9 RADIATION Survey COMMONWEALTH OF PUERTO RICO NUCLEAR CENTER DEPARTMENT OF HEALTH ---Page Break--- ---Page Break--- EVALUATION OF HEALTH HAZARDS DUE TO UNINTENTIONAL IRRADIATION OF THE GONADS DURING ROUTINE ABDOMINAL X-RAY EXAMINATION OF MALE AND FEMALE PATIENTS IN PUERTO RICO. REPORT NUMBER 3 - SURVEYED AREAS OF THE NORTHERN REGION ARECIBO - BAYAMON - CAGUAS - FAJARDO AREAS. MICHAEL GILEADI - SENIOR ASSOCIATE PUERTO RICO NUCLEAR CENTER MAY 1971 ---Page Break--- "I believe it is important that we keep in mind that our goal is not to deny or even delay a single x-ray examination that is needed by a patient. Rather, we wish to develop a system such that only those x-rays are given which are needed and only the best techniques are employed to reduce the average doses from x-ray examinations to not more than 10% of present values," Dr. Karl Z. Morgan, Director Health Physics Division, Oak Ridge National Laboratory (From the testimony presented before the House of Representatives on bill HR. 10700, October 11, 1967) The primary purpose of the Joint X-ray Radiation Survey sponsored jointly by the Puerto Rico Nuclear Center and the Department of Health of the Commonwealth of Puerto Rico is to evaluate possible radiation hazards associated with selected groups of x-ray diagnostic procedures. The responsibility for radiation protection and control associated with the use of radiation in medicine, education, and commerce in Puerto Rico rests with the Radiological Health Program in the Department of Health of the Commonwealth of Puerto Rico. ---Page Break--- TABLE OF CONTENTS: Introduction. Secretary of Health, Commonwealth of Puerto Rico. Summary Collection and Analysis of Statistical Data. Recommendation Letter and Sample Questionnaire. Surveyed Areas of the Northern Region, Puerto Rico, Statistics 1968. List of Tables. List of Figures. Manufacturer's Calibration Report. Caguas Area Statistics 1968...

Fajardo Area Statistics 1968... Arecibo Area Statistics 1968 Bayamon Area Statistics 1968, Appendix 1 Radiotherapy in Puerto Rico Appendix Uh ia Nuclear Medicine in Puerto Rico References 1m 124 140 14 155 ---Page Break--- ACKNOWLEDGEMENT TO ALL THE WONDERFUL MEDICAL WORKERS IN THE SMALL AND IN THE BIG COMMUNITIES, WHO IN SPITE OF THEIR TREMENDOUS WORKLOAD WILLINGLY DEVOTED THEIR TIME AND EFFORT TO HELP US IN THIS SURVEY — THIS THIRD REPORT IS DEDICATED — w ---Page Break--- INTRODUCTION This is the third progress report within the framework of the Joint Radiation Survey, sponsored by the Department of Health of the Commonwealth of Puerto Rico and the Puerto Rico Nuclear Center. It contains information related to the evaluation of possible health hazards associated with a selected group of diagnostic x-ray procedures performed in the four contract and noncontract areas of the Northern Region of Puerto Rico, namely Arecibo, Bayamon, Caguas, and Fajardo. This is a densely populated region, with a total population of 1,168,500. Most of the information is presented in the form of statistical and dosimetric data—valuable both per se and within the context of the hazards evaluation. As the survey progressed, more and more ramifications of the problem became apparent. This is significant, since our most effective weapon in radiation protection is possibly the knowledge and the awareness of potential hazards associated with certain procedures. This report contains an appendix on radiotherapy practices in Puerto Rico; to our knowledge, this is the first survey on this subject. Since the first x-ray was brought to the island in 1912 to La Princesa prison in San Juan by Dr. José Carbonete, and the first city milligrams of radium were brought by O.A. González Martine in 1925—both diagnosis and therapy in our community have made enormous progress. Today we have twenty x-ray units for various types of x-ray radiation therapy, about fifteen radionuclide units for deep penetrating radiation and more than eight units in nuclear.

médecine. In our community, cancer is the second cause of death. The commendable development of radiotherapy and nuclear medicine indicates the dimension of the efforts made against this major foe of our population. Nuclear medicine, more than any other field of medicine, has benefited from the close cooperation of various disciplines such as electronic engineering, physics, chemistry, and medicine, and has made enormous progress in the last few years in Puerto Rico. More than ten centers around the island, both public and private, are already using the most modern instruments for nuclear medicine procedures such as renal function, thyroid uptake, blood volume determination, and nuclear scanning procedures for the inner organs of the body. There is data pointing to a correlation between radiation and tumors in the following organs: leukemia in the blood, skin, sarcoma of the bone, lungs, liver, etc. Excessive radiation may reduce the lifespan of the irradiated individual as radiation decreases the general immunity of the body. The following table points to a shortening of the lifespan of radiologists due to an accumulated occupational dose. AVERAGE AGE AT DEATH United States-1958: Physicians having no known contact with radiation: 65.7 years. Specialists having some exposure to radiation (dermatologists, urologists, etc.): Radiologists: In Puerto Rico the average lifespan of those over age twenty-five in 1966 was: Males = 67.49 years Females = 73.11 years. National Academy of Sciences-National Research Council. "The Biological Effects of Ionizing Radiation". Summary Reports, Washington, D.C. 1956. Puerto Rico Department of Health, Division of Demographic Registry and Vital Statistics, 1968. The above statistical findings indicate that radiation damage may justly be considered as an occupational hazard, and that we ought to investigate and determine the occupational exposures of various types such as the average exposure received by radiologists, x-ray.

technicians, radiotherapists, nuclear medicine technicians and industrial workers dealing with radiation sources. The intention is to computerize our data for increased efficiency and for better accessibility. Due to our interest in the well-being of the younger generation, we also intend to investigate radiation sources and measurements in the secondary schools and college laboratories, scheduled as a future joint project of the Department of Health and the Muckean Center, whose collaboration has produced such trustful results to date. Co C6 fone Entesto Coté Yokdén, H.0. Secretary of Hi vi ---Page Break--- ---Page Break--- Per capita SUMMARY ‘annual gonadal doses associated with a selected group of abdominal and thoracic X-ray diagnostic procedures have been determined in the four surveyed areas of the Northern Region during 1968. The Genetically Significant Dose for the Northern Region of Puerto Rico 1968 will be evaluated after completing the Survey of the San Juan Metropolitan Area, which probably has more units than the four surveyed areas of the Northern Region. The most significant results and data are tabulated below: Summary of Significant Results [Surveyed area of the Northern Region-1968] Aguas Fajardo, Arecibo Total Number of diagnostic x-ray units (excluding dental x-ray units) in Area 32 18 46 3 150 Total number of abdominal x-ray diagnostic examinations termed "genetically hazardous" performed in public institutions and in private offices 42,201 11,330 37,572 20,101 121,208 Total number of thoracic examinations performed in public institutions and in private offices 89,654 12,638 78,209 43,493 223,904 Number of x-ray diagnostic examinations performed in public institutions only 1,710 43,211 133,916 44,405 53,262 Total number of all x-ray diagnostic examinations performed in public institutions and in private offices 166,933 48,803 166,596 77,102 59,434 Population per x-ray unit 50 TBE The number of x-ray examinations per 100 patients in public institutions.

18.2 10.5 2.0 as.8 Number of radiologists tw 3 6 a3 Population per radiologists 184, 500 58,050 114,226 56,776 39,884 | Mean gonadal dose per about nal x-ray diagnostic examination (meade). 517.2 511.8 513.9 55.2 521.7 Mean gonadal dose per thoracic x-ray diagnostic examination (rads) 0.93 1.03 70 1.04 88 Per capita per annum gonadal dose due to abdominal and thoracic x-ray

diagnostic examinations (rads) 58.3 50.0 56.4 49.8 ---Page Break--- “The Arecibo Area dose evaluations are based on dose measurements made at the Arecibo District Hospital using a Siemens-200 MA x-ray unit as irradiation source. This source was chosen as typical because of its frequency of occurrence in this area. Dose evaluations in the Caguas, Fajardo and Bayamón Areas are based upon measurements made on a Picker-200 MA unit - typical of these areas. "An appendix added to this report contains information concerning Radiotherapy and Nuclear Medicine in Puerto Rico. SURVEYED AREAS OF THE NORTHERN REGION “The Northern Region consists of five Areas: (1) the San Juan Area, (2) the Arecibo Area, (3) the Bayamón Area, (4) the Caguas Area, and (5) the Fajardo Area. Areas surveyed in this report include: " Bayamon * 340,600 ” Caguas 369,000 Fajardo” 116,100 ‘Total population of surveyed Areas + 1,168,600 ‘The four surveyed Areas represent the most densely populated parts of Puerto Rico. “There are two District (Regional) Hospitals in these surveyed Areas, one in Arecibo and one in Fajardo (in Caguas a Sub-Regional Hospital will be opened in July, 1971). ‘The major medical facilities in the surveyed Areas include: (a) 23 Health Centers (b) 10 private hospitals (c) 9 private clinics (d) 4 Public Health Units (e) 3 I.B. hospitals and T.B. Centers ‘There are a total of one hundred fifty diagnostic x-ray units in the Surveyed Areas (with the exception of dental units) and there were 459,434 x-ray examinations performed in the surveyed Areas in 1968, including 111,204 abdominal examinations termed “genetically hazardous” and 223,994 thoracic.

examinations. During the same time interval, 955,014 exposures (films) were made. During the year 1968, 459,494 diagnostic x-ray examinations among a population of 1,168,500 amount to an average of 39 X-ray examinations administered per 100 population. The global gonadal dose received by the total population of 1,168,500 in the year 1968 was evaluated by the present survey as 68,213,628 mrads. This figure includes gonadal doses due to a selected set of abdominal x-ray diagnostics as well as all thoracic x-ray diagnostics. Background Facts Some basic background facts referring to the specific demographic and socioeconomic patterns of Puerto Rico are given herewith in an attempt to facilitate the understanding and interpretation of data and results presented within the framework of this survey. Puerto Rico is the smallest and most easterly island of the Greater Antilles with an approximate area of 3,439 square miles. Approximately 78 percent of its total area are mountains and hills; the rest is a narrow coastal area, with some valleys. The population of the island was 2,799,100 in 1968 and the projected population for 1973 is 2,985,000. The mountainous area is predominantly rural, where the population lives in a rather traditional fashion. As a contrast, the urban areas are rapidly developing, industrializing, and changing their socioeconomic structure. In the past, Puerto Rico's economy was largely agricultural (sugar, coffee, tropical fruits, etc.), but in the last two decades dramatic changes and tremendous technical developments have taken place, raising the average per capita income substantially. The development of the economy was accompanied by even more significant improvements in the field of health, the most significant ones being enumerated below: (2) The death rate has been dramatically reduced from 20.9% in 1937 to 6.06 in 1970. (b) Infant mortality has been reduced from 138.6 per 1000 live births in 1937 to 28.5 per 1000 live births in 1970. (c) Deaths associated with deliveries.

