975 and 1976 suffered from pollution-related ailments (e.g., asthma, allergies, irritation, and broncho-pulmonary diseases). In relatively pollution-free areas like Luquillo and Naguabo, however, such cases were notably less.

However, only ten percent of the cases were linked to pollution. Furthermore, the study alleged to have found a correlation between cancer deaths and polluted areas. Southern coastal plain vital statistics are shown in Appendix I, Table 4.

Tomás Morales Cardona, a biophysicist and professor at the University of Puerto Rico Medical school, measured the lung capacity of 454 residents of Cataño and found that more than five percent of them had an obstructive respiratory disease, such as asthma, bronchitis or emphysema, and 50 percent suffered from problems in their upper respiratory system such as allergic reactions, nasal problems, and sore throats.

In similar tests on 397 residents of Santa Isabel, only one person, 0.25 percent, was found with a lung disease. Morales, who carried out similar tests in Guayanilla, told us he will finish analyzing his data in the next few months.

The Environmental Quality Board (EQB) is now asking the federal government to designate Guayanilla and Cataño as "central regions" under the Clear Air Act. This designation would prohibit any more air polluting industries from coming in. The EQB is now in the process of validating the air pollution dispersion model to determine whether compliance plans due June 30, 1979 will be strict enough to bring Guayanilla within the federal standard, or whether further actions will have to be taken.

In 1972, the Environmental Quality Board (EQB) prohibited the use and sale of fuel anywhere on the island containing more than 2.0 percent sulfur after April, 1973. Although other levels in other areas are higher, a figure of one percent was set on fuel burned in Guayanilla.

The system has eight intermittent monitors, four to measure particulates and four for sulfur dioxide,

which provide a reading every six days. It also records data from eight Water Resources Authority sulfur dioxide monitors that operate continuously. The intermittent samples, which yield about 50 readings per year, are statistically valid, but may miss many of the peaks in pollution levels, which can significantly vary between different days and hours of the day.

Today, there is a better understanding of the process of environmental assessment (Appendix A, Figure 1b) and the influence of heavy fuel oil composition and boiler conditions on particulate emissions has been reported. Atmospheric contamination depends on a multitude of factors, with the most pertinent being the type, quantity, and location of the emission source, and the specific atmospheric patterns capable of displacing and diluting the gaseous and particulate pollutants.

The diluting effect is produced by weather conditions such as temperature, wind direction and velocity, humidity, and rainfall. Precipitation aids in clearing the air of solid impurities by depositing them on pastures, rivers, lakes, etc. Some of the contaminants are dissolved, some are mechanically flushed down by the condensation of water vapor, and some interact photochemically to form photooxidants as end products.

The predicted particulate and sulfur dioxide concentrations for 1978 and 1985 are shown in Appendix I, Tables VI-VII, and Figure 6. The predicted particulate air quality levels for both 1978 and 1985 were found to exceed the primary particulate standards (75 mg/nm³ annual geometric mean) in the following Air Quality Maintenance Areas (AQMA): San Juan, Guayanilla, Ponce (1985 only), Mayaguez, Dorado, Guanica (1985 only).

The sulfur dioxide standards (80 mg/m³ annual arithmetic mean) were also found to be exceeded both in 1978 and 1985 in several AQMAs: San Juan, Guayama (1985 only), Guayanilla, Yabucoa (1985 only), and Dorado (1985 only).

Only, "These results show an indication of the seriousness of our environmental problem. However, any interpretation of ambient level measurements and air quality trends must consider the serious limitations of present data-collection practices. More importantly, in Puerto Rico, up to now, there have been no efforts (with the exception of isolated measurements on total particulates and trace metals) oriented to generate badly needed information on reactive volatile hydrocarbons, polycyclic aromatic hydrocarbons, metals, or photo chemical oxidants."

"To help solve this crucial lack of environmentally significant information, work will be conducted by researchers of the Institute for Energy, Environment, and Biomedical Sciences of Catholic University of Puerto Rico in collaboration with the Fossil Fuel Research Program of the Center for Energy and Environment Research. This is an attempt to elucidate for the first time some of the chemical and biological aspects of pollution in the Guayanilla-Pefuelas area. Clearly, this study is badly needed to support preventative medical care programs in Puerto Rico." (Appendix I, Figures 4 and 5)

2. Results and/or Benefits Expected

This proposal attempts to:

1. Improve our knowledge of the chemical composition of the volatile hydrocarbons and the acidic, basic, neutral, and polar fractions isolated from airborne particulates in the neighborhood of a petroleum-petrochemical environment. This is necessary to obtain a better understanding of the potential health hazards associated with the transport and penetration of particulates into the respiratory system.

2. Measure both the size distributions and chemical composition of particles in ambient air, in order to understand the sources and the behavior of airborne particulates in the atmosphere. Observations on size distributions of trace elements and/or key organics in particulates, if sufficiently distinctive, could be used as a means of source identification if data on size distributions is available.

Particles from specific types of sources were available. The proposed research aims to correlate toxic properties such as mutagenic and teratogenic effects with the chemical composition of selected test fractions.

The proposed research will also be of significance to cancer epidemiology studies underway at the Center for Energy and Environment Research of the University of Puerto Rico. It will also aid field, clinical, toxicological, and laboratory investigations to be undertaken at the recently created Institute for Energy, Environment, and Biomedical Sciences at the Catholic University of Puerto Rico.

The research will help initiate work toward establishing a damage function for the Guayonilla-Pefuelas area. Researchers at the Catholic University of Puerto Rico are currently planning studies to characterize the nature and magnitude of the population at risk affected by given levels of pollutants.

The research will also strengthen the infrastructure for studies related to the atmospheric emissions arising from coal or coal-oil slurries combustion power plants. These fossil fuels are alternatives currently under the active consideration of our government energy policymakers. Studies on the nature of air emissions will affect decisions regarding control techniques before or after combustion.

The research will provide public officials with an effective database for efficiently allocating limited resources among the many conflicting demands for pollution control and other aspects of social welfare. It will act as a vehicle for the training of environmental health scientists and for continuing mission-oriented research at the Catholic University of Puerto Rico and the Center for Energy and Environment Research.

Research Plan

Research Approach 2: Background

Although reactive hydrocarbons have been fully recognized in the past two decades as having an important role in the photochemical reactions of air pollutants, the techniques for the isolation and quantitation of the ambient hydrocarbons, due to their sub-ppm concentration and complex mixture, remain challenging.

Reports detailing these phenomena have only recently started to emerge. For instance, the earliest description of atmospheric hydrocarbons was made by Eggeraten and Nelsen in 1959. Their procedure for trapping large volumes of air and some data for atmospheric analyses were included. A monitor of the C1 to C6 aliphatic hydrocarbons in the Los Angeles atmosphere was then presented by Beligan. The individual analysis of C3-C12 hydrocarbons in Paris was conducted by Raymond and Guiochon. Auto exhaust was identified as a common source for most of the individual aliphatic and aromatic hydrocarbon species in the atmosphere. Touw, Richards, and Faure have described a versatile GC method for the determination of C1-C12 volatile organic compounds in city air and applied it to the identification of more than 200 volatile organics occurring in the air of three large South African cities. The identification of the volatile compounds in city atmosphere has been accomplished by others employing the more powerful GC/MS technique. Altshuller and Bufalini have reviewed the hydrocarbon photooxidation mechanisms covered in the literature through 1964. More recently, Altshuller has reviewed the formation and removal of SO₂ and oxidants from the atmosphere. The review describes the transport and chemical transformations of organics, nitrogen oxides, and ozone, and the conversion of sulfur dioxide to sulfates and the transport of these species. Stephens and co-workers reported rates of reaction of aliphatic hydrocarbons in the ultraviolet irradiation of atmospheric samples. However, Altshuller and co-workers cited that the acetylene reaction is undetectable and butane reacts very slowly with natural sunlight. Also, the report shows that no marked synergistic effects on rates of hydrocarbon reaction were observed in comparing the irradiation of these complex atmospheric hydrocarbon mixtures with the laboratory irradiations of single hydrocarbons with nitrogen oxides. In addition to the light.

Hydrocarbons and heterocompounds, the polynuclear aromatics, are frequently found in the dust-fall of polluted atmospheres. However, no data is available on these potentially carcinogenic compounds in this island.

