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Report on Current Training and Research Activities
at the Puerto Rico Nuclear Center

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REPORT ON CURRENT TRAINING AND RESEARCH ACTIVITIES
AT THE PUERTO RICO NUCLEAR CENTER

Purpose of Report

During recent years the AEC, as most government agencies, has been working with an increasingly tight budget. To assure the best utilization of available funds it has been considered advisable that PRNC concentrates its efforts in programs which can be carried on better in Puerto Rico than in the mainland. For the purpose of evaluating the current training and research activities from this point of view, this report enumerates said activities classifying them in one of three categories:

- I. Programs which can be better developed in Puerto Rico
- II. Programs which can be better developed in the mainland
- III. Programs which would fall under category II, but are considered important to Puerto Rico

This classification should be helpful in reviewing the present achievements of PRNC and in establishing its limitations and weaknesses, with the final goal of general programmatic decisions for the best accomplishment of our mission.

Criteria upon which classification is based

- I. Programs which are better developed in Puerto Rico:

It first seems difficult to state that there are scientific activities than can be better developed in Puerto Rico. In the mainland there are many well established scientific institutions which are better equipped, with larger scientific staff and budgets, and with capabilities to undertake practically any scientific endeavor. In contrast, Puerto Rico has many of the limitations of a developing country, with a weaker scientific community and

with limited supporting technical personnel. In such a context, it may be concluded that scientific work is better accomplished in the mainland.

However, there are certain scientific activities that can be developed better in Puerto Rico, since they are directly related to the unique characteristics of Puerto Rico:

1. Tropical environment providing unique opportunities for research in terrestrial ecology, agriculture and medicine.
2. The proximity of the Atlantic Ocean and Caribbean Sea allows year-round activities in marine biology.
3. An island whose size and location make it to a certain extent an isolated system, suitable for controlled field experiments.
4. There are health problems with a much larger incidence in Puerto Rico than in the mainland. The medical community in Puerto Rico is therefore in a better position to take advantage of this clinical material.

This uniqueness of Puerto Rico appears limited to areas within the Life Sciences. However, scientific development in any one of these areas requires the support of the physical sciences. Any activity within the physical sciences which gives support to a program which can be better developed in Puerto Rico (as determined by above criteria) should therefore also be considered within this same category. Even though physical science "per se" is better developed in the mainland, as a "support activity" it is more effective in proximity to the main program.

Puerto Rico also offers uniqueness as compared to the mainland in serving as a training center for Latin Americans. This uniqueness is due to:

1. A more compatible cultural environment
2. Bilingualism
3. The fact that conditions in Puerto Rico as a developing country resemble more those prevailing in Latin America

II. Programs which can be better developed in the mainland

This would cover all other activities not falling within Category I, although a special and third category is being included for activities that are considered important to Puerto Rico, even though they can be better developed in the mainland.

It might be implied that no activities in this second category should be sponsored at PRNC. However, activities in this category can play an important role in contributing to the development of the scientific staff by allowing a certain amount of flexibility in their secondary interests. Such activities must be planned so that their overall cost is minimal with the fullest possible utilization of the available equipment.

III. Programs which would fall under category II, but are considered important to Puerto Rico

The Puerto Rico Nuclear Center is an essential part of the scientific programs of the University of Puerto Rico, and the impact that the laboratory has had, and should continue having, on these programs cannot be overestimated. Thus any PRNC

activity which contributes to the scientific development of the University should be considered important to Puerto Rico. The most reliable evidence for the effectiveness of the Puerto Rico Nuclear Center's contribution in this area is the extent of student and faculty participation in these activities. This criterion has been used in classifying category III programs.

It should be pointed out here that the training programs for Latin Americans at PRNC derive a direct benefit from any upgrading of the scientific potential of the University of Puerto Rico.

On the following pages, the training and research activities of the Puerto Rico Nuclear Center have been classified in the three categories defined above, and listed under the Division administering the program. Presenting the report in this form provides a review of each Division's activities. Financial support is provided by the AEC in all cases unless otherwise stated.

RADIOECOLOGY DIVISION

The Division of Radioecology is comprised of the Marine Biology, Terrestrial Ecology, International Decade of Oceanographic Exploration, Jobos Bay and related programs. All of the research conducted under these programs utilizes the uniqueness of the tropical environment and/or facilities offered by the Puerto Rico Nuclear Center.

