PRELIMINARY PROPOSAL TO:
U.S. ENVIRONMENTAL PROTECTION AGENCY

HIGH FIELD GRADIENT MAGNETIC SEPARATION
FOR
WASTE WATER PURIFICATION APPLICATIONS IN PUERTO RICO

prepared by
U. Ortabasi and A. MeB. Block

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
UNIVERSITY OF PUERTO RICO — U.S. DEPARTMENT OF ENERGY
HIGH FIELD GRADIENT MAGNETIC SEPARATION FOR
WASTE WATER PURIFICATION APPLICATIONS IN
PUERTO RICO

Submitted by:
CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
UNIVERSITY OF PUERTO RICO

Prepared by:
Dr. Ugor Ortabasi
Dr. Arthur McB. Block

Center for Energy and Environment Research
University of Puerto Rico
INTRODUCTION

This proposal is the outcome of intense discussion among CEER personnel reflecting very great concern about the effects of water pollution and potable water shortages on the health and welfare of the people of Puerto Rico. The present level of contamination of Puerto Rico's fresh surface water and ground-water as well as of its aquatic recreational areas and beaches is already alarming and increased population pressures are anticipated to aggravate the problem of pollution control. The population density of Puerto Rico, an island 30 x 150 mi. in size is rated the 6th highest worldwide and with most of the population (ca. 90%) resident on a very narrow coastal plain the effective population density may be the highest in the world. The large volume of waste generated by Puerto Rico's advanced industrialization programs population density pressures and a fragile coastal zone environment have all combined to produce a grave challenge to the health, welfare and lifestyle of Puerto Rico's 3.2 million inhabitants.

At several locations on the island hazardous water pollutants from industry, municipalities and communities are discharged to the environment with little or no treatment. In the past, a great number of community activities and projects aimed to minimize adverse health conditions and social and esthetic effects associated with water contamination. In the light of the existing conditions on the island however, it appears obvious that conventional treatment management methods have failed to significantly reduce water pollution, much of this attributable to non-point sources (eq. storm overflow). New methods and technology development appear to be urgent priorities for reclamation of polluted water to meet Puerto Rico's requirements by 1990.

BACKGROUND

In a new program, CEER proposes the application of a novel and powerful technology, called High Gradient Magnetic Separations (HGMS) as an efficient and flexible means to remove pollutants from waste waters at very high rates of throughput. HGMS utilizes "state of art" technology and its applications worldwide, now include.

- Mineral Processing
- Effluent and Waste Water Treatment
- Chemical Processing
- Biochemical Processing
- Pharmaceutical Processing

In the case of wastewater treatment from sewage plants it has been shown that HGMS is clearly superior to conventional processes used in the purification of water. The advantages of the methodology include overall cost savings, considerably smaller space and land area requirements, very high throughputs,
continuous operation, improved sludge properties and very broad range of applicability.

PROJECT OBJECTIVE

The primary objective of this project is the testing and establishment of high gradient magnetic separation of industrial and domestic waste water. The secondary objective is utilization of the technique for water reclamation and reuse.

The tasks necessary to achieve this goal are:

1. Acquire Sala Magnetic Mobile Laboratory demonstration trailer.
2. Training and familiarization with the equipment.
3. Select sites for wastewater testing.
4. Test magnetic separation on each effluent.
5. Assign "effectiveness" of separation parameters to each type of waste.
6. Prepare cost estimates for "problem" industries and for total upgrading (water upgrading to potable quality).

PROJECT METHODOLOGY

The objective of this project can be achieved by the utilization of the following methods briefly outlined in correspondence to the specific tasks:

1. Rent, overhaul and ship the already operational mobile lab from Sala Magnetics, Boston, MA.

2. The course offered by Sala Magnetics and Boliden Kemi will be given by 2 specialists to a team of 6 persons: 1 scientist, 1 scientific associate, 1 technician and 3 graduate students.

3. Contact industries and arrange (on a discrete basis) a demonstration for problem wastes. Contact municipalities and government agencies. Choose 10 widely different waste problems.