The composition of polynuclear aromatics extracted from airborne particulates will obviously be dependent on the extraction and purification procedure involved and could also depend on the size distribution of airborne particulates. Recent reports have shown the presence (Table 11) of a number of sulfur-containing heterocyclics, aza-arenes, and polycyclics with partially saturated rings. Compositional studies on particulates are of great environmental concern because of a wide environmental distribution of particulates obtained from various combustion processes, and the potent mutagenicity of a number of compounds adsorbed on particulates such as certain polycyclic aromatic hydrocarbons (PAH).

Figure 2 shows Azanarenes formed as trace pollutants by the incomplete combustion of N-containing organic matter have been found in the basic fraction of New York City's suspended particulate matter. Azanarenes, with the exception of neutral indole and carbazole homologs, are found in the basic organic fraction of suspended particulate matter. Although, in general, this fraction only constitutes a small percentage (0.5 ~ 3%) of the organic matter, bioassay data have shown the basic fraction to be carcinogenic to infant mice when administered subcutaneously.

The benzene extractable compounds from airborne particulate matter from a residential area were separated into neutral, acidic, and basic substrates. In the neutral fraction, saturated aliphatic

hydrocarbons, polynuclear aromatic hydrocarbons, and polar oxygenated substances were identified. The acidic fraction consisted mainly of a homologue series of fatty acids and aromatic carboxylic acids, some...

The text contains hydroxy substitutions among them. The basic fraction consists of nitrogen-containing analogues of the important polyaromatic hydrocarbons present in the neutral fraction. Pierce and Katz have described a method for the analysis of polycyclic quinones derived from polynuclear aromatic hydrocarbons.

9,10-Anthraquinone, benzo(4)pyrene-6,12-quinone, benzo(1)pyrene-1,6-quinone, benzo(3)pyrene-3,6-quinone, and dibenzo(b,def) chrysene-7,14-quinone were identified in samples of suspended particulate matter collected in Toronto, Ontario. The carcinogenic activity of a particular compound is very dependent on its structure, shape, size, electronic, and steric factors. All seem to be important.

For example, the addition of alkyl substituent groups in different positions on the ring of certain PAHs can either have an activating or deactivating influence. Similarly, the substitution of a sulfur for an ethylene group in a ring may increase or decrease the carcinogenic activity of that particular compound.

Since the pyrogenesis of PAH is strongly dependent on combustion conditions, the content of PAH sampled in an industrial area is a composite of emissions from various points and mobile sources. For this reason, it is reasonable to expect PAH to differ quantitatively and qualitatively among different cities and even locations within each city.

These considerations, coupled with the recent identification of many sulfur-containing polycyclics in air particulate matter, indicate that information about polycyclic heterocompounds must be included in studies concerning the environmental hazards of petroleum-related industrial operations.

Finally, the composition and size distribution of particulate material in the atmosphere has been under investigation for several years. The aerosol in the atmosphere consists of substances of various origins, such as soil, ocean, organic material, and gases. After production, the aerosol is mixed and further modified.

It ages. This includes the mixing of aerosols of different origin, coagulation to form new particles, adsorption of gases, and chemical reactions within the particles, mainly in the presence of liquid water and dry oxygen.

These processes also involve timescales and wet removal. A detailed explanation of some properties of aerosols is described by Juenicke. Since several organosulfur compounds have been detected in atmospheric particulate matter, the problem arises whether, besides oxidation to sulfate, SO₂ might also react with other species. However, the concentration of various sulfur-containing compounds is small and it appears that they might come from exhaust gases and stack emissions, rather than through the combination of SO₂ with organic compounds from various sources. It will be interesting to see if when the Puerto Rico Olefins, Inc. plant starts operations, the concentrations change correspondingly.

It is also reported that by equilibrating particulate matter with SO₂, sulfonic acid derivatives are formed. The formation of these compounds seems to be of minor importance in the conversion phenomena of SO₂. However, its importance in enhancing the toxic effects of these particles cannot be discarded at this moment. Since the concentration of pollutant aerosols with respect to particle size is important in the evaluation of their atmospheric transport and penetration into the respiratory system, several studies have been conducted utilizing high and low volume cascade impactors.

High volume cascade impactors are most useful in applications when aerosol mass loadings are very low and large volumes must be sampled to provide significantly weighable or analyzable mass on all stages. They can also be used in high mass load atmospheric environments to collect short term samples. Various workers have reported, however, that high volume impactors very often experience particle bounce effects which result in a displacement of the larger particles mass to smaller size.

Stages. The phenomenon of particle bouncing is believed to be due to the inability of dry solid particles to adhere to dry impaction surfaces. Instead of impacting, the particle recoils off the surface and is carried to successively smaller particle stages. There is considerable evidence that this error can be minimized by the application of an adhesive humectant to the impaction stages. In addition, many impactors now in use sample air at the rate of about 1-2 m³/hr. Hence, in a 24-hour sampling period, only about 10-50µg of any one element will be present, distributed over several collection surfaces. Consequently, higher sensitivity analytical techniques must be used in order to collect enough particles for chemical analysis, especially if organic compounds are of interest. Sampling times of 4-9 days may be necessary, according to the degree of air pollution and weather conditions.

Recent investigations on composition and size distribution of in-stack particulate material at coal-fired power plants have revealed three broad classes of enrichment factor (EF) distributions for particulates. Most elements show little, if any, enrichment (compared to the input coal) as a function of particle size. Several of the more volatile, toxic trace elements do exhibit increased enrichments on smaller particles, and two elements, Fe and Ce, show decreasing enrichments with decreasing particle size. Potentially toxic metals and organic compounds will be analyzed and results compared with those found in other areas. For instance, elements for which EF values are referred to as "enriched" elements. To determine their origins, we must find sources whose particles have equal or greater enrichment.

Description of Specific Research Plan: A detailed analysis of organic and metallic pollutants entails the techniques of sampling, extraction, separation, and characterization. These techniques will be described separately in their experimental sequence. Firstly, characterization of hydrocarbons and

Metals. A. Sampling and Size-Distribution Measurement: To obtain meaningful representation data, sampling locations are very crucial. In order for the data obtained to be statistically related to different variables such as source, meteorological conditions, time of day, etc., the sampling locations will be categorized according to the predominant nature of the area (e.g., power plants, industrial, freeways or residential). The sample will be collected based on the results obtained from

simulation runs employing the Environmental Quality Board's computer model. Proper communication with the board already exists.

Size distribution of particulate material will be established by aerodynamic sizing of airborne particulates using a five-stage Sierra impactor. Proper sampling times will be established as needed. Moreover, sampling of particulate matter will be carried out utilizing high-volume samplers with glass fiber filters. The glass fiber filter will be used to analyze for total inorganic pollutants, particularly lead, mercury, iron, vanadium, and nickel.

The metal analysis as a function of particulate size distribution will supplement work currently conducted at Catholic University on metals in particulates. Calibration methods for high-volume samples will be used according to the techniques described in the literature. Volatile hydrocarbons will be trapped by using either cryogenic collectors for gas samples, adsorption of the organic components in the air on a high surface adsorbent, or by means of the method of Young, Richard, and Faure using Mylar plastic bags for small samples and a charcoal sampler for large samples.

This will be followed by a contamination-free transfer of the sample to a flame ionization detector gas chromatograph or one with a specific flame photometric detector. The cryogenic collection requires small volumes (0.1 - 0.5 liters) of air samples while the adsorption method may require an air flow rate of approximately 4 liters per minute.

Detectable concentrations by the cryogenic and adsorption methods are 10° gm/liter and 1072° gm/liter, respectively.

3. Analysis

a. Extraction - Extraction of organic compounds such as polynuclear aromatic hydrocarbons will be accomplished by solid-liquid or liquid-liquid extraction. Initial liquid/solid extraction with ether will be followed by a variety of common solvents such as benzene, cyclohexane, chloroform, benzene/methanol. Ether may turn out to be a convenient solvent because the loss of sample material during the evaporation of the extracts is reduced as compared to other higher boiling solvents. All extractions will be done in semi-darkness and precautions will be taken to ensure the uniform treatment of each sample and extract. After extraction, the solvents will be carefully evaporated in the dark at room temperature under reduced pressure.

b. Separation - Separation techniques for extracted compounds from particulate matter could include gel permeation, column chromatography, thin layer chromatography, vapor phase preparative chromatography, glass capillary gas chromatography, and high pressure liquid chromatography (HPLC). In particular, a generalized approach (used extensively in our own laboratories) for the liquid chromatographic analysis of very complex hydrocarbon mixtures will be tried in this work. As in crude oil analysis, the fractionation of particulate extracts into saturates, aromatics, and polars (mostly nitrogen and oxygen containing polar compounds) will be desirable. Further separation of the aromatics and polars will be performed followed by the selection of given peaks or groups of peaks followed by reinjection into a different and convenient HPLC column or into a GC or GC/MS system. The HPLC approach (Figure 3) will be supplemented by a modification of the procedure of Haines and Thompson (Figure 4). This will generate conveniently separated fractions for...