I. Programs better developed in Puerto Rico:

A. Marine Biology Program (funded by DBM - Program 06)

The main research area used is a seventeen-mile stretch of ocean off the west coast of Puerto Rico. It is unique in that the area receives drainage waters from three major rivers which have diverse geologic substrata: limestone, volcanic and serpentine. It is the only AEC program dedicated to tropical marine ecology.

1. Basic marine biological and ecology studies include investigation of the following biological systems:
 - a. coral reefs
 - b. mangrove
 - c. pelagic and mud bottom
 - d. turtle grass
 - e. benthic foraminiferans

Research activities include the measurement on the transfer of:

- a. energy
- b. biomass
- c. carbon
- d. nitrogen
- e. trace elements

between trophic levels in food webs.

2. Background oceanographic and limnological studies
 - a. Measurement of physical and chemical characteristics of the marine areas needed for the biological and ecological studies.
 - b. Studies on the sedimentation of river-borne suspended particles.
 - c. Studies on the physical and chemical forms of elements transported into estuarine areas.
 - d. The influence of soluble organic compounds on the reactivity of trace elements with the electrolytes of sea water .
3. Analytical methods for trace elements
 - a. Development and refinement of techniques for the determination of trace elements in the marine systems.

B. Terrestrial Ecology

The diversity of Puerto Rico with respect to its geology, soils, climate and vegetation makes it an ideal location for conducting research in tropical ecosystems. While this diversity could be found in other tropical areas the great advantage here is the fact that it has been compressed into 3100 sq. miles and is readily accessible.

1. Research projects
 - a. Rainfall interception in a Puerto Rican Rainforest
 - b. The chemical importance of the first tenth of an inch of rainfall in a Puerto Rican Rainforest
 - c. The chemistry of rainfall, throughfall and stemflow in a Puerto Rican Rainforest
 - d. Leaf litterfall production in a tabonuco forest in Puerto Rico
 - e. The chemistry and cycling of elements in litterfall of a tabonuco forest in Puerto Rico
 - f. The chemistry of freshwater streams in the Luquillo National Forest of Puerto Rico
 - g. Distribution of the radioisotopes ^{137}Cs , ^{134}Cs and ^{88}Sr in terrestrial systems of Puerto Rico

- h. The identification and distribution of fauna in fresh water streams of the Luquillo mountains
 - i. The behavior, population and vocal organization of Eleutherodactylus sp. in Puerto Rico
2. Thesis research
- a. The Uptake of Selected Elements by the Dominant Species of Fresh Water Shrimp in the Fresh Water Streams of the Luquillo Mountains.
 - b. Identification and Life Cycles of Fresh Water Shrimp in Sonadora and Espiritu Santo Rivers of the Luquillo Forest.
 - c. Mating and Territorial Behavior of the Snail Caracolus caracolla. (student sponsored by UPR)

C. International Decade of Oceanographic Exploration (funded by National Science Foundation)

IDOE is an international effort to assess the extent of pollution in marine waters surrounding the United States: the Atlantic and Pacific Oceans, the Gulf of Mexico and the Caribbean Sea. PRNC, because of its location and facilities, was contracted to carry out research in the Caribbean.

- 1. Measurement of heavy metals in marine food chain of the Caribbean.
 - 2. Measurement of hydrocarbon (petroleum) levels in marine food chains of the Caribbean.
 - 3. Measurement of chlorinated hydrocarbons (biocides) in the marine food chains of the Caribbean.
- D. Jobos Bay Program (partly funded by PRWRA)

This program conducts extensive ecological research on the effects of the power complex on the ecology of Jobos Bay and surrounding areas.

E. Guayanilla Bay Project (funded by PRWRA)

This project deals with the investigation of elevated temperature effects on mangrove and turtle grass communities. The high temperatures are created by the discharge of cooling waters from a fossil fuel electrical plant.

F. Site Selection Survey (funded by PRWRA)

Under this project ecological investigations are made at coastal sites that may be considered for future location of power generating plants.

TROPICAL AGRO-SCIENCES DIVISION

Tropical lowland agriculture studies are greatly needed in Latin America to raise food production. In most cases results obtained in Puerto Rico can be applied directly to Latin America since work is performed under similar tropical climate, soil types, crops, insects and disease conditions. Strong collaboration with UPR is essential. PRNC's expertise in nuclear techniques as applied to agriculture should play a significant role in the broader overall agricultural program under Dean Salvador Alemañy, which includes the academic faculty, the Experiment Station and Extension program. Collaboration with the Federal Experiment Station should also be enhanced. Such integrated effort is most beneficial to Puerto Rico and Latin America.