4. Station the laboratory for 1 week in a convenient place for the magnetic separation treatment demonstration. Try treatment varying: seed and poly electrolyte concentrations, matrix loading, residence times, magnetic field and flow rate.
5. Analyze influent and effluent with respect to suspended solids, pH, apparent color, turbidity, settleable solids, BOD, COD, Coliform bacteria and heavy metals.

6. Classify wastes using a matrix of influent characteristics with respect to ability (% removal or change) of magnetic separation to treat the waste. Calculate costs of separation based on estimated effluents - per diem. Using appropriate EPA data, calculate cost of total upgrading and also compare costs with conventional treatments.

The proposed methods will be divided into three separate operational phases with the exception of the last task, which will be the final report and recommendations.

The planned operational phases are:

I
   Task 1
   Task 2
   Task 3

II
   Task 4
   Task 5

III
   Task 6
   Task

PROJECT TIME SCHEDULE

Approximately 12 months is estimated for the completion of this program section.
<table>
<thead>
<tr>
<th>MONTHS</th>
<th>1</th>
<th>2</th>
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<th>4</th>
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<td>Task 6</td>
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</tbody>
</table>

**Final Report**

**Task Review & Analysis**
PROJECT MANAGEMENT PLAN

The proposed management plan for this project is shown on the organization chart below. As part of the CEER research program, accounting and administrative procedures will be handled by the appropriate CEER facilities. Personnel to be used on this project will be drawn from CEER staff, University faculties, and other sources as required for specific tasks of predetermined duration. CEER facilities and equipment will be used and supplemented where necessary with project supplies.

CENTER FOR ENERGY & ENVIRONMENT RESEARCH
CEER*

* General management plan of CEER is illustrated on attached organization chart

UGUR ORTABASI
PRINCIPAL INVESTIGATOR

PROJECT
ARTHUR McB. BLOCK
PROJECT LEADER

3 CONSULTANTS

RESEARCH ASSISTANT 1
GRADUATE STUDENTS 3

PHASE I ORTABASI, BLOCK, Scientific Assoc. & Consultants

- TASK 1 Ortabasi & Consultants
- TASK 2 Block, Scientific Assoc. & Consultants
- TASK 3 Ortabasi, Block, Scientific Assoc. & Consultants

PHASE II BLOCK
Scientific Assoc., Research Asst., Graduate Student

- TASK 4 All
- TASK

PHASE III ORTABASI & BLOCK

- TASK 6 Ortabasi & Block
- TASK
- TASK (Final Report)
PROJECT BUDGET (12 months period)

It is proposed to develop this project utilizing the matrix technique of project management and staffing. During the 12 months period, personnel will be used for varying periods of time for discrete task assignments. Where possible they will be drawn from other CEER or University programs on an available time basis. Utilization of part time personnel appears to be one way of reducing overall project costs and eliminating the sometimes costly "dead spots" in which personnel have finished a specific element of their task and must wait for additional information or material. The matrix approach allows for efficient team operation at minimum personnel costs. Items marked with an * are costs to supplement equipment, supplies, and services supplied by CEER. This latter includes laboratory space, highly sophisticated laboratory equipment, vehicles and boats, and all administrative and accounting services.

ESTIMATED BUDGET for 12 months period
Personnel (task determined time)

<table>
<thead>
<tr>
<th>Role</th>
<th>F.T.E.</th>
<th>Percentage</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Investigator</td>
<td></td>
<td>10%</td>
<td>4,000.00</td>
</tr>
<tr>
<td>Project Leader</td>
<td></td>
<td>50%</td>
<td>10,000.00</td>
</tr>
<tr>
<td>Scienc. Assoc.</td>
<td></td>
<td>50%</td>
<td>7,000.00</td>
</tr>
<tr>
<td>Res. Asst.</td>
<td></td>
<td>100%</td>
<td>6,200.00</td>
</tr>
<tr>
<td>3 x Grad. Students</td>
<td></td>
<td>100%</td>
<td>5,400.00</td>
</tr>
<tr>
<td>3 x Consultants</td>
<td></td>
<td></td>
<td>15,000.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>47,600.00</td>
</tr>
<tr>
<td>Total Salaries</td>
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<td></td>
<td>47,600.00</td>
</tr>
<tr>
<td>15% Fringe</td>
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<td></td>
<td>7,140.00</td>
</tr>
</tbody>
</table>

Operating expenses and services

Materials & Supplies (estimated) 4,500.00

--- 4,500.00-

Equipment and supplies*

Rental & Shipping, Overhaul of Sala-Lab. 20,000.00

Sub Total 79,240.00
Overhead 41% 32,488.00

Total Project 111,728.00

EPA Share: 95% 106,142.00

125,142.
LITERATURE REFERENCES


APPENDICES

Appendix A : Overview of High Gradient Magnetic Filtration.