andjor complications of pregnancy were 7 per 1000 live births in 1992, it has dropped to 5 per 1000 live births in 1970, (@) Life expectancy increased from 48 years in 1940 to 71.7 in 1970, ‘These achievements, no doubt, are due to improvements of public health, and of the socio- ‘economic level, especially during the last few years.! Out of a total population of 2,739,100 in 1968 there were 1,261,300 males and 1,877.80 females. in the 15-29 age group the number of males and females was approximately equ however in the 90-44 age group the number of females was significantly

larger: 181,00 males 88 compared to 218,500 females.” Among others this may be a reason why the total number of x-ray examinations is higher for females than for males in Puerto Rico and so is the global gonadal dose to the female population. For example, in the Bayamén Health Center a total of 16,749 photofluorographies were performed in 1968. Out of this, 3,850 were for male patients and 13,399 were for female patients. The preponderance of the female patients in photofluorography-cases was due to the fact that the Bayamén Health Center mostly screens the working population in the industrial area of Bayamén, of which about 80% are women. In the Fajardo District Hospital it was pointed out by the Chief Radiologist that females receive 704 of the x-ray examinations in the hospital due to the specific demographic distribution of the ares, ‘arly marriages are customary in Puerto ico; there were 149 live births to mothers below 16 in 1968 and 11,393 lve births to mothers within the 15-19 age bracket, Tota live birth in Surveyed Areas of the Northern Region-1968: 22,579. LIVE BIRTHS RY MEDICAL PACILITIES AND BY LOCATION, P. R.~ 1968, Geographie Government Hospitals, Private Home & Other Location Municipal Hospitals & Hospitals Locations. T°**! Health Centers Caguas and 7.645, 1,975 536, 10,156 Fajardo Arecibo 6,103 1,394 498 7,995 Bayamin 3,800 ‘999 129 4.498 TOTAL 17,038, 4,368 4.363 22.519 Data based on Plan for Hospital and Medical F

Department of Health, * Vital Statistics of the Department of Health, Commonwealth of P.R. lites, 1968. Commonwealth of Puerto Rico, 3 ---Page Break--- “The number of pelvimetries performed in 1968 in the Surveyed Areas is 2,120, meaning that approximately one out of every ten live births was accompanied by a pelvimetry. Of 9,223 live births in the Western Region in 1968, one of every three live births was accompanied by a pelvimetry and in the Southern Region in 1968, which had 13,981 live births, approximately one of every twenty-eight live births was accompanied by a pelvimetry. “Two levels of health care are conducted by the Puerto Rico Department of Health: focal Health Centers and District (Regional) Hospitals. “The basic unit of health care in Puerto Rico is the Health Center, which provides free medical care, preventive health services, and certain social services. There are sixty-six Health Centers on the Island distributed among seventy-seven communities. ‘There were five District (Regional) Hospitals operating on the Island in 1968" (1) The District (Regional) Hospital in Ponce, serving the twenty municipalities comprising the Southern Region, with a 412 bed capacity and 15 x-ray units. The total number of x-ray examinations performed in the hospital during 1968 was 33,126. (2) The Fajardo District Hospital serves the seventeen municipalities comprising the Eastern Area; has a 280 bed capacity and 8 x-ray units. X-ray examinations performed in this hospital in 1968 totaled 28,548 in number. (3) The Arecibo District Hospital, serving twelve municipalities, has 280 beds and 6 x-ray units. The number of x-ray examinations performed in this hospital in 1968 was 33,800. (4) The Aguadilla District Hospital, also serving twelve municipalities, has 300 beds and 3 x-ray units. In 1968, 27,569 x-ray examinations were performed in this hospital. (5) The Rio Piedras District (Regional) Hospital is also the University Hospital. This facility has 395 beds and 30 x-ray units. During 1968, 70,620 x-ray examinations were performed.

‘Also in 1968, there were four tuberculosis hospitals with X-ray units, two hospitals for mental illness, and one hospital for leprosy. In addition, there were 16 private hospitals with 38 X-ray units and 16 private clinics with 25 X-ray units. “The following table shows the trend in exposures in the last fifteen years in the District Hospitals. © Commonwealth of P.R. Department of Health, Plan for Hospital and Medical Facilities, 1968, ---Page Break--- YORK PERFORMED IN THE RADIOLOGY DEPARTMENTS OF THE DISTRICT HOSPITALS * NUMBER OF EXPOSURES (FILMS) TAKEN IN THE DISTRICT HOSPITALS IN THE LAST FIFTEEN FISCAL YEARS, BY LOCATION AND BY YEARS. ‘Puerto Rico 1954-1970 r T Yonge ff aguessite 1956-57 | 32,436 | 15,336 36,795 27,756

30,966 1957-58 14,246 | 19,988. your 33,624 WL asus | s6ye2e 21,378 23,564 37,467 1 wsenee pou) ee | + ! [ne 0,348 Hiowas |p | au Tact fest ross | aera Tass | yam 4.08 ese _||_on_ | yn | sean] 22,000 10455) wom ean | wow | ae | nan 63 swore | saa f esse | ay sse | soars 14,006 von haar | angie | gg | waar Tn Cuvatesy oF the Ens tom god atin Sov tom, Departnient of Mesto) Puerto Ri ---Page Break--- COLLECTION AND ANALYSIS OF STATISTICAL DATA Surveyed Areas of the Northern Region Puerto Rico ~ 1968 Following previous experience, the data was collected by means of properly designed questionnaires, mailed to all public and private medical facilities in the Surveyed Areas, along with a cover letter from the Deputy Secretary of Health, Dr. Carlos Nate. Instead of using several questionnaires—as has been done in the previous part of the survey—a special questionnaire was prepared for private medical offices in order to expedite data collection. ‘A sample of this questionnaire and that of the cover letter is part of the report. In spite of the high (70%) rate of response, it was nevertheless necessary to visit each facility because part of the returned questionnaires was not satisfactorily completed and because some of the data had to be rechecked. Even though cooperation was in general very good, data from

the majority of private offices was given on a weekly basis only, which understandably introduced certain inaccuracies in data compiling. For obvious reasons we chose to accept these inaccuracies instead of excluding the ‘ures referring to the private sector. The breakdown of data by ages also posed certain difficulties due to the fact that approximately 80% of both public and private medical facilities do not keep records of their patients’ ages. Logbooks in the x-ray departments of even the large District Hospitals were somewhat incomplete. In some places the breakdown by ages was missing, in other places data for certain months had not been entered, etc. The breakdown by age in private offices could only be estimated from the average weekly figures. Hopefully, computerization of data which is to begin next year in all District Hospitals and some Health Centers will significantly improve this situation. In order to collect data in some of the private hospitals, we used a sampling technique choosing data from the files for the weeks of March 1-6, 1968, June 9-13, 1968, September 16-21, 1968, and November 23-28, 1968. All collected data were thoroughly checked for accuracy and reliability, and data pertaining to public institutions were confirmed by the signature of the responsible person in charge. Once reliability and accuracy were established, data were uniformized and tabulated, and certain rates and indicators of interest were derived, and suitable interpretations added, wherever considered desirable figures were added for better presentation and clarification of the situation. ---Page Break--- RECOMMENDATION LETTER AND SAMPLE QUESTIONNAIRE ---Page Break--- ESTADO LIBRE ASOCIADO DE PUERTO RICO DEPARTAMENTO DE SALUD SAN JUAN, PUERTO RICO, 00908 24 de junio de 1970 a los Médicos de Hospitales Públicos y Privados, Médicos en Práctica Privada y Radiólogos De B. Carton Be Miter, MD. Subsecretario de Salud, Asunto: Encuesta sobre radiación y evaluación de la radiación a los géneros durante los exámenes de rutina de

Rayos X en hombres y mujeres de Puerto Rico. El Departamento de Salud, conjuntamente con el Centro Nuclear de La Universidad de Puerto Rico, perteneciente a la Comisión de Energía Atómica de los Estados Unidos, está realizando un estudio minucioso de todas las facilidades de Rayos X en Puerto Rico, mediante una encuesta y una evaluación de los posibles peligros no intencionados que pudieran tener los diferentes equipos de Rayos X existentes en la isla. Esta encuesta está siendo realizada por el Sr. Michael Gileadi, M.S., Científico Asociado del Centro Yoclear de Puerto Rico, y sus ayudantes, quienes le visitarán periódicamente para explicarles cómo se conducirá dicha investigación. Bajo la dirección de la Universidad de Puerto Rico se hizo un estudio similar que fue de gran provecho para estas instituciones y médicos privados, ya que se pudieron identificar y corregir a tiempo pequeños defectos en los equipos que ofrecían algún peligro de

radiación no intencionada. Al mismo tiempo se pudo determinar con gran certeza qué medidas tomar para evitar radiación innecesaria a los géneros de ambos sexos. Reafirmamos que le ofrecerá al autor Gileadi la mayor cooperación y toda la información necesaria para que esta investigación científica y constructiva tenga el mayor de los éxitos. ---Page Break--- ‘Table 1N, Table 2N, Table 3: Table 4: Table 5 Table 6. Table 7: Table 8 ‘Table 9.N. Table 10.8: ‘Table 11-8: Table 12.8) ‘Table 13; ‘Table 14N: ‘Table 15-8) ‘Table 16 LIST OF TABLES Municipalities in Surveyed Areas of the Northern Region, Puerto Rico-1968 Distribution of X-ray Units by Geographic Location, by Medical Facility and Population per X-ray Unit. Surveyed Areas of the Northern Region, Puerto Rico 1968, Total Number of X-ray Examinations in Public Institutions. Total Number of Patients and Number of X-ray Examinations per 100 Patients, Surveyed Areas of the Northern Region, Puerto Rico-1968, Distribution of Diagnostic X-ray Units in Operative Condition, by Medical Facility and by Manufacturer. Surveyed Areas of the Northern Region,

Puerto Rico-1968, census of Diagnostic X-ray Units. Surveyed Areas of the Northern Region Puerto Rico-1968, Number of Abdominal Diagnostic X-ray Examinations by Area, by Type of Examination and by Sex. Surveyed Areas of the Northern Region, Puerto Rico-1968, Number of Thoracic X-ray Diagnostic Examinations by Type of Examination and by Sex. Surveyed Areas of the Northern Region, Puerto Rico-1968. Number of Abdominal X-ray Examinations by Type of Facility and by Type of Examination, Surveyed Areas of the Northern Region, Puerto Rico-1968 Number of Films Exposed (Exposures) in Abdominal Radiography Examinations by Type of Facility and by Type of Examination, Surveyed Areas of the Northern Region, Puerto Rico-1968, Number of Films Exposed (Exposures) in Radiographic Examinations of the Abdomen and Thorax and by Type of Facility. Surveyed Areas of the Northern Region, Puerto Rico-1968. Evaluation of the Mean Gonadal Dose due to a Selected Set of Abdominal X-ray Diagnostic Examinations in Surveyed Areas of the Northern Region, Puerto Rico-1968, Evaluation of the Mean Gonadal Dose due to Thoracic X-ray Diagnostic Examinations in Surveyed Areas of the Northern Region, Puerto Rico-1968. Total Number of Diagnostic X-ray Examinations in Public Institutions and Private Offices Compared to the Population by Areas. Surveyed Areas of the Northern Region, Puerto Rico: 1988. Per Capita, per Annum Mean Gonadal Dose due to all Genetically Hazardous Abdominal X-ray Examinations, Surveyed Areas of the Northern Region, Puerto Rico-1968, Per Capita, per Annum Mean Gonadal Dose due to all Thoracic X-ray Examinations. Surveyed Areas of the Northern Region, Puerto Rico-1968 Per Capita, per Annum Mean Gonadal Dose due to all Genetically Hazardous Abdominal and Thoracic X-ray Examinations, Surveyed Areas of the Northern Region, Puerto Rico-1968, n ---Page Break--- TABLE IN MUNICIPALITIES IN SURVEYED AREAS OF THE NORTHERN REGION, PUERTO RICO ~1968 © AREA MUNICIPALITIES Caguas Err) Total Saw Lorenzo |