At present there are a number of collaborative research programs in the planning stage:

- A. In collaboration with UPR and Federal Experiment Station
 - 1. Crop improvement by mutation breeding -- beans, starch crops such as yams, yautía, etc.
- B. In collaboration with UPR
 - 1. Food preservation by irradiation -- root crops such as yams, yautía, yuca, etc.
 - 2. Entomology -- nematode study
 - 3. Soils investigations
 - 4. Environmental stress physiology -- heat tolerance, high-temperature photosynthesis, photorespiration
- I. Programs better developed in Puerto Rico
 - A. Training
 - 1. Teaching of university courses on nuclear techniques applied to tropical biology, agriculture, and special problems in radiation biology.

2. On the job training in the application of nuclear techniques to agriculture and food preservation (one trainee from Colombia sponsored by OAS)

B. Thesis research

Eight graduate students are active at present in research leading to M. S. degrees in biology, chemistry or agriculture (four are from Puerto Rico and four are from Latin America). However, only one project has been classified under this category because of its relevance to tropical agriculture. The others are listed under category III.

1. Studies to determine the presence of growth inhibitors in the seminal structures of *Carica papaya*. in order to improve germination.

C. Research activities directly related to tropical agriculture

1. Quality improvement in plantains -- to improve vitamin A and C content in fruits and the fruit pulp to peel ratio.
2. Yield improvement by low dose radiation stimulation in yams and soybeans. (Cooperative work on yam with Federal Experiment Station).
3. Induced Sterility Project (financed by DEM--program 06 and small financial support from USDA terminating June 30, 1972).

Puerto Rico offers advantage over other tropical areas in the mainland: being an island it is convenient for field tests since migration is minimized and species numbers are few. The Insect Sterility program collaborates with the academic community as follows:

a. Thesis research of one M.S. student:

Comparison of Haemolymph Protein Profiles in Inherited Partial Sterility and Normal Lines of *Diatraea Saccharalis* (Fab.) (Crambidae, Lepidoptera)

b. Research participation of a graduate student (non-thesis):

Rearing Methods for the Southern Green Stink Bug

4. Soybean mutation breeding program

Objectives: (a) to improve its adaptation to tropical environmental stresses.

(b) to improve quantity and quality of its seed protein.

5. Developing microanalytical techniques for assaying sulfur-containing amino-acids, in particular methionine in soybeans.

To be used as a mass screening technic to isolate high methionine mutants.

6. Electrophoretic studies of isozyme patterns of various enzymes in soybeans (partly involving joint appointee)

The last three projects are classified under category I because of interest in improving the adaptability of soybeans to the tropical environmental stresses. If this were not so, they would be classified in category III.

III. Programs important to Puerto Rico:

A. Thesis research

1. Complementary effects of ionizing radiation and lipoxidase activity on the fatty acids of soybeans (sponsored by OAS)
2. The effect of temperature on the mitotic cycle in Vicia faba L. (sponsored by UPR)
3. Microanalysis of sulfur-containing amino acids by isotopic dilution and neutron activation (sponsored by UPR)
4. Electrophoretic analyses of several seed protein fractions of Glycine max L. (sponsored by UPR)
5. Characterization of the degradation products of enzymatic and radiation breakdown of fatty acids by electron spin resonance and gas liquid chromatography (sponsored by UPR)
6. Electrophoretic studies of cytoplasmic and mitochondrial malate dehydrogenase isozymes in soybean seedlings.
7. Mutagenic effect of N-methyl-N'-nitro-N-nitrosoguanidine on histidine operon of Escherichia coli strain C.

MEDICAL PROGRAMS

As a developing country, Puerto Rico has health problems similar to those found in Latin America. The predominance of certain health conditions such as tropical diseases (sprue and parasitosis), certain anemias related to malnutrition, and some forms of cancer (cervix, esophagus, oral and pharyngeal cavities, stomach) makes Puerto Rico a specially suitable place for research and training in these areas. Latin Americans coming to Puerto Rico find advanced medical knowledge and techniques which may be applied on return to their respective countries. Through the years, the efforts of the Puerto Rican professional community have resulted in a significant increase in the life expectancy of its population.

