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FEASIBILITY STUDY OF THE CORRELATION
OF LIFETIME HEALTH AND MORTALITY
EXPERIENCE OF AEC AND AEC CONTRACTOR
EMPLOYEES WITH OCCUPATIONAL RADIATION EXPOSURE

December 31, 1969

Progress Report

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TABLE OF CONTENTS

	Page
ABSTRACT	vi
I. INTRODUCTION	1-1
II. BACKGROUND	11-1
III. ACTIVITIES AND OBSERVATIONS OF FOURTH YEAR (FY 1969)	111-1
A. Status of Work at Oak Ridge	111-1
1. External Radiation Exposure Data	111-1
2. Internal Radiation Exposure Data	111-2
3. Work History Data	111-3
4. Personnel Security Questionnaire (PSQ) Data	111-6
5. Quality Check in Compiling Information and in the Completeness of Employee Rosters	111-6
6. Programming for Project Analyses and Summary Printouts by Oak Ridge Computer Technology Center	111-9
B. Status of Work at Hanford	111-10
C. Work Status Regarding Feed Mills	111-16
D. Disability Claims Under Social Security, Early Withdrawals, and Completeness of Withdrawal from the Labor Force as Additional Measures of Possible Biological Injury from Ionizing Radiation	111-17
1. Data Available on Withdrawal from Covered Employment	111-18
2. Types of Withdrawals	111-20
3. The Retirees	111-21
4. The Disabled	111-24
5. Additional Observations Pertaining to Retirement and Disability Data	111-27

IV.	OUTLINE OF PROCEDURES FOR FY 1970	IV-1
V.	CONCLUSIONS AND RECOMMENDATIONS	V-1
APPENDIX A	The AEC Health and Mortality Study	A-1
TABLES 1-24		
FIGURES 1-6		
REFERENCES		

TABLES

Table 1	Union Carbide Employer Roster Validation by Comparing it with Social Security Employer Tax Reporting (form 941-A)
Table 2	Comparison of Population Exposure Parameters of External Radiation for the Three Plants of Oak Ridge and the one at Hanford
Table 3	Preliminary Data on the Age and Number of Union Carbide Employees According to Sex and Color Hired in Different Periods for X-10* in Oak Ridge Divided into Those Separated and Those Still Employed, 1943-1968 (*also for Y-12, K-25)
Table 4	Estimates of Ionizing Radiation from Diagnostic Medical X-rays at Hanford Compared to Occupational Radiation Exposure (for employees who were at Hanford continuously from 1/1/46 through 8/31/56, including those who died within this period)
Table 5	Hanford Population Exposure Parameters--Estimated from Hanford Data of 1944-1964, Inclusive; on-site only
Table 6	Hanford Population Exposure Parameters--Estimated from Hanford Data of 1944-1964, Inclusive; includes off-site exposure
Table 7	Insured Workers Aged 62-64: Estimated Number Eligible for Retired-Worker Benefit who Retire before Age 65 by Sex, Numbers (in thousands) and Percent
Table 8	Labor-force and Work Status by Severity of Disability and Sex: Percentage Distribution of Non-institutional Population Aged 18-64 by Labor-force Status, Spring 1966
Table 9	Awards of Old-age Benefits to Retired Workers Under Social Security
Table 10	Percentage of Workers Eligible for Retired-Worker Benefit in Current Payment Status by Broad Age Group and Sex, 1955-1968
Table 11	Benefit Awards to Retired Workers: Number and Percentage Distribution by Year of Award in Relation to Year of Entitlement, 1962-1967

TABLES (Cont'd)

- Table 12 Benefits Withheld from Retired Workers on Account of Earnings, at the end of 1967
- Table 13 Magnitude and Severity of Reported Disability in Non-institutional Population Aged 18-64, Spring 1966
- Table 14 Magnitude of the Number of Workers with No Covered Employment Beyond the Specified Years by Insurance and Entitlement Status by Age Group and Sex, 1937-1960 Inclusive (1 Percent Sample)
- Table 15 Disability Claims Allowances and Denials Under Social Security Program, 1955-1968
- Table 16 Number and Gross Termination Rates of Disabled Workers in Receipt of Monthly Disability Benefits from Death, Recovery, Attainment of Age 65 and Other Causes, 1958-1969
- Table 17 Estimated Disability Incidence Rate per 1,000 by Age at Onset by Sex for 1957 and 1963
- Table 18 Disability Determination Awards in a Given Year by Year of Onset
- Table 19 Graduated Death Termination Rates for OASDI Disability Beneficiaries in Selected Ages by Sex, 1957-63, Compared with Non-disabled (per thousands)
- Table 20 Comparison of Graduated Death Rates of OASDI Beneficiaries with the General Population for Males and Females, 1959-1961
- Table 21 Comparative Incidence of Compensable Disability and Death for Working Men and Women
- Table 22 Death Rates Per Thousand Population Based on Group Annuity Experience (GA-1951) Compared with that of the General Population of the United States
- Table 23 Comparison of 1955 Death Rates for Male Workers Insured Under OASDI and of Total Male Population
- Table 24 Comparison of 1955 Death Rates of Female Workers Insured Under OASDI and of Total Female Population.

FIGURES

- Figure 1 Phasing of AEC Health Study and Estimated Progress
 (Aug. 1969)
- Figure 2 Mancuso Project Data Base
- Figure 3 Sample Printout of Y-12 Employee Work History
- Figure 4 Diagnostic Medical X-Ray file by Individual
 Employee. (Complete File 1-1-46 to 9-1-56.)
- Figure 5 Annual X-Ray Dosage by Year Within Type
- Figure 6 Annual X-Ray Dosage by Type Within Year

ABSTRACT

This is the fifth annual progress report under Contract No. AT(30-1)-3394 on a project begun in June, 1964 as a feasibility study, and renewed in June, 1965 as a five-year study to test, in selected atomic energy installations, the predicted feasibility of carrying out an epidemiological investigation of the correlation of lifetime health and mortality data with occupational radiation exposure in AEC installations. The five-year study began after a one-year study had determined that the necessary data routinely collected as a part of the occupational health programs in several major installations were retained over the years, and these data were sufficiently complete to provide the basis for a long-term mortality study of persons occupationally exposed to radiation. The purpose of the ultimate study would be to ascertain empirically whether there were any lasting biological effects from radiation exposure received from employment in these installations since they came into operation. The present study was initiated as a pilot test run of selected facilities (Hanford, Oak Ridge, and early laboratories and feed mills) to identify the problems, and to develop methods for extending the study to all AEC Contractor facilities, and for many years to come. Such an extension eventually would be statistically necessary for studying the presence or absence of effects on human populations of the low-level occupational radiation exposures received by atomic energy workers over long periods of time.

This is true because of the low levels of exposure involved and also because at this stage of our knowledge it would be unwarranted to extend findings, whether positive or negative, from one installation to another. Moreover, some effects of possible interest may require long and varied periods of observation before they are detectable, in order to meet the time requirements of possibly-long latent periods that must pass before these effects become manifest. Previous reports have discussed in detail the project objectives, design, and data abstracting procedures. The present report will describe briefly the progress to date, the plans for the following years, and current conclusions and recommendations.

The feasibility of concluding a meaningful study with the available data has essentially been established. Except for some of the very early contractors, and the recent whole body counting data, all radiation exposure records at Hanford and Oak Ridge, as well as personal data and sibling data from Hanford, have been abstracted and transferred to magnetic tape in suitable format. The personnel and sibling identification data at Oak Ridge have been abstracted and conversion to the magnetic tape file is now being completed. Personal and exposure data abstracting for the feed materials plants files that were shipped to Oak Ridge is now underway. Printouts of summary radiation exposure frequency distribution for Oak Ridge and Hanford have been presented in previous reports and are summarized in this report. Additional summaries of occupational radiation exposure distributions at Hanford and comparisons between occupational radiation and medical x-ray exposures at Hanford are presented in this report. Since delays

have been encountered in completing the recording of some of the work history data, getting social security numbers for siblings, obtaining the lists of deaths from the Bureau of Old Age, Survivors, Disability and Health Insurance (OASDHI), and getting copies of death certificates from the various states, the remaining phases of the study will require approximately four years or more before all mortality and disability data are available for a complete epidemiological evaluation.

The present report also includes an appendix describing in broad outline the design and the procedure of the entire study as conceived at this time. The methodology for electronic data processing as outlined in the preliminary Hanford report presented in May, 1969, is applicable for use in all AEC facilities.

I. INTRODUCTION

This progress report covers activities of the period June 1, 1968 through July 31, 1969, under AEC Contract No. AT(30-1)-3394, begun in June, 1964, as a one-year pilot feasibility study, and renewed in June, 1965 as a five-year study to test, in selected atomic energy installations, the predicted feasibility of carrying out an epidemiological investigation of the correlation of lifetime health and mortality data with occupational radiation exposure in AEC installations. This pilot study was initiated to actually begin a limited study of selected atomic energy facilities and to develop methods for a broader extension of the study to all AEC Contractor facilities and to continue it over a number of years to come. This extension, to larger employee populations and longer time periods, would eventually be necessary in order to obtain more complete exposure and work history records on each employee, as well as to provide better statistical sensitivity for detecting any low-level effects. A larger study population would provide confirmation, at lower exposure levels, of the presence or absence of lasting effects on human populations of the low-level occupational radiation exposures received by atomic energy workers over varying periods of time and varying periods of possible latency. Extension is also indicated by the fact that, in the light of our incomplete knowledge of the phenomena under study, it would be hazardous to generalize findings from one installation to others. The investigators presented in March, 1969, their conclusion that the feasibility of a meaningful epidemiologic study had already

been established in terms of obtaining a reasonably accurate determination of the mortality and exposure status of a vast majority of employees and suitable controls. Expansion of the project to other AEC facilities as soon as possible was recommended, as in previous progress reports, and was supported by members of the AEC scientific staff. Previous renewal proposals and annual progress reports have discussed in detail the project objectives, design, and data abstracting procedures. (1-11) The present progress report will review the progress made to date and will outline the work planned for the next year.

Since delays were encountered in completing the recording of all data, getting social security numbers for siblings, obtaining the lists of deaths from the Social Security Administration (SSA), or from the Veterans Administration for veterans, and getting copies of death certificates from the various states, plans were presented last year for phasing the remaining years of the five-year study over a 4-5 year period. In the meantime, additional sources for obtaining data on environmental exposures to agents other than radiation have been explored, radiation exposure and personnel data accumulating in present and future years are being integrated on to the magnetic tape files in the installations that are presently included in the study. Plans are being made for extending the study to other AEC facilities should this subsequently be possible, as previously recommended. For reasons stated in previous reports, the "five-year test runs" have been focused on AEC plants at Oak Ridge, Hanford, early laboratories, and several feed materials centers (including early groups of the

Manhattan Engineer District). Cohorts of atomic energy workers are included who began employment at any time in the years 1942 through 1968.⁽⁷⁾

The project is still planned so that it can be successively and continuously followed up in future years as the number of man-rem and years of observation continue to increase with time, which we deem essential for conclusive findings, especially if these findings are negative.

The five-year study was originally divided into three phases (see NYO-3394-3)⁽²⁾: I. Organizing, arrangements with other agencies, statistical design, data abstracting, and conversion to magnetic tape; II. data processing, programming, tracing death records (through Federal and state agencies), and obtaining death certificates; III. coding deaths, data processing, data analysis, presentation of results, and phasing into further studies (including a proposed continued follow-up of all AEC Contractor employees for the indefinite future). The parts of Phase I in regard to organizing, collecting and transfer to magnetic tape of personnel and radiation exposure data at Hanford have now been completed, except (a) some general quality test procedures to assess the completeness of employee rosters and the consistency and completeness of the information abstracted, and (b) radiation dose records for maintenance and construction contractors (CPFF). The transfer to magnetic tape of available radiation exposure data at the three plants in Oak Ridge has also been completed, with the exception of whole body counting data and radiation dose records for CPFF maintenance-type contractors. The personnel data collection for Carbide

personnel as well as those of earlier contractors at Y-12 and X-10 are nearly completed and will be ready during FY1970 for processing through SSA.

Thus, almost all of Phase I has been completed, the procedures and programming for carrying out most of Phases II and III have been completed, and the tracing of death, and (hopefully) of disability data, through the Social Security Administration has begun. In the meantime, additional sources of information on environmental exposures and work histories are being used to fill in and supplement information from other sources to ensure that we will not attribute to radiation those effects on health that may be caused by other occupational hazards that may be concurrently found in any of these installations.

The abstracting of available PSQ data in Oak Ridge has been completed for terminated employees and all PSQ abstracting and conversion to magnetic tape will be completed in FY1970. Although some of the Oak Ridge PSQ data was previously destroyed, enough sibling data has been recoverable for use as additional controls for some of the cohorts. Further control populations will be matched by SSA after they receive the population data from the study facilities. The procedures in this respect are described in the Appendix.

The abstracting of the radiation exposure data on the early duPont workers at Hanford and Oak Ridge has been transferred to magnetic tape and integrated into the ORNL radiation exposure files by the Computer Technology Center. This would have to be matched with Hanford tabulations for these same individuals to see that their exposure records are complete,

without duplication, and to develop an effective pattern of analysis for employees appearing in two or more installations.