Appendix B : SALA- High Gradient Magnetic Filtra-
tion Pilot Plant Trailer.
APPENDIX A
OVERVIEW OF HIGH GRADIENT MAGNETIC FILTRATION

The use of magnets to separate substances of varying character is not new. Magnetic separation techniques have been used since the nineteenth century to remove tramp iron and to concentrate iron ores. A variety of conventional magnetic separation devices is in wide use today. These devices generally separate relatively coarse particles of highly magnetic material containing large amounts of iron from nonmagnetic media (direct filtration).

In recent years magnetic devices have been developed which are capable of separating even weakly magnetic materials of micron size at inherently high flow rates. These so-called "high gradient magnetic separators" have been designed to maximize the magnetic forces on fine, paramagnetic materials. They are capable of efficient separation of even weakly magnetic suspended solids or precipitates for which conventional magnetic separation techniques are ineffective. This capability is the result of the development of a filamentary ferromagnetic matrix and a large volume, high-field magnet. The combination of an efficient magnet and high gradient matrix permits the economical production of strong magnetic forces over a large surface area in the active volume of the separator. The separations may be carried out economically, and at process rates of up to several hundred gpm/ft².

For normally nonmagnetic colloidal material in polluted water, the addition of magnetic iron oxide (magnetite) along with a flocculating agent can render these colloids sufficiently magnetic to be removed by high gradient magnetic separators (indirect filtration). The machines provide the rapid filtration of many pollutants from water with a small expenditure of energy. Removal is much more efficient than with sedimentation because the magnetic forces on fine particles may be many times greater than gravitational forces. This technology has a high potential for use in water pollution control.

High gradient magnetic separation is used in the kaolin clay industry to remove weakly magnetic impurities of less than 2 micron size from clay. Industrial-size high gradient magnetic separators treat up to 60 tons per hour of dry clay, as a 30 percent slurry.

Other proven applications for HGMS magnetic separators include iron ore, feldspar, and many other types of mineral beneficiation. Waste reclamation and recycling, ultra purification of chemical refractories and powders,
removal of smoke stack particulates, cleaning of refueling pool waters at nuclear power plants, steam purification and other thermal power applications, and steel mill waste water purification are some of the recent problems that HMS magnetic separators are or will soon be handling. All are direct applications and do not require the addition of a seed or flocculant to be effective.

Besides CSO and raw sewage, high gradient magnetic separation is applicable to numerous nonmagnetic waste waters such as paper mill wastes, electroplating waters, secondary effluent polishing, potable water processing, on board ship treatment of gray and black water, and almost any polluted stream in which the goal is to remove all solids from the water portion.

PRINCIPLES OF HIGH GRADIENT MAGNETIC FILTRATION

Magnetic and Competing Forces

High gradient magnetic separators, like all magnetic separators, utilize the interaction of magnetic and competing forces on a mixture of magnetic and nonmagnetic particles to provide separation based on the magnetic susceptibilities of the particles. The magnetic forces of attraction in a high gradient magnetic separator hold the magnetic particles to the edges of the matrix fibers while the competing hydrodynamic forces carry the fluid and nonmagnetic particles through the separator. For small particles the forces of hydrodynamic drag are larger than gravitational forces, and increase with slurry velocity in the separator. The magnetic forces necessary to trap these particles must therefore be large.