36,500 eran vanucon 31,900 canto Scemo Caguas Area, Total 369,000, Sonora. ‘areceo | arecwo Ramana Streccone ra Srocows. aor Sonata aes, ros aus wana tenov's pereraney Srisco Surveyed Areas of Vesa basa 32,500 The Northern Region ‘aregeo Area, Total 302,600, Orne Above Data Are Quoted From The Annual Data Statistics Report, 2 ---Page Break--- Table 2-N Distribution of X-Ray Units by Geographic Location, by Medical Facility and Population per X-Ray Unit, Surveyed Areas of the Northern Region Puerto Rico-1968. wen ER | ERAS ease, T romnaron | eran ee LOCATION FACILITY X-Ray Units per X-Ray 1 Unit. ‘Caguas [Aguas Buenas | Private Office n T 8,200 19,200 Tore ewes fe ree aso seve [= festa oer PRET] Siew) mets Year ae | ciara — 5 me aie Tio] season [oe ae ro : [eer a craves peat aras| Tat ‘vagucca mare ornces] > 75,980 ree | ---Page Break--- Table 2-N (cow) wees, — fueen oF | sceucarion | Population racy Ne rs per Geographic Area | Location Fajardo cea EAGT ENTER 13,000 | wo cna NT CaEoe - 300 | NoeRay UNIT aaa

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moweras vont | savas] = Sa aon Ec EE a Ota we cans TOTAL 198,713 2,738 20 pees | woeme oan Pap = 0 one | wean cenren son | = ruse veactn ont | ~e0,0¢¢ [= = fo orante Tora | ro.ass [= = eens | veatn conan snare | 3780 a Favanoo AREA Tora | 410,341 es wmeceo | astncT vasa sous ere # tectating 3,998 pho ---Page Break--- TABLE 88 (cow eoctren® | weocan raceiry | ToaeMme® | mt meen leet, 2588s weceo | vent conren veyi68 ‘1 mane each > Terao: | agers | asere ors vse abet RTO BS suis nase ee on. soson poor | 0,017 a 32 inane Tome [Taste ar Tae Ren nan SRST cam HEALTH CONTER 20,278 ces TeACIN CENTER 7,080 = = ARES TASTARER GENERA | a5, 02 eer 7 wosmra 028 : 23 fuse wean owt Ol 12,766 as womans ftames Tora Br, 788 mo ee wanar Pusu eat ut | 18,892 20,736 109.0 ‘SAN AOUSTIM HOSPITAL] 6, O36 5.38) ero reer n 2,043 7,000 792 aware wanmac | 48, 062 = = ant ToT 36233 335 Cc = = GUEGRADLLAS [PEALTH CENTER iste STUDS [RATE CENTER A Too 265 hy 093, he "SAN wigDEL LMC 3379 UTuADO TOTAL T1509 Visa Bask [WEALTH CENTER. 27,376 Sancver casraNe 10%) [ume Fveos eave Tora 33,570 + tecteting 14,867 peter toeroeraehte. 20 ---Page Break--- TABLE. 3H CCoNT) Sea |

Haeaes “ecanion_[_ "nea rcniry Busine | Sagieahets "= anece0 AREA Toma | $56,449 | 133,916 taseanaoras [neat conte [e078] aoe = ros wee Oey -Fe neo fae stn ose [1,381] sear aae——[-¥ay-9s} a Tae ee CO = vows [ean cenren = Rana EATEN = ‘oRocovis | weacTH CENTER = Ton enue | wear cone = Veta aca wea even = SaranON AREA TOTAL Tasos a hae ee? He sss2a2” | ise NOT INCLUD TE OFFICES, Nitarions”—cetodian aedical facilities having ao Torey tits ---Page Break--- ‘Table 3.8, which indicates the ratio between the total number of patients treated in an institution and the number of diagnostic x-ray examinations per 100 patients in the same institution provides interesting information concerning the procedures practiced in the surveyed ‘medical institutions. ‘Some private hospitals have a ratio of $25 diagnostic x-ray examinations per 100 patients Aue to the practice of performing a routine chest diagnostic ray examination on nearly every admitted patient Ft was found that (with the exception of the tuberculosis hospitals und tuberculosis centers where the number of S-ray examinations per 100 patients is understandably high), the largest number of diagnostic stay eNamtinations pee 100 patients were performed in private hospital. sees i? fy f } ost Ey ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- ---Page Break--- iice [prem SER cue pee ype Sr we 28 ---Page Break--- Table 6-N contains technical specifications of the x-ray units, year of installation, and other ‘relevant data characterizing the performance of the x-ray unit. These data are not only indicative of the quality of the radiography to be obtained by means of the particular x-ray unit, but also of the associated gonadal dose. This is so because the aperture of the x-ray beam is determined by collimation. If the unit has no variable collimator, every radiography is obtained by a large aperture irrespective of the film size, even though from the diagnostic point of view only that portion of the beam is useful which affects the film.

For the screen, thus, if an x-ray unit is not equipped with a variable collimator, all radiographies are done with a large aperture, thus placing the testes into the direct beam at certain positionings such as abdomen, flat, lumbar spine, and [LV.P.], even though the part of the direct beam that goes through the testes does not arrive at the film and is therefore superfluous from the diagnostic point of view. The role of the variable collimator is to cut down the aperture to the minimum size compatible with the diagnostic objective and thus exclude the testes from the direct beam whenever possible from the diagnostic point of view. Most modern x-ray units are equipped with variable collimators, and thus their use tends to decrease the average gonadal dose. The ovaries are less likely to be excluded from the direct beam than the testes. This is the most probable reason for the testicular doses to be smaller than the ovarian doses in Puerto Rico. In comparison, in the United States where the proportion of variable collimator-equipped x-ray units is smaller than

in Puerto Rico, it was found that the testicular doses are in general greater than the ovarian doses. A recent report of the U.S. Public Health Service, Oct. 1969, stated, “It was estimated that restriction of the x-ray beam to an area no larger than the film size would result in a reduction of the genetically significant dose from 65 to 19 millirads per person per year.” Most x-ray units installed in public institutions in Puerto Rico after 1960 are equipped with variable collimators, and in the last few years, variable collimators have been installed on many older units. As may be seen from Table 5-N, in the last few years the following changes in operating x-ray equipment have occurred in the surveyed areas of the Northern Region: 1) a total of 51 new x-ray units with variable collimators installed in public or private offices, 2) 17 variable collimators were added to previously installed x-ray units, 3) 9 modern x-ray units (for mass chest examinations) installed since.

1966. Other x-ray units in this Region include 1) 58 x-ray units with cones, 2) 18 x-ray units for fluoroscopy only, which were predominantly older units. The total number of x-ray units in the Surveyed Areas of the Northern Region is 150, "Miller, James W. Activities in the Division of Radiological Health Medical X-ray Program, X-ray in Medicine and Industry, Proceedings of a Public Health Conference, Univ. of Miami, Bur. of Radiol. Health, March 1970. ---Page Break--- Table 6-N shows that in all the Surveyed Areas of the Northern Region, the nine abdominal examinations considered “genetically hazardous” represent approximately 25% of the total number of diagnostic x-ray examinations performed in 1968, ---Page Break--- Table TN shows that thoracic x-ray examinations amounted to 59.6% of the total number of x-ray examinations performed in the Surveyed Areas of the Northern Region in 1968. ---Page Break--- NUMBER OF THORACIC X-RAY DIAGNOSTIC EXAMINATIONS, BY TYPE OF EXAMINATION IN THE SURVEYED AREA OF THE NORTHERN REGION PUERTO. TOTAL OF DIAGNOSTIC THORACIC X-RAY EXAMS BY TYPE FORAY FOR A ROVER CEOS: RADIOGRAPHY | PHOTOFLUOROGRAPHY TOMOGRAPHY TOTAL MALE 10 | REF 12.030 EXE) COS PSS ASZRPAOW | SANI | ---Page Break--- NUMBER OF ABDOMINAL X-RAY EXAMINATIONS BY TYPE (OF FACILITY AND BY TYPE OF EXAMINATION, SURVEYED AREAS OF THE NORTHERN REGION 76 wiconi196. eraisanen | Wosmeice | RB TBAT El fens | SRREO™™ | UME | Total 4432 | 6282 | 20500 | 940 | 39 | 4,093 | 10,887 | 25,871 | YEAR OF FILMS COLORED (EOS) m ABOMINAL, ODGALPHYC | (Siiiattond. oy Pore or PaeuiTe uo’ oy TwPe or eaaunaTon ants moe tin PS BET ome | BRIER Siti | paomoasrs ree ores rom seoomen | [fet aso nai 20,495] egere | «| ene fone net rary cc aes s (Sgn. 35, 420

(2,264 2,312, 1.730) fear bem 5ST 380 eso 79990) Pe se zeal ea — Ht a TT tae ne rom TT ree fern seers ae a2 ---Page Break--- TABLE 10-W NUMBER OF FILMS EXPOSED (EXPOSURES) IN RADIOGRAPHIC EXAMINATIONS OF THE ABDOMEN AND THORAX BY TYPE OF FACILITY SURVEYED AREAS OF THE NORTHERN REGION PUERTO RICO-1968 Frequency of Examination of X-ray Examinations | Type of Facility | Number of Exposed Films | By Type of Area | Facility | THE AREA OF THE BODY AS SHOWN AT | Total | Total Exposures 4,900 | 57 169 102,069 | from 147,366 | 57,169 4208,5 Films | Other | 10,074 | 23,486 | films | Total | 10,076 | Total | 10,380 | 100,768 | 9005 || RRTS 112,068 | 144,983 | Pic Quality Feature | Guirs | Onis ape y ese | 3,209 | 11,396 | cases | (P49, | 620 | 756 | amcce Fee Pieces | at fri: 36,590 | 65,873 | EPMTS | 75,556 | 36,590 | 112,146 Total 225,994 | 335,198 || Total | 327,720 | 287,204 | 509,014 Pig, Moments Scaling 00 Coprographine with Cacy X Naporuran for each Teanin (Catstograne, Beay-section Pins) are sadlopeaphice e¢ select ‘Tssune Shove below the Gelected Level ate Blurves eat ty s+ chang ofa) pntoinrotaphie, | thototivrearpiy: A wethd ehrahy « ptotoeaphy te tater of ---Page Break--- TABLE -IIN EVALUATION OF THE MEAN GONADAL DOSE DUE TO A SELECTED SET OF ABDOMINAL, X-RAY DIAGNOSTIC EXAMINATIONS IN SURVEYED AREAS OF THE NORTHERN REGION PUERTO RICO -1968 Area aay Ree | TOTAL NUMBER |