The major part of the personnel and exposure data available for the early feed mills and laboratories (Mallinckrodt Chemical Works, National Lead Company of Ohio and S.A.M. Laboratories at Columbia University) have been abstracted, data control sheets have been prepared, and most of the National Lead Co. data are on magnetic tape. Cross-checks with the Manhattan Engineer District (MED) card file (now in ADP form) have shown some names missing, and social security numbers for some are not complete. Some of the missing data have been obtained from other AEC offices or facilities, more may be available in Federal record centers where some of the files have been sent. Employee index cards are also available for twelve additional plants and laboratories that participated in the early MED work. Selected exposure data are now being converted to the ADP file, but further efforts will be needed to merge the various sources of exposure data since some of the bioassay data files have been found to be either incomplete and/or require further clerical work to fill in missing data.

Some interim data on radiation exposures at Hanford and Oak Ridge were presented in previous progress reports. Print-outs of more complete summary radiation data on the three Oak Ridge facilities were presented in last year's report.⁽⁷⁾ The complete external radiation exposure records (including H-3 exposure) of Hanford employees has now been printed out from the magnetic tape file, and a sample of the Hanford personal

exposure record is presented in this progress report. Summaries of the medical x-ray study results for Hanford employees^(6,7,10) who worked during the entire period 1946-56 have also been obtained and are presented in this report, together with comparisons of the relative magnitudes of medical and occupational exposures each year for the 1946-56 period. When medical exposures were weighted according to tissue mass irradiated, average annual medical exposures turned out to be lower than estimated whole body occupational exposures. Rank correlations between medical and occupational exposures, occupational radiation exposure frequency distributions, and the degree to which medical exposure influences the exposure category based on an employee's occupational exposure have been studied and are also summarized in this progress report. A comparative summary of penetrating radiation exposure data from Hanford is shown with similar data of the three Oak Ridge installations in Table 2.

Additional data printouts have been obtained from the Computer Technology Center in Oak Ridge to divide exposed and non-exposed employees by different personal, cohort, employment and other demographic characteristics. These trial printouts simulate some of the types of operations required in the final presentation of project results and analyses, so that the programming for these printouts will be useful toward the final phase of the study. Also, the results of these trial printouts will be helpful in determining the most efficient sub-groupings of the data for statistical analysis. Dr. Marvin Kastenbaum has begun to examine the possible ways of grouping the cohorts according to employment and demographic

characteristics in order to obtain reasonable numbers of cases within each grouping of interest for the contingency table presentations and analysis of project data.

Further details on the progress of this study will be summarized in the following sections of this report.

11. BACKGROUND

Previous reports (1-11) have presented in considerable detail the scientific rationale and objectives of this project (see also the Appendix of this report). Again, the statements in these previous reports remain applicable. By the very nature of the epidemiological investigations that must be carried out in examining long-term, low-incidence, health effects on employee populations, rapid advances in the knowledge of biological effects of low-level irradiation of large human populations are not to be expected. Within the past year, however, one of our staff (B.S.S.) has reviewed a more limited study of British atomic energy workers, and has submitted a critique of this investigation for publication together with the results of the British study. Neither the study nor the critique are yet published. However, nothing in the methodology or findings of the British study would alter the purposes or designs of the present investigation.

The main reason for this study initially was the absence of other studies or data that could be used to ascertain low-level radiation effects on human populations without a direct examination of populations occupationally exposed to radiation. Thus, this study was designed to be carried out at two large AEC installations, and several small laboratories and early feed materials centers, in order to provide a fairly large sample of atomic energy workers exposed to radiation and/or the other stresses of the normal work environments, dating from the earliest years of the atomic energy program to the present, and hopefully into the future. A large

sample is required both to enlarge the body of observation and perhaps more important to allow observations when a longer period of latency may be required for some adverse influences to take effect. The study was also designed to be carried out utilizing data in the routine exposure and personnel records already collected at these AEC facilities. The employees and appropriately designed controls would be followed year after year through the reporting mechanism for workers used by the Social Security Administration. The staffs of the Division of Biology and Medicine and Operation Safety, of the U.S.A.E.C. had an early and decisive role in the development of this project, and are already well aware of the scientific rationale behind the study.

The scientific and public interest in the effects of radiation exposure (independent of or in addition to other environmental exposures) on human populations has continued to be an important factor in the planning and progress of the peaceful uses of nuclear energy and is bound to expand rapidly in years ahead.^(12,13) Much attention in the press and at scientific conferences during the past year has focused on various studies and assertions related to the possible effects of low-level fallout radiation or reactor effluents on human populations, without substantive scientific evidence. Only detailed long-term epidemiological investigations, with several methods of controlling for other environmental causes of disease,⁽¹⁻¹¹⁾ can ultimately prove or disprove the existence of any detectable effects of low-level radiation exposure, some of which may not manifest themselves for 30 or more years following the exposure.

In last year's report, we re-emphasized our earlier statements⁽¹⁻³⁾ to indicate that the project investigators in this study did not have any a priori expectations of observing (or not observing) significant differences in crude mortality rates or gross life shortening in the AEC Contractor population attributable to low-level ionizing radiation. Extrapolations of the incidence rates of certain radiation-induced diseases⁽¹⁻³⁾ to the occupationally-exposed populations indicate (if the extrapolations are deemed valid) that effects calculated even for the entire atomic energy employee population would be subject to large statistical uncertainties because of dilution effects, in dealing with the gross mortality rates of large populations. This is why this study has been carefully designed to ensure that the population is subdivided in optimum ways to search for any higher-risk (or highly exposed) sub-populations in which survival time is measurably reduced, or in which certain specific causes of death might be observed at significantly increased incidence. This type of epidemiological design requires many types of "control" populations, and the necessary identification and work history data to allow a critical evaluation of the possible reduction in life expectancy and possible differentials in specific causes of death within the populations, followed longitudinally in time, which could be specifically related to radiation effects. After the employee populations have been properly identified, and their work histories and exposures have been established, they will be grouped in the final analysis into relatively homogeneous categories of work history and exposure, within the limitations of obtaining a

reasonable number of employees in the study and control populations in each sub-grouping. Then, objective statistical tests will be applied to pinpoint the presence or absence of significant differences in the overall mortality (or disability) patterns between exposed and control populations, or in the incidence of specific causes of death between specific exposed and control sub-groups. Finally, if warranted by the results, statistical calculations may be made to obtain estimates of dose-response relationships, or upper limits of the effect of low-level radiation on survival or possible changes in specific causes of death compared to incidence rates in appropriately selected controls. (For more details see the Appendix.)

In last year's report, we mentioned (page 11-4, Reference 7) the desirability of establishing a continuing study of low-level radiation effects on man, to include not only mortality studies, but also the extension to other physiological phenomena, temporary or long-lasting disability, or any non-specific cause that cuts short the working life of employees. The need for studying these other indices of health effects was recognized by the investigators at the beginning of this study, but mortality by specific causes of death was the only health effect measure included in this study as a result of the practical difficulties in obtaining other reliable and objective data. However, during the past year some progress has been made toward including an examination of disability patterns in the exposed and control populations, utilizing already-available records of the Social Security Administration. Since there would be no expected or consistent bias

in the recording of disability by the Social Security Administration, between the AEC employee populations and the several types of controls, this type of disability study might turn out to be an even more sensitive and objective index of population health effects than the somewhat subjective and selected indicators of morbidity used in previous investigations. A more detailed discussion of the plans and progress in carrying out the investigation of disability patterns is presented in Section III D.

In last year's report we also mentioned that, at higher doses (in the hundreds of rad), available human data suggest that the non-specific increase in mortality rate or life shortening in a human population may be easier to detect statistically than the increased mortality from a specific disease. This easier detectability of non-specific effects may also pertain to the study of morbidity in terms of disability; in fact, an individual may survive for many years after removal from the work force, or from a specific type of employment, as a result of an occupationally-induced disease. Moreover, at lower exposure levels the mortality from radiation-induced diseases may be only one-fifth to one-tenth of that for acute exposures,⁽¹⁴⁾ so that leukemia and/or other specific causes of death may not appear in a statistically-significant differential number of cases until many years after more general, non-specific, population effects become evident.

Thus, we now plan to study disability patterns and causes of disability as well as specific causes of death, and the complementary picture of overall mortality and non-specific life shortening in "exposed" groups, compared in each case

with the parallel experience among several appropriately-matched control populations. We again recommend that in the future other comparative indices should be explored, such as chromosomal anomalies, specific hereditary diseases in descendants of the employee populations, and other physiological and biological parameters studied only in a cursory way in previous investigations.

As indicated in the previous section, the organizing and abstracting of radiation and personnel data in the major installations under examination in this pilot study are nearly completed. The data obtained indicate the feasibility of defining employment characteristics, exposure potentials, work histories within each installation, and demographic characteristics of the major part of the work force of these installations, since their beginning in many cases. The experience of the investigators with other previous and recent^(8,9) mortality studies conducted with the use of SSA records have already demonstrated the feasibility of establishing deaths for AEC contractor employees and controls through the use of Social Security and State records, and have led to definitive findings not possible by less exacting analyses. Summaries of exposure and personnel records in previous reports⁽¹⁻⁷⁾ have illustrated the availability of sufficient data for dividing the cohort populations into suitable exposure subgroups over specified periods of time. Thus, the investigators continue to feel that this pilot study will itself yield useful findings, and that the extension of this project to other installations and forward in time is necessary for conclusive findings.

An extension of the project, as soon as possible, to other installations and its continuation into the future would not only add to the statistical power of the project (both in population cohort sizes and longer periods for observing the appearance of latent effects), but would also make it possible to account for all exposure data for employees who may at one time or another have joined AEC installations not included in the present study. Another contribution of extending this study to other AEC plants would be the completion of occupational radiation exposure records for certain employees who have served in several AEC installations at different periods of their employment. Further, without this extension, an unknown number of workers, some with the longest and greatest radiation exposure, may not even be included in the current study. But perhaps the most important rationale is that, at this stage of our knowledge, it would be hazardous to extend findings from one AEC installation to another. Additional justification for extending the project has been given in previous reports,⁽¹⁻⁷⁾ and is reinforced by the completion of data abstracting at Oak Ridge and Hanford, as described in the following sections of this report, and in the Appendix.

III. ACTIVITIES AND OBSERVATIONS OF FOURTH YEAR (FY1969)

Previous reports of this project⁽¹⁻¹¹⁾ have presented the detailed procedures for recording the personnel, exposure, and work history data required for this project. Also, a recent report⁽¹⁰⁾ has been submitted by the Hanford staff, summarizing the data collected and describing the ADP data file and programming systems maintained at Hanford for the continued collection and organization of data for this project from Hanford contractors. An appendix prepared for the Hanford report by the investigators is attached to this report. In this section, activities of the past year and progress to August 1, 1969* will be reviewed, and additional procedures or summary information will be presented for future reference. Figure 1, updated from Figure 15 of last year's progress report,⁽⁷⁾ presents an overall diagrammatic summary of the present status of the project.

A. Status of Work at Oak Ridge

1. External Radiation Exposure Data

A summary of the status of data abstracting for the project at Oak Ridge as of April 1, 1969 is shown in Figure 2. As indicated in last year's report, the abstracting of external radiation exposure data and conversion to magnetic tape are essentially completed. These data were available

*In May, 1968, the fiscal year of this project was changed to begin on August 1.

from routine personnel monitoring records and were supplemented as described last year for the following periods:

ORGDP (K-25), 1946-1967; ORNL (X-10), 1943-1967;
Y-12 (Carbide only), 1943-1967.

Data have also been abstracted at Oak Ridge for about 4,000 Hanford-duPont personnel who were employed in the 1944-1946 period and who never returned to work for General Electric. Frequency distributions of external skin and whole body exposures were obtained from the computer and presented in last year's report. These data, when updated, can be used in evaluating project results when the mortality data and work history data are complete. However, we have discussed the feasibility of obtaining additional information from Oak Ridge for use in determining the relative limits of sensitivity and precision of the monitoring methods used each year in each plant. Data have also been requested on the radiation exposure for CPFF maintenance-type contractors for the Oak Ridge facility. This information will allow possible adjustments that may be needed to ensure the use of comparable exposure categories when the populations are divided into separate cohorts.

2. Internal Radiation Exposure Data

As mentioned in previous progress reports, all available data on occupational radiation exposure from internal radionuclide burdens is indirect. The available bioassay data on radionuclide excretion for employees at Oak Ridge was abstracted and reported in previous years. This data will allow, for some cohorts, a degree of differentiation between

employees with and without measurable exposure to the intake of radionuclides. This type of data may also help to supplement available work history data in characterizing employees by the nature and extent of their employment. The periods of time for which bioassay records are available and kept current on tape for all employees in the internal exposure evaluation programs are: ORGDP-1948 to 1967; ORNL-1950 to 1967; Y-12-1950 to 1967 (see Figure 2). Illustrative printouts of numbers of persons in various bioassay categories, including bioassay for several non-radioactive agents, were presented in our second annual progress report.⁽⁴⁾ We have discussed the feasibility of developing a simplified "standard man" technique for the conversion of excretion rate data to body burden or organ dose.