Maximizing the Magnetic Forces

High gradient magnetic separators effectively maximize the magnetic force on even weakly magnetic particles. The magnetic force \( F_m \) on a particle is given by the following expression:

\[ F_m = vM \text{ grad } H \]

where \( v \) is the volume of the particle, \( M \) is its magnetization, and \( \text{grad } H \) is the magnetic field gradient that acts on the particle. The magnetic field gradient appears in the expression for magnetic force for the following reason. Placed in a magnetic field, all particles develop north and south poles at either end as shown in Figure III-1. In a uniform field the net force on a particle will be zero, since the field exerts an equal and opposite force on either end of the particle. In a gradient magnetic field, however, the force exerted by the stronger field at one end of the particle will produce a net force on the particle. Therefore, the larger the change in field across the particle (magnetic field gradient), the greater the force on the particle.

The magnetization of ferromagnetic fibers, like those in the high gradient magnetic separator matrix, produces extremely high magnetic field gradients. It turns out that the greatest force is produced on the particles when
MAGNETIC FORCE

\[ F_M = VM \text{ grad } H \]
- magnetic field gradient
- particle magnetization
- particle volume

COMPETING FORCE
hydrodynamic drag

\[ F_C = 3\pi \eta bV \]
- slurry velocity
- particle diameter
- slurry viscosity

FIGURE III-1  CUT-AWAY VIEW OF HIGH GRADIENT MAGNETIC SEPARATOR
FIGURE III-2  MATRIX MATERIALS USED IN HIGH GRADIENT MAGNETIC SEPARATORS

Expanded Metal

Stainless Steel Wool
Separated are important operational variables in addition to those cited above. Thus, seeded water treatment is dependent upon the maintenance of a delicate chemical balance in order to achieve an effective union of suspended solids and seed particles before their magnetic removal.

MAGNETIC SEEDED WATER TREATMENT AS APPLIED TO CSO AND RAW SEWAGE

The seeded water treatment (mag-seed) process is a unique application of high gradient magnetic separation to the removal of nonmagnetic suspended and colloidal-sized particles suspended in a liquid medium (usually water). It has considerable potential in a large number of effluent waste water cases where certain standards must be met before disposal, as well as in some closed loop operations where corrosion products or contamination may result in degradation of liquid quality within the system. The system is of particular interest for its possible application to CSO and raw sewage and a number of other areas. Calculations for effectiveness of separation, economics of capital investment and operating costs, land requirements, dependability, process flow rates, and detention times, etc., have so far been favorable in comparison with presently available technology.

PREVIOUS WORK

This report is a continuation of Report #600/2-77-015 (March 1977) entitled, "Treatment of Combined Storm Overflows by High Gradient Magnetic Separation." In that portion of the study, full descriptions and references are provided for the physics and concepts involved in magnetic filtration. In completing that work, both bench and continuous pilot plant runs were performed at Sala Magnetics, Inc. in Cambridge on CSO and raw sewage trucked in from the Cottage Farm Chlorination and Detention Facility (Cambridge) and the Deer Island Sewage treatment Plant (Boston). These tests showed clearly that the seeded water treatment process could effectively and efficiently treat these waste water samples. However, limitations in the pilot plant system and lack of freshness in the sample volume suggested that an on-site test with a slightly larger and more flexible system would be necessary before jumping to demonstration size. A mobile system also would allow the performance of on-site testing with several different effluent situations in order to provide a maximum amount of design and cost estimating input. Whereas in the previous study CSO had been slightly aged and relatively static within the test period, with a mobile trailer on location it would be possible to profile an actual storm event, as it occurred, in order to study in detail the possible problems and solutions unique to combined storm overflows (e.g., first flush loadings, multiple separator storm suction, required influent monitoring systems, etc.).

PRESENT CONTRACT GOALS

The present effort is designed to demonstrate the pilot-scale effectiveness of SALA-HOME® magnetic filter treatment of CSO, and to use this information as a basis for further larger scale tests. Various design criteria and
Operating characteristics of the separator system were studied in some retail in order that accurate costing projections could be made for full-size integrated wet and dry weather treatment systems.