RADIOTHERAPY AND CANCER DIVISION

Program developed in collaboration with and support from the UPR School of Medicine. Additional funds are provided by three grants from the National Institute of Health which are administered through the School of Medicine:

1. Training grant
2. Planning grant
3. Radiation Therapy Oncology Group grant
(at national level)

I. Programs better developed in Puerto Rico:

A. Training Activities

1. In-service training -- minimum training recommended is one year unless candidate already has experience in radiotherapy.
2. One or two-month in-service training in collaboration with the Bronx V. A. Hospital to provide their residents the opportunity of practice in female care in a community with high incidence of cervical cancer.

B. Research activities related to types of cancer with high incidence in Puerto Rico

1. Study of leukemia incidence in patients treated for carcinoma of the cervix.
2. Three versus five fractions per week in external irradiation of cervical cancer.
3. Comparison of 4500 rads vs. 5000 rads in external irradiation of cervical cancer.
4. Study of the value of a boost of irradiation (2000 rads) after a dose of 5000 rads for carcinoma of the esophagus.
5. Study of prognosis of carcinoma of the cervix in women 30 years of age and younger.
6. Densitometric analysis of dose distribution in head and neck cancer.
7. Split course radiotherapy of carcinoma of various sites.*
8. Radiotherapy of carcinoma of the prostate.*

* NOTE: Being carried out as part of a national study by the Radiation Therapy Oncology Group.

III. Programs important to Puerto Rico:

A. Training Activities

1. Residency program -- three year training program accredited by American Board of Radiology. It includes three months in radioisotopes applications, 3 months in radiobiology and one month in medical physics.
2. Training activities carried out in collaboration with UPR School of Medicine for third and fourth year medical students.

B. Research activities carried out by residents

1. Clinical study of the experience with brain tumors
2. Clinical study of reticulum cell sarcoma

CLINICAL APPLICATIONS DIVISION

I. Programs better developed in Puerto Rico:

A. Training Activities

1. Basic course in Clinical Applications of Radioisotopes
8 weeks - full time
2. Course on special topics - Introduction to Radioimmunoassay,
Topic for 1972 - 4 weeks, full time (UPR School of Medicine)
3. In-service training
4. Training on clinical research

B. Research activities directly related to local health problems

1. Daily Ingestion of Iodine with Natural Diet of Inhabitants
of Puerto Rico (UPR School of Medicine)
2. Determination of Splenic Function in Tropical Sprue
(UPR School of Medicine)
3. Measurement with the Whole Body Counter of Vitamin B₁₂
and Iron Absorption in Patients with Intestinal
Malabsorption.
4. Study on Intestinal Absorption of Labelled Vitamin B₁₂
(B₁₂ ⁵⁷Co) measured by Whole Body Counter in Children
with various gastro-intestinal disorders (UPR School of
Medicine)

II. Programs better developed in the mainland:

A. Research Activities

These projects, although falling within this category,
are justified because the availability of patients and
physical resources makes it possible to conduct them at a
minimal cost.

1. Renal Plasma Flow and Glomerular Filtration rate in
Thyroid Disorders.

2. Evaluation of the Function of the Spleen by External Measurements.
3. Measurement with the Whole Body Counter of Vitamin B₁₂ Absorption in Thyroid Disfunctions.

III. Programs important to Puerto Rico:

A. Training Activities

1. Elective on Nuclear Medicine for fourth year medical students for period of three weeks, half-time (UPR School of Medicine)

B. Research Activities

These activities also contribute to the scientific development of local academic community since projects are carried out in collaboration with the School of Medicine.

1. Lung Scanning in Children with Congenital Cardiac Malformations.
2. Isotopic Angiocardiography in Congenital Cardiovascular Diseases.

MEDICAL SCIENCES AND RADIOBIOLOGY DIVISION

I. Programs better developed in Puerto Rico:

A. Training

1. Radiobiology for radiotherapy residents - 3 months
2. Staff teachers radiobiology for M.S. program in Radiological Health
3. Training within the three research programs sponsored by the Division of Biology and Medicine:

3 trainees in Schistosomiasis (sponsored by UPR)
3 trainees in Fascioliasis (2 sponsored by PAHO)
3 trainees in Virology (1 sponsored by UPR)

B. Research directly related to local health problems

1. Studies on the host-parasite relationship in Schistosoma mansoni. Radiation effects and application of radio-isotope techniques.