3. Work History Data

All work history data on current and terminated Union Carbide employees, and ORNL employees who terminated before the takeover by Carbide in 1948, have now been abstracted and transferred to magnetic tape. These data have been obtained for about 180,000 individual employees and include employment dates, job titles, departmental assignments, and changes in job status as recorded in payroll records. Key punching of some of the related data of Tennessee-Eastman operations of the 1943-1947 period at Y-12, on uranium urinalysis results, has been delayed until FY1970 as a result of personnel ceilings at the computer center. However, the personnel and work history data recorded on the forms presented in Figures 1 and 2 of last year's report⁽⁷⁾ have now been transferred to the magnetic tape files.

The abstracting of log book data at ORNL for use in assisting the tracing of each employee through his potential environmental exposures is continuing. However, the key-punching and transferring of these data to magnetic tape have awaited priority at the Computer Technology Center and will be completed in FY1970.

The pilot study to determine whether the computer could place workers in three crafts in their environment was completed. Some additional work will be needed to achieve a complete link between an individual and all of his job codes, but this link is deemed feasible by the time the data are all available for analysis.

Figure 3 is an illustration of an employee's work history at Y-12. Also printed out in this test on a 1% sample of Y-12 employees were: Work History Reports, showing each employee's name, department, payroll status, badge number, social security number, dates of change in job type, job code, job title, date of birth, sex and race; Uranium Air Sampling Reports, for departments 2617, 2619, and 2793, giving each employee's name, department numbers and each year and quarter assigned, number of air samples, and the average uranium air activity for each department and quarter in units of disintegrations per minute per cubic meter; each person's Radiation Monitoring History, including the name, badge number, in vivo measurements of uranium and thorium body burdens for the years since whole body counting was begun (1961), uranium urinalysis data in disintegrations per minute excreted per day, and annual film badge exposures estimated for skin and whole body; Mercury Exposure Registers, printing out the

name of each employee and the mg/l of Hg in urine measured for each quarter; Potential Beryllium Exposure Register, giving the years and months each employee was potentially exposed to beryllium; lists of persons restricted from mercury exposure (although this turned out to include no one in the 1% sample of these three departments indicated above*); a Mercury Restriction History, giving the number of employees restricted each year from further mercury exposures (averaging about 100 employees each year from 1955-1967); Beryllium Restrictions, which also included no individuals in the particular 1% sample; and the Beryllium Restrictions for individuals, Abnormal Chest X-Ray printout, showing the numbers of employees at Y-12 who were restricted each year, 1947-1967 as a result of an abnormal chest x-ray (averaging about 6 per year from 1959-1967).

Additional data have been planned for incorporation into the magnetic tape file for use in defining characteristics of the work environment other than radiation. These include data on chemical toxicants measured in air (now completely abstracted at K-25 and X-10), facility descriptions (except for classified data); work assignment surveys carried out by interviewing supervisors who have been at Oak Ridge over all the years of operation; and further cross-checks of the recorded populations with Social Security and other records to ensure as far as possible the complete identification and placement of employees who ever worked for any of the operating contractors at Oak Ridge.

*Next year's report will show crafts with multiple exposures as well as clinical chest x-ray findings.

4. Personnel Security Questionnaire (PSQ) Data

Data on sibs of the same sex as each employee have been abstracted from all available PSQ forms. (As indicated in previous reports, however, all of the PSQ forms under A-D in the alphabet were destroyed in 1965 before the stop-destruction request was received by ORO.) The PSQ data on terminated and active employees, indicated in Appendix A of last year's report,⁽⁷⁾ have now been converted to magnetic tape. There are a large number of other employees, including almost all non-Carbide employees, for whom PSQ's are lacking, or the information available is so restricted that it is of no value.

5. Quality Check in Compiling Information and in the Completeness of Employee Rosters

In the initial phase of abstracting personnel and work history data from the records to the specially-prepared record form, quality checks were applied to test the consistency with the information was being abstracted. This was achieved by re-doing a sample of 5% of the recorded cases by a different recorder and analyzing the two sets to determine any inconsistencies in the two independent recordings. This was done in Oak Ridge when a special staff was hired to abstract the information from the AEC security files in Oak Ridge. Because of delays when the recording was taken over by the Oak Ridge Computer Technology Center, no quality checks have been made to measure objectively the consistency with which trained clerical personnel under trained supervision are able to abstract personal and occupational data. In Hanford,

also, a 5 percent sample of the records was recorded by a different recorder and the two recordings compared to measure consistency. Eventually, we may present these comparisons to indicate to the interested public the precise degree of precision with which such recordings were made. At present, it would suffice to say that genuine inconsistencies were below the 1 percent level, and if one may assume one of the two recordings was the correct recording then the net error in recording would be below one-half of 1 percent. In transferring the information from the summary sheet to a punched card and then to the magnetic tape, both in Hanford and Oak Ridge, all keypunching was 100 percent verified.

For Oak Ridge abstracting of information, in lieu of a quality check sample we have the early recording of some 12,000 to 13,000 records abstracted first from the AEC security records in Oak Ridge. When the Computer Technology Center took over the recording they recorded, without exception for all employees, using the personnel records kept by Union Carbide. This early recording is now being transferred to magnetic tapes to check against the file recorded by CTC, both to ascertain the completeness of the roster as well as the consistency of the personal and occupational information abstracted. This would give some indication of the quality in the consistency of the information in the two sets of records for the same employee.

To check on completeness of the roster of employees for Oak Ridge, and to a limited extent for Hanford, we have the information of individuals in the early Manhattan Engineer

District, which was put on tape for many uses. In addition, we have a collection of early telephone directories of employees in the three Oak Ridge plants. We have a list of key employees who were given awards for their accomplishments by General L. Groves, who initiated and supervised the work of MED until AEC took over in 1947. These lists will be compared with the roster of employees at Oak Ridge and also Hanford. A more general check of the completeness of these rosters is available through Form 941-A, preserved by the Social Security Administration. This form is the quarterly tax reporting form required of each covered employer to submit to the Social Security Administration with the quarterly payment of Social Security taxes, including employer share and employee share withheld by the employer. This form lists by social security number and name every employee subject to the tax. In the first quarter, every employee who worked for any length of time and was paid would be on the list. In a few instances, this record for multi-plant employers is difficult to use since employees from plants other than the AEC installations are included in the same listing without distinction, but these are the exception to the rule. In most instances, employees working in AEC installations can be distinguished, and where this can be done Form 941-A provides an excellent check to determine the completeness of the rosters. Such checks are to be made where there is any uncertainty of the completeness of the record, and where employees working in an AEC installation can be distinguished from other employees of a given contractor. We have already, for Union Carbide operating in Oak Ridge, Form 941-A for

the first quarter of 1945. For Tennessee-Eastman, we have the quarterly wage reports for all of the quarters in which TE operated Y-12.

To date, only one attempt has been made to check our roster against that obtained from the Social Security Administration. The results are shown in Table 1. It is seen that the apparent discrepancy is less than 1 percent. This might be drastically reduced when we make a reverse match and separate in our roster the non-matched persons to compare with the 87 non-matched persons given in Table 1.*

6. Programming for Project Analyses and Summary Printouts by Oak Ridge Computer Technology Center

As already indicated in previous reports, all programming, keypunching and conversion of data to the magnetic tape study file has been carried out for the three plants at Oak Ridge by the Oak Ridge Computer Technology Center (CTC). The CTC has assigned special programmers, systems analysts, and coordinators to this study for maintenance of continuity in the project.

During the past year, Hanford staff members visited the CTC at Oak Ridge and made arrangements to incorporate the Hanford data into the study file at Oak Ridge. A relatively minor amount of additional programming will be required at the CTC to incorporate the Hanford data into the Oak Ridge

*It must be appreciated that these comparisons would have to be kept to a minimum because of the costs involved. It costs something for the SSA to reduce Form 941-A for our use. The names on this form with the social security numbers would have to be keypunched and put on magnetic tape to match our rosters.

systems for data evaluation and printout. Hanford will, of course, continue to maintain a duplicate of its own file for special studies of the Hanford population, as well as for use in verifying certain computer manipulations at Oak Ridge.

During the past year, printouts requested as mentioned in last year's report⁽⁷⁾ have been provided by the CTC, including the breakdowns of the population into characteristic sub-groupings to determine sub-group sizes, and the printouts to test the systems for retrieving work history and environmental data on each employee, as mentioned previously. Printouts of radiation exposure data and frequency distributions provided by the CTC for the three plants in Oak Ridge have been presented in previous progress reports and estimated exposure parameters are repeated in this report with the addition of Hanford to the three installations at Oak Ridge (Table 2). Table 3 presents a summary of the numbers of Union Carbide employees in different age groups who are still employed, or who have separated from the three plants at Oak Ridge. Some additional testing of this nature will be carried out in FY1970, as well as the ADP conversion of remaining data at Oak Ridge, and the programming for incorporation of death certificate and pathology data to begin in FY1970.

B. Status of Work at Hanford

The data-collection phase at Hanford is now completed, except for (a) the continuing collection of data under the systems that have been established, and (b) the addition of the data base for CPFF maintenance-type contractor employees.

Personal identification and radiation exposure data have been incorporated into the magnetic tape files for about 32,700 employees spanning the years 1944-1965, and more than 2,000 "non-starts"*. Magnetic tape containing rosters of employees and sibs has been sent to the Social Security Administration to identify sibs and to initiate the searching for those employees and/or sibs for whom death benefits have been claimed and for the eventual establishment of control populations. As described in the following Section D of this report, arrangements are being made with the Social Security Administration to obtain the current employment, retirement, and/or disability status of the employees and controls for use as possible indicators of differential morbidity.

Since the data abstracting phase at Hanford was nearly completed in FY1968, a detailed summary of the Hanford data file has already been presented in last year's progress report.⁽⁷⁾ During the past year, the Hanford staff has prepared a detailed description of its data file, including methods of data collection, programming systems designs, and information for interpreting occupational and medical radiation exposure data. The Hanford report⁽¹⁰⁾ has recently been presented to the AEC staff, together with a preface introducing the report and relating the work done at Hanford to the overall project, and an appendix describing broadly the way these data would be analyzed (see Appendix A). This report should be valuable in extending this or similar

*These are persons who were given employment tests and found fit for employment but who, for one reason or another, did not accept a job in an AEC installation. They are being used as one type of control.

studies to other facilities. Some of the material collected together in the Hanford report has also been discussed and presented in previous progress reports⁽¹⁻⁷⁾ of this study.

During the past year, the retrieval of job code and organizational data necessary to the tracing of work histories of employees over the years and for the different Hanford contractors was completed. The data obtained are also described in the Hanford report.⁽¹⁰⁾ Printouts have also been provided, according to last year's requests,⁽⁷⁾ of statistical summaries and correlation co-efficients related to the studies of diagnostic medical x-ray exposures in the years 1946-1956, and occupational exposures for each year of Hanford operations. The preliminary printouts of medical x-ray exposures presented in last year's report have been corrected and weighted to provide the kilogram-rad doses for each diagnostic medical procedure, and a complete medical dose record for each person employed continuously and diagnosed at Kadlec Hospital over the 1946-1956 period. The complete record of this type has been printed out and provided to the project investigators, together with the various frequency distributions and tests requested⁽⁷⁾ for the purpose of assessing the relative importance of medical exposures compared to occupational exposures at Hanford, and more specifically to ascertain the extent that the inclusion of medical exposure does not alter the radiation gradient based on occupational radiation measurements only. As described in last year's report,⁽⁷⁾ the measured midline doses for each procedure were weighted according to tissue mass exposed to obtain the kilogram-rad contribution of each diagnostic procedure.

Medical exposures were compared with the "whole-body" or "penetrating" portions of the annual occupational exposure, weighted by an assumed 70 kg mass, to obtain in the first approximation a comparison between the gross magnitudes of the relative radiobiological importance of each source of exposure. Of course, the skin exposures and other detailed data already described⁽⁷⁾ for both medical and occupational exposures will be retained in the study files for future use in the actual evaluation of project results according to the actual exposure situations for each individual employee. For details of this comparative study, see the Hanford report.⁽¹⁰⁾

In Table 4, we have calculated from the data printouts the average annual medical and occupational exposures for the population of employees in the 1946-1956 period for whom medical as well as occupational exposure evaluations were carried out. For this purpose, the total annual medical exposure of each individual in units of kilogram-rad was divided by 70 kg to estimate the equivalent whole-body dose in rem, since most of the penetrating portion of the occupational exposures measured by personnel dosimeters essentially involve the whole body or a major portion of the body.

One of the surprising results of this comparison was the fact that the average medical exposures, even for the unfiltered, wide-cone x-ray procedure utilized at Hanford in the 1946-1956 period, when weighted by tissue mass as described, turned out to be always lower than the average occupational exposure. In fact, on the average, about one-third of the occupational radiation dose on a whole body basis.

This was true even when the occupational exposure was averaged over all the employees including those who were not monitored and who had zero recorded occupational exposure. In Table 4, the overall average annual medical exposure of 39 millirem per year may be compared to an average of 80 millirem per year for all employees, 140 millirem per year for monitored employees, and 188 millirem per year for those monitored employees with positive, non-zero recorded occupational exposures. This comparison does not include exposure from internal radiation sources, which may be appreciable for certain limited groups of employees. Other extraneous exposures will have to be examined separately and considered in the final evaluation and discussion of project results.