The extension of EPA Contract #68-03-1119 was performed in two parts: Effort I extended the data base of the previous work on the then-existing 1 gpm pilot plant with several specified tests, and upgraded that original pilot plant by means of a dual-magnet system, with more advanced controls, installed in a mobile unit; Effort II included on-site testing of the mobile unit, including several storm flows, as well as completion of the necessary backflushing, cleaning and sludge evaluations. With the information gained from these efforts and from previous testing using the seeded water technique, basic design and operating characteristics could be developed as a basis for the generation of costs and criteria for a demonstration-scale system.
APPENDIX B
SALA-HGMF®
AWT MAGNETIC FILTRATION PILOT PLANT TRAILER

A fully automated, self-contained magnetic filtration Advanced Water Treatment pilot plant uses Sala's unique Mag-Seed™ flow sheet designed for the filtration of municipal and industrial waters containing nonmagnetic pollutants. The mobile trailer includes laboratory, office, and storage space. The laboratory can be equipped to measure a variety of water quality parameters.

The pilot plant is designed to operate automatically and continuously without attention for a period of 24 hours. A stripchart recording turbidimeter provides a continuous readout of effluent quality. The pilot plant includes two magnetic filters to simulate the operation of a full-scale variable flow capacity system. The larger magnet can reach a maximum background magnetic field of 5 KG. Usually much lower fields are required for cooled water treatment applications.

APPLICATIONS
- Municipal waste water
- Shipboard sewage
- Combined storm overflow
- Polishing step for secondary effluent
- Pulp and paper mill process waste waters
- Chemical industry effluents
General Specifications

Pilot Plant Specifications

Flow Capacity: 10 gpm (0.6 liter/s)
Sludge Production: 1 lb/hour (0.5 kg/hour)

Utilities Requirement

The SALA-HGMF* magnetic filtration pilot plant trailer can be provided fully self-contained so that no utilities services are required.

The Sala Magnetics Mag-Seed™ magnetite seeded filtration process makes possible the magnetic filtration of nonmagnetic contaminants from waste waters. Through this process contaminants such as coliform bacteria, viruses, organic material contributing to color and turbidity are coagulated and flocculated around a highly magnetic seeding material and are thus rendered susceptible to trapping on a magnetized filler bed. Even certain dissolved contaminants such as trace metals and phosphorous are trapped on the filler bed in this way.

Results obtained on combined storm overflow, on raw sewage, on secondary effluent from a conventional sewage treatment plant, and on paper mill aeration lagoon effluent are displayed in the following table.

PERCENT REMOVALS FOR TYPICAL APPLICATIONS

<table>
<thead>
<tr>
<th>Application</th>
<th>BOD₅</th>
<th>Coliform</th>
<th>Color (apparent)</th>
<th>Turbidity</th>
<th>Suspended solids</th>
<th>COD</th>
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<tbody>
<tr>
<td>CSO</td>
<td>92</td>
<td>99.85</td>
<td>93</td>
<td>86</td>
<td>96</td>
<td>75</td>
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<tr>
<td>Raw Sewage</td>
<td></td>
<td>99</td>
<td>82</td>
<td>88</td>
<td>91</td>
<td>67</td>
</tr>
<tr>
<td>Secondary Effluent</td>
<td>98.3</td>
<td>71</td>
<td>85</td>
<td>88</td>
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<tr>
<td>Paper Mill</td>
<td>95</td>
<td>-</td>
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The SALA-HGMF* Magnetic Filtration Pilot Plant is available for lease or sale. Requests for quotation for full-scale systems are invited.

Specifications subject to change without notice. For further information contact the Sala Company or Sales Agent nearest you.

SALAMagnetics 247 Third Street, Cambridge MA 02142
Copyright 1977 Sala Magnetics Inc.

Tel (617) 868-2550 Telex 32-1475
SMI Bulletin 24200108 7718 GB
CURRICULUM Vitae

Name: Ugur Ortabasi
Born: Ankara, Turkey - June 1, 1938, U. S. Citizen
Married: Ilse Ortabasi, 2 Children

January 1978 - Present

HEAD OF THE ENERGY DIVISION OF THE CENTER FOR ENERGY AND ENVIRONMENT RESEARCH (CEER), University of Puerto Rico.

Responsibilities include: Research, Development and Planning in the fields of Solar Technology, OTEC, Conservation, Fossil Fuel, Nuclear and Biomass.

PROJECT DIRECTOR FOR CEER in the "Photovoltaic Concentrator Applications Experiment" awarded to the Energy Office of Puerto Rico in response to PRDA EG-78-D-04-0035.