Further detailed analysis. Column chromatography and preparative gas chromatography will also be used as supplementary techniques when separating and collecting individual components as needed. Various GC column packings will be explored in this work. Some suggested ones presented in the Supelco Literature on hydrocarbon and polycyclic aromatic hydrocarbons have been found very useful in our current work on petroleum composition and biodegradation. Other suggested ones based on the literature and our own experience will be explored. For instance, high-temperature gas chromatograms could be run on a gas chromatograph with a stainless steel column packed with 3% Dexsil 300 on 60/100 mesh Chromosorb W or a support-coated open 1-254 tubular column (Scor) silicone PC-550 column, temperature programmed. Since mass spectra of isomeric compounds show little difference, prior chromatographic resolution is necessary.

Aromatics are separated using n-heptane. Porasil separates using an H₂O:MBOH gradient. Bondapak C18 is used to collect particulates. Individual compound identification is done by GC/MS. Figure 3 shows the high-performance liquid chromatography scheme for organic extracts. Separation is done using n-heptane on Bondapak-Nil. Asphaltenes and polars are separated using a specified method. Individual components are noted. Note: HPLC is modified with a four-way valve for column backflushing.

Particulate solvent extract is done with anion resin (dual silica-alumina) or Amberlyst 4-29. Less acidic extracts use Amberlyst A-15. Bases and neutral acids are extracted separately. Nitrogen compounds adsorption saturates. Figure 4 outlines the separation scheme for organics in airborne particulates.

High-resolution methods are necessary for their identification. Inert glass capillary columns in such analysis will be desirable. This is valid since glass capillary and conventional gas chromatography are used.

Photographic separations and HPLC techniques will be widely utilized in this work as major identification tools. They will be further described in the following section. The retention time of 20 common compounds and the properties pertinent to the chromatogram are shown in Table nm. Characterization - Gaseous and Light hydrocarbons in the part per-billion range will be characterized by flame-ionization gas chromatography. Specific sulfur detectors will also be used in this work. For reliable sulfur analysis using a flame photometric detector, the column should possess high-resolution properties, since large amounts of hydrocarbon are known to quench the emission of small quantities of sulfur compounds when eluted simultaneously. A micro-coulometric detector will be employed if necessary. Current work in our labs is finding the use of a micro-coulometric detector very useful for the analysis of benzo and dibenzothiophene derivatives in petroleum. A system involving pyrolysis-cc-Microcoulometer, as reported by Drushel, will be employed to explore the presence of sulfur-containing families of benzothiophene, dibenzothiophenes, etc.

Columns with graphitized carbon black could be used for gas chromatographic separations of

hydrocarbons. Typical retention times for a variety...

(Note: The second paragraph is not readable and seems to be a series of random characters. Please provide a readable version for correction.)

Hydrocarbons are included for reference purposes (Table ITT). Porous layer open tubular columns using graphitized thermal carbon black show high selectivity for geometrical isomers, and allow difficult separations at temperatures lower than with Dexsil columns. By changing the nature or the concentration of the stationary phase, a range of selectivities may be obtained from that of the pure graphitized thermal black support to that of the pure liquid stationary phase. Several other standard support materials will be employed during the gas chromatographic separation procedure.

High-pressure liquid chromatography (HPLC) has many distinct advantages over other forms of chromatography. Resolution of isomers is equivalent to gas chromatography with a greater number of theoretical plates (e.g. 5,000). Unlike gas chromatography, there is no requirement for volatility or thermal stability, it is only necessary that the compounds be soluble in some solvent - aqueous or organic. The efficiency of this technique, with its superior utility for the study of labile reactive molecules, has made the study of chemical carcinogenesis and the

analysis of complex hydrocarbon mixtures more approachable than previously envisioned. Analysis of the eluate fractions from chromatography will be achieved if necessary by a combination of ultraviolet, fluorescence, infrared, nuclear magnetic resonance and mass spectrometry. Mass spectrometry will be used to identify complex samples (e.g., sulfur-containing and nitrogen containing polycyclic and polycyclic aromatic hydrocarbons in particulates). This instrument will be directly interfaced with a gas chromatograph with computerized data acquisition and used in conjunction with HPLC and column chromatography separated fractions. The ancillary techniques allow for the separation and characterization of individual components simultaneously. With the aid of reference compounds, unique structural formulas could be assigned for some basic ring systems.

Standard addition will be performed to determine the concentration range by integrating the mass spectrometer output. Confirmation of the identities of many of the PAHs reported in the literature was accomplished by comparison of GC retention times with those of acquired standards. However, the accumulation of many more standard compounds will be necessary to provide the positive identification of all compounds.

Table I: Reaction Times on Purely Carbon Track

Title: Si-30 on CB-2 Cotton Nitrogen 91°C, Neat etc.

(Note: This section of the text appears to be a table with some missing or unclear entries that are difficult to correct without context)

Ultraviolet-visible absorption spectroscopy could also be employed in the identification and determination of polynuclear hydrocarbons. This offers the advantage that the wavelength maximum of a compound is independent of the presence of other compounds, if sufficiently diluted. Nuclear magnetic resonance spectroscopy could also be employed for the determination of specific methyl-aromatic hydrocarbon mixtures of structurally similar compounds. The identification of these carcinogens could be made on the basis of relative chemical shifts, methyl chemical shift at infinite

dilution, and peak multiplicity information.

Atomic absorption spectrometry will be used for quantitative metal analysis. Details of the procedure are discussed in Walsh et al. Briefly, a portion of each sample filter is low temperature ashed, the residue is dissolved in AP and HNO₃, and the solution is diluted for direct injection elemental analysis using a Perkin Elmer Model 503A atomic absorption spectrophotometer with a Model 2100 heated graphite analyzer. Preliminary analysis will be performed by means of an optical emission spectrograph.

2. Chemical Transformations of Reactive Pollutants in the Presence of Hydrocarbons

Or other local contaminants. Recently, Pitts and collaborators have reported that polycyclic aromatic hydrocarbons adsorbed on glass fiber filter paper are activated, as shown by Ames mutagenic test, when exposed to filtered air. The authors isolated strongly mutagenic substances, including the nitro derivatives. This suggests a simple way to study some transformations of reactive atmospheric pollutants present in the industrial sector of Guayanilla-Penuelas. The adsorbed samples will be selected from the manufactured basic petrochemicals and other industrial products of the area (e.g., Appendix I, Fig. 3, and Table IV).

General Procedure - Atmospheric reactions involving basic petrochemical intermediates will be studied by submitting them to the following procedure:

1. Selected contaminants will be allowed to interact with the atmosphere under existing conditions in the neighborhood of a petroleum petrochemical complex.
2. The isolated contaminant material will be tested for (a) mutagenic activity and (b) the presence of transformation products.
3. The results will be compared with control experiments.

The biological activity and/or the nature of the new components will be studied further. The reactions will be promoted by mixing high volumes of atmospheric air with the contaminant under study. High boiling contaminants will be studied by treating a glass fiber hi-vol filter with it and using a modified high volume sampler to pull air through it. Volatile contaminants will be injected into the mainstream of air and the reaction products trapped in a cold trap. In these experiments, the atmospheric air composition may be altered by filtration, drying and/or addition of other components to simulate a typical condition such as when a large emission of an industrial substance escapes to the environment (e.g., chlorine, reactive olefins...). The treated contaminants will be extracted, tested for biological activity, and analyzed for the presence of new components by modern methods.

Analytical Techniques: Simple experiments, as mentioned above, can assist in understanding the potential effects of variations in air flow patterns, chemical, and physical changes. In general, they help illustrate the interaction of meteorological, and chemical and physical processes under conditions of extreme complexity, such as those encountered in heavy industrial complexes. The data generated from these experiments can also help identify pollutants that can remain in the air

for extended periods.

Air Pollution Model: The power plant model, one of two Gaussian type models employed by the Environmental Quality Board of Puerto Rico, is capable of performing a dispersion analysis. It calculates maximum quantities of SO₂ for different stacks, based on fuel sulfur content. This model does not consider all emission sources, it only uses point sources as input; area sources are ignored. The model accounts for terrain features by adjusting the effective plume height based on local topography. Generally, both the power plant model and the Air Quality Display Model (AQDM) will be useful in estimating the impact on ambient air from sources emitting particulates and sulfur dioxide. Specific sampling sites will be selected with the aid of these planning and regulatory tools.