Tables 5 and 6 present population exposure parameters describing the general magnitudes of occupational exposures at Hanford, in the same manner as presented for the three plants at Oak Ridge in last year's report.⁽⁷⁾ Table 5 includes data on numbers of employees monitored and average annual exposures and durations of exposure for employment only at the Hanford site; Table 6 includes off-site exposures also, such as those received at weapons test sites.* Apparently, the inclusion of off-site exposures does not change the overall occupational exposure picture very much. There were 23,398

*Examination has revealed that at least in recent years (since 1964) when General Electric was replaced by other contractors at Hanford, for an employee who transferred from one of these contractors to another the accepting contractor considered the previous radiation dose received at Hanford as "off-site" radiation. Since the difference between Tables 5 and 6 is very slight, this error for the years 1944-1964 can not be large, and it is being remedied.

Hanford contractor employees monitored for radiation exposure (off-site and on-site) over the period 1944-1964. Their cumulative occupational exposure is on the order of 40,000 man-rem, averaging about 0.26 rem/year for an average of 6.8 years per employee of employment in monitored jobs. The corresponding average exposure rates at the three Oak Ridge plants were⁽⁷⁾: 0.25 rem/year for an average of 6.5 years per monitored employee at ORNL; 0.15 rem/year for an average of about 5.1-5.4 years at Y-12; and 0.12 rem/year for 3.8-3.9 years at K-25 (see Table 2). These estimates are still subject to some adjustments for bias in recording low exposures when further information on accuracies and sensitivities of methods over the years becomes available. However, the general magnitudes of these averages are believed to be in the correct range for the cumulative population averages, since a major part of the cumulative population dose is contributed by those employees who receive the larger doses (compare (g) and (h) of Table 6, for example).

Figure 4 presents a sample page from the complete printout of the diagnostic medical exposure of each employee continuously employed at Hanford over the 1946-1956 period of the medical x-ray study. These records consist of about 1 cubic foot of computer printout, for about 2,300 employees. The printout of individual occupational exposure records covers about 30,000 monitored employees over the 1944-1964 period, and only a small sample of the more than 10 cubic feet of printout was submitted to the project investigators for checking during the past year. A preliminary sample of the occupational exposure record was presented in last year's report.⁽⁷⁾

Figure 5 presents the cumulative annual integral body dose in KG-RAD and the integral skin doses in Meters²-R (MMR), for each type of diagnostic medical procedure (as coded in last year's report⁽⁷⁾), and for each year within each type. Figure 6 presents similar data, except it is arranged by type within each year. These data are presented here for use in any future interpretations of trends in medical x-ray exposures over the years included in this study.

Other printouts pertaining to the rank correlations between medical and occupational exposures, and numbers of transitions between various dose groupings,⁽⁷⁾ were also provided by the Hanford computer center. These printouts indicate that for the dose groupings selected, and the particular 1946-1956 population studied, the inclusion of the weighted medical exposure in the employee's dose record would not appreciably change the ranking of employees according to annual occupational dose, or the numbers of employees within each dose group. Also, the low correlation between medical and occupational exposures for each individual indicates that the diagnostic exposures would be fairly well randomized between the various occupational exposure groups, and does not alter materially the dosage gradient based on occupational radiation exposure.

C. Work Status Regarding Feed Mills

The data on S.A.M. Laboratories of Columbia University (during the Manhattan project), Mallinckrodt plants at Destrehan and Weldon Springs, Missouri, National Lead of Ohio,

and other feed mills, has been transferred to the University's staff office in Oak Ridge, as indicated in last year's report. (7) Most of these data have still not been transferred to magnetic tape, since additional clerical work has been required to prepare the data for keypunching. We have also found that several sources of Mallinckrodt bioassay data, from different kinds of records, may have to be merged in order to provide the most complete recording of all bioassay data on each employee. Further clerical work will also be required on some of the external exposure data before it is ready for keypunching. However, this phase of the project can be carried out by project staff while the Social Security records are being abstracted, and should not appreciably affect the time schedule of the project. Transfer of some, and perhaps all, of the available feed mill data to magnetic tape should be accomplished in FY1970.

D. Disability Claims Under Social Security, Early Withdrawals, and Completeness of Withdrawal from the Labor Force as Additional Measures of Possible Biological Injury from Ionizing Radiation*

Arrangements are being worked out with the Social Security Administration to obtain comparative data for employees of AEC contractors working in an AEC installation and for their out-of-plant controls with respect to claim rates for disability benefits and early retirement from Social Security-covered work, with or without full or partial retirement benefits. Such

*Prepared by Dr. Barkev S. Sanders, October, 1969.

comparisons would be made on the presumption that if truly there are lasting harmful biological effects from exposure to low-level ionizing radiation these effects should be measurable not only in terms of reduced longevity and differential causes of death but also in other and perhaps less intensive insults to health--or through what we might consider in a broad sense as earlier senescence associated with reduction in employment or complete withdrawal from the labor force, earlier than normal. The use of such additional indicia of possible lasting injury from low-level ionizing radiation would probably enhance our ability to detect and measure any harmful effects with the sample sizes that of necessity we would be limited to work with, more than would be the case if the study were to rely exclusively on evidence based on reduced longevity and differential causes of death between the "exposed" and their respective controls.

1. Data Available on Withdrawal from Covered Employment

In the United States the Social Security Program was actually instituted in 1937. That is, beginning with 1/1/37, taxes were levied on employers and employees to finance a broad retirement program. Actual benefit payments for retirement did not begin until 1/1/40. The original act covered only industrial workers, representing roughly about two-thirds of the entire work force (including the self-employed). Since that inception, however, the coverage has been extended progressively so that today, excluding clandestine employment to avert paying Social Security taxes, the coverage encompasses

perhaps 95 percent of all the civilian jobs, including most of the self-employed. The only large groups now excluded are: the Federal Civil Service, in a sense workers covered under the Railroad Retirement Program--which for qualifying purposes is closely linked with the larger Social Security Program; and men in the armed forces whose service period are post facto credited as covered employment with an assumed wage base (the contribution for this is from the general treasury funds). Under these circumstances, at present when a person with employment taxable under the Social Security Program fails to report earnings under that program, it is highly probable that he is no longer in the employed labor force. In the earlier years, when covered employment was relatively restricted, failure to report covered earnings could have meant either dropping out of the employed labor force or transferring to non-covered employment. However, since the probability of being one or the other should be about the same for "exposed" employees vis-a-vis the controls, the comparative withdrawal rate for the two groups would still be meaningful if large enough to be statistically significant.⁽¹⁴⁾ Therefore, a consistently higher withdrawal rate from covered work for the "exposed" as compared with the withdrawal rates of appropriate controls might imply a lower average health status for the "exposed".⁽¹⁴⁾

2. Types of Withdrawals

There are now actually three distinct types of withdrawals:

(A) Workers not attached long enough to covered employment, or otherwise not eligible for any form of Social Security benefits, who for one reason or another leave the covered labor force--and often leave at least all the employed labor force, regardless of covered employment as we have indicated earlier. The exact magnitude and characteristics of this group are difficult to estimate. In the earlier years when the magnitude of this group was relatively the largest, a significant fraction of this separation may have merely meant transfer to non-covered employment. Such transfers would have no health significance, but those that were not part of this transferring group could be significant.⁽¹⁴⁾ Today, transfer to non-covered employment is small and discontinuance of covered earning could be an index (with little dilution) of people with comparatively reduced health, which induces them to leave the labor force.

(B) A second group who terminate their covered employment are those who actually apply for disability benefits. The vast majority of these are persons with long-enough covered employment to satisfy the prior employment qualifying requirements for disability benefits. For some of these, disability is deemed to be serious enough to meet the qualifying conditions, for others these requirements are not satisfied (see Table 15). Both of these groups are deemed significant for our comparative analysis and their relative frequency among the "exposed" and the controls should be relevant to our inquiry.

(C) The third group of separations are those who have worked long enough in covered employment and are old enough so that they are eligible for retirement. Among these, a significant consideration for us is the lapse of time between the date when first the individual could qualify for retirement and the date when he actually retires. A second criterion is employment earnings after retirement. The assumption here is that on the average those taking advantage of their retirement early have a higher proportion of members with reduced health. The converse assumption may be made with respect to retirees with employment earnings, compared with retirees without such earnings. To the extent that these assumptions are valid, the comparative ratios of these different groups among the "exposed" employees, as compared against their controls, could be indicative of any differential health effects for those employees with occupational exposure to low-level ionizing radiation.

The Retirees: Originally, retirement with cash benefits under Social Security was restricted to those aged 65 and over. No benefits were paid prior to age 65. Of course not all people retired at 65. For many years, the mean retirement age was 69, gradually dropping to 68, and now it is of course much lower. Beginning with November, 1956, women could retire as early as age 62. However it was not until August, 1961 that men were also allowed to retire as early as age 62. For men, however, the "regular" age of retirement still remains at 65. But

both men and women who retire before age 65 receive actuarially-reduced benefits, i.e., benefits which are theoretically equivalent whether one starts drawing at 62 (in lower monthly benefits) or at 65. The benefit reduction is 5/9 of 1 percent for each month of entitlement before age 65. Thus, the employee who retires on his 62nd birthday gets 80 percent of his Primary Benefit Amount--the benefit which he or she would have gotten had he delayed his retirement until age 65. On computing the Primary Benefit Amount the women have some advantage; for them the passage of time in months over which the taxable earning contributions are divided stops running at age 62, while for men this continues up to age 65. The quarters of covered employment required for retirement and the monthly retirement benefits have also been modified over the years. Monthly benefits have been liberalized, and quarters of covered employment required to qualify for retirement benefits have been reduced--more for women than for men, because of the cut-off at age 62, instead of 65, as originally required.

A quarter means a quarter of a year, three months: January-March, April-June, July-September, or October-December. A quarter of coverage is one in which an employee earns a total of \$50 or more in covered employment. This specification might be the only specification in the original enactment in the 1935 act that has remained unchanged. With the exception of certain transitional benefit extensions to certain age groups, the minimum quarters of coverage required has also remained unchanged--6 quarters. Also, the maximum quarters of coverage required for irrevocable eligibility to retirement and death benefits in a sense has remained the same--40 quarters. But

actually, while initially the time lapse to which coverage requirements were referred began with 1936, now for those with more recent coverage the reference date is 1950 or age 22, whichever comes later. First, one-half of the quarters elapsed (up to a maximum of 40) from 1950 or age 22 to the date of attaining the "normal" age of retirement must have been covered; later this was liberalized to one out of every three elapsed quarters, and now one quarter out of every four elapsed quarters. These changes, even though important in explaining the changes in the volume of retirees, will be of no significance in our analysis in terms of comparative retirement by age, and proportion with earnings among the retired, comparing the "exposed" employees to the controls, who are always of the same sex, age, and certain other characteristics. Thus, we may compare, per 1,000 "exposed" male, white employees of a given age, the proportion eligible for retirement that retired at age 62 (as soon as eligible for retirement) or shortly after (see Table 11), with the corresponding rates found for the different control groups that were not "exposed". Similar comparisons can be made for those retiring in subsequent age intervals in proportion to those continuing full-time employment.

Still another level of comparison with health implications may be made among those retired, depending on presence or absence of continued post-retirement earnings, and perhaps levels of post-retirement earnings in terms of the size and continuity of such earnings.

The Disabled:

The marked association between ill health and reduced and interrupted employment is a well-known phenomenon, and it is not limited to those who actually file for disability benefits or those who are allowed such benefits--aside from the fact that cash benefit payments for the disabled did not begin until 1957. The reader must appreciate that "disability" for which cash monthly benefits are paid are for relatively severely defined conditions. There are many in the employed population with ill health and other handicapping conditions, which may affect their longevity and their capacity to continue holding a job, but who could not meet the legally-set criteria for disability benefits. Thus in a recent paper by Dr. L.D. Haber, entitled "Demographic Correlates of Disability" it is said:

"At the beginning of 1966, 18 million adults aged 18-64 in the United States were limited in ability to work because of chronic health conditions or impairments. This was more than one-sixth of the civilian non-institutionalized population of working age. Almost one-half of the men not in the labor force were disabled; more than one-quarter of the unemployed men were disabled."(16)

In another paper by the same writer the interrelationship between continued employment and disability is stressed thus:

"Employment: The proportion of the disabled population in the labor force is considerably smaller than for the non-disabled. Most of the difference between the full-time employment rates for men were due to the severely disabled, only 4 percent of whom were employed full time. The full-time employment rate for men 55-64 years of age with occupational and secondary work limitations were lower than that of non-disabled men."

"Although women have a variety of other reasons for not working, disability also deterred many women from entering the labor force. Among non-disabled women aged 45-54 and 55-64, the proportion employed remains constant, at about half. Among disabled women, the proportion employed declined with age, from one-third to one-fifth."(17)

The magnitude of this differential is illustrated by Table 4, which we are reproducing here as Table 8.