RADIATION DOSE AREAS — | SEX| EXAMINATION | MILLION OF EXAMINATIONS | TO ALL EXAMINED PATIENTS | MILLIRADS, 460.5 22,489 10,356,184 582.0 19,712 11,472,364 4462 2,290, 790 566.3 6,196 3,508, 794 429.5 20,932 3,990,294 620.2 16,640 10,320,126 47.9 9,309 4,392,917 619.5 10,792 6,685,644 449.1 37,864 | 26,030,185 598.8 33,340 | 3) 986,950 CAGUAS FAJARDO ARECIBO BAYAMON TOTAL uM F ™ F M F M F M ia GRAND TOTAL 521 Te 111, 204 58,01 7,135 (COMPILED FROM TABLE {I-C,II-F,!I-A AND 11-8) a ---Page Break--- TABLE -12N EVALUATION OF THE MEAN GONADAL DOSE DUE TO THORACIC X-RAY DIAGNOSTIC EXAMINATIONS IN SURVEYED AREAS OF

THE NORTHERN REGION, PUERTO RICO - 1968, MEAN ABSORBED GLOBAL RRA areas — [sex [DOSE PER ExA-| TOTAL NUMBER | paTION DOSE MINATION MILLI-| OF EXAMINATIONS] TO ALL. EXA— RADS MINED paTienTs| MILLIRADS cacuas | M 1.29 43,186 55,709 F oso | 46,468 27,860 Favaroo 1M 740 6,108 8,607 F 068 6,530 4,457 Ce 35,147 35,506 ARECIBO F 0.44 43,062 15,267 O38 pavamon 183 16,617 30,4 F 35 26,876 14,858, mi 125 TO1, 058 730,231 TOTAL F 3a 122, 936 66,462 RAND ToTal| ea 223,994 196,693 (COMPILED FROM TABLE 9-C, 9-F, 9-A AND 9-8.) ---Page Break--- TABLE -13.N TOTAL NUMBER OF DIAGNOSTIC X-RAY EXAMINATION IN PUBLIC INSTITUTIONS AND IN PRIVATE OFFICES AS COMPARED TO THE POPULATION BY AREAS. SURVEYED AREAS OF THE NORTHERN REGION, PUERTO RICO — 1968. AREAS | TOTAL NUMBER NUMBER OF EXAM OF EXAM. POPULATION | PER 100 POPULATION ICAGUAS | 166,933 369,000 45.2 FAJARDO | 48,803 116,100 42.0 ARECIBO | 166,596 342,800 48.5 Bayamon | 77,102 340,600 22.6 TOTAL | 459,434 1,168,500 39.3 ---Page Break--- TABLE —14N PER CAPITA, PER ANNUM MEAN GONADAL DOSE DUE TO ALL GENETICALLY HAZARDOUS ABDOMINAL X-RAY EXAMINATIONS SURVEYED AREAS OF THE NORTHERN REGION, PUERTO RICO - 1968 GLOBAL ANNUAL | POPULATION IRRADIATION DOSE | SURVEYED AREAS TO ALL PATIENTS | OF THE NORTHERN MRADS REGION PUERTO RICO R68 PER CAPITA PER ANNUM MEAN GONADAL DOSE MRADS MALE 26,030,185 572,565 a FEMALE | 31,986,950 595,935 53.8 Total | 58,017,135 1,168,500 TABLE -15 N E 49.7 PER CAPITA, PER ANNUM MEAN GONADAL DOSE DUE TO ALL THORACICAL X-RAY EXAMINATIONS SURVEYED AREAS OF THE NORTHERN REGION PUERTO RICO - 1968 GLOBAL ANNUAL | POPULATION IRRADIATION DOSE | SURVEYED AREAS | TO ALL PATIENTS | OF THE NORTHERN MRADS REGION, PUERTO RICO - 1968 PER CAPITA PER ANNUM MEAN GONADAL DOSE MRADS 130,231 572,565 227 66,462 595,935 1,168,500 2 FOZ 595,935 168 ---Page Break--- TABLE ~16N PER CAPITA, PER ANNUM MEAN GONADAL DOSE DUE TO ALL GENETICALLY HAZARDOUS ABDOMINAL AND THORACICAL X-RAY EXAMINATIONS SURVEYED AREAS OF THE NORTHERN REGION PUERTO RICO — GLOBAL ANNUAL) POPULATION | PER CAPITA IRRADIATION

DOSE | SURVEYED AREAS | PER ANNUM TO ALL PATIENTS | OF THE NORTHERN | MEAN GONADAL MRADS | REGION 58, 213.8 The per capita per annum gonadal dose in the Surveyed Areas reached 49.8 mrem in 1968. Southern Region: 1968. In the Western Region 1968. These numbers probably indicate structure and 19 technote on and the other Regions mentioned have. The comparison becomes possible after the completion of the ws ---Page Break --- Figure: Figure 24: Figure 3-8 Figure 4: Figure 5-8: Figure 6.8: Figure 7-5; LIST OF FIGURES Geographical Distribution of Medical Facilities Equipped with X-ray Units, Surveyed Areas of the Northern Region, Puerto Rico-1968 Distribution of X-ray Diagnostic Units. Surveyed Areas of the Northern Region. Puerto Rico-1968, Distribution of X-ray Units by Manufacturer, Surveyed Areas of the Northern Region, Puerto Rico-1968. Variation of Population and Number of X-ray Diagnostic Units in Public and Private Medical Institutions. Surveyed Areas of the Northern Region, Puerto

Rico-1940-1968, Percent Distribution of Diagnostic Abdominal and Thoracic X-ray Examinations in Medical Institutions by the Type of Facility. Surveyed Areas of the Northern Region, Puerto Rico-1968. Distribution of X-ray Diagnostic Examinations by Type of Examination ‘Surveyed Areas of the Northern Region, Puerto Rico-1968. Total Number of X-ray Examinations per 100 Population per Annum by Geographic Location. Surveyed Areas of the Northern Region, Puerto Rico-1968, 39 ---Page Break --- FIGURE I-W GEOGRAPHICAL DISTRIBUTION OF MEDICAL FACILITIES EQUIPPED WITH X-RAY UNITS SURVEYED AREAS OF THE NORTHERN REGION PUERTO RICO-1968. Surveyed areas: (names) medical centers in Puerto Rico. FIGURE 2N DISTRIBUTION OF X-RAY DIAGNOSTIC UNITS IN SURVEYED AREAS OF THE NORTHERN REGION PUERTO RICO —1968. ---Page Break --- ---Page Break --- FIGURE 4N VARIATION OF POPULATION AND NUMBER OF X-RAY DIAGNOSTIC UNITS IN PUBLIC AND PRIVATE MEDICAL INSTITUTIONS SURVEYED AREAS OF THE NORTHERN REGION PUERTO RICO - 1940-1968. 1,168,500 150 X-RAY UNITS

Hot NUMBER OF 966,169 94 80 40. 851,089 20-- 7 10-+ 1940) The small difference in population between 1950-1960 (30,810) can probably be accounted for by a large emigration to the mainland during this ---Page Break--- Figure 4N shows that the number of x-ray units in the Surveyed Areas of the Northern Region has increased within the period of 1960-68 from 94 to 150, a growth corresponding to 63%. This growth is primarily due to the expansion of the x-ray program in public institutions. In the course of this expansion, most obsolete x-ray units were replaced by modern units equipped with variable collimators. This feature is of extreme significance from the point of view of radiation protection since the collimator reduces the beam size to the size of the film, thus putting the testes out of the direct beam in the diagnostic procedures termed Lumbar Spine, Abdomen, and ILV.P. For accuracy’s sake, it should be noted that the ovaries will remain in the direct beam in spite of collimation. During the period 1940-1968, the number of diagnostic x-ray units within the surveyed Areas increased from seventeen to one hundred fifty. These figures do not include dental x-ray units. Since, however, the population of the Surveyed Areas increased during the same period from 851,089 to 1,168,500, the figure may be presented in a form standardized for population. Thus, in 1940 there were 1.99 units per 100,000 population and by 1968 this figure had risen to 128 units, representing close to a sevenfold increase 48 ---Page Break--- FIGURE 5-N PERCENT DISTRIBUTION OF DIAGNOSTIC ABDOMINAL AND THORACIC X-RAY EXAMINATIONS IN MEDICAL INSTITUTIONS BY THE TYPE OF FACILITY. SURVEYED AREAS NORTHERN REGION. PUERTO RICO-1968. HOSPITALS 30.45 % (102,069) PRIVATE OFFICES 19.65 % (65,873) CLINICS, HEALTH CENTERS rw) PUBLIC HEALTH UNITS 35.53 % (19,115) + Reference to Table 10-8. ons termed "genetically hazardous”. “4 ---Page Break--- The above figures clearly indicate the vital role of the Health Centers and Public Health

Units in Health Services administered to the population of Puerto Rico. Among other services, Health Centers and Public Health Units administer mass chest examinations. Another important role of Health Centers and Public Health Units is to make a diagnosis on the first visit of the patient and in case of necessity to refer him to the regional hospital. Health Centers and Public Health Units are the primary nucleus for Health Services to the population, administering their services free of charge. Figure 6-N shows that the largest portion of X-ray examinations (thoracic and abdominal) in the Surveyed Areas were performed by Health Centers and Public Health Units, the second largest portion by hospitals. As a comparison, there are quoted herewith the parallel figures for the Surveyed Areas of the Northern Region, Southern Region, and Western Region. Percentage of Abdominal and Thoracic Examinations by Geographic Location and by Hospitals and Public

Health Units in Surveyed Areas of the Northern Region 38.05, Southern Region, and Western Region 33.46. Abdominal examinations termed occasionally have variations. The concept of Health Centers in Puerto Rico includes all general hospitals. The Public Health Units are serving only outpatient medicine. This includes their main role of preventive care.

---Page Break---

FIGURE 6N DISTRIBUTION OF X-RAY DIAGNOSTIC EXAMINATIONS BY TYPE OF EXAMINATIONS SURVEYED AREAS OF THE NORTHERN REGION, PUERTO RICO - 1968. THORACIC OTHERS EXAMINATIONS 27.04% 48.75% (124,236) (223,994) UPPER 1.03% ABDOMINAL EXAMINATIONS 28.50% (204) LOWER 13.27% + See table 8-4. The number of X-ray procedures in the Upper Abdomen includes: Cholecystography, Lumbar Spine and Centrointestinal Series. The lower includes: Abdomen, Barium Enema, I.V.P., Pelvis, Hip Joint, and Pelvic.