Meteorological Consideration: Puerto Rico, located between 18°00" and 16°30' North latitude, has a maritime tropical climate, except at some of the higher interior locations. This climate is characterized by minor diurnal and seasonal temperature changes, high humidity, persistence of the northeast trade wind, and convective cloud types.

The mean annual temperature at Ponce, for instance, is 71.2°F. The mean daily maximum temperature is 88.1°F, while the mean daily minimum temperature is 69.4°F, a diurnal variation of 18.7°F. Relative humidities are generally high in this climatic zone, being over 60% half the time. Despite being poorly understood, the significance of the meteorological parameters discussed above in air pollution control is undeniable.

"Net denied. Temperature and humidity (including solar radiation) affect the mechanisms of oxidation and hydration, as well as the rate of chemical and toxicological modification. These factors may impact the amount of harmful pollutants in two ways. First, by accelerating the physicochemical changes, which can lead to a decrease or increase in toxicity. Second, by washout caused by rain. Once generated, most pollutants become airborne. The local wind direction determines where these airborne wastes will go. Puerto Rico is situated in the region of the trade winds, one of the most steady and persistent wind regions on Earth. In these regions, the wind blows from easterly directions most of the time.

Westerly winds are rare. Wind roses for three meteorological stations in the Guayanilla area are shown in Figure 5. Wind conditions at the surface in coastal areas can differ greatly from those at 5,000 feet due to effects introduced by the terrain, particularly the diurnal oscillations produced by the land and sea breeze (Figs. 57). These two factors are crucial in determining the behavior of air contaminants released into the atmosphere in a coastal area. The stability of the atmosphere and the effects on horizontal and vertical wind fluctuations determine the horizontal and vertical dispersion of airborne material. Wind speed is important in this respect, not only because of mechanically induced turbulence but also because of the functional relationship between the vertical gradients of wind speed and temperature. In general, the three most important parameters for the practical determination of the transport and diffusion of airborne material - wind speed, wind direction, and vertical stability - will be considered in analyzing the results of this work. Wind rose and other meteorological information for Guayanilla

Has been recently generated by the 590° AC."

The result of a contract arrangement with the former office of Petroleum Fuels Affairs, now the Puerto Rico Energy Office (Figure 8). This work was performed during the tenure of Juan J. Rigau as the executive director.

Source: Environmental Quality Board (EQB). Figure 7 was on page 90 in the section "Seek and Say Son."

The mutagenicity and teratogenicity of airborne pollutants: this proposal will also establish whether or not selected airborne particulate extracts (in total particulate and/or specific size ranges) and/or its chemical transformation products are identified as mutagenic to certain strains of bacteria and teratogenic to mammalian organisms. Annually, significant amounts of several thousand toxic chemicals from the petroleum-petrochemical industrial complex and power plant operations are released into the environment, none of which have been tested for mutagenicity or teratogenicity.

Section 2, Background: The Ames mutagenicity test is the method of choice among the assays utilizing bacteria. A series of specific strains of salmonella typhimurium were developed by Ames, which are noted for their sensitivity to mutagenic agents in the area of the genome regulating histidine synthesis. The salmonella typhimurium strains are auxotrophic for histidine production, so when inoculated into minimal media where this amino acid is absent, they cannot grow. If the bacteria are mixed with a mutagenic agent, a potential carcinogen, it may cause back mutations in that part of the genome and reinstate the ability to synthesize histidine. Therefore, colonies of these prototrophic organisms will appear on the minimal media, thus indicating that the substance tested exhibits mutagenic properties. Some substances do not present mutagenic activity directly, but may acquire this property when processed by the cellular enzyme systems which convert them to active agents. Therefore, any compound can potentially be a mutagen.

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Showing no direct mutagenicity, it is re-tested using a liver microsomal preparation (5-9 mixture) and bacteria. This procedure allows for metabolic processing, rendering them as active carcinogens. Once any of the tests have given positive results, a quantitative test will be performed again, but using different amounts of the tested 07a-mutagen, to determine its potency as a mutagenic agent.

2. Methodology (Work scheme as actually run in our laboratory)

- a. Particulate organic samples will be solubilized in an appropriate solvent such as ethyl alcohol, acetone, dioxane, or DIO (Diagram 1).
- b. Direct Spot Tests screening: The 4 tester strains of Salmonella Typhimurium (92-98, TA-100, TA-1535, 1A-1537) are grown separately overnight in nutrient broth.
- c. A portion of 0.1 ml of bacterial growth is mixed with 2 ml of molten agar, overlaid on minimal media, and allowed to solidify. This is done in triplicate for each strain per substance to be assayed.
- d. A sample of 10l of the solubilized agent is placed in the center of each plate so that as it diffuses,

it will establish a range of concentration. In this way, there will be a place of optimal concentration for mutagenesis to occur. Controls will be both negative, plates having no carcinogen added, and positive, plates to which mutagenic agents known to affect each specific strain will be added.

e. The plates are incubated for 72 hours at 27°C. Colonies that appear in test plates are counted and compared to negative controls. An increase of at least two-fold in the number of revertants is considered positive.

f. Quantitative plate incorporation assay: Test will be carried out as above but utilizing a series of concentrations of each substance giving a positive result (0.2, 1, 20, and 500l per plate) added to the molten agar and mixed with the bacteria. There should be a dose-response curve for the agent corroborating the original results and determining the potency of the mutagenic agent.

The potency of the agent is tested with a microsomal mixture (5-9). The test will be utilized for substances that give negative results on the screening test. The procedure is similar to the one outlined above, but a microsome fraction will be added to the molten agar (45°C), bacteria, and carcinogen mixture. Positive and negative controls are also carried in this assay. The results are determined by counting the number of revertant colonies after 72 hours of incubation compared to the negative control plates.

Solubilized Particulate Fraction:

- Spot test (screening)
- Positive and negative results: colonies/no colonies
- Plate incorporation assay with different concentrations of 5-9 mixture (microsomes)
- Dose-response curve for positive and negative colonies

Section 1196 B. Teratogenicity Test:

Background: Recently, sulfur-containing aromatic hydrocarbons have been detected in airborne particulates and refinery wastewaters. This makes toxicity testing of substances present in emissions and discharges to the environment necessary when human exposure to these substances is significantly increasing. Furthermore, it is known that the effect of certain harmful chemicals in the normal environment can lead to congenital malformations in humans.

The study of teratogenic effects has been included in procedures laid down for toxicological evaluation of most medical substances. However, teratogenicity is only one example of embryotoxic effects, some of which are long-term or even very long-term. The importance of prenatal toxicology extends beyond any particular field of therapy. It must be seriously considered in the context of occupational exposure as well as in any neighborhood exposed to the transport and transformation of primary pollutants. To the best of our knowledge, only one chemical agent in the environment...

A contaminant or pollutant has been established as embryotoxic in man, namely, methyl mercury, which causes both prenatal and postnatal toxicity in the form of Minamata disease.

For the detection of possible teratogens in samples of fractions of different sizes of airborne

particulate matter in areas near energy-producing plants, the following procedures will be followed. It is important to observe that these procedures are currently being used in our laboratory testing benzothiophene as a possible teratogen. (See Diagram 2)

Methodology (Work scheme as practiced in our laboratory):

Unmated female mice weighing 30g or more and in the estrous phase of the cycle will be caged with males at 10:00 PM. Those mice observed in copulation will be isolated and considered zero days pregnant (see step 1 of Diagram 2).

Some strains will be used in others to compare the susceptibility to the teratogen. They are maintained in individual cages, fed a diet of Purina chow and water ad libitum. Experimental groups of pregnant mice will be weighed and treated with intraperitoneal injections of appropriate doses of the testing samples of fractions of airborne particulate matter.

The initial dose of the teratogenic sample will be the acute, single LD50 for mature mice. Ten pregnant mice of 9-12 days of gestation will receive this dose (see step 2). Injection is made with a 21-gauge needle into the right lower quadrant of the abdominal cavity. Others will be treated with the sample by absorption.