UNITED NATIONS ASSIGNMENT AS CONSULTANT TO TURKEY in relation to "Re-Transfer of Technology Program"

October 1977 - January 1978

SENIOR VISITING RESEARCH SCIENTIST, Center for Energy and Environment Research (CEER), University of Puerto Rico

Director of Solar Energy Technology and Materials Research Program of CEER.

Responsibilities include; the organization of a developmental nucleus consisting of professors and graduate students from UPR Mayaguez and Rio Piedras campuses, preparation and development of a sound Solar Energy Technology program with the aim of its becoming strong and competitive.

June 1976 - October 1977

SENIOR RESEARCH PHYSICIST, Technical Staff Division, Corning Glass Works.


- June 1976

SENIOR PHYSICIST, Technical Staff Division, Corning Glass Works.


b) Bio-Medical Research: Joint Project with Bio-Organic Department of CGW to develop a Nanosecond Fluorescence Spectrometer to study molecular kinetics of ligand - bio-polymer interactions. Single photon coincidence electronics and data reduction and analysis.

c) Academic Activities: CONTINUING EDUCATION FACULTY at Elmira College, N. Y. Lectures on Nuclear Engineering, Solar Engineering and Modern Physics.

- 1973

RESEARCH FELLOW IN PHYSICS, Corning Glass Works R & D Laboratories.

- 1971

ASSISTANT PROFESSOR, The University of Florida.

Research and Teaching at undergraduate and graduate level. Lectures on "Radiation Interaction with Matter" and "Application of Isotopes." Supervision of Master of Science candidates. Responsible for the AEC Research Contract No. AT-(40-1)-3345 on "Chemical Structure Studied by Nuclear Techniques." Summer work at Lawrence Radiation Laboratories, Berkeley, California as Research Visitor.

- 1969

GRADUATE ASSISTANT, Western Reserve University and University of Florida.

Received Ph.D. DEGREE IN NUCLEAR ENGINEERING from the University of Florida.

Experience in nuclear theory, fast nuclear electronics, computer analysis automatic data processing, reactor experiments, and radiation physics as applied to radio-scanning of the body. Theoretical work in crystal physics and electronic structure of metals.

- 1965

Undergraduate and Graduate study at the Universities of Gottingen and Hamburg, Germany. DIPLOM PHYSIKER DEGREE from the University of Hamburg, 1965.

Experience in experimental nuclear spectroscopy, nuclear electronics, theoretical work in nuclear models, hyperfine interactions in metals. Independent study in physical oceanography.
PAPERS


Indoor Test Methods to Determine the Effect of Vacuum on the Performance of a Tubular Flat Plate Collector, 1976 ASME Winter Annual Meeting, December 5, New York, N.Y.

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BOOKS:

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Experimental Optics, translation from German into Turkish, Verlag Industries-Druck GMBH, Gottingen (1961).

Experimental Electricity, translation from German into Turkish Verlag Industries-Druck GMBH, Gottingen (1961).

AWARDS

DAAD Fellowship for 4 years, Germany, 1961-65.

Award of the University of Hamburg for Outstanding Foreign Students, Hamburg, Germany, 1965


Recipient of the two years CGW Fellowship Award in Physics as a result of a nationwide competition.
Several Patents pending in the field of Solar Energy Conversion.
CURRICULUM VITAE

Name
Arthur McBride Block

Social Security No. 143-30-5543

Address 65th. Infantry Sta. P.O.B. 30918
San Juan, Puerto Rico 00929

Telephone No. 809 - 761-9359 (home) 809 - 767 - 0350 (Business)
Physical Data Height - 5'10"
Weight - 170
Health - Excellent

Place and Date of Birth Newark, N.J., June 26, 1938.

Citizenship U.S.A.

Civil Status Married, 2 children

Languages English (spoken, written and reading), Spanish
(spooken, reading), French (reading), German (reading), Russian (reading-dictionary supplemented).