---Page Break---

FIGURE 7N NUMBER OF X-RAY EXAMINATIONS PER 100 POPULATION PER ANNUM BY GEOGRAPHIC LOCATION. SURVEYED AREAS OF THE NORTHERN REGION & PUERTO RICO - 1968. 50: 48.5/100 45.2/100 42.0/100 40. 100 30

« x2 SQ BE a+? 5 38 36 Sto. 2 2 Ba ou Ra THE AREAS-CAGUAS FAJARDO ARECIBO BAYAMON ---Page Break--- DOSE MEASUREMENTS Surveyed Areas of the Northern Region as ---Page Break--- ‘Accurate and reliable dose measurements are an indispensable requirement for evaluating the quantifiers used to characterize the radiation hazards. In the framework of this part of the survey, dose measurements were carried out using x-ray units typical of the area as irradiation sources. Such typical x-ray units were the Siemens 300 MA x-ray unit in the Arecibo Regional Hospital and the Picker 200 MA unit in the Health Center of Bayamón. Measurements were carried out both in vivo and using a Rando phantom in lieu of the patient, always accurately simulating positioning and collimating techniques used in actual procedures. ‘For a detailed description of the method and the instrumentation used for accurate and reproducible dose measurements, as well as the computational method used for evaluating the relevant quantifiers, the reader is referred to Report I of the Joint Radiation Survey pp. 53-58. ‘Based on the census of x-ray units in the surveyed areas, dose rates measured at the Siemens 300 MA unit were used to evaluate the quantifiers in the Arecibo area, while for the same reasons in the Caguas-Fajardo and Bayamón areas, dosimetric data measured on the Picker 200 MA x-ray unit were used. “Table 1D and Figure 1D are instrumental in evaluating the half-value layer and effective energy of the Siemens 300 MA x-ray unit. “Tables 2D-4D and the corresponding figures 2D-4D present intercalibration data pertaining to the Siemens 300 MA unit. Figure 5D shows the relationship of dose rates as measured in vivo and on a Rando phantom in identical x-ray diagnostic procedures. cy ---Page Break--- ‘Table 1D Table 2D Table 3D. Table 4D: LIST OF TABLES Determination of HLV.L. in X-ray Unit Siemens-300 MA. Arecibo District Hospital, Puerto Rico-1968, LIF-TLD Powder and Victoreen 228 Ion Chamber Intercalibration Data. District Hospital, Arecibo, Puerto Rico. LAP-TLD.

Powder and Victoreen 227 Ion Chamber Intercalibration Data Surveyed Areas of the Northern Region, Puerto Rico - 1968, 1AF-TLD Powder and Victoreen 228 Ion Chamber Intercalibration Data Surveyed Areas of the Northern Region, Puerto Rico. 50 ---Page Break--- Tae Ho

DETERMINATION OF KVL. IN RAY UNIT SIEMENS - 300 MA (PLEOPHOS 4), VARIABLE COLLIMATOR, TOTAL FILTRATION 3.5 mm AL, TEMP 72°F [ARECIBO DISTRICT HOSPITAL PUERTO RICO]. Thickness Victoreen 228 REORG EFFECTIVE ENERGY 88B-1 630 m Jp2.7 8 DENSITY OF AL TOTAL MASS, AL. COEFFICIENT Pps Kor. €FF 38.6 Kor TUBE VOLTAGE 76K. ‘TABLE 20 LIF-TLD POWDER AND VICTOREEN 228 ION CHAMBER INTERCALIBRATION DATA, HVL 4.25 m/m AL. EXPOSURES MEASURED ON THE SURFACE OF SKIN. SIEMENS - 300 SERY UNIT, TUBE DYNAMAX 40, 100 MAS, TFD 90 cm. DIRECT BEAM DISTRICT HOSPITAL, ARECIBO PR. VICTOREEN | CORRECTION 228 READING FOR READING TO. mR tir 2,100 2,380 636 3,387 1645 4,000 44 627 ‘© BACKGROUND CORRECTION SUBTRACTED ---Page Break--- NAME 30 LIF-TLD POWDER AND VICTOREEN-227 ION CHAMBER INTERCALIBRATION DATA EXPOSURES MEASURED AT LOCATION OF THE TESTES 20 cm CAUDAL FROM CENTRAL SEMI-ANGLE USING 100 MAS AT A TFD=90 cm SURVEYED AREAS OF THE NORTHERN REGION PUERTO RICO. Transition Sample Use to Compare to FESS WCE 7" overall output SIEMENS - 300 MA _Trainee? now ARES TUBE VOLTAGE VICTOREEN 227 CONNECTION TRUE EXPOSURE LIF-TLD__ PATH OF VICTOREEN ee EROS mA | PAR | (Seat aeonas atime TCE I | tit - = + 4 so | sao | vs | seas | 520 om 4 zo | seo | ties | ggez | 30 oot 33 M8 11S | aeons See 38 235 | toe | tent | Feo Sea aoe 4-0 LIF-TLD POWDER RO VICTOREEN- 228 ION CHAMBER INTERCALIBRATION DATA DOSES MEASURED AT DEPTH OF 12 cm ON THE PULANOW AT OCCUPIED DISTANCE OF RASRTEM: SIEMENS 300 MA averages measured at, (edit and review) [per year] [Rear col Be | 530 | 380 | sas} sora | sags vreo | izis) sa 90 | 830 ero | 850) 1060 | 221.0 2880 3020 ja: 30 ---Page Break--- Figure 1-D: Figure 2D: Figure 3D: Figure 4D: Figure 6-0: List OF FIGURES Determination of Half Value Layer by Graphical Method, Transmitted Radiation

Vs. Absorbed Thickness. Surveyed Areas of the Northern Region, Puerto Rico - 1968, LiF-Victoreen Intercalibration Curve LiP-TLD Powder Dosimeter and Victoreen 228 Intercalibration Curves, LiP-TLD Powder Dosimeter and Victoreen 228 Ion Chamber Intercalibration Curves of TLD and Victoreen Dosimeters in Phantom and In Vivo. ---Page Break--- INTENSITY TRANSMITTED FIGURE 1 - DETERMINATION OF HALF VALUE LAYER BY GRAPHICAL METHOD. TRANSMITTED RADIATION VS. ABSORBED THICKNESS.* SURVEYED AREAS OF THE NORTHERN REGION PUERTO RICO ABSORBER THICKNESS: | mm AL 54 ---Page Break--- FIGURE 2D LIF-VICTOREEN INTERCALIBRATION CURVE. SIEMENS - 300 X-RAY UNIT TFD = 90 cm CENTRAL BEAM (REF: TABLE-20) LIF-TLD READING ARBITRARY UNITS. ° 6,500 8 Se ie zZ! ¥ g 6,000 i 5a ge 4,000: 5,000 3,000: VICTOREEN-228 4,000 2,100 3,600 60 70 80 90 TUBE VOLTAGE - K.V. ---Page Break--- 800" 700" VICTOREEN READING ~MR 630) 600. 500 400. 360 340. SIEMENS ~ 300 M.A. X-RAY ONT nowecT BEAM (REF: TABLE 3-0) FIGURE - 3D LIF-TLD POWDER DOSIMETER AND VICTOREEN 228 INTERCALIBRATION CURVES. - f 0938 METERS AT THE LOCATION OF "TESTES 200 + LF TLD READINGS 500 400 40 60 76 80 56 20 TUBE VOLTAGE ~ KW. ---Page Break--- FIGURE - 4D LIF-TLD POWDER DOSIMETER AND VICTOREEN 228 ION CHAMBER INTERCALIBRATION DATA. eso 85 SIEMENS 300 M.A. X-RAY UNIT (REF: TABLE-40) VICTOREEN-226 REAL LIF-TLD READING 8 1,200 60. 70 80 (90 TUBE VOLTAGE - K.V. 51 ---Page Break--- Figure 30 INTERCALIBRATION CURVES OF TLD AND VICTOREEN DOSIMETERS AND IN VIVO. é Seis at ree location OF TESTES 38 ---Page Break--- MANUFACTURERS CALIBRATION REPORTS FOR VICTOREEN - 927 and VICTOREEN - 228, IONIZATION CHAMBERS 59 ---Page Break--- WOODLAND AVE, CLEVELAND, CH (Calibration Report To Lliatinoai Aran Rese sate MAY_7 1958 1388 Resistor {/F3q He 222" 1s2;_ 633 enn tay Teche Lely ritered Kay Iepecent ted w ilies tite a Ss oes ee ch om as ao ° 2089 bas 2.0 ao e ony Fos vin 0 1.03 9 Do 0 10 as am 2.2 Factors for Certainty a) Ht earineatot oy. de The

Wictorees Instrument Gos Testi ‘Chevelant, chlo 60. ---Page Break--- CALIBRATION REPORT To Electronics of Rests Repair MAY 7 1968 Register # WS ROC Serial # MSP 48) 169 Model #222 209 435 X-RAY TECHNIQUE (Moderately Filtered X-Rays) average | Total Purity | Kew mmAl mney Et Model and Correction Factor (Multiplier) for Technique Serial No. o oH oo a) BChamber 282 8k ei > ie 228 Se position Poias uheation Po cativraet ty: Le s for High Caengy Chambers and Probes, No Extra Charge, in, No Extra Charge on New oF Repair Instrument (OGRay Lab) Ct ---Page Break--- ---Page Break--- PRESENTATION OF STATISTICAL DATA CAGUAS AREA 63 ---Page Break--- ‘The Area of Caguas includes twelve municipalities in the Northeastern part of the Island, with a total population of 360,000. Caguas, founded in 1775, is the largest city in the area with a population of 76,000. The entire area, and especially the city of Caguas, is a growing industrial and commercial section. There are six community hospitals: Aibonito, Caguas, Gurabo, Juncos, San Lorenzo, and Yabucoa. There are accredited private schools such as Colegio Católico de Caguas, Notre Dame High School, Colegio Bautista, and public vocational schools. This area needs more general hospital beds. As in the Mayagüez Area (see Report Number One), this results in a migration of patients to the areas of San Juan and Fajardo for medical services. Many films exposed in private and public institutions are sent to Fajardo for interpretation. An Area Sub-Regional Hospital is in the final stages of preparation for full operation; it will have six stationary Westinghouse x-ray units and four mobile units with special grid control. LIST OF TABLES ‘Table 1-C: Municipalities of the Caguas Area and Their Population, Puerto Rico-1968, Distribution of Diagnostic X-ray Units in Operative Condition by Medical Facility, by Geographic Location and Population per X-ray Unit, Caguas Area, Puerto Rico-1968. ‘Table 3-C: Total Number of X-ray Examinations in Public Institutions, Total Number of Patients and Number of