The observations made by Dr. Haber and the data given in Table 8 are derived from household surveys which, as one of the authors (B.S.S.) of this progress report has shown through his own studies, are subject to wide margins of inaccuracies through over-reporting and (much more often) under-reporting of the information sought.⁽¹⁵⁾ In the Haber study, the working definition of disability, which influenced the respondent's self-classification of whether or not he was disabled, was:

"Disability is...a limitation in the kind or amount of work (or housework) resulting from a chronic health condition or impairment lasting 3 or more months. The extent of incapacity ranges from inability to perform any kind of work to secondary limitations in the kind and amount of work performed."(18)

Table 8 shows, by and large, a smaller proportion of the disabled in the labor force; this is particularly marked for the severely disabled, and more pronounced among the males than females. It shows a smaller proportion of the disabled as employed, particularly full-time employment. Again the disparity was most marked for the severely disabled, and for males 4.1% for the disabled as against 83.7% for the non-disabled and for females 0.3% for disabled and 35.2% for non-disabled. Unemployment is higher among the disabled and these

adverse associations become more pronounced with advancing age. This differential is surely reflected among those eligible for retirement, inducing much earlier retirement among those with disabilities in comparison to others without disabilities. It is hypothesized that a very high proportion of those who retire early, especially males willing to retire early with reduced benefits, resort to early retirement on account of ill health. Some of these in all probability could qualify for disability benefits if they were to apply, but the vast majority would not be able to meet the relatively exacting medical requirements for these benefits. This is the rationale for our interest in a comparative analysis of retirees of each sex by age of retirement in relation to age of eligibility; and for the retired, our interest in the presence or absence of post-retirement earnings and the magnitude and regularity of such earnings. We are hopeful that we can obtain the necessary data from the Social Security Administration (SSA) on the basis of special arrangements developed for this study between the AEC and the SSA.

These additional means of examining morbidity in an objective way may provide a more sensitive indicator of health effects when applied over the entire duration of our inquiry including the years to come. As we have indicated in all our progress reports, this study must continue for a number of years in order to allow sufficient time for any disease manifestations with long latent periods to express themselves in the population. This extension in time would also add to the size of the study population, thus reducing variances in

discerning health effects.

Additional Observations Pertaining to Retirement and
Disability Data

The changes in size of the retired population of the United States since 1943, when the plants to manufacture the atomic bomb were first built and began operation, are illustrated in Table 9.

Table 9 shows with some year-to-year fluctuation a general sharp increase in the number of retirement awards under Social Security since 1943. The total number of persons awarded retirement benefits between 1943 and 1968 inclusive comes to over 21 million. This would suggest that in our population perhaps between 40 or 50 percent would fall in this category. The annual number retiring under Social Security at this time is about one and a quarter million.

As already indicated, the differential we are seeking in retirement among the "exposed" and the controls is the relative proportion who retire early. Even of those who retire after their 65th birthday, some retire earlier than others even though they are all eligible to retire at 65, and some continue work past age 72, after which age full employment is no bar to receiving full retirement benefits. This is shown by Table 10. Table 10 begins with 1955. It is indicated, however, that percentage of delayed retirement has in general declined with time especially among males. In 1955, of the males eligible to retire in ages 65-71, only 58 percent retired; in 1968, this percentage is about 80; for females, these percentages are 69 for 1955, and 81 for

1968. Even of those, age 72 and over, who could draw full benefits despite their continued full employment, it appears a certain proportion fail to assert their claim, especially among males--perhaps because they had not been advised properly. However, over the last two years, apparently 100% of those age 72 and over who are eligible have been drawing their retirement benefits. Some of these could be in full-time employment.

Apparently, many workers, after they apply for their retirement benefits and know that they are eligible for benefits if they were only to withdraw from employment, continue their employment, sometimes years after their entitlement. This status is defined as:

"The state or condition of meeting the applicable requirements for receipt of benefits, including the filing of a claim."

This delay is demonstrated by Table 11. The table is limited to the years 1962-1967. For these years, the proportion of the eligible population awarded monthly benefits in the same year in which they became entitled to retirement benefits was on the order of 45-60%; almost as many were awarded benefits a year after eligibility and nearly 5 percent 2 years after eligibility.

As we have indicated, of special significance are males who retire at reduced benefits prior to "normal" age of retirement. For males, such early retirement became possible for the first time near the end of 1961. For females, early retirement became possible in November, 1956. The numbers of females and males eligible for early retirement and the

number and proportion of them who retire prior to age 65 has been shown in Table 7, from 1957 through 1968 for females, and from 1962 to 1968 for males.

For males, the proportion that resorts to early retirement is between 20 and 25 percent. For females, the percentage retiring before age 65 is substantially higher, between 40 and 45%.* As indicated earlier for those retiring before age 65, the benefits are reduced by 5/9 of one percent for each month of retirement prior to age 65.

Tables 7 through 11 indicate that a large proportion of workers who have attained retirement age are retired and there is marked differential among workers as to how soon to retire after they are able to do so at their own volition. It may be presumed that among the multiplicity of factors going into the making of this decision an important element is the state of health of the worker. Therefore, if exposure to ionizing radiation is damaging to health we should find early retirements proportionately more frequent among the "exposed" than that which we find among the controls.

As we indicated earlier, even those retired can be subdivided into categories which carry health implications. In 1935, when the Social Security Program was being enacted one of the most cogent arguments in its support was that it would draw the aged from the labor force and thus reduce unemployment. Therefore, one of the basic provisions was that those granted retirement benefits should not be gainfully employed. To make this enforceable, they tied the payment of retirement benefit

*Because of increase in taxable limits and aside from that because of rising wage levels, delayed retirement is apt to result in higher benefits for those who are able to continue full employment.

to withdrawal from covered employment. The provision was that any one with as much as \$15 earnings in a month from covered employment would not be eligible for his or her retirement benefits for that month. From the very beginning there has been much pressure to eliminate or, at least, to relax this restriction. As a consequence, there has been progressive relaxation of the restriction, so that at present the retired worker can keep his full retirement benefit in any month in which his earnings do not exceed \$140, and any year in which his total earned income does not exceed \$1,680. For the excess above \$1,680 but not above \$2,880 per year he loses \$1 (one dollar) in benefit for every 2 dollars earned; finally, for amounts earned in excess of \$2,880 he loses \$1 benefit for each \$1 earned. These restrictions are for those in ages under 72; for those persons of age 72 and over, there is no restriction on earnings, whatsoever. (19)

For these retired workers, both those under 72 and those over, we assume that on the average those with earnings are healthier than those without earnings, and the healthiest are among those with substantial earnings on a more or less regular basis. We are hopeful that the arrangements worked out between AEC and SSA will make it possible for us to group retired workers into several categories on the basis of their having, or not having, earnings; and in terms of the approximate magnitude and continuity of such post-retirement earnings. For those under age 72, such earnings will be reflected through reduction in their benefit amount, if their earnings are above

the maximum non-deductible earnings permissible. As indicated before, this maximum has been increased over the years. Aside from this, SSA continues to record earnings from covered employment. These earnings are subject to Social Security taxes as any other earnings, so information on continued earnings for those under 72, as well as those 72 and over, should be available, except when fraudulent means are used not to report such earnings. That such fraudulence exists is certain, although perhaps no one knows how extensive such concealment is as present. The fact that a certain proportion of retired workers continues to have substantial earnings is suggested by Table 12.*

Table 12 indicates for 1967 the number of retired workers under age 72 whose benefits are reduced or eliminated entirely because of earnings from employment, including self-employment. In that year, from another tabulation we determine that more than 42,000 retirees lost completely their retirement benefits because of earnings. It should be noted that reduction in benefits because of post-retirement earnings is more frequent among males than among females, and more frequent among those retiring on or after age 65, thus strengthening our inference of high prevalence of ill health among those retiring before age 65, especially males. In 1967, there were 1,040,000 retired workers under age 65 and 10,979,000 retired workers in age 65 and over. Of these, over half (5,708,000) are aged 72 and over, and therefore, would not be included in Table 12.

*At present, post retirement earnings are recorded, and annually the pension amount is re-calculated in the event that the new taxable wages add to the retirees' Primary Insurance Amount.

The remaining 5,271,000 are approximately divided into 3,136,000 males and 2,135,000 females. Thus the proportion of males whose benefits were withheld in 1967 was 21 percent and for females less than 10 percent (9.6). For those under age 65 with post-retirement earnings shown, the proportion is 4 percent for males and about 2 percent for females.

At present, when we do not know all the employment characteristics of AEC contractor employees, it would be hazardous to venture any estimate of the increased potential for useful conclusions to our study by adding these differential characteristics of those eligible for retirement and those retired to the previously-selected criteria of reduced life expectancy and differential death rates. However, we can be certain that the extensions would enhance the chances for more definitive findings.

We have indicated the general magnitudes of the retired groups that might prove useful in our comparative appraisal of the health status between the "exposed" and the controls. The population under age 62 who leave the labor force might prove even larger in overall magnitude. Table 8, which we reproduced from a recent paper by Dr. Haber, is one clue to this. This table presents the number of workers withdrawing from the labor force before reaching retirement age. One fraction of these are those eligible for disability benefits since 1957 and for freezing their OASI rights since 1955. On these we have considerable data, particularly those who are found eligible for monthly cash benefits. We shall consider these when we take up the disabled group under Social Security. Numerically, however, the major portion are persons

who would not be eligible for disability benefits as presently provided-for, i.e., category (a) under the previous subsection 2.

As to those withdrawing from the labor force without formal retirement, there are two broad classes, aside from those who apply for disability benefits: (a) those who, when they attain age 62, would be eligible for retirement benefits, and (b) those not qualified for retirement benefits. To the extent that they become beneficiaries under Social Security when they attain retirement age, we have considered the first group in our discussion of the retired population. But it is probable that a significant proportion of these early dropouts have not had long enough employment to qualify for disability or retirement benefits. In addition, a certain proportion of these may die before they attain age 62 so as to be able to retire.

A crude indication of the size of this population might be in terms of the so-called disabled as given by Dr. Haber, but, as indicated before, the magnitude of these could be substantially larger than that estimated by Haber on the basis of his 1966 survey. The age-sex and race composition of this group is summarized in Table 13 by severity status, as reported by the respondent or some member of his family. The table indicates that the prevalence of disability rises sharply with age and is higher among the non-whites than whites, especially among non-white females. The proportion classified as severely disabled is higher for females, especially non-white females. It must be remembered that these are based on the interviewee's own assessment of her or his condition.

Aside from the questionable objectivity and completeness of this classification of the handicapped on the basis of household interviews, of necessity limited to the non-institutional civilian population, we have no information except for the time of interview (Table 13), how many of these so-called disabled have worked in the past and with what regularity. Nor do we have any indication of the extent to which such employment has been in jobs subject to Social Security coverage. Therefore, it is probable that a large proportion of the population with lower health status may not be eligible for disability benefits partly because of the nature of their health limitation, and partly because of their failure to meet the qualifying conditions in terms of covered employment for disability or for retirement benefits, as the case might be.

Another clue that this group is relatively large--probably much larger than those who report themselves disabled--is the rate at which employees with covered wages drop out of covered employment. Unfortunately, the latest statistics that we have found on this is for the period 1937 through 1960. One must extrapolate the frequencies prevailing then to what they would be for 1969. These statistics are given in Table 14.

Table 12 for the period 1937-1959 reflects all categories of withdrawal from the covered labor force. It includes withdrawals for jobs not subject to Social Security, withdrawals for disability with a formal disability claim or not, withdrawal because of death or retirement with, or without, retirement benefits. We have considered in some detail the magnitude and certain characteristics of the retired that are

of special interest to us in our inquiry. We shall do the same for the disabled who formalize their withdrawal from covered employment by filing a disability claim for benefits. These groups are a part of the separations indicated by Table 14, but they account for only a part of it. The other part, perhaps constituting more than half of the total, are persons without long enough attachment to the covered labor force to be eligible for any cash benefits. Again it may be assumed that, on the average, the health status of this group would be lower than the groups of the same age and sex continuing work in covered employment. If this presumption is valid, a higher proportion of those who drop out from covered employment should be found among the "exposed" as compared with controls, if there are any lasting adverse health effects from low-level ionizing radiation.

The table shows at all ages and for both sexes that a significant fraction of those no longer in covered employment are uninsured for retirement benefits and many are uninsured for disability benefits. The uninsured males who dropped out between 1938-1959 number almost 70,000 or 29 percent of those dropping out for any reason whatsoever. This proportion would rise to about a third if we included the deceased not entitled to retirement and disability benefits, and those with current insurance status only, which except for those very close to retirement age near 1936 or 1950 would lose eligibility to retirement benefits after a year and a half. Except for the transitional groups just mentioned, currently insured status is a requisite only for death benefits.

For females, as would be expected, those uninsured when separating from covered employment are substantially larger, over 133,000 or about 48 percent of all those dropping out from covered employment between 1938 and 1959. In considering the data in Table 12, one should observe that the numbers represent only a 1 percent sample. Therefore, the cumulative total especially at this time is bound to be very large, and the proportion without qualifying coverage for retirement and disability benefits might be almost as large as for the period 1938-1959. We are led to infer, therefore, that numerically this group could be considerably larger than the 18 million reporting themselves with disabilities in ages 18-64, or even that group who are retired on account of age, the 21 million or more allowed retirement benefits between 1943-1968, inclusive.

The third special category of interest to us are those who file a disability claim. Recognition of disability under Social Security was enacted into law for the first time in 1954. The initial law becoming operative in 1955 merely provided for freezing the worker's retirement status so that he would not have his benefits reduced or lost because of failure to continue in covered employment. Therefore, between 1955 and 1956 no provision was made for payment of any cash benefits. Beginning with 1957, monthly cash benefits were paid to those age 50 and over who met all the criteria to receive such monthly benefits. For those under age 50 who met these other criteria, their OASI rights were frozen, and if their disability continued until they attained age 50, they were then eligible for cash disability benefits.