Schistosomiasis is a disease primarily of the tropics and marginal temperature areas in the orient. In the western hemisphere it occurs in a number of Caribbean islands, and in Venezuela, Surinam, and Brazil. It is a public health problem in Puerto Rico, thus providing a field-study background for training and research as well as laboratory investigation.

2. Ecological and Radiobiological Studies on Fasciola hepatica.

This program is being supported with the collaboration of the Commonwealth Department of Agriculture and the Agricultural Experiment Station of the University of Puerto Rico.

Fascioliasis or liver fluke disease is truly a worldwide parasitic infection. In the western hemisphere it is serious, extending into the western and southern areas of the United States of America. In Perú, serious occurrence in school children has been reported. The program of research and training at PRNC is the first of its kind in the Americas. Because of the Island's location, the seriousness of the parasitic infection in Puerto Rico, and the increasing expertise in the Island, as well as initiative already taken, there is strong justification to support PRNC as the best place for a United States of America supported Research-Training Center for fascioliasis.

3. Radiation Activation of Latent Viruses in Wild Arthropods and Vertebrates.

Puerto Rico is a tropical island infested with mosquitoes, ticks, nematodes, protozoan, etc., all of which harbor active or latent virus infections, and the population is exposed to many viruses. This environment is suitable to study:

- a. viral latency;
- b. the significance of viral persistence in mosquitoes, ticks, nematodes, protozoa, etc.;
- c. effects of viral infection on the virulence of certain parasites (Ex. Entamoeba histolytica);
- d. and to demonstrate possible viral etiology of certain cancers.

II. Programs better developed in the mainland:

A. Research

1. Trypanosoma cruzi

Trypanosomiasis cruzi, or Chagas disease, is currently a joint project of PRNC and the National Institute of Health in Bethesda, Maryland, where the work is now being done. The tissue protozoan causing this serious disease is not endemic in Puerto Rico, because the vector is not here. However, close proximity to endemic areas has raised the question on the wisdom of continuing such studies in Puerto Rico. The United States is sufficiently removed for security against transmission.

PHYSICAL SCIENCES DIVISION

I. Programs better developed in Puerto Rico:

A. Training activities

1. Radioisotopes Course -- A one-month course given twice a year.

B. Research in support of programs directly related to Puerto Rico

1. Light Scattering Studies with Natural Water Bodies (in collaboration with Terrestrial Ecology Program)

II. Programs better developed in the mainland:

A. Research not directly related to Puerto Rico and without impact in the academic community.

1. Radiation Chemistry Studies

a. Radiation Induced Aromatic Substitution

b. Electrophilic Aromatic Triphenylmethylation (in collaboration with IVIC)

During the four years of existence of this program it has had only one trainee. Although the trainee was quite important (a Ph. D. student from University of Sao Paulo) it is considered that the main cause for his participation was the AEC "Atoms in Action" exhibit in Sao Paulo. I believe this program is therefore not justified. Steps should be taken to reorient Dr. Eberhardt's interests.

III. Programs important to Puerto Rico:

A. Research

1. Gamma Radiolysis of Heterocyclic Molecules Program (sponsored by DBM, Program 06)

Its impact in the academic community has been well established. The candidate who was awarded the first Ph. D. granted by the Chemistry Department did her research under this program. Recognition of the program on the Rio Piedras campus may be evidenced by the participation of Dr. Rafael Arce, a UPR chemistry professor, and the presence of two students working for their Masters' degrees.

No one on the mainland has shown interest in research in this area and, considering the capabilities of Dr. Alec Grimison and DBM's interest in supporting his work, we could classify this program under category I.

2. Scintillation Studies

a. Liquid Scintillation Counting

b. Thioxanthone and related compounds

Due to the graduate students participating in these programs they are classified in this category. Programs of this type are badly needed in the particular local environment of Puerto Rico, both as a support facility for applied studies and from the training viewpoint for Puerto Rican and Latin American students. Doubts exist, however, as to whether communication between Dr. Castrillón and the Chemistry Department has been effective. If the situation does not change, the programs should be considered as being in category II, and Dr. Castrillón's participation at PRNC should be reoriented.