X-ray Examinations per 100 Patients, Caguas Area, Puerto Rico-1968. Table 4C: Distribution of Diagnostic X-ray Units in Operative Condition, by Medical Facility and by Manufacturer, Caguas Area, Puerto Rico-1968. Table 6-C: Census of Diagnostic X-ray Units, Caguas Area, Puerto Rico-1968, Table 6-C: Number of Abdominal X-ray Diagnostic Examinations by Medical Facility, by Type of Examination and by Sex, Caguas Area, Puerto Rico-1968, Table 7-C: Number of Diagnostic Thoracic X-ray Examinations by Geographic Location, by Medical Facility and by Sex, Caguas Area, Puerto Rico-1968, Table 8-C: Total Number of All X-ray Examinations, Total Number of Abdominal Examinations and Total Number of Thoracic X-ray Examinations by Medical Facility, Bayamón Area, Puerto Rico-1968, Table 9-C: Mean Gonadal Dose per Patient due to Thoracic X-ray Examinations, by Type, Caguas Area, Puerto Rico-1968, Table 10-C: Mean Gonadal Dose per X-ray Examination by Type of Examination and by Sex, Caguas Area, Puerto Rico-1968. Table 11-C: Computation of the Mean Per Capita Gonadal Dose due to a Selected Group of Genetically Hazardous Abdominal Diagnostic X-ray Examinations, Caguas Area, Puerto Rico-1968, Table 12-C: Per Capita, Per Annum Mean Gonadal Dose due to All Genetically Hazardous Abdominal and Thoracic X-ray Examinations, Caguas Area, Puerto Rico-1968, 64 ---Page Break--- TABLE 1-C MUNICIPALITIES OF THE CAGUAS AREA AND THEIR POPULATION PUERTO RICO-1968* MUNICIPALITIES Aguas Buenas 19,200 Aibonito 22,100 Caguas 77,000 Cayey 43,400 Caguas 23,400 Arroyo 20,100 Humacao 34,200 Juncos 28,500 Las Piedras 17,800 Naguabo 20,900 San Lorenzo 30,500 Yabucoa CAGUAS AREA TOTAL + The above data are quoted from the Annual Vital Statistics Report, Commonwealth of Puerto Rico Department of Health, 1968. 65 ---Page Break--- amar ROOT 66 ---Page Break--- ---Page Break--- em oF acest ay ty ter cweO WRIA, ELT a a MATE SAR ARAARAB ote “oot |] 88 Tenicipat ---Page Break--- we eget rlentttancne ltsee [i etiey _[eSttntor "oe faceaiey [Sataacor

| 160 a0 PEaG t) 69 ---Page Break--- [en " Ee Ra] a‘lesg, (ES P ms —_| vam eee [me eae fee pe pe for ese rm o= ow Yop m7 ee ee er Bi __ [ise rss? Spee "io ive Satter omen. Hee | [ne mi, | » "iat : = ow Los PSS va 19 [tive fees ie es” __foeersg | oe ioe 2p feo ee [eageemer Pow Tagan Jes i “= ps | fen ise prom [i sear [eee of Yaga spar’ pees fm [iste clea [as re amv fr men ote ema (ra Ty ice. rT eae : 2 fee fas [rae ae ee aa 0 ---Page Break--- cmorra nic ecstion | or ‘oer _| Series sole En a | mem |ra.cmcer [ricer 290 | 1060 [rete | ounce | sft Aad etree Tat ees — foot 7 soem? | oe fentinstor | 2.3 ze 59 lone i" Jrewcoe Jaumicipan | c.t. 00 we | ~ esis __| te (ease iss eer lsitteeee | | ---Page Break--- 2 ---Page Break--- ---Page Break--- TENE PUG, ace, egtebntcyettcee an 9) ther privnce mtn otfeee eae with x= srcor'gart of hte sapors one tnt’ Thal’ ntaae of petatat ion tof einen he eoveeting CHT NE HesuaG'Es tha lane sano septs " ” “ ---Page Break--- INOW OF Dracoeric monactcAL aut RatRIONS Wy cRGERAPKEC LOCATION ascton sat 7,67 fae, ---Page Break--- pase eee mater of Ary ananinttions inclnte bende thevacteal and shoninat, all other s-ray exatnattons: 6 ---Page Break--- Ye eu SOE PK ATEN Oo Te MMACCALSNY eMUT SESS SS Sal sapycatinsion wr state 9 kag stot to os opens n ---Page Break--- TABLE 10-C MEAN CONADAL DOSE PER X-RAY EXAMINATION BY TYPF_OF EXAMINATION AND BY SEX ‘CAGUAS AREA, PUERTO RICO-1968 Wiliivads per Fxanination type of Examination Male Fenale Cheat 1.68 2 Photofivorograpic 23 22 Tomographic 38.6 5.0 Abdonen 395.0 433.0 ‘Sholecystograph 10.0 180.1 Lumbar Spine 170.5 950.6 Gaserointeatinal Series 180.2 695.5 Barium Enema 1,210.0 750.4 Lue. 1,000.0 720.4 Petvie 246.2 o16 Hip Joint 100.0, 283.5 Pelvinatey : 1,100.4 18 ---Page Break--- TABLE 11-c COMPUTATION OF THY MEA PER CAPITA GONADAL DOSE DUF Tn A SELECTED GROUP OF GENETICALLY IAZARDOUS ARDOMINAL DIAGNOSTIC. X-RAY. EXAMINATIONS CCAGUAS AREA, PUERTO RICOW196R Tema Sem Taba Exposure | Adsorption | Total musher| Irradiation ree Tose of Abdominal] Dose to

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at Floor X-Ray Room 1316 Notes: Dynamax 40, 1-2 mm tubes used, with the exception of Room: / 427 (C-50) which uses Dynamax 50, 2 mm aluminum added filters in all. MO-120-C, Mobile uses grid control tube. 8 ---Page Break--- Figure 1-0: Figure 2C: Figure 3¢: LIST OF FIGURES Distribution of Medical Facilities Equipped with X-ray Units by Geographic Location, Caguas Area, Puerto Rico-1968, Distribution of X-ray Diagnostic Units by Geographic Location and by Type of Facility, Caguas Area, Puerto Rico-1968 Variation of Population and Number of Diagnostic X-ray Units in Public and Private Medical Institutions, Caguas Area, Puerto Rico- 82 ---Page Break--- FIGURE Ic DISTRIBUTION OF MEDICAL FACILITIES EQUIPPED WITH X-RAY UNITS BY GEOGRAPHIC LOCATION CAGUAS AREA PUERTO RICO— 1968, } eas A, Caguas woseiran s 2-cumcs C) Sewenuta cévrens 2 4-Puerto WEALTH UNITS AND 8. centers I S-PRIVATE OFFICES CD 83 ---Page Break--- Figure - 2¢ DISTRIBUTION OF X-RAY DIAGNOSTIC UNITS BY GEOGRAPHIC LOCATION AND BY TYPE OF FACILITY, CAGUAS AREA, PUERTO RICO 1968. ewosaras O loc WEALTH UNITS AND TE. centers oes O) PRIVATE OFFICES CO ‘S-WEALTH centers O Ba ---Page Break--- FIGURE- 3¢ VARIATION OF POPULATION AND NUMBER OF DIAGNOSTIC X-RAY UNITS IN PUBLIC AND PRIVATE MEDICAL INSTITUTIONS. CAGUAS AREAS, PUERTO RICO 1940 - 1968 60. 80: 40. 30. 20. YEARS 1940 1950 1960 1968 POPULATION 290,430 295,291 369,000 85 ---Page Break--- PRESENTATION OF STATISTICAL DATA FAJARDO AREA 86 ---Page Break--- ‘The Fajardo Area consists of the municipalities of Fajardo, Ceiba, Culebra, Loiza, Luquillo, Rio Grande and Vieques. The present population of the area is 116,100. This area comprises the extreme northeast section of the island of Puerto Rico. ‘The municipality of Loiza is the most densely populated with 32,800 inhabitants but Fajardo, with a population of 24,700, is the cultural and medical center of the area. ‘Two of the seven municipalities of this area are small islands to the east of Puerto Rico, one of which, Culebra, is located seventeen miles off the coast to

the east, Low altitude light rainfall gives the island a vegetation sufficient to support large herds of white Brahma cattle, the island's main industry. There are no medical facilities for the 900 inhabitants of Culebra, therefore, the facilities of the island of Vieques or the mainland facilities of Fajardo are used. The island of Vieques is ten miles southeast of the Puerto Rico mainland and has a population of 8,400 inhabitants. The island has a Government Health Center equipped with an x-ray unit. nd LIST OF TABLES Table 1-F: Municipalities of the Fajardo Area and Their Population, Fajardo Area, Puerto Rico-1968, Table 2-F: Distribution of Diagnostic X-ray Units in Operative Condition, by Medical Facility, by Geographic Location and Population per X-ray Unit, Fajardo Area, Puerto Rico-1968, Table 3-F: Total Number of X-ray Examinations in Public Institutions, Total Number of Patients and Number of X-ray Examinations per 100 Patients, Fajardo Area, Puerto Rico-1968, Table 4-P: Distribution of Diagnostic X-ray Units in Operative Condition, by Medical Facility and by Manufacturer, Fajardo Area, Puerto Rico-1968, Table 5-F: Census of Diagnostic X-ray Units, Fajardo Area, Puerto Rico-1968, Table 6-F: Number of Abdominal X-ray Diagnostic Examinations by Medical Facility, by Type of Examination and by Sex, Fajardo Area, Puerto Rico-1968. Table 7-F: Number of Diagnostic Thoracic X-ray Examinations by Geographic Location, by Medical Facility and by Sex, Fajardo Area, Puerto Rico-1968, Table 8-F: Total Number of All X-ray Examinations, Total Number of Abdominal Examinations and Total Number of Thoracic X-ray Examinations by Medical Facility, Fajardo Area, Puerto Rico-1968, Table 9-F: Mean Gonadal Dose per Patient due to Thoracic X-ray Examinations, by Type, Fajardo Area, Puerto Rico-1968, Table 10-F: Mean Gonadal Dose per X-ray Examination by Type of Examination and by Sex, Fajardo Area, Puerto Rico-1968, Table 11-F: Computation of the Mean Per Capita Gonadal Dose Due to a Selected Group of Genetically.

Hazardous Abdominal Diagnostic X-ray Examinations, Fajardo District Hospital, Fajardo Area, Puerto Rico-1968, ‘Table 12-F: Per Capita, Per Annum Mean Gonadal Dose due to All Genetically Hazardous Abdominal and Thoracical X-ray Examinations, Fajardo Area, Puerto Rico-1968. a7 ---Page Break--- TABLE 1 MUNICIPALITIES OF THE FAJARDO AREA AND THEIR POPULATION ‘PUERTO RICO-196' POPULATION. MUNICIPALITIES. Ceiba 13,100 Culebra 300 24,700 Loíza 32,800 Loquatito 12,100 Río Grande 24,100 Maunabo 8,400 FAJARDO AREA TOTAL. 116,100 4 The above data are quoted from the Annual Vital Statistics Report, Commonwealth of Puerto Rico Department of Health, 196. ---Page Break--- ---Page Break--- 1 0 ---Page Break--- ‘MAINE OF BROME PER MSE MM COM EBCAL ATLITY A AF MEE WS SAAS HE ---Page Break--- ---Page Break--- NAME 6 SREE OR MAORI RN ECARPTE FRSTN, A RAJRTE SIS [SE] RISE | NG) AOS OM TRIAT OTEE ETN VAONOIOCAOTHCON AN 3) AL TAY PRIVATE MBES OHN APES WTH 98 ---Page Break--- RUT Panto DEES TEAT 08 9 BAE 5] PIETIE TEEL AA EA RE EAT 1300 |2,0M JOE] E[OE 73] SOE ASE FESSE " PAJRTA REN TOA [200 OO FIVOFOSOM FOM PA] 2 | FESS [ENE AOE ---Page Break--- OT FAAS AA A] FER TSAR NO [10 AS | 0.13 SA | SIA | ANS PASS IITEMNE TABLE 10-F MEAN GONADAL DOSE PER X-RAY EXAMINATION BY TYPE OF EXAMINATION AND BY SEX® 'FAJARDO AREA, PUERTO RICO-1968 WILITVADE PER PRASINATION TYPE OF EXAMINATION YATE ENALE CHEAT 1.88 92 PHOTOFIUOROGRAPHIC 223 2M [TOMOGRAPHIC 34.2 4.9 ABDOMEN, 335.0 433.0 JROTECTYATOGRAPHY 10.0 200.4 LUMBAR SPINE 170.5 950.6 LCOSTROINTESTINAL SERI 180.2 685.5 ARIN ENECA 1,210.0 250.4 NVR. 1,000.0 720.8 ELVIE 746.2 61.6 TIP JOINE 700.0 283.5 IPETVINECE: ‘* Mean gonadal DOSE JEACED TN THE ON PICKER 200 MA X-RAY UNIT WITH PX-10 TUBE. 95 ---Page Break--- TASE UTR ‘COMPUTATION OF THE MEAN PER CAPITA GONADAL DOSE OF TO A SELECTED GROUP (OF GENETICALLY HAZARDOUS ABDOMINAL DIAGNOSTIC X-RAY EXAMINATIONS PAJARDO DISTRICT HOSPITAL, TAJARDO AREA, PUERTO RICO-1968 TN TT A RI EXPOSURE TOTAL NUMBER | TRADIATION PER OF ABDOMINAL | DOSE TOLL PERMINATION | PER