Via the skin, a small portion of the hind legs' skin will be shaved and 0.015 ml of the sample is dispensed over the bare skin twice a day during the first ten days of gestation (see step 2). Samples are dissolved in distilled water, while insoluble ones will be dissolved in dimethyl sulfoxide (DMSO). On the eighteenth day of gestation, the day before expected littering for controls, the mice are anesthetized with ether and the abdomen is opened. The uteri of control and treated mice are carefully examined; the total number of live and dead fetuses and implantation sites are considered the total number of conceptuses. Viable embryos will be weighed and examined grossly. Abdomens will be opened and stored in 20 percent neutral formalin or Bouin's solution to be studied later. Some will be eviscerated, stored in 95 percent ethanol, and later cleared and stained for study of the osseous skeleton. If all of the fetuses have been resorbed leaving only residual implantation sites in surviving pregnant animals, further studies are pursued (see step 3). 55+

Many chemicals, at doses causing resorption at the time of implantation if given on one of the following 3 to 4 days, allow fetuses to survive, showing developmental abnormalities at sacrifice on the eighteenth day of gestation. Since implantation in the uterine mucosa is at about the end of the fifth and beginning of the sixth day, groups of ten pregnant mice will receive the initial dose of sample fractions of particulate matter, which will be tested for teratogenicity from days 6-8, 8-10, 10-12, and 12-16 of gestation respectively. By the fourteenth day of gestation, the fetuses can survive much higher doses, and for this reason, we are not going beyond that gestational age. Groups of ten pregnant mice in each category of gestational days will serve as controls, receiving injections of distilled water or DMSO. Similar groups of controls will be exposed to absorption of distilled water or pus by the skin. In the case that no...

The effect of the testing sample is found, and no malformations are present in the offspring, the dose of the testing teratogen must be increased (step 4). If after doing this no effect is found, it will be rejected as a possible teratogen.

However, if birth malformations are present in the offspring of one or more of these groups of experimental pregnant mice (steps 3-5) as a result of abnormal embryogenesis caused by the testing teratogen, the following procedures will be followed (see steps 6-8). All those groups which give positive results will be repeated for confirmation. Then, the incidence of abnormalities or malformations will be calculated for each one of the testing samples of fractions of airborne particulate matter (step 6).

Also, the litter 1050 and the teratogenic range below Litter 1050 will be calculated for each sample. In order to study the malformations, the fetuses will be subjected to a free-hand razor blade sectioning technique which permits a gross study of all the organs and systems of the fetuses. After doing this, a cytological study of each one of the malformed organs or systems will be done using histochemical and electron microscopical observations (steps 7-8).

Besides, for the confirmation of the absorption of the testing teratogen by the mother's organism, it is necessary to do cytological studies of the liver and the kidney of all experimental pregnant mice which give rise to abnormal fetuses, and compare them with those organs of the control pregnant mice (steps 7-8).

3. Rationale for Selected Approach

This proposal covers an extremely important area of preventive environmental health. First, since no previous study of this nature has ever been attempted in Puerto Rico, our intent was to integrate the best resources available at Catholic University of Puerto Rico and the University of Puerto Rico. Operational costs to develop an inherently expensive research project will be minimized by pooling resources.

This is an important factor if the experience generated in this project is to be applied later to other heavily polluted and densely populated areas like Cataño, on the north coast of the island. Catholic University took the initiative to investigate the Guayanilla-Peñuelas area because of its close vicinity to the sector, a key element when field work and detailed knowledge of the area is involved. We partnered with CEER because of their detailed knowledge of the petroleum-petrochemical industry, petroleum composition, the availability of trained personnel, and good lab facilities.

Second, a multidisciplinary approach was followed in the design of the plan of work in order to generate data with a system perspective of the problem. This will increase our opportunities to help not only in defining the existing conditions in the south coast industrial complex, but also in communicating our results effectively to the Commonwealth of Puerto Rico regulatory agencies and the governor's office.

Third, we believe that it is important that the researchers associated with the project are professionally qualified and recognized as objective and non-partisan. This is essential every time solutions to sensitive and important problems are involved.

Fourth, we selected this project because we are convinced of the need to explore areas of biomedical interest associated with the process of energy consumption and production. This will facilitate integration into the field of various groups already interested, planning and/or conducting

research work at the basic sciences departments of our two major Schools of Medicine.

Unusual Features: One of the most unusual features of the proposed work is that this proposal probably represents the only opportunity that Puerto Rico will get in a long time to come to explore under a professional perspective the problems associated with the emissions of particulate matter in a heavily industrialized sector. In particular,

Problems are associated with the emissions to the atmosphere in a fully integrated petroleum-petrochemical complex and potential future ones if a selection is made on a proposed coal-operated power plant.

The South Coast Complex has currently shut down three of its major plants: The Puerto Rico Olefins, Hercor Chemicals, and PPG, all producers of very reactive pollutants. This highly unusual circumstance will permit us to assess the impact of their respective emissions in the aggregate of contaminants available for characterization. This, of course, is an important and unique event that could bring knowledge of great importance to the United States Environmental Protection Agency in its efforts to harmonize economic development and environmental degradation. It is envisioned that in the course of next year, these plants will again be operating. So, this is an opportunity that should not be passed.

As previously expressed, this work constitutes a multidisciplinary effort involving researchers from various backgrounds. They are in a position to induce themselves a multiplier effect by promoting additional research in their respective institutions.

Methods of procedure, analysis, and evaluation: Experimental procedures and analysis have been described in detail in the corresponding sections of the plan of work. The evaluation process will try to tie closely the findings of the work with current regulatory issues of interest to the government, industry, and the academic sectors. Project management should also try to establish the implications of the work to future designs of industrial complexes and relevance to baseline studies, particularly if a decision on the proposed coal-power plant is finally taken. Close supervision of all phases of the work will be maintained throughout project development in order to keep all principal investigators aware of the progress made by the different groups. Monthly meetings of all project personnel will serve to exchange views and help solve problems.

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Characterization of polycyclic aromatic hydrocarbons, particularly sulfur-containing polycyclics, will be performed and the data generated under this program will be correlated with other research and analytical efforts conducted at the Center for Energy and Environment Research, the Department of Health, and the Environmental Quality Board of Puerto Rico.

2. Principal Investigator, Dr. Gabriel Infante (25%) - This investigator will be in charge of the metal analysis in particulates. His participation will also include collaboration in the separation, characterization, and quantification associated with chemical transformations of reactive pollutants in the presence of local air contaminants.

3. Principal Investigator, Dr. Do Carrasquillo (25%) - This investigator will be in charge of determining chemical transformations of environmental airborne pollutants and the analysis of volatile hydrocarbons. He will also collaborate in the characterization of nitrogen-containing polycyclic aromatic hydrocarbons.

4. Two B.S. Undergraduate Students - Students from the Physics Department will conduct research assigned by the principal investigator. They will operate the apparatus needed to sample particulates and collaborate in the running of the air pollution model.

5. B.Sc. Undergraduate Student - This student from the Chemistry Department will conduct research assigned by the principal investigator. He will conduct the metal analysis in particulates and other associated tasks.

6. Principal Investigator, Dr. Hilda Lopez (40%) - She will be in charge of the teratogenic tests and the supervision of graduate students of the Department of Anatomy, UPR Medical School.

7. MSc. Graduate Student, Mr. Calixto Soto - He will be doing teratogenic tests as part of his thesis work for the Ph.D. degree. He will devote 100% of his time to this project.

8. BSc. in Biology (100%) - This person will be in charge of the preparation of the histological.

Sections on animal care and feeding:

12. Principal Investigator (Dr. José A. Carrasco) (40%) - He will be in charge of the Ames Mutagenicity Assay and supervision of graduate students from the Department of Microbiology, UPR, Medical School.

13. Medical Technologist (100%) - will conduct work on the Ames test under the supervision of a well-trained technician currently performing the Ames assay in our lab.

14. Utility Man - will take care of animals, cleaning of cages and labware in the mutagenicity and teratogenicity laboratories.

Facilities and Equipment Presently Available at Catholic University of Puerto Rico:

To support energy and environment research programs at Catholic University of Puerto Rico, the Administration has created an Institute for Energy, Environment, and Biomedical Sciences. The laboratory facilities will be finished this summer and are located at the Medical School (See Appendix II for diagram). This concept will prove highly beneficial to the development of interdisciplinary research work in collaboration with undergraduate and graduate students and

professors of the College of Sciences and the Medical School.

Equipment available for this project includes chemical and biological hoods, two research gas chromatographs, colorimeters, high vacuum line facilities, thin-layer chromatography apparatus, ultracentrifuges, Soxhlet extraction apparatus, and six high volume samplers. Major laboratory equipment available to the Institute from other on-campus facilities include infrared and ultraviolet spectrophotometers, Turner fluorometer, nuclear magnetic resonance spectrometer, atomic absorption, etc. For that reason, only the equipment judged to be indispensable for this work is requested under this proposal.