By October, 1960, this age limitation for cash benefits was removed. Furthermore, initially the disability program provided monthly benefits to disabled workers only, ignoring dependents. Subsequent legislation has extended benefits to the dependent spouse, children under 18, and more recently children in ages 18 to 22, if attending school, thus paralleling the benefits for dependents of workers retired on account of age. There have been other amendments which have in general liberalized the benefits and moderated the criteria for eligibility for benefits. These changes are reflected in the rising number of allowed claims for disability benefits as may be seen from Table 15. There are also disability benefits for children disabled prior to age 18, but these do not concern us in this study.

Currently disability is defined as:

"(A) unable to engage in any substantial gainful activity by reason of any medically determinable physical or mental impairment which can be expected to result in death or has lasted or can be expected to last for a continuous period of not less than 12 months, or (B) blindness; and the term "blindness" means central visual acuity of 20/200 or less in the better eye with the use of correcting lens."*

The disability benefit payment begins with the 7th month of disability once the adjudication is completed. The burden of proof rests with the applicant. Initial determination of the existence of disability is made on the basis of evidence presented to each state agency designated to make such determination. These agencies present their findings and

*Compilation of the Social Security Laws, Vol. 1, pp. 117 (Includes all amendments through January 1968). The 12 month limitation in Part (a) of the definition is new, previously the intent was disability of more or less permanent nature.

recommendation to the Bureau of Disability, which if it concurs in the validity of the claim, authorizes the payment of benefits. The federal adjudicators can annul state recommendations for benefits, but they are barred from reversing state disallowances of benefits.

In January, 1969, the number of disabled workers receiving disability benefits was 1.3 million, a small fraction of the 18 million disability cases in the non-institutional population in ages 18-64, inclusive, estimated by Dr. Haber on the basis of his 1966 survey. Of course, the 1.3 million also includes some institutionalized cases excluded from the 18 million estimate. Since 1955, the allowed claims for disability under the Social Security Program approached 3 million. This is shown in Table 15.

Table 15 gives for each year, 1955-1968 inclusive, the number of disability claimants whose claim was allowed, the number denied, and the number of all claimants allowed or denied. In combination they aggregate close to 5 1/2 million, starting with 95,531 in 1955 and rising to 653,246 in 1968. The allowances start from 57,221 in 1955 and rise to 299,061 in 1968. Of the total applicants about 55 percent (54.6) are allowed and the balance denied. The percentage allowed ranges from a low of about 46 percent in 1968 to a high of 66 percent in 1962. There is no clear-cut continuing trend in the proportion of claims allowed.

Even though the total number of allowed disability benefits approaches 3 million, the number of beneficiaries in receipt of monthly benefits at the end of 1968 was about 1.3 million. This reflects the high termination rates for this group of beneficiaries. Normally, there are three paths of

termination from an allowed disability claim: these three are (1) death, (2) rehabilitation, and (3) attainment of age 65 when the beneficiary is transferred to the benefit role of the aged. These are shown in Table 16.

Table 16 is a composite of columns (3), (4), (8), and (9), which are taken from a recent actuarial publication⁽²⁰⁾ while columns (5) and (6) were supplied by the Bureau of Disability Benefits, Social Security Administration, and the remaining columns were derived.

Table 16, column (2), shows a progressive increase in the number of terminations in each year, from 52,949 in 1958 to 208,899 in 1967. This increase in a large measure reflects the sharp increase in the number of disabled workers applying for disability benefits. The actual termination rate, however, shows a progressive decline except in 1967. The rates declining from 0.2868 in 1958 to 0.1600 in 1966 and rising to 0.1804 in 1967. The number of terminations by death also show a progressive rise, although the year-to-year increase varies mildly; however, death rates show a progressive decline from 0.1522 in 1958 to 0.0795 in 1968. Deaths are the most important cause of termination; they account for about one-half of all terminations, and more than one-half in the early years. Recoveries through rehabilitation show a very steep rise in numbers, especially after 1961 when the age limitation for cash benefits was removed. The number rehabilitated in 1958 was 1,397 and in 1967, 37,151. The recovery rate also shows a sharp increase after some irregularities prior to 1962. Throughout the period, recoveries account for about 10 percent of all terminations, but in

1967 they represent almost 18 percent of all terminations.

Next to death, the most important cause of termination is the attainment of age 65. Over the entire period this cause accounted for almost 39 percent of all the terminations. In 1967, deaths represented 44 percent, recoveries 18 percent, attainment of age 65, 37 percent of all terminations. Table 16 is limited to those disability claimants who desire cash benefits; prior to October, 1960, cash benefits were paid only to those age 50 and over, and those under age 50 had merely their old age and survivors rights frozen. In October, 1960, this limitation was removed. This change sharply increased the number of beneficiaries in receipt of cash benefits and changed their age composition. This change increased sharply the number of deaths reported. Although the death rate continued to decline, recoveries increased sharply and damped the influence of terminations by attainment of age 65. A second influence that affects the pattern and magnitude of terminations operating throughout the period is the changing mix of beneficiaries according to the years since they came on the disability rolls. As we shall see, the death rate for the disabled is highest in the year of onset and it declines progressively if the disabled survives. This decline presumably would continue until the death rate of the disabled approaches the death rate of the non-disabled of the same sex and age where it would begin to rise again with advancing age, in the same way as for the non-disabled.

In all probability a third factor is (a) increasing relaxation in the criteria of claims rejection, and (b) more

attractive benefits--both of which increase the new beneficiaries and reduce the severity levels for the new entrants. This trend has been operative and chances are it will continue to remain operative. This shift contributes to the progressive decline in death rate and increase in recovery rate. Thus, while in the initial years deaths accounted for more than 50 percent of all terminations, and for the entire period 1958-1967 they accounted for over one-half (50.6) of all terminations, in 1967 they were 44 percent of all terminations and this decline is apt to continue for many years.

Aside from the comparative disability rate between the "exposed" and the controls, the study of disability claimants, whether the claim is approved or denied, will also have one or more diagnoses of disease or handicapping condition. The diagnoses for disabled is perhaps more accurate than that found on the death certificate for the deceased. The differential diagnoses of the "exposed" should reflect any unique contribution made to their disability by their exposure to radiation.

The increased disability claim rate referred to above is born out by a comparison of claim rates for 1957 with 1963. If such rates were available for later years, in all probability the disparity would be still greater. The claim rates for successful claimants by the year of incidence of disability for the years 1957 and 1963, the only period for which such rates have been derived, are given in Table 17.

Table 17 shows a higher differential for women's rates in 1957 and 1963 than for men. This is a common characteristic of disability compensation that would become progressively more marked as women learn to take advantage of this benefit program.

Since our study begins with 1943 and disability benefits became available in 1955 (freeze benefits), there is, in a sense, some loss of data, but this is only partial. Even though first awards occurred in 1955 many of those who were awarded their benefits in 1955 had the onset of disability in prior years. This is indicated by Table 18.

Of course, the more severely disabled would be included among those dropping out of covered employment even if there were no disability compensation program.

The pattern of deaths among the disabled in relation to time from the date of onset of disability is given in Table 19.

The death rate in the year of onset is for a fraction of a year for those who survive the 7 (payment is made for the 7th month) months disability waiting period following the onset. If adjusted to include exposure time after the 7 month waiting period, the rate for the year of onset would be much higher than the rates shown for "1 year after" onset. Similarly, the rates for "5 year and after" are distorted; were they to represent age specific rates for the 5th year, they would be lower. Even so, the rates for the disabled remain much higher than the rates for non-disabled lives of comparable age from the general population, which has a death rate somewhat higher than the population eligible for SSA benefits, as

demonstrated in Table 19.

Table 19 shows consistently lower death rates for females in comparison to males. As we have said, the inclusion of the disabled would enlarge our population for which any critical differences might be found between the "exposed" and the controls. Some idea of the relative magnitude of the disabled population and the number deceased is reflected in Table 20. Death rates used in Table 20 are for the general population, which includes a significant proportion of individuals in working ages who are not in the labor force. Were life table rates available for covered workers, their death rate would be somewhat lower than those used in Table 20.

Table 21 shows the comparative rates for death and incidence of disability, the latter based on 1963 experience as shown in Table 17. Were more recent disability rates available, they would be higher compared to death rates in 1963 used in Table 21.

Table 21 shows that for males the general death rate is 2 to 3 times higher than the rate for becoming disabled (and thus for becoming eligible for disability benefits). The rates for becoming disabled divided by death rates for corresponding ages range from a high of 3.6 for those under age 25 to a low of 1.9 for those age 55-59. For females, the ratio is less than 2 fold except for those under age 25, ranging from 3.6 for those under age 25 to 1.3 for those age 50-54. As we have said, had death rates been restricted to SSA qualified population they would have been somewhat lower; and had the disability rates been based on current experience, they would have been somewhat higher. Therefore, one

might estimate that for males the excess death rates would be between 2 to 2.5 times, and for females about 1.5 times, the corresponding disability rates.

The lower mortality of covered workers as compared to the general population for those age 62 and over for whom such rates have been developed is demonstrated by Table 20.

With respect to the comparisons of death rates shown in Table 20, it should be observed that the retired in age 62, who despite having on the average a poorer health status as compared to those eligible for old age benefits who continue working, nevertheless have a 10 percent advantage over all those age 62 and over in the general population. Had we been able to obtain the death rate for all those eligible for retirement this percentage in all probability would have been appreciably larger than 10 percent.

The reader should not be misled by these low percentages. In the age group 62 and over, the retired males represent the bulk of the male population of age 62 and over. Were it possible to separate the population into: (1) those either working or having worked sufficiently to be eligible for disability or retirement benefits under OASDI; and (2) those not working and not eligible for benefits or equivalent rights under some other retirement program such as Civil Service retirement; then the disparity in the death rates for these two groups would in all probability approach or even exceed 30 to 40 percent. In many comparative studies of death rates for workers with death rates of the general population, this distinction is overlooked. This is perhaps the most important basic reason why actuarial tables developed for

annuitants who are gainful workers show much lower mortality rates than the mortality rates obtained from the United States life tables based on the population in general. When we have data to develop life tables for the working population exclusively (those in the general population who worked in ages 20-65) we shall find that such life tables would come close to approximating life tables for annuitants that have been developed by insurance carriers.

This is supported by Table 22 which compares the life expectancy based on Group Annuity Experience, 1951, and that for the general U.S. population based on 1959-1961 U.S. life tables. These annuitants are employees of large corporations (predominantly) with employer-financed retirement programs. Almost all of AEC contractors have private retirement programs for their employees. Therefore, the life expectancy of these employees would be considerably greater than that for general U.S. population.

For females, the excess of mortality in the general population compared to the SSA population approaches 30 percent. The women in the labor force in the more advanced ages is proportionately much less so the separating out of the SSA population here would not raise the differential mortality in our study as much as for males. Yet, a 50 to 60 percent differential would seem highly probable for females as well. Working females, in older ages especially, are probably a more highly selected group as far as health is concerned than working males.

Having decided to use, as criteria for biological injury from low-level radiation of occupational origin, both disability and deaths, we must anticipate a considerable overlap of these two criteria. That is, in following the disabled among the "exposed" and the controls we would frequently find a given individual perhaps at one time as a drop-out from covered employment, later as disability beneficiary or early retiree, and again as a death case. So in some sense the inclusion of the three other groups is not all a net gain in the statistical power of the study; there is some overlap between the "morbidity" and "mortality" populations.

In spite of this overlap, there is a substantial net increase, represented in the OASDI population by the 1.3 million current beneficiaries under disability, and numerically a much larger group among those retiring early with or without pension, and those continuing to earn after retirement, who are still living. The numbers in the "drop-outs" who are still alive would be much larger than in the preceeding two categories. But the net increase in the numbers of non-duplicated individuals studied is only one aspect of the gain we expect from the extension of our objective measures of "injury to health" of the "exposed". An even greater gain is the gain in the accelerated time when such differentials might come under our observation. If death were the only criterion 10 or 15 years might be presumed elapsed in some cases between the injured health from radiation and the eventual premature death that would bring the injury to our attention in a study of mortality alone.

By following the "dropouts", the "disabled" and the early retirees we in a sense may reduce the so-called periods of latency, and we are enabled to see events "before their time". Moreover, by observing cases "ahead of time", and being able to add to our pathological findings of contributing causes of death the pathological findings from disability, we are increasing the discriminant sensitivity of our criteria in determining any differentials between the "exposed" and the controls. We may also better determine the possible underlying causes of any differences that are observed, whether these are attributable to exposure to low-level ionizing radiation and/or other agents or causes. The extensions indicated, therefore, should greatly enhance our chances of observing any significant biological injury from occupational exposure to low-level ionizing radiation, or on the other hand the absence of any significant effects, than would be possible if the study was restricted to death rates and the differential causes of death only.