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---Page Break--- PRESENTATION OF STATISTICAL DATA ARECIBO AREA 100 ---Page Break--- ‘The Arecibo Area is part of the San Juan Region. This area includes eleven municipalities on ‘the north central coast of the Island. Arecibo is the largest city of the area; an important indus- trial and commercial center with a population of

83,400 in 1968. In the Arecibo Area, there are four Health Centers and five Municipal Hospitals, and in the city of Arecibo, a District Hospital with a School of Nursing, a Municipal Hospital, a Public Health Unit, and two private Hospitals. Table 1A: Table 2A: Table 4A: Table 5A: Table 6A: Table 7: Table 8A: Table 9.4: Table 10-4: Table 11A: LIST OF TABLES “Municipalities of the Arecibo Area and their Population, Puerto Rico-1968. Distribution of Diagnostic X-ray Units by Medical Facility, by Geographic Location and Population per X-ray Unit, Arecibo Area, Puerto Rico-1968. Total Number of X-ray Examinations in Public Institutions, Total Number of Patients, and Number of X-ray Examinations per 100 Patients, Arecibo Area, Puerto Rico-1968. Distribution of Diagnostic X-ray Units in Operative Condition, by Medical Facility and by Manufacturer, Arecibo Area, Puerto Rico-1968. Census of Diagnostic X-ray Units, Arecibo Area, Puerto Rico-1968. Number of Abdominal X-ray Diagnostic Examinations by Medical Facility, by Type of Examination and by Sex, Arecibo Area, Puerto Rico-1968. Number of Diagnostic Thoracic X-ray Examinations by Geographic Location, by Medical Facility, and by Sex, Arecibo Area, Puerto Rico-1968. Total Number of All X-ray Examinations, Total Number of Abdominal Examinations, and Total Number of Thoracic X-ray Examinations by Medical Facility, Arecibo Area, Puerto Rico-1968. Mean Gonadal Dose per Patient due to Thoracic X-ray Examinations, by Type, Arecibo Area, Puerto Rico-1968. Mean Gonadal Dose per X-ray Examination by Type of Examination and by Sex, Arecibo Area, Puerto Rico-1968. Computation of the Mean Per Capita Gonadal Dose due to a Selected Group of Genetically Hazardous Abdominal Diagnostic X-ray Examinations, Arecibo Area, Puerto Rico-1968. Per Capita, Per Annum Mean Gonadal Dose due to All Genetically Hazardous Abdominal and Thoracic X-ray Examinations, Arecibo Area, Puerto Rico-1968. 101 ---Page Break--- TABLE 1-A MUNICIPALITIES OF THE ARECIBO AREA AND THEIR

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20. YEARS 1940 POPULATION 318,400 325,448 305,375 342,800 * not including dental units 123 ---Page Break--- PRESENTATION OF STATISTICAL DATA BAYAMON AREA 124 ---Page Break--- ‘The Bayamón Area, comprising eleven municipalities with a total population of 340,600, is part of the Northern Region. ‘The city of Bayamón, population 117,000, is highly industrialized and growing rapidly. ‘The lack of adequate general hospital and other medical facilities in the Bayamón area forces a flow of patients to San Juan for medical services and is a contributing factor in the heavy traffic on the Bayamón-San Just highway, which impedes the dispatch of emergency patients who need immediate medical attention. LIST OF TABLES ‘Table 1-8: Municipalities of the Bayamón Area and their Population, Puerto Rico-1968. ‘Table 2B: Distribution of Diagnostic X-ray Units by Medical Facility, by Geographic Location and Population per X-ray Unit, Bayamón Area, Puerto Rico-1968. ‘Table 9B: Total Number of X-ray Examinations in Public Institutions, Total Number of Patients, and Number of X-ray Examinations per 100 Patients, Bayamón Area, Puerto Rico-1968. ‘Table AB: Distribution of Diagnostic X-ray Units in Operative Condition, by Medical Facility and by Manufacturer, Bayamón Area, Puerto Rico-1968. ‘Table 5B: Census of Diagnostic X-ray Units, Bayamón Area, Puerto Rico-1968. ‘Table 6B: Number of Abdominal X-ray Diagnostic Examinations by Medical Facility, by Type of Examination and by Sex, Bayamón Area, Puerto Rico-1968. ‘Table 7B: Number of Diagnostic Thoracic X-ray Examinations by Geographic Location, by Medical Facility and by Sex, Bayamón Area, Puerto Rico-1968. ‘Table 8: Total Number of All

X-ray Examinations, Total Number of Abdominal Examinations and Total Number of Thoracic X-ray Examinations by Medical Facility, Bayamón Area, Puerto Rico-1968. ‘Table 9-8: Mean Gonadal Dose per Patient due to Thoracic X-ray Examinations, by Type, Bayamón Area, Puerto Rico-1968. ‘Table 10-8: Mean Gonadal Dose per X-ray Examination by Type of Examination and Sex.

Bayamón Area, Puerto Rico - 1968 ‘Table 11.R: Computation of the Mean Per Capita Gonadal Dose due to a Selected Group of Genetically Hazardous Abdominal Diagnostic X-ray Examinations Bayamón Area, Puerto Rico - 1968, ‘Table 12.B: Per Capita, Per Annum Mean Gonadal Dose due to All Genetically Hazardous ‘Abdominal and Thoracical X-ray Examinations. Bayamón Area, Puerto Rico - 1968. "Based on the Plan for Hospital and Medical Facilities, Commonwealth of Puerto Rico Department of Health, 1969, 125 ---Page Break--- TABLE 1-R MUNICIPALITIES OF THE BAYAMÓN AREA AND THEIR POPULATION PUERTO RICO - 1968* Municipalities Population Barranquitas Bayamón Cataño Comerío Corozal Dorado Naranjito Orocovis Toa Alta Toa Baja Vega Alta BAYAMÓN AREA TOTAL * The above data are quoted from the Annual Vital Statistics Report, Commonwealth of Puerto Rico Department of Health, 1968. 126 ---Page Break--- ---Page Break--- 128 ---Page Break--- fle f. iv s Fes aA Z Lf, [*rrangut tam) nasieh a . [vate Of teas | T [18-1 a + te Tyo 1 TP : Tee RTT TPE, | Te bs ~ 129 ---Page Break--- fweseat ‘ Thowr ou ot he 40 inst ic wey ete Inthe Ryan ares, nt rm 8 130 ---Page Break--- 131 ---Page Break--- nen TT Pie Te ial ne | ae ‘So clog poplin, an ppepianea of 3 of ich ar piney wo nayenoe area otal 7 3.093 weno 4 Tactodiag 290 enoerobien ‘tel maior (cuminetioce inlnde bvide thoracieel an abdoinal, all other scray amination 132 ---Page Break--- taser 10 WEAN CORADAL DOSE PER TARAY SAMINATION BY TYPE OF RIAMEWATION AND HT SEE eradiated in the Baymon Besley Canter with « Picker 200, Tube PE-10, Vaciabte Zontinator, Teer! vam of Exmminacion vale cent 3.89 Protoftuarogeaphic 2 Tomographic m2 Abdomen os hotacyetograshy 10.9 Lamar Spine 370.5 Gentrointentieal Series 190.2 ecium Enema 4,210.6 Lure |__ 1,000.0. ‘ 720.4 etwie 16,2 as itp Jotne rm.0 203.5 tvioeeey _ 00.6 Moker x-ray vuits were the pore comon (15 aut of the tatal of M xray unin vars Picker-nada £3 the Reyanon Area, 1968) 133 ---Page Break--- TARE 11-8 COMPUTATION OF THE MEAN PER CAPITA GONADAL DOSF. DU TA

SELECTED GROUP (OF GENETICALLY HAZARDOUS ABDOMINAL DIAGNOSTIC X-RAY EXAMINATIONS BAYAMON ARFA, PUERTO RICO-1968) Exposure Per Examination [per rota Examined type of Mine Examinations [Number of Patients examination _|sex | radiogens _|milli rads [examinations | milli rads Abdomen M 364 335, | 2,060 690,100 F. ave 1 433 1,700 736,100 i oo} sss | 5,580, rt 136 180, aba 159/120 M 186 | v0 | 2,000 | 340,000 Same {cost i9s3__| 1,857,303 i T centroincent. | m. | 195 | ato} a379 | 48,220 Series Fl yas | ese an 2481520 7 Te ee tee Barium ways 1,210 686 830,060 Enens re | as 70 | 86 627000, Lv. x jayne | 2,000 1,365 | 1,365,000 ej 7a 720 1j64a | 151837680 Pelvis ™ so | 1a os | 513,996 rm 6 i 62. 745 463190 T Rip Joint M 7 | 700 | sr 490,400 Fe 308 \ 286 | 616 174,944 Petvinetey 1199 | a0 596 653,400, ‘Total mM. | 512.9 4719 9,309 4,392,917 Fo} on3 19:5 10792 | 6)685,644 GRAND TOTAL 599.0} sta | 20,101 }11, 078,561 a af | ---Page Break--- TABLE [2-8 PER CAPITA, PER ANNUM MEAN GONADAL DOSE DUE TO ALL GENETICALLY HAZARDOUS ABDOMINAL AND THORACICAL X-RAY EXAMINATIONS BAYAMON AREA, PUERTO RICO-1968 GLOBAL ANNUAL POPULATION | PER CAPITA IRRADIATION BAYAMON AREA | PER ANNUM DOSE TO ALL PUERTO RICO-1966 | MEAN GONADAL PATIENTS dose MRADS 4,423,326 166,894 6,709,502 173,706 11,124,996 340,600 ---Page Break--- Figure 1-8: Figure 2.8: Figure 3.8: LIST OF FIGURES Distribution of Medical Facilities Equipped with X-ray Units by Geographic Location, Bayamón Area, Puerto Rico-1968. Distribution of X-ray Diagnostic Units, by Geographic Location and by Type of Facility, Bayamón Area, Puerto Rico-1968. Variation of Population and Number of Diagnostic X-ray Units in Public

and Private Medical Institutions, Bayamón Area, Puerto Rico-1940-1968, 136 ---Page Break--- FIGURE I-B DISTRIBUTION OF MEDICAL FACILITIES EQUIPPED WITH X-RAY UNITS BY GEOGRAPHIC LOCATION, BAYAMON AREA, PUERTO RICO—1968 (77 Total acta \ BAYAMON oN 1® - [o-oo @ f 5 wa COROZAL NaransiTo! @ pin, orocovis i-HosPiTaLsO —PUBLIC HEALTH UNITS AND Te, CENTERS [J 2-cunies [}