Center for Energy and Environment Research:

Research facilities at the Center for Energy and Environment Research are the typical ones encountered in an institution dedicated to solar energy research, terrestrial,

Marine and human ecology. The Fossil Fuels Research Program of the Division of Environmental Health and Impact has developed a research effort covering the microbial degradation of high sulfur crude oils. Equipment available for the separation and characterization of petroleum fractions includes two research gas chromatographs with flame photometric and flame ionization detectors with glass capillary column capabilities. We also have a HPLC instrument with UV and differential refractometer detectors and a back flush four-way valve attachment, TLC, IR, and UV spectrophotometers.

Well-equipped microbiology laboratories are available as part of the facilities of the Fossil Fuel Program and Medical School, UPR. A Hewlett Packard Model 5985A quadruple mass spectrometer with online gas chromatography-computer capabilities and dual chemical/electron ionization source is available to our program under special arrangement from the Horse Racing Commission Laboratory. They charge us for materials and a percentage of the maintenance and service contract depending on time demand on the instrument.

Animal room, electron microscopy facilities, compound microscopes, and some cages are available as part of the facilities for the teratogenic work.

Budget schedule: The project director and principal investigators are active participants in the energy-environment programs started at the Institute for Energy, Environment, and Biomedical Sciences of Catholic University of Puerto Rico and the Center for Energy and Environment Research. Both research-oriented organizations support their respective academic faculties to which they serve in addition to the island of Puerto Rico in helping develop energy and environment research programs. The proposed budget includes compensatory time for their research involvement in the proposed project. Salary is estimated based on the percentage of time that will be dedicated to project development using their yearly salary as a base.

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and it doesn't seem to follow any recognizable language or code. It could be an incorrectly formatted text, damaged file or an encrypted message. Without more context or correct formatting, it's impossible to accurately fix the text.

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APPENDIX I

Table I: Socio-Economic and Energy Indicators in Selected Fiscal Years Terminating on June 10.

Table II: Fuel Used by the Puerto Rico Water Resources Authority for Power Generation.

Table III: Puerto Rico Petroleum Flow Pattern and Relation of Energy Used and Lost in the Process Calendar Year 1976 in Thousand Barrels.

Figure 1a: Chemical Configurations Related to Sulfur and Nitrogen Derivatives in Fuel Oil.

Figure 1b: Components of Environmental Assessment.

Figure 2: Municipalities, Standard Metropolitan Statistical Areas, and Selected Places.

Figure 3: Existing Refining and Petrochemical Industry - 1975.

Table IV: Petrochemical Production in U.S. and Puerto Rico.

Table V: Southern Coastal Plain Vital Statistics.

Figure 4: Incidence Rates for Ten Common Primary Sites in Puerto Rico 1975.

Figure 5: Trend of Incidence of Lung Cancer in Puerto Rico 1974.

Table VI: 1978 Projected Air Quality Levels Annual Arithmetic Mean.

Table VII: 1985 Projected Air Quality Levels Annual Arithmetic Mean.

Figure 6: Predicted Particulate Air Quality Annual Average- Area Sources Only 1975-75.

APPENDIX II

Diagram of Catholic University of Puerto Rico Institute for Energy, Environment, and Biomedical Sciences Facilities.

APPENDIX III

Letter from the President, Catholic University of Puerto Rico.

Letter from the Executive Director (now President) of the Environmental Reality Board of Puerto Rico and the corresponding answers.

APPENDIX IV

Curriculum Vitae Project Director and Principal Investigators.

APPENDIX V

Table: Municipality Population Live Births Number Rate

Guánica 17,810 461 25.9

Yauco

39,000 944 28.2 Guayanilla 20,370 sq. 26.1 Pefuelas 19,010 468 26.6 Ponce 183,380 4,946 27.0
Juana Diaz 42,810 1,089 25.4 Santa Isabel 18,540 515 27.8 Salinas 26,040 678 26.0 Cayama
45,270 1,080 23.9 Source: Puerto Rico Department of Health

SOUTHERN COASTAL PLAIN VITAL STATISTICS

Figure 5 'TREND OF INCIDENCE OF LUNG CANCER 'PUERTO RICO 1974

TABLE VI 1978 PROJECTED AIR QUALITY LEVELS ANNUAL ARITHMETIC MEAN

San Juan 86

Ponce 78 28

Mayaguez 100 20

Caguas

Guayama 88 85

Lares-Utuado-Adjuntas 6 20

Aguadilla 6

Arecibo

Guanica 65

Yabucoa

UNIVERSIDAD CATOLICA DE PUERTO RICO

Ponce, Puerto Rico - 00781

May 11, 1978

Eng. Pedro Gelabert
Executive Director
Environmental Quality Board
San Juan, PR 00902

Dear Engineer Gelabert,

We are convinced that there exists a causal relationship between pollution levels and certain damages suffered by our society. Thus, it's necessary now, as it was in 1970, to set new goals in light of new knowledge. Since the goals of a clean environment cannot be achieved in isolation, we, at Catholic University of Puerto Rico, have decided to contribute by developing the concept of an Institute for Energy and Biomedical Sciences. The Institute will study the environmental aspects of energy producing and consuming operations following a systems approach. Interdisciplinary and multidisciplinary research efforts employing the resources of Catholic University will help our government, as well as other sectors, in harmonizing environmental measures.

Considerations with the requirements of an energy policy. Our biomedical approach will help in establishing the quantitative expression of relationships between exposure to specific pollutants, and the type and extent of the associated damage to a target population. For example, by identifying locations of susceptible populations exposed to relatively hazardous levels of pollutants, the effects of allocating specific pollution control resources can be assessed. In this regard, the data required to develop physical or biological damage functions will be obtained through epidemiological, field, clinical, toxicological, or laboratory investigations. To help achieve these objectives, we have decided to construct special laboratory facilities. Microbiology, biochemistry, organic chemistry, physiology, tissue culture, infectious disease, and analytical chemistry laboratories will be finished in the next few weeks. The administration in collaboration with our faculty is already preparing research proposals oriented to: better understand how physical, chemical and biological agents interact, better understand the transport and transformation of synthetic chemicals, better understand human risk factors, better train research scientists and science undergraduates.

APPENDIX. IZ

Eng. Pedro Gelabert
Page 2
May 11, 1978

With this concept in mind, we wish to invite you to give us a presentation covering your areas of interest and those problems in which our Institute can contribute more effectively to the solution of regional needs. I will be looking forward to your reaction on these and other matters.

ESTADO LIBRE ASOCIADO DE PUERTO RICO /OFICINA DEL GOBERNADOR

June 28, 1978

"Ambiental Quality"

June 15, 1976

SCHOOL OF MEDICINE

Dr. Francisco J. Carreras
President
Universidad Catolica de Puerto Rico
Ponce, Puerto Rico 00731

Dear Dr. Carreras,

In response to your

Comunicación del día 1 de mayo, deseo indicarle que en la Junta de Calidad Ambiental estamos comprometidos en la búsqueda de soluciones a los problemas ambientales presentes y futuros. Por tal motivo, coincido con usted en que es necesario que continuamente evaluemos los logros alcanzados y nos fijemos nuevas metas a la luz de los nuevos conocimientos científicos. Creemos además que es imprescindible la integración de los esfuerzos institucionales públicos y privados para poder lograr la meta de la conservación y protección de nuestro ambiente. La iniciativa de ustedes al crear el Instituto de Energía y Ciencias Biomédicas es digna de encomio y por los objetivos que se han fijado estoy seguro que harán una contribución importante a la solución de la problemática ambiental de Puerto Rico. Les felicito por tan brillante idea. Tan pronto tenga oportunidad me gustaría programar para compartir con ustedes aquellos problemas y áreas de interés particular en las cuales yo considere que el Instituto podría contribuir efectivamente a la solución de necesidades y problemas regionales. Mi ayudante ejecutivo, el Sr. Wilfrido Soto de Arce, se comunicará con su oficina para fijar la fecha y hora más adecuada.

---Página de separación--- APÉNDICE IV ---Página de separación---

DATOS PERSONALES:

Lugar y Fecha de Nacimiento: Juan José Ríos Sepúlveda, 24 de Noviembre de 1939, Sabana Grande, Puerto Rico.