Education

High School Newark Academy, Newark, N.J.; Diploma 1956

University Cornell University, Ithaca, N.Y.; A.B. 1961
   Major: Chemistry and Physics

Advanced Degree Rutgers - The State University, New Brunswick,
   N.J.; Ph.D. 1967 - Major: Physical Chemistry
   Minor: Analytical Chemistry - Thesis: "Laser
   Light Scattering from Uniform Spherical Particles"

Professional Experience

Present Scientist II, Center Energy Environment Res., Terrestrial
Ecology Division; Duties: Chemical Program Development,
Instruction of Analytical Techniques to Other Members
of the Division, Maintenance and Repair of Instruments,
Adaptation of Standard Methods for Field Work, Computer-
ized Data Management (FORTRAN, RPGII; IBM 370 System);
Grant and Proposal Submission, Administration of Pro-
gram; 3 Laboratory Assistants, 4 Graduate Students.
Salary: $17K - 19K.
1975 - 1975

Scientist I, Puerto Rico Nuclear Center, Terrestrial Ecology Division and Physical Sciences Division; Duties: Development of Irradiative (Gamma Co-60) Analytical Techniques. Theoretical Prediction of Matrix Isolated Fluorescence of Purines and Pyrimidines, Development of Background Radiological Data for Northwest Puerto Rico, Measurement of Radioactivity Background in Northwest Puerto Rico, Training of Field and Laboratory Technicians for Dosimetry and Monitoring Technical Measurements, Development of a Position Paper Concerning Chemical Data Necessary for the Assembly of a Trace Elements Transport Model of the Rio Espiritu Santo Drainage Basin, Computerized Data Management (FORTRAN); Supervision: 2 field technicians, no more than 6 laboratory aides. Salary: $12,000-15,500/year.

1968 - 1972

Assistant Professor, University of Puerto Rico, Rio Piedras, Puerto Rico; Duties: Instruction of Students at Graduate and Undergraduate Levels, Teaching of Physical Chemistry, Laboratory Instruction of Physical Chemistry, Admissions, Curriculum Committee, Grant Proposal Development and Submission, Original Investigation in Physical Chemistry, Publication of Scientific Articles in Chemical Journals, Participation in Scientific Conferences and Seminars; Supervision: Between 25 and 30 undergraduate students and 5 graduate students in research duties. Salary: $9,700-12,000/year.

1967 - 1968

Lecturer, University of Puerto Rico, Rio Piedras, Puerto Rico; Duties: Same as those 1968-1972; Supervision: About 28 undergraduate students in instructive duties. Salary: $8,000/year.

1962 - 1967

Laboratory Instructor, Rutgers - The State University, New Brunswick, N.J.; Duties: Laboratory Instruction to Undergraduate Students in General Chemistry, Quantitative Analysis and Instrumental Analysis, Student and Course Evaluation, Problem Grading in Graduate Courses, Tutoring of Students with Background Problems; Supervision: Between 15 and 30 students per class (usually 3 classes of 3 hours per week). Salary: $250-320/month.

Other


Acting Head, Terrestrial Ecology Division, Puerto Rico Nuclear Center, Rio Piedras, Puerto Rico; Duties: Responsible for Maintenance of Programs On-going During Absence of the Head of the Division. (1973-1976, a total of approximately 30 weeks during this time period). Salary: No additional compensation.


Chairman - Scientific Program Committee, Caribbean Chemical Conference IX, Dec. 8-11, 1977, Condado Holiday Inn, San Juan, Puerto Rico.
Societies, Memberships, Office Held, Honors, Distinctions

Colgate-Palmolive Research Fellow 1964-65.

Sigma-Xi Society: Associate Member 1965; Member 1973; Councillor-San Juan University of Puerto Rico Club 1970-71, 1974-76.

Association of Southeastern Biologists

International Society of Quantum Biologists

American Association for the Advancement of Science

American Chemical Society - Puerto Rico Section Chairman 1978

Society of Microbiology of Puerto Rico

American Men & Women of Science

Public Conferences and Lectures


Meetings, Symposia and Conferences Attended


X Congreso de Químicos Latinoamericanos, San José, Costa Rica; Feb. 1969.

Northeast Region Sub-Section Meeting, American Chemical Society- "Metrochem", San Juan, Puerto Rico, 1971.


Inter-lab Conference on Hydrology and Trace Element Transport in Ecosystems, Puerto Rico Nuclear Center; Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee; U.S. Department of Agriculture,


American Chemical Society, Local section executive orientation meeting: Asheville, N.C. Carolina; Apr., 1976.