NUCLEAR SCIENCE DIVISION

I. Programs better developed in Puerto Rico:

A. On the job training

1. Activation analysis using the neutron generator -- one trainee from Bolivia sponsored by OAS

III. Programs important to Puerto Rico:

A. Academic courses related to research in the Division

1. Solid State Physics (sponsored by UPR)

2. Radiation Chemistry (sponsored by UPR)

B. Thesis research in collaboration with Department of Physics

1. Specific heat measurements on Triglycine sulfate at the critical region

2. ESR of alkali halides

3. Thermoluminescence in ferroelectrics

4. Light scattering from Triglycine Fluoberillate at the critical region

Thesis research in collaboration with Department of Nuclear Engineering

1. High frequency dielectric properties of Triglycine sulfate
 2. Electroreflectance and thermorelectance from BaTiO_3
- C. Radiation Chemistry Program (sponsored by Division of Research, Program 05)

The program carried out by Dr. Rupert Lee is definitely having an impact on the chemistry graduate program at the Mayaguez campus. Five M.S. students are participating at present and an Assistant Professor of Physics is collaborating on studies using ESR on irradiation effects of alkaline earth oxides.

As in the case of Dr. Grimison's program it could be argued that this research could be classified under category I.

D. Neutron Diffraction Program

Support from the AEC Division of Research will terminate at the end of fiscal year 1972, but the program will continue with the funds provided by a grant from the National Science Foundation. PRNC will continue to make available the equipment assigned to the program as well as laboratory and office space, and reactor time. PRNC is obviously interested in maximum utilization of the reactor facility.

The University has expressed interest in the program and has made available a faculty post at the Physics Department for the appointment of a physicist who will collaborate in the research. Such an arrangement should have a significant effect in attracting graduate students.

NUCLEAR ENGINEERING DIVISION

This Division is also identified as the Nuclear Engineering Department of the University of Puerto Rico and both PRNC and the University share its operating expenses.

I. Programs better developed in Puerto Rico:

A. Training

1. M. S. in Nuclear Engineering -- twelve students at present, 9 Puerto Ricans and 3 Latin Americans

2. Participation in M. S. courses without university credit -- 2 Latin Americans students (one sponsored by OAS)

B. Thesis research directly related to Puerto Rico

The more recent trend of Nuclear Engineering education which emphasizes reactor utilization instead of reactor design is illustrated by the last three projects:

1. Thermal flux distribution in the TRIGA-FLIP Reactor
2. Activation analysis used in a sedimentation study of certain rivers in Puerto Rico
3. Trace elements in the average Puerto Rican diet
4. Activation analysis of air pollution in Puerto Rico

III. Programs important to Puerto Rico:

A. Training

1. Nuclear Engineering courses for non-nuclear engineering undergraduates
2. Intense summer training on reactor supervision specifically designed to train graduate engineers employed by the Puerto Rico Water Resources Authority (to be financed by PRWRA)
3. Intense summer training on reactor operation specially designed to train PRWRA employees with some engineering education (to be financed by PRWRA)

B. Thesis research

1. Activation ratio technique for measuring absolute thermal neutron flux
2. Measurement of mass absorption coefficient of 3 Mev and 14 Mev neutrons
3. Assymmetric source method used in reactivity measurements

REACTOR DIVISION

- I. Programs better developed in Puerto Rico:
 - A. Training
 - 1. Reactor operation and reactor supervision -- four trainees have participated this year

- III. Programs important to Puerto Rico:

- A. Training
 - 1. Will collaborate with Nuclear Engineering Division in summer training of PRWRA employees.

HEALTH AND SAFETY DIVISION

- I. Programs better developed in Puerto Rico:

- A. Training
 - 1. M. S. program in Radiological Health in collaboration with the School of Public Health of the University of Puerto Rico, Medical Sciences Campus (partly financed by grant from Department of Health, Education and Welfare) -- Ten students enrolled, 3 of which are Latin Americans.
- B. Survey projects in collaboration with Commonwealth Department of Health
 - 1. Medical X-ray
 - 2. Dental X-ray

- III. Programs important to Puerto Rico:

- A. Educational activities strengthening the scientific programs of the University
 - 1. Collaborates with Biology Department, Mayaguez in the offering of a M. S. program in Health Physics - PRNC main participation is in the supervision of thesis research.

- B. Research activities in collaboration with University professors
 - 1. Radiation Damage of Macro-Molecules in collaboration with a professor from the Physics Department
 - 2. Calorimetric Techniques in X-ray Dosimetry in collaboration with a professor from Department of Electrical Engineering, UPR Mayaguez.