Posiciones: Consultor en Energía y Medio Ambiente 1977- Director - Oficina de Asuntos de Combustibles de Petróleo, 1973-1976- Oficina del Gobernador, Commonwealth de Puerto Rico. Consultor - Administración de Desarrollo Económico, 1969-1973.

Educación: 1956- Escuela Secundaria de la Universidad de Puerto Rico, Río Piedras, Puerto Rico. 1960- Licenciado en Ciencias, Universidad de Puerto Rico. 1965- Máster en Ciencias, Universidad de Puerto Rico. 1969 - Doctor en Filosofía, Wayne State University, Detroit, Michigan.

Tesis: "La Bioestereoquímica de B-Hidroxisulfóxidos", tesis de M.S., Universidad de Puerto Rico.

Rico, 1965, "Stereochemical studies in organo-sulfur Chemistry", Ph.D. thesis, Wayne State University, 1969, Dissertation Abstracts International, 32 (5), 2612-8 (1971).

RESEARCH EXPERIENCE:

In charge of the Radioisotope Division, Instructor for the Radioisotope Division, Radioisotope Techniques course. Research Assistant - Puerto Rico Nuclear Center 1962-1965 in the Organic Sulfur Chemistry Program under the supervision of Dr. H. Harry Szmant. Research Fellow - Wayne State University 1965-1969, Exploratory Research in Sulfur Chemistry under the direction of Dr. Carl R. Johnson. Senior scientist (Ad Honorem) - Puerto Rico Nuclear Center. Lecturer (Ad Honorem) - Department of Chemistry, University of Puerto Rico, Mayaguez Campus.

Member - University of Puerto Rico (Rio Piedras Campus) Graduate Examination Committee. 1972 - Dr. Gu-Chao Liu, Ph.D., Organic Chemistry. 1973 - Dr. James Sanabia, Ph.D., Organic chemistry. 1974 - Carmen Lopez, MSc., Bio-Organic Chemistry.

Member - University of Puerto Rico (Medical Sciences Campus) Graduate Examination Committee. 1974 - Francisco Fuentes, MSc. Candidate, Microbiology. 1977 - Jesus Gonzalez, MSc. candidate, Environmental Health. 1977 - Leocadio Melendez, MSc. Candidate, Environmental Health.

HONORARY SOCIETIES:

PROFESSIONAL SOCIETIES:

PUBLICATIONS:

RESEARCH ADVISOR FOR GRADUATE STUDENTS:

Mr. Jorge Pichardo, "Thermodynamics of Anions in Solution" 1973, University of Puerto Rico, Chemistry Department, Rio Piedras Campus in collaboration with Dr. Gerald Stevenson.

Miss Carmen Lopez, "Toxicity Effects of Selected Organosulfur Compounds on Microbial Organisms" 1972, (School of Medicine, University of Puerto Rico in collaboration with Dr. Fermin Sagaréfa).

Mr. Francisco A. Fuentes, "Repression by Glucose of the Degradation of Benzothiophene by Pseudomonas Aeruginosa PRC-1, and Reversal by Adenosine-3', 5' Monophosphate", 1974, (School of Medicine, University of Puerto Rico in collaboration with Dr. Fermin Sagaréfa).

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"Institute for Petroleum Research and Sulfur Studies: A Program for the Application of the Scientific Resources of Puerto Rico in the Environmental Control Field," April 1970, research proposal prepared for the Department of Research and Development, Commonwealth of Puerto Rico.

"Control Techniques for Sulfur Air Pollutants: Preliminary Evaluation of Schemes for the Removal of Sulfur Dioxide from Smelter Gases," May 1970, research proposal prepared for the Department of Research and Development, Commonwealth of Puerto Rico. During his tenure as Director of the Office of Petroleum Fuels Affairs of the Commonwealth of Puerto Rico, prepared and/or coordinated the preparation of the following proposals: - "Toxicity Studies of Sulfur-Containing Petroleum Fractions" - "Development of a Simulation Model of Puerto Rican Refineries for the Assessment of Fuel Availability as a Function of Refinery Configuration and Raw Material Inputs" - "The Isolation, Identification and Quantitation of Reactive Hydrocarbons in Selected Environments and their Photochemical Reactions in the Atmosphere of Puerto Rico"

'ADDITIONAL ORAL PRESENTATIONS: - "The Office of Ferrolux Fuels Affairs Petroleum Energy Resources Education Program" - "Desulfurization of Organo-Sulfur Compounds and Petroleum Fractions by Microorganisms" - "The Puerto Rico Energy Model: An Aid for the Decision-Making Process" - "The Application of Science and Technology to the Pollution Control Field in the Petroleum Industry", 30th Annual Convention, College of Chemists of Puerto Rico, Hotel San Jerónimo, 1971. "New Approaches of the Economic Development Administration Directed to a Greater Development of the Petroleum Industry in Puerto Rico", Seminar on the Petroleum Industry sponsored by the Institute of Chemical Engineers, Ponce, 1971. "Gas Chromatographic Techniques in Compositional Studies of Sulfur Compounds in Petroleum", Seminar on Gas Chromatography sponsored by Perkin-Elmer and Burpee Sales, Hotel San Jerónimo, 1972.

"Research Work at the Department of Research and Development of Fomento and Its Relation to EDA's Programs", Monacilles Rotary Club, 1972. "Industrial Aspects of Sulfur Chemistry", 1972 Seminar Program, RED Department, Economic Development Administration. "Modern Techniques for the Control of Pollutants in Petroleum Refineries", Deep Water Ports Seminar sponsored by the

Institute of Chemical Engineers, July 7, 1973. Multiple presentations covering matters related to the petroleum-petrochemical industry and the Puerto Rico energy future of which the following are typical:

8 "La Oficina sobre Asuntos de Combustibles Derivados del Petróleo: Análisis de Nuestra Actualidad Energética", Colegio Universitario de Cayey, 18 de Julio, 1975. "La Estructura de la Industria Refinadora y el Mercado de Combustibles en Puerto Rico". Presented as the closing speech for the "III Convención Centroamericana y del Caribe de Expendedores de Petróleo", San Salvador, 24-26 Abril, 1975. "Nociones sobre el Impacto de los Proyectoados Aumentos del Petróleo", Taller Sobre Costo de la Vida, 19 de Agosto, 1975. "La Explotación de Potenciales Yacimientos Petrolíferos en Puerto Rico", Asociación Americana de Profesores de Física, Sección de Puerto Rico, Colegio Universitario de Cayey, 3 de Septiembre, 1975. "La Problemática de la Energía y Estrategias de Conservación Ante un Petróleo que se Agota", Convención Anual Asociación de Detallistas de Gasolina de Puerto Rico, 5 de Octubre, 1975. "Marco para la Formulación de Políticas de Conservación de Energía en Puerto Rico", Taller de Costo de la Vida, 30 de Octubre, 1975. "Aspectos de la Problemática Energética Puertorriqueña", Colegio Sacrado Corazón, 12 de Febrero, 1976. "La Lengua y las Ciencias Técnicas", Comentarios del doctor Rigau en representación del Colegio de Químicos, Instituto Augusto Malaret, 17 de Febrero, 1976. "Producción de Energía, su Tecnología y el Ambiente", Departamento de Física, Universidad de Puerto Rico, Recinto de Rio Piedras.

April 8, 1976.

ADDITIONAL ORAL PRESENTATIONS AND SPECIAL ACTIVITIES:

"Petrolec: Its Future and Environmental Impact", Symposium on Energy Crisis, Problems Without Solution?, sponsored by the faculty and Bachelor of General Studies of the University of Puerto Rico and the Center for Energy and Environment Research, November 30, 1977.

"Energy Status in Puerto Rico", Society of Government Economists, April 23, 1976.

"Energy Situation in Puerto Rico", Regional College of Carolina, May 11, 1976.

"The Contribution of Bicycle Transportation to Local Energy Problems", Seminar-Workshop on Bicycle Transportation in PR, Hotel Racquet Club, May 13-14, 1975.

"Oil and its Potential in PR Costs", University College of Humacao, June 11, 1976.

"Energy Status in Puerto Rico: An Assessment of the Petroleum Situation", presented at the Third Annual UMR-MEC Conference on Energy, University of Missouri-Rolla, October 12-14, 1976.

"Our Energy Dilemma: Science, Technology and Something More", comments presented by Dr. Juan J. Rigau, at the College of Engineers, Architects and Surveyors before a forum sponsored by the Small Business Administration, October 27, 1976.

Member, Environmental Advisory Committee to the President, University of Puerto Rico, 1972.

Program Chairman - "Analytical Techniques for the Control of Atmospheric Pollution", seminar held in Ponce, August 23-25, 1972.