There has been a gross failure among most health workers to appreciate fully that continuous employment even in the so-called productive years of life is a highly discriminating index of health, and in all probability even more so in ages considered within the period of retirement. These assertions supported by Table 22 are corroborated and strengthened by Tables 23 and 24 as well, taken from a paper published by the Actuary of the Social Security Administration.⁽²¹⁾

Table 23 compares the death rates per thousand in 1955 for males in specified age groups 15 and over for (a) those with sufficient employment covered under social security to have insured status, for whom some covered earning was reported

in 1955; with (b) those with insured status, though showing no covered earnings in 1955, separately and in combination with the death rates of the general population in corresponding ages in 1955. The contrasts at different ages when studied carefully bear out our assertions about employment as an index of health--especially recent employment.

The averages, for ages 15 and over, are 12.0 per thousand (for the general population death rate) and 10.8 for males with sufficient duration of covered earnings to be insured under the Social Security Program (i.e., combining (a) and (b)). The reader must appreciate that a very large fraction of the total male population consists of the population with insured status in categories (a) and (b). Had it been possible to separate the (a) and (b) groups from the general population, the average death rates for the remaining population, without insured status, could be 15 or 16 per thousand. But, of course, the exclusion of those with insured status from the male population does not eliminate those employed in non-covered employment. Had it been possible to exclude from the remainder of the "general population" all those with appreciable work history, comparable to the extent of covered employment to have qualified as "insured", the contrast between this residual group and the "insured" instead of being 12.0 to 10.8 would probably approach something like a rate of 22 per thousand or even higher (i.e., about double the rate for the insured).

Table 23 also provides a comparison of death rates of male insured workers who had some earnings from covered employment in 1955 with those insured workers who did not have any such earnings in 1955. The death rates are materially higher in

the latter group at every age except those in ages 15-19. For all ages 15 and over, the death rate is 7.1 per thousand for those with covered earnings in 1955, and 18.2 for those insured but with no covered earnings in 1955. In this comparison, unlike in the comparison of the death rate of insured workers with that for the general population, the two groups have been separated. Thus, while the combined death rate for all those with insured status was 10.8 per thousand, the rate for those with covered earnings in 1955 is only 7.1, while for those without 1955 covered earnings it is 18.2 per thousand. Again, the reader should be reminded that a certain unknown fraction of the men among those without 1955 covered earnings were active workers with earnings in 1955 from non-covered jobs or even covered jobs where, for one reason or another, earnings were not reported to the government. Had it been possible to remove these active workers, the contrast for the remaining insured workers would have become even greater, perhaps as large as 7.1 to 25.0.

Thus, attachment to the employed labor force per se is apparently a highly discriminating health index. Our study would demonstrate most strikingly and forcefully for the first time the continuity of this index in disability and early withdrawal from gainful employment. This index is, of course, most sensitive in terms of recent attachment to the employed labor force and probably more so for those approaching the retirement years. In Table 23, the contrast between the insured with covered earnings in 1955, and those without, increases progressively with age. Thus, the highest contrast in relative death rate between those with 1955 covered earnings,

and those without, is for persons in ages 60-64. The death rate for this age group is 15.0 for those with 1955 earnings and 52.9 for those without, a 1 to 3.53 ratio. Even for those in ages 75 and over, the death rate for those with 1955 covered earnings is 50.3, in contrast to 116.3 for those insured but with no covered earnings. The 50.3 rate, even though it is for all those above age 75, is actually lower than the death rate for male group-insured annuitants whose death rate for those in ages 75-79 was found to be 75.1 (Table 22). The contrast would have been still greater had the death rate for annuitants been for all males age 75 and over, as was the case for the death rate for men with covered earnings in 1955. Because of this difference, one must not compare the death rate of insured workers with no earnings in 1955 with that of group annuitants.

To be sure the age contrast for those with insured status in ages 75 and over, as compared with those in ages 75-79, is moderated by the fact that very few persons in extreme old age in 1955 could have had insured status. One must remember that the Social Security taxes were levied for the first time in 1/1/37, and the minimum requirement for gaining insured status has been that they must have had some employment in each of 6 quarters. Therefore, the aged who could have had insured status in 1955 was restricted to those who were still employed in covered employment until at least about the middle of 1938.

Table 24 provides the same sort of comparisons in death rates by age for females. The contrast between those females

with insured status and the general population of females (including the insured) is markedly greater in favor of the insured than was the case for males. For all ages 15 and over, the death rate is 5.0 for the general population, and 3.4 for those with insured status. This sharper contrast compared to males in part is attributable to the fact that the proportion of all women aged 15 and over who had insured status was considerably smaller for women than for men, and this reduced overlap accounts in part for this sharper contrast. But besides this, at least in older ages, health is a greater discriminant element with respect to continuing employment of women than of men. This is borne out by the fact that, while in younger ages the comparative death rate between women with insured status who had covered earnings in 1955 and those who did not is lower than that for the males in these two groups, in ages 20 to 44, in older ages the converse is the case for most age groups. Some of these differences to be sure reflect historical changes which have brought about the entry of women in larger and larger numbers in the labor force from all economic levels, especially married women.

Comparing the death rate of women in ages 75 and over with the death rate of women annuitants in ages 75-79 (Table 22) shows that even the entire group of the insured has a death rate that, had it been limited to ages 75-79, in all probability would have been at least as low as 55.1 for female annuitants--actually it is 59.5 for all females with SSA insured status in ages 75 and over. For females with covered earnings in 1955, the death rate in ages 75 and over is much lower than that for female annuitants, 22.2 versus 55.1,

respectively; a 1:2.5 contrast, in spite of the fact that for the annuitants the rate is confined to those in ages 75-79, while women with covered earnings contain some members past age 79, though admittedly not very many.

That continuous employment is a reliable touchstone of good health, especailly in older ages, and probably more discriminating for women than men, is suggested by the summary figures abstracted from Tables 22, 23 and 24 comparing death rates per thousand for men and women in age 70 to 74.

POPULATION GROUP	Death Rates per 1,000			
	MALES (70-74)		FEMALES (70-74)	
	No.	%	No.	%
The entire U.S. Population (1959-61)	56.7	176.6	35.5	331.8
Whites	56.2	175.1	34.6	323.4
Non-whites	61.8	192.5	46.5	434.6
GA-1951 (Annuitants)	47.5	148.0	30.5	285.0
1955 General Population	58.7	182.9	37.9	354.2
Those with SSA insured status	54.2	168.8	26.3	245.8
Covered earning in 1955	32.1	100.0	10.7	100.0
No covered earning in 1955	67.5	210.3	33.2	310.3

The comparison above shows consistently that the contrast in death rate for women in ages 70-74 is substantially more marked in favor of women with recent attachment to the employed labor force in comparison with other women, than the contrast between comparable groups for men.

IV. OUTLINE OF PROCEDURES FOR FY1970

During the next project year some work will be done on each of the phases of work in Figure 1 that have not yet been completed, except for the final evaluation and reporting of project findings. This phase can begin only when all data are available for each cohort included in the study. We expect that by about the end of FY1972, evaluation of project results can begin for at least the Hanford and Oak Ridge facilities, for cohorts from the beginning of operations up to and including the year 1968 or 1969.

The project plans for the next year include the following activities:

- (1) Additional trial runs with the completed radiation exposure and personnel data file at Hanford and Oak Ridge to assist in designing methods of analysis of project results, and in organizing a system for computer analysis of project data;
- (2) Begin requesting and processing death certificate data from States and Veterans Administration (for veterans), using lists prepared by computer at Oak Ridge;
- (3) Completion by the end of FY1970 of the abstracting and taping of remaining personal data and sib data at Oak Ridge on Tennessee-Eastman and some of the other early contractors;

- (4) Submission of sibling data from Oak Ridge (this has been done by Hanford) to the Social Security Administration for identification and assignment of social security numbers;
- (5) Further quality control checks of various types to determine the completeness of rosters of monitored employees and all other employees of operating contractors;
- (6) Searching of special sources of information of various types, including the roster of Manhattan Engineer District employees of operating contractors on computer tape at Oak Ridge, in order to fill in social security numbers or other identification data found to be missing on portions of the population included in the Study;
- (7) Actively pursuing the matter of purging the 1 percent Continuous Work History Sample of the Social Security Administration, as completely as possible, of employees who have ever worked in any AEC or MED installation;
- (8) Completion of arrangements with the Social Security Administration (SSA) to match the employees in Hanford, as well as the eligible but "never worked" control populations, each with 2 controls from the SSA Continuous Work History Sample of 1 percent of all covered workers;

- (9) Process additional members of the study group, siblings, and other controls through Social Security, to determine those who are deceased and the place and approximate date of their deaths;
- (10) Obtain copies of death certificates from all states and the Veterans Administration and begin to code specific causes of death for deceased former employees and controls;
- (11) Follow-up the collection of continuing personnel and exposure data in Hanford, Oak Ridge, and National Lead to maintain an updated file;
- (12) Transfer to computer tape the data from early facilities and feed mills such as Mallinckrodt Chemical Company, National Lead Company of Ohio, SAM Laboratories, and others;
- (13) Continue studies of health physics and industrial hygiene files, such as survey logs, air sampling records, and bioassay results, that have been found useful in providing work history and exposure-potential information not available from other sources, both at Hanford and Oak Ridge. These data are needed to provide better grouping of employees according to possible exposure to occupational stresses or agents other than radiation;

- (14) Merge the files for each plant and for Hanford and Oak Ridge, for more efficient data processing and analysis, while still keeping each plant identifiable for analysis as an individual entity;
- (15) Evaluate the data on the pilot study at Hanford of the medical radiation exposure of about 2,300 employees, compare medical and occupational radiation exposure distributions, and compare the general implications of these findings with those for the nation proposed by the United States Public Health Service;^(22,23)
- (16) Examine the exposure frequency distributions and the nature of the exposed and control populations to begin formulating the specific statistical tests and procedures for evaluation of project findings;
- (17) Explore possibilities for including in the Study the contractor maintenance workers (CPFF) at Hanford and Oak Ridge who have been exposed to radiation and other toxic agents;
- (18) Continue the development of statistical methods of evaluating project findings;
- (19) Developing appropriate procedures with the Social Security Administration for the identification and measurement of criteria associated with the various forms of withdrawals from the labor force attributable to health among those exposed to radiation and other possible industrial hazards, and among the controls;

(20) Complete and develop additional quality checks for testing the reliability and completeness of personal and exposure data of employees compiled at Hanford, Oak Ridge, and from other contractors and check on the completeness of the rosters through cross matching of employee rosters for selected quarters with quarterly tax reports filed by employers with the Social Security Administration (Form 941A);

(21) Re-explore with AEC the advisability and budgeting of certain supplementary studies which were deferred in the past:

(a) A comparative mortality study of chemists and physicists known to have worked in radiation at the time when basic work in developing the atom bomb was developed. Rosters of these workers could be compiled from "A History of the United States Atomic Energy Commission" and from the personnel files of the various universities where this work was carried on. The life expectancy of these Atomic Scientists can be compared with that of their peers from the same universities who were not engaged in work with similar radiation hazards. The study would be analogous to that carried out by Drs. Seltser and Sartwell of Johns Hopkins. (24)

Some of the deaths of these early scientists may not be found through the present Social Security follow-up since professionals in universities

were not included under the Social Security System until in 1950. The information on survival would be obtained from professional directories, from American Men of Science and from other standard sources other than from the Social Security Administration on which we are relying heavily for the follow-up of AEC contractor employees;

- (b) The follow-up of a national roster of all AEC and AEC contractor employees with an aggregate life time occupational exposure to ionizing radiation amounting to 5 Rems or more. For this national sample to be followed through various channels to trace all deaths, as controls we may use the 1 percent AEC and AEC contractor employees who are in the Social Security 1 percent Continuous Work History Sample maintained by the Social Security Administration since the inception of the Social Security Program, back in 1937. The 1 percent sample is needed to purge the national sample before matching with Hanford, Oak Ridge and other employees;
- (c) A comparative analysis of Workmen's Compensation experience of AEC employees and employees of AEC contractors with the experience of other large employers in similar industries

as the AEC contractors with the exception of the low-level radiation hazard.

- (22) Evaluation of the extent of off-site radiation, its completeness and efficacy of its recording and its contribution to the individual's total radiation exposure, select from Hanford Roster all employees transferred, from Oak Ridge, Armed Services, or other employers, who could have been exposed to ionizing radiation prior to their transfer to Hanford. Ascertain the cumulative amount of radiation exposure to determine the completeness of this off-site radiation compiled by Hanford. The same should be done with Oak Ridge and other contractor employees to determine the completeness of prior exposure to radiation for transferred employees.

V. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are based on those made previously⁽¹⁻⁷⁾ and are still considered valid:

- (1) The extension of the present pilot study to a broader base to encompass a larger population exposed to ionizing radiation by the inclusion of other AEC contractor facilities will be required to further test and augment the observations that will be derived from the pilot study of Hanford and Oak Ridge, and also to detect differences in biological effects which may be peculiar to certain installations because of the uniqueness of their operations. Also, more person-roentgen-years are needed to investigate the long-term, rare effects which also have long latent periods, as presented in previous reports.⁽¹⁻⁷⁾ It is recommended that the project be expanded to include all AEC contractor facilities. However, if the immediate expansion is to be confined to a few facilities, then the priorities of selection should be: 1) Los Alamos, the earliest and most complex, provides the largest time interval (allowing the appearance of effects having the longest latent periods), and the earliest interest and scientific efforts relative to plutonium; 2) Rocky Flats, (Dow Chemical), which although comparatively recent, has the largest population that may have been exposed to plutonium; 3) The Mound Laboratories (Monsanto), also one of the earlier facilities with plutonium operations;

- (2) The costs associated with updating the annual records of exposure to both toxic and radiotoxic agents should be considered as a normal operating expense, and should be budgeted-for accordingly. Such records are a normal requirement of the AEC Manual Chapters and are utilized for the normal conduct of business, i.e., compensation claims, civil actions, administrative control reports, etc. Since the study has produced a format and computer program that readily permit the extraction of exposure data, and that can be utilized to maintain life-time exposure histories, consideration should be given to standardizing record-keeping techniques throughout the AEC using the study data base as a model; and requiring their upkeep as a routine operating expense. Since some kind of record keeping is being maintained at each location at the present time due to AEC requirements, one could satisfy the study program data base requirements and markedly improve the general, non-uniform, methods now being followed at a cost savings while at the same time extending the study area without requiring special funding or budget;
- (3) We again reinforce our conclusions concerning the need for retention of all records that might produce personnel and exposure data pertinent to this study. The original purpose of retention of all health physics records was to permit evaluation of accumulated exposure to assure proper control as well as to determine any associations of biological effects with

radiation. The maintenance of records assumes one would be able to reconstruct the life-time exposure history reasonably well with a minimum of effort. In fact, the regulations require an employer to furnish such radiation histories for an employee within a reasonable time. The retention of all such records would serve the various purposes presented above;

- (4) The project should include a study of all other environmental agents of exposure, as well as both internal and external radiation. The study should also ultimately include enough different atomic energy installations to identify different types and degrees of exposure from the various sources so that synergistic effects of the various types of environmental agents may be studied independently and in combination. It is very difficult in any retrospective study of any one facility to be sure that we have identified all of the exposures of the given individuals. Nevertheless, a concerted effort in this regard is mandatory;
- (5) Evidence has been obtained that the extension of our project to other AEC installations will enable us to better fill the gaps in the records of some radiation workers who have transferred to other installations not at present included in our study. If complete work histories of all employees are not included for each cohort, then this adds some additional uncontrolled variation in our final data analysis. Also,

in some cases, an employee who is not properly identified may appear twice in the study in two different atomic energy installations and this would influence to a certain extent the final evaluation of project results. Complete records would allow the easy identification and follow-up of an employee throughout the entire period of the atomic energy program, as well as for prior employment histories identifiable from Social Security records. We have also found in many instances that employees knowledgeable in the history of operations and environmental exposures will soon be reaching retirement age and may not be available much longer; consequently, immediate steps should be taken relative to inclusion of other facilities, to obtain the necessary information as soon as possible;

- (6) Our experiences this past year continue to emphasize our previous recommendation to establish an AEC Health Evaluation Center. This center should be developed now to participate in the collection and analysis of project data so that there can be better coordination between project activities at the various AEC sites, and a smoother transition into a continuing study and a permanently established agency that can review the increasing amount of data periodically and follow employees through to the end of their spans. The data collected in the study so far at each site are available in a form that can be analyzed not only

within each facility, but also can be programmed into a uniform format for an over-all evaluation of project results. The data to be stored in the Health Evaluation Center should be maintained with the maximum flexibility of retrieval and analysis available from various developments in systems technology. Data storage should include descriptions of various process activities to provide information on environmental agents in addition to radiation;

- (7) The conversion of all personnel and radiation data as a result of this research project to an electronic data processing system at Hanford and Oak Ridge has established the means for instantaneous retrieval of the complete work history and radiation exposure, at any point in time, or for the cumulative exposure of any employee or group of employees. We have been informed that even at this early stage the savings in cost and the contribution of benefits to management, relative to the reconstruction of data for compensation claims and other uses, have been substantial and perhaps sufficient to offset the costs of this research project. It is evident that the reconstruction of the data in the form required by this project, and the continuation of this system, will pay for itself in management-by-products alone, if it has not already done so. In addition, the continuation of this project would tend to avoid the inadvertent destruction of records

needed for tracing exposure histories, which we have found difficult to trace in many cases in the past;

- (8) In the current study, controls are selected on the presumption that they are employed individuals who in the course of their employment have been free from the possibility of having been exposed to low-level occupational radiation exposure. To validate this presumption, it is necessary to purge from the 1 percent continuous work history sample all employees who have ever worked in an AEC installation. Otherwise, in some instances we would be matching as a control with an AEC contractor employee, who has been working in Oak Ridge or Hanford, one who worked in Los Alamos, or Rocky Flats or some other AEC installation. Then, our presumption would not hold, of course. In fact, instances could occur in which the control could have a higher occupational dose from ionizing radiation than the potentially-exposed individual who worked at Oak Ridge or Hanford. In this connection we recommend that further consideration be given to determine the feasibility of identifying AEC contractor employees from all AEC installations, i.e., installations other than Oak Ridge and Hanford that are in the 1 percent continuous work history sample maintained by the Social Security Administration, so that the 1 percent sample could be purged prior to matching for controls. Of

course, if the study were to include all the AEC installations, as we recommended, then such purging would present no problem. In addition, as a further check, the availability of this purged portion of the 1 percent sample, which represents employees of all or most all AEC contractors, would in turn give us an additional study sample of "exposed" populations for whom we have much more detailed information from Social Security, for better matched controls;

- (9) There has been some fear on the part of some experts on radiation effects in man that even if we were to include all AEC contractor employees the population (person-rem-year) still may not be large enough to measure the life-shortening effect resulting from occupational exposure to low level ionizing radiation. As discussed in our previous reports, if the study is to be carried on through at least the 1980's, as we have recommended, then a sufficient number of person-roentgen-years will ultimately accumulate to allow useful conclusions. Still another way to enhance the sensitivity of the present study is to extend the concept of reducing longevity to that of reducing productive life, both through premature death and through premature withdrawal from the labor market. It is believed this could multiply the discriminating power of the current study by a

factor of perhaps four, and give more definitive findings than we would otherwise have if the study were in terms of longevity alone. As indicated in Section III D, steps have been taken at this time to enlarge the criterion from death alone to withdrawal from gainful work by AEC contractor employees, as compared with their appropriate controls. Rates and causes of disability in this connection are also being explored as an additional possible index of biological effects;

- (10) Future budgeting should include retrieval and extraction of records data for CPFF maintenance contracts as well as other operating contractors.

APPENDIX A

The AEC Health and Mortality Study

The Beginning: As indicated in the Forward of this report⁽¹⁰⁾ the Divisions of Operational Safety and Biology and Medicine of the United States Atomic Energy Commission (AEC) for many years had felt the urgent need for an extensive empirical study designed to ascertain any lasting biologically adverse effects from exposure to ionizing radiation by AEC employees and employees of AEC contractors incident to their working in various AEC installations. In 1964 the AEC approached the Graduate School of Public Health, University of Pittsburgh, with the offer of a contract for the School to undertake such an empirical study for the Commission. The University, after some nine months or so of exploratory inquiries to check on the availability of a minimum of employee records and related data, agreed to accept the contract and undertook the study.⁽¹⁾

The Scope and Nature of the Study: The AEC staff had formulated neither the scope nor the precise nature of the study. Such a formulation was left to the study team. Almost from the very first the University staff assigned to the study felt the scope should be the inclusion of all the production employees of AEC contractors, considering each installation, i.e., each organized plant, as a distinct experiment to be studied separately, though the ultimate outcome would be based on a pooling and integration of the findings from all the different installations. Similarly, the staff believes that the study should include all the operating employees of

each plant from the date that inplant operations began and continue the follow-up of the employees into the future indefinitely as long as a more precise determination of a possible biological harm, its nature and extent, is deemed justified. The staff has decided that the initial criterion of a possible lasting harm be tested in terms of a shortening of life expectancy, and a differential in causes of death among employees exposed to occupational ionizing radiation as compared with employees not so exposed.

This has meant not relying on the industrial medical records of the different AEC plants which, in the thinking of the AEC staff, represented one important body of data to be analyzed in testing whether or not there had been harmful lasting biological effects from occupational exposure to radiation. It has been the feeling of the study staff that the routine industrial medical records have too great a variance to serve as a measure of lasting biologically harmful effects from occupational radiation. Besides, the study requires out-of-plant controls; it will not be possible to obtain medical records of comparable nature for these controls. It was, therefore, decided to place the major emphasis on relative life expectancy and on differential causes of death between those exposed occupationally to ionizing radiation and their appropriate controls not so exposed, taking into consideration, to be sure, the intensity of the exposure, the cumulative total exposure, and the passage of time since the exposure occurred.

In those installations in which we have worked, where there are available medical records, we use these with respect to bioassay data on occupational exposure to various toxic substances including internal emitters. Eventually, medical records might be used in the light of feedback information from specific findings from the comparative analysis of differential causes of death and perhaps disability, looking for early prognostic clues if certain causes appear to be associated with exposure to ionizing radiation more often than expected.

Moreover, as the Hanford Study, the basic data for which are described in the body of this report,⁽¹⁰⁾ has demonstrated so well, there could be plants in which occupational and other personal information deemed necessary for the study can be partially derived from medical records if, as in Hanford, all employees are required to have at least one medical examination each year. In Hanford, information culled from medical records has in many instances supplemented that derived from personnel folders with respect to occupational pursuits, organizational affiliation and place of work--all of which might prove significant in reconstructing the occupational hazards to which the employee may have been exposed. The study group is, therefore, interested and would like to see all available medical records be put on magnetic tape for permanent preservation of the records for varying uses that the plant might have for records, for local studies--such as studies carried out by the staff of the Hanford Environmental Health Foundation, as well as for easy access of this type of data for testing

hypotheses that are sure to arise in the course of the current inquiry regarding the lasting biological effects of low-level chronic exposure of man to ionizing radiation.

The Study was initiated with the earliest established installations in Oak Ridge, Tennessee and Hanford Works in Richland, Washington. To date it has also been extended to a number of feed mills and early laboratories, some of which began operation even before Oak Ridge, to provide uranium to Oak Ridge for its operation and to develop the underlying theory. Hopefully, funds will be found to extend the Study as soon as possible to all other AEC installations. An early decision in this respect is urgent to avert further loss and destruction of old records essential to the study. This destruction can be averted only by putting the data on magnetic tape for preservation and for periodic updating such as described in this report for Hanford.

The information abstracted for each employee is minimal since it had to be limited to a least common denominator, i.e., information that could be obtained from most installations and for the entire period of operation since the installation was first established. The scope and character of information compiled is described in this Hanford Report.⁽¹⁰⁾

The Design of the Study: The Study is a longitudinal follow-up of each employee from the date that he entered employment in an AEC installation until his death. It is important, therefore, to continue the follow-up more or less indefinitely for many years to come until the confidence limits of the findings are deemed satisfactory. To enhance the early results from the present partial inquiry the criteria for

testing biologically significant harm has been enlarged to include, in addition to life expectancy as such, the length of productive life, i.e., the age of withdrawal from active employment and reasons for the withdrawal preceding the terminal point of death.

The follow-up is made possible with the cooperation of the Social Security Administration by the use of the social security number as a link. These numbers were assigned to all industrial workers since the inception of the social security program in 1937. Each number given to a worker is unique and identifies him positively. Over the years the coverage has been extended to other groups in the working population so that today nearly 95 percent of all gainful pursuits, whether as employee or as self-employed, are included under social security and an individual in these pursuits can be followed therefore throughout his life. (The only large group at present excluded are the 2.6 million Federal Civil Service employees. But even for them, those who serve for less than 5 years many are covered by social security.)

Negotiations are going on currently between the Atomic Energy Commission and the Social Security Administration for the latter to supply follow-up information, not only with respect to the approximate date and the State of death of the individuals who are being followed up in the Study, but also information for those being followed up who have filed a claim for disability under the social security program, those who were granted disability benefits and others whose claim was denied,

causes of disability for which claims were filed, those who have retired from gainful work and are receiving old age benefits, their date of retirement and finally, those not retired who have not engaged in covered employment for the last one or more years for reasons unknown. The extension to disability and early withdrawal from the labor force should increase the chances of discerning biological injuries, if indeed there have been such injuries from low-level ionizing radiation, than would be the case if the study were to be restricted to mortality only and possible differentials in the causes of death.

Other Industrial Hazards: In order to establish possible lasting harmful biological effects from ionizing radiation it is essential to take into consideration all other potentially harmful industrial exposures by employees of AEC contractors in the course of their employment since any possible harmful effects from ionizing radiation are in no sense unique. Therefore, to avert attributing to radiation, harmful influences incident to other occupational hazards, it is important to take into consideration all other types of potentially harmful exposures and explore any possible interaction of antagonistic or synergistic nature between radiation and these other potential industrial hazards.

To isolate and fix any biologically harmful effect from radiation as such, with and without these other potential hazards, it is necessary to follow the past exposure records of all groups and subgroups with different cutoff points as to intensity and duration of their internal and external exposure to radiation in the presence and absence of these other

potential hazards in different combinations, permutations and intensities as well as duration to test possible interactions and possible differential effects on the employee. In the Hanford report information obtained with respect to internal and external radiation is described in Section IV-B, and information regarding other possible industrial toxicants to which certain Hanford employees were exposed is described in Section V-E. (10)

The essence of the entire Study is to compare the post-exposure duration of economically productive life, causes of withdrawal from