S-PRIVATE OFFICES 3-HEALTH CENTERS A. ---Page Break--- FIGURE - 28 DISTRIBUTION OF X-RAY DIAGNOSTIC UNITS, BY GEOGRAPHIC LOCATION AND BY TYPE OF FACILITY: BAYAMON AREA, PUERTO RICO-1968, TOA BAJA A BAYAMON © TOA ALTA @® COROZAL, NARANJITO COMERIO OROCOVIS PARRANQUITAS > -Hospitals © 4-PUBLIC HEALTH UNITS AND TE, CENTERS [—] 2-counties] S-PRIVATE OFFICES 3-HEALTH CENTERS A, o 18 ---Page Break--- FIGURE 36, DISTRIBUTION OF POPULATION AND NUMBER OF DIAGNOSTIC X-RAY UNITS IN PUBLIC AND PRIVATE MEDICAL INSTITUTIONS, f ma ts et ne: nce wimm_e 4 LY te Year 1950 1960 1968 Peru. ane 88,37 ———“3ai,817 3a, 713 "sa to 139 ---Page Break--- APPENDIX I RADIOTHERAPY IN PUERTO RICO 140 ---Page Break--- ‘Table LR: ‘Table 28: ‘Table 38: LIST OF TABLES Distribution of Therapeutic X-ray Units Used for Superficial Treatment by Location, Manufacturer and Number of Patients, Puerto Rico-1970, Distribution of Intermediate (Orthovoltage) Therapeutic X-ray Units by Location, Manufacturer and Number of Patients Puerto Rico-1970, Distribution of Radionuclide Applicator Units Used for Deep Therapy by Location, Type of Source and Source Activity, Puerto Rico-1970. 141 ---Page Break--- TABLE -1R DISTRIBUTION OF THERAPEUTIC X-RAY UNITS USED FOR SUPERFICIAL TREATMENT BY LOCATION, PUERTO RICO-1970 MANUFACTURER AND NUMBER OF PATIENTS tT F rameracruneA] — RARER OF tocavin | wecicaL raoLITY x a ce worst ___|xve eserrenian rosmm [sen euecine |ioo| 2 JSAN WAN | PRNUCLEAR CENTER | PICKER 120 8 Sourcee warn? | | Grekoee Nese cen evecrme jroo| so MT OFFICE PROREK RAY * eT is (TWO HEADS) | 100) gave Girone | 95 nvensa [Gworexcs) | 99 [Gwensac’! | 33 Jenevecrmc | 100 Sencectme | 1) Rexer Sew 120 tan femur 129, ace [owaoae Gwe |svimano [oo] 75 avacie? [wea center [a F wncuan [100 WOT WuRE YET ORLNTION oF KerDCATE (OeTWROLTACE) areAPreTLC oaAY OHTS renee | omcotonent cl (een. vieetrie sere. 79 ranae Nowpttat ‘een. mscerte ey ---Page Break--- efit meses li = q ea ee re faeteeal ete jc __| nso os norener 969 » 200. Ie ft [eee on Jeccss Jo" Jom eam ai | am saan fa lua mun

a num ten [saa] aeeeee ae = ea ct feat nef ot sent ie = 143 ---Page Break--- APPENDIX II NUCLEAR MEDICINE IN PUERTO RICO 144 ---Page Break--- STATISTICAL DATA ON NUCLEAR MEDICINE IN PUERTO RICO - 1970 ‘The beginning of nuclear medicine goes back to 1994, when Nobel Laureate George De Hevesy first used heavy water to determine the total body water content of a patient. In 1936, G. G. Hamilton and R. B. Stone of the University of California administered Na-24 to patients for diagnostic purposes. ‘The era of nuclear medicine began in earnest in August 1946, with the last shipment of artificially produced radionuclides from Oak Ridge National Laboratory, Oak Ridge, Tennessee to a St. Louis, Missouri Hospital. In Puerto Rico, one of the first thyroid uptake determinations was delivered by the Nuclear Chemical Instrument Corporation (now Nuclear Chicago) in 1986, to the Mimiya Hospital in Santurce. Very soon, nuclear methods became an integral part of diagnostic, providing otherwise unavailable information on an organ and its function, as well as supplying corroborative evidence to support a suggested diagnosis. Moreover, nuclear diagnosis is safe and accurate. Today, more than fifty nuclear medical units are operative on the Island. ‘The Atomic Energy Commission's List of Licensees authorized to own and use radioactive sources for nuclear medical purposes in Puerto Rico enumerates the following facilities: nuclear medical departments, Presbyterian Hospital and 145

---Page Break--- Having visited the above facilities, it was learned that out of the 10 physicians using radioactive nuclides in 1970, eight were practicing diagnostic and therapeutic nuclear medicine while two were practicing only diagnostic nuclear medicine. Radioactive tracers are used to determine the in vivo distribution of the labeled material. Relevant parameters entering in the choice of a certain radioactive tracer are, among others, the energy and the half-life of the emitted radiation. ‘The emitted photons have to have sufficient energy to be

detectable outside the body. ‘Technetium 99m, which emits a 140 keV gamma ray, with no associated particulate radiation and which decays with a half-life of six hours, is one of the tracers having the most desirable physical characteristics for in vivo applications. I-131, with a 0.637 MeV gamma ray and a half-life of 8.08 days, was used in 9.811 thyroid uptake studies in 1970, amounting to 81% of the total 11,518 function studies. I-131 was used in more than 93% of all the function studies (thyroid and others). Blood volume determination (442 cases) was generally conducted by means of I-131 labeled albumin. ‘Another rather widely used radionuclide in function studies was Co-67, primarily for ‘Vitamin B-12 absorption tests. It was used three times as frequently as the longer half-life Co-60. Scanning procedures, based upon the differential concentration of a certain radionuclide in a given body organ, were used in a total of 6,621 cases in Puerto Rico in 1970, as shown in the Table NM-3. 146 ---Page Break--- ‘Table LNM ‘Table 2M: ‘Table NM: ‘Table 4.NM ‘Table 5-NM: ‘Table GNM: ‘Table 7.NM: LIST OF TABLES Distribution of Radioisotope Equipment for Nuclear Scanning by Medical Facility, Manufacturer and Year of Installation, Puerto Rico-1970. 1 Medical Function Procedures Performed During 1970, Principal Nuclear Medical Scanning Procedures Performed, Puerto Rico-1970 Brain Scanning Procedures by Type of Radionuclides Used, Puerto Rico-1970. Relative Frequency of Organ Scanning, Puerto Rico-1970, Principal Radiopharmaceutical Therapy Procedures Performed, Puerto Rico-1970. Number of Trainees in the Clinical Applications Division, PRNC by Type of Trainee, Country of Origin and Year of Training Puerto Rico, ut ---Page Break--- tention Hesal-| Teas teatly 148 ---Page Break--- Lesa & var = ote EEEES | col line Tse rs \ ses tec ee [ne |e | outa sae 2 se teense [af | [Ser [eet ncte [ssue ma cnteens bee SES [esos [ear Tg concer T see - suc [ent natinm fans | : mee tees se tow Ts ee | SE wet cosas | onsite sane fast“ aioe smi fae foe

Soomter! Ad tata 15 ey sate oss | sn acne inate fel See ate {encase se —[ioe | amy foitsslest cuicnge | autonstic come councers | 196) ree sears ---Page Break--- PRINCIPAL NUCLEAR MEDICAL FUNCTION PROCEDURES PERFORMED DURING 1970 Puerto Rico Ten scans | rn OF ecco PR rower] [eee Lea — re aba 000 vauwve CETERUNATION [Sap ooHerURATE | RENAL FUNCTION EVALUATED WITH VITAMIN B6 ASCORBIC ACID VOLUME DETERMINATION TSMneL ED TAN | VTA 8p ABSORPTION LABELED Fars be SURVIVAL LORIE Om GRATE | ROM TURNOVER, LABELED ALBUMIN ‘CARDIAC OUTPUT 150 ---Page Break--- PRINCIPAL NUCLEAR MEDICAL SCANNING PROCEDURES PERFORMED ---Page Break--- Table 1 4 shows the brain scanning procedures by radionuclide TABLE 1 & Brain Scanning Procedures by Type of Radionuclides Used Puerto Rico 1970 Number of | Percentage of Procedures Radionuclide | type of Procedure | performed | Performed ned Brain Scanning 4,208 78.72 Te-99m Brain Scanning 256 16.7% foers Brain Scanning 6 bat ig-197, Brain Scanning 8 SE ig-203 TOTAL, 2,535 300.02 Relative frequency of organ scanning is given in Table MM 5. TABLE 1 5 Relative Frequency of Organ Scanning Puerto Rico 1970 Tae Far tent mhyroid 38.74 brain 23.17 Liver 16.96 Kidney 5.62 Lung 2.99 ovner 2.47 Total 190.00 ---Page Break--- Table NM 6 gives the breakdown of pharmaceutical therapy procedures performed in Puerto Rico in 1930, TABLE 1 6 Principal Radiopharmaceutical Therapy Procedure Puerto Rico 1970 Taber Radio of Per ‘Treatment Nuclide | compound Patients | cent Hyperthyroidism | 1-131 | sodium iodide| 180 91.83]

Thyroid Cancer | 1-131 | sodium iodide| 11 5.68] Soluble Leukemia P-32 | Phosphate 4 2.44 Malignant Colloid Cysts | Effusions Awei98 | cold 1 . ES =p TOTAL 196 __| 100.00] Four various procedures in radiopharmaceutical therapy were used in Puerto Rico in 1970. The number of administrations of 1-131 for therapeutic uses was 180, or 97% of all therapeutic treatment, 92% of all therapeutic procedures was for hyperthyroidism ‘The Clinical Radioisotope Applications Division offers a basic course in clinical

applications of radioisotopes twice annually for physicians and other medical personnel and a nuclear medicine orientation course for medical technologists 153 ---Page Break--- TABLE 7-200 NUMBER OF TRAINEES IN THE CLINICAL APPLICATIONS DIVISION -PRNC BY TYPE OF TRAINEE, COUNTRY OF ORIGIN AND YEAR OF TRAINING PUERTO RICO rrr corey 7 Siar Toca no of | of of | Now of Year type of Trainees trainees| origin trainees | Trainees 1968 | Physicians (M.D.) 5 [Argentina 1 Bolivia 1 Dominican Rep 3 Medical Technicians 2 | Ecuador 1 Venezuela 1 Medical Technologists 43 [Puerto Rico | 30 i‘ ogi Puerto 3 1969 | Physicians (M.D.) 7 [Paraguay L Medical Technicians 4 [Argentina L Uruguay 1 Spain 1 Puerto Rico | 7 Medical Technologists 51 |Dominican Rep.) 2 Puerto Rico | 50 62 EE 1970 [Physicians (M.D.) 3 |Greece 1 Medical Technicians & [Ecuador ‘ [Argentina 1 Bolivia 1 Venezuela i Dominican Rep.| 1 Puerto Rico |_3 12 1971 Physicians (M.D.) 5 [Peru 1 Medical Technicians 2 [Colombia 1 Bolivia 1 Costa Rica 1 [Honduras 1 Puerto Rico | 2 ‘ Medical Technologists 49___[Puerto Rico | 48 54 (RAND TOTAL 178 154 ---Page Break---