SPECIAL ACTIVITIES:

Special Advisor to the Chairman, Gasoline Price Commission, 1973.

Chairman-Seminar on "The Petroleum-Petrochemical Industry - An Analysis of Some Key Factors", Hotel Flamboyan, September 25-27, 1973.

Member-Organizing Committee, Annual Seminar on "Environmental Pollution Abatement", 1972.

Chairman-"First Conference on Energy-Environment-Public Health", Medical Sciences Campus, University of PR, June 15-17, 1977.

Advisor in several capacities to the President of the

University of Puerto Rico, 1974-1977, Advisor to the President. Catholic University of Puerto Rico, 1977-, Advisor to the President. University of the Sacred Heart, 1974-, Member-Puerto Rico Task Force for the reorganization of the Puerto Rico Nuclear Center, 1976, Director, Project 60, Center for Energy and Environment Research, University of Puerto Rico, 1977-. Member-Senior Advisory Committee, Center for Energy and Environment Research, University of Puerto Rico/ERDA, 1977. Consultant to the Faculty of Natural Sciences, Catholic University of Puerto Rico, 1977. Consultant, Catholic University Medical School, 1977. Consultant to the Department of Environmental Health, Graduate School of Public Health, Medical Sciences Campus, University of Puerto Rico, 1977.

RESEARCH INTERESTS: Greener Chemistry of sulfur compounds in petroleum and petroleum products: petroleum composition, and desulfurization studies. Energy planning and economics. Dr. H. Harry Samant, Chairman, Department of Chemistry, University of Detroit, Michigan. Dr. Carl R. Johnson, Professor, Department of Chemistry, Wayne State University, Detroit, Michigan. Dr. Ismael Almodovar, President, University of Puerto Rico, Rio Piedras, Puerto Rico.

INSTITUTION AND LOCATION: University of Kansas, Lawrence, Kansas, Ph.D. 1971. University of Kansas, Lawrence, Kansas, M.S. Case Institute of Tech., Cleveland, Ohio, B.S., 1964, Physics. Academic Achievement Scholarships, Case Institute of Technology (1962-64). Teaching Assistantship, Kansas University (1964-66, 1968-69). Research Assistantship, Kansas University (1970-71).

Environmental Monitoring Positions Held:

1. Physics Professor, Catholic University of Puerto Rico, Ponce, P.R. (Assistant Professor 1971-73; Associate Professor 1973-77; Tenure granted 1976).
2. Graduate Research Assistant, Physics Department, University of Kansas 1969-71.
3. Visiting Professor of Physics, Faculty Exchange Program sponsored by the Ford Foundation.

Foundation Universidad de Oriente, Cumana, Venezuela, 1906-68. Graduate Teaching Assistant, University of Kansas Physics Department 1964-66. Research Technician, Youngstown Sheet & Tube Research Lab, Summers 1963-65. Two talks given at the National Meeting of the American Physical Society and the American Association of Physics Teachers in New York, Winter, 1971. Invited talk on the Undergraduate Research program to monitor particulate contamination in Ponce, P.R., given at the National Summer Meeting of the American Association of Physics Teachers, June, 1977. Invited Participant in Faculty Summer Institute on "Energy Production and the Environment" sponsored by Oak Ridge Associated Universities, Oak Ridge, Tennessee, July, 1977. At the Catholic University: 1. System Manager for the Digital Equipment Company Computer (11/03 and 11/34) in the Physics Department, 1976-77. 2. Computer programming consultant for various professors at the Catholic University.

Coordinator of the "First Educational Congress on Energy", Ponce, Puerto Rico 1976. Research Director of Student Project to Monitor Particulate Air Contamination in Ponce, Puerto Rico, 1976-77. Kwak, M., Nicholas, R., Stump, R., "Meson and KD Interactions at 3.4 GeV/c," *Il Nuovo Cimento* 68, s1972. Eckert, M., Kwak, M., Nicholas, R., Stump, R., "Final States with a Viable Hyperon in KD Interactions at 3.4 GeV/c," *Nuovo Cimento* 144, 363 (1973). "Development of a Colony of Organisms in a Computer Model", *Science-Ciencia*, Vol 20 Num, 3. De Jesus, R., Malendez, W.I., Peres, J.H., Eckert, R.R., "Measurement of Particulate Air Contamination in Ponce: An Investigation Project", *AAPT Announcer* Vol. 7, No. 2, Spring 1977. Invited paper given at the AAPT Summer meeting.

Article to be Published:

7. BIOGRAPHICAL SKETCH

Arnaldo Carrasquillo is currently an Associate Professor at Santa Isabel, Puerto Rico. He completed his education at various universities:

- Bachelors in Chemistry, University of Puerto Rico, Rio Piedras, 1939.
- Masters in Organic Chemistry, University of Puerto Rico, Rio Piedras, 1986.
- Ph.D. in Organic Chemistry, Ohio State University, Columbus, Ohio.

He has also held several positions:

- Senior Research Participant, Catholic University of Linz, Austria.
- Professor of Chemistry, Catholic University of Puerto Rico, Ponce.
- Research Assistant in Organic Chemistry, Ohio State University, Columbus, Ohio, 1966.
- Research Assistant, Puerto Rico Nuclear Center, University of Puerto Rico, Rio Piedras, PR, 1962.
- Chemistry Instructor, University of Puerto Rico, Rio Piedras, PR, 1959.

Publications:

- 'Chemistry of Organoboron Compounds', 1966.
- 'Cyclopropylacetylenes', *J. Chem. Soc. Chem. Communications*, 495, 1969.
- 'Ring Contractions via Insertions', *Tetrahedron Letters*, 2,109, 1977.
- 'Reactions of Strained Rings with Electron-Deficient Acetylenes', Ph.D. Thesis, 1971.

- 'Studies on Larvicidal Activity', Arnaldo Carrasquillo, Ernesto Pereira, Second W.B.S Symposium, New Orleans.

Recent Publications:

- 'Larvicidal Effect of Tropical Plant Extract', Ernesto Pereira and Arnaldo Carrasquillo, Second W.B.S Symposium, New Orleans, 1974.
- 'Isolation of the Active Principle of a Larvicidal Plant Extract', Arnaldo Carrasquillo, Ernesto Pereira and John del Valle, Third Annual Paris Science Symposium, New Orleans, Louisiana, 1975.
- 'Larvicidal Activity of Extracts from Piper Marginatum', Ernesto Pereira, Arnaldo Carrasquillo, and James Yayo, 1976.
- 'The Nature of the Major Components of the Larvicidal Extracts from Piper Marginatum', Arnaldo Carrasquillo, Ernesto Pereira, Javier Rivera, American Chemical Society Senior Technician Award, 1977.

2. Gs Ae Infante, Radiology of Potpia Nuclear Center, 1969. 3. Os He Wooler, Ae Julian, and G, A, Infante, "Radiolysis of Glycine Anhydride" Revista Latinoamericana De Quimica, 2(12), 1971. 4. Master Thesis, Edited by the Puerto Rico University.

Curriculum Vitae - José A, Carrasco-Canales

Publications:

1966 'A human pathogenic fungus recovered from soil for the first time in Puerto Rico. Torres-Blasin, G, and Carrasco-Canales, J.A. Mycopathologia et Mycologica Appl. 28:330-332.

Soil studies in Puerto Rico. Torres-Blasini, G. and Carrasco- Canales, J.A, Mycopathologia et Mycologica Appl. 29: 177-182.

Bacterial ultrastructure. Carrasco-Canales, J.A. (*) Paper presented at the Second International Forum on 'Treatment of Infectious Disease sponsored by the Veterans Administration and the University of P.R. School of Medicine, San Juan, P.R.

Structure and function of bacteria. El Koury, A., Carrasco- Canales, J.A, and Borrero, G. Paper presented at the Round Table on Core Concepts in Teaching Microbiology to Pharmacy Students. Annual Meeting of the American Society for Microbiology.

Study on the adaptation of nucleic acid hybridization techniques to the classification of Staphylococcus. Carrasco Canales, J.A., Colón, S. Annual Meeting of the Association of Clinical Scientists. Annals of Clinical and Laboratory Science.

Genetic control of interferon synthesis in chick fibroblast monolayers. Colón J.Z., Rios Olivares, E., Rodriguez Nieves M., and Carrasco-Canales, J.A. Annual Meeting of the Association of Clinical

and Laboratory Science, Annals of Clinical and Laboratory Science. (*) Author presenting paper.