American Chemical Society/Puerto Rico Section, 1st senior technical meeting (Meeting-in-Miniature): La Parguera, Lajas, Puerto Rico; Dec., 1976.


Research Students and Projects Supervised


David Santiago Mesa; Isolation and purification of enzyme glycogen phosphorylase-a isolated from the muscle of the blue crab (Callinectes danae) jointly supervised with Dr. Fermín Sagardía, Sch. of Med. UFR; Ph.D. (1969-1972). Biochemistry.


Pura A. Ríos; Inhibition kinetics of glycogen mobilization by enzyme glycogen phosphorylase isolated from the muscle of the blue crab (Callinectes danae) jointly supervised with Dr. Fermín Sagardía, Sch. Med. UFR; Ph.D. (1968-1972). Biochemistry.


Grants and Contracts


Commonwealth of Puerto Rico; Department of Housing, 1969. "Grant of Surplus Electronic Equipment"; estimated value: $10,000.

U.S. Department of Health, Education and Welfare, 1972. "Equipment for Modernization of Undergraduate Laboratories"; Written by members of the department of chemistry, University of Puerto Rico and administered through the department. Physical chemistry section written by A.McB. Block, specifying equipment for an undergraduate experiment in photo-chemistry, estimated amount: $5,000.

Puerto Rico Water Resources Authority, 1973-1975. "Environmental Data for the Environmental Report in Support of Location of Thermo-nuclear Power Generation Facilities in Barrio Islote, Arecibo, Puerto Rico"; Contract awarded to Puerto Rico Nuclear Center, Principal administrator: Dr. Frank G. Loewman, responsible agent; Suu.-director: Dr. Michael Cancy, negotiating agent; Research coordinator: Dr. James D. Parrish, liaison agent with contractors; Director of Terrestrial Ecology Studies: Dr. Richard G. Clements, principal investigator; Head of Radiological Background and Information Studies: Dr. Arthur McB. Block, co-principal investigator. Radiological information for U.S. Atomic Energy Commission Docket #50-376. Reporting in most cases was through Dr. Clements, though on a number of occasions, direct communication with Dr. Parrish, or with a contracting agent representative was requested. Contract duration: Nov. 1973 - June 1975. Total budget (estimated): Salaries (including overhead and fringe benefits) $90,000; Equipment, material and supplies $20,000. (Budgetary data reflects estimates, not committed funds, and applies only to the radiological section).
Promised Abstract


"Purification and Properties of Glycogen Phosphorylase-A Isolated from the Muscles of Blue Crabs (Callinectes danae)", D. Santiago, P.A. Ríos de Santiago, A. McB. Block and F. Sagardia ibid.


"Cinética de la Polimerización de Glucosa a Glucogeno con Agente Catalítico de Fosforilasa de Glucogeno Aislado de los Musculos del Cangrejo Azul (Callinectes danae)", A.McB. Block, D. Santiago, P.A. Ríos de Santiago and F. Sagardia, ibid.


"Molecular Orbital Calculations for the Alpha, Beta, Gamma (Lindane), and Delta Isomers of 1,2,3,4,5,6-Hexachlorocyclohexane (BHC)", A. McB. Block and L.W. Newland, invited communication, International Union of Pure and Applied Chemistry (IUPAC) Conference on Pesticides III, Helsinki, Finland (1974).


"Some Observations on Pesticide Uses in Puerto Rico and Other Tropical Areas: A Research Prospectus for Pesticide Technology", -8-


"Thiobetah Analogos of Plant Auxin (Indole-3-Acetic Acid)", A.McB. Block and F. Santos. IX Caribbean Chemical Conference, San Juan, Puerto Rico, Dec. 8-11, 1977.


G.R. Stevenson, A.E. Alegria and A.McB. Block, "Equilibrium studies by electron spin resonance XIII. The relationship between charge density and ion pair dissociation determined by the use of g values", J. Amer. Chem. Soc. 97, 4859 (1975).


A. McB. Block and N. García, "Commentary on the analysis of mercury in soil and sediment", J. Environ. Qual. 6, 232 (1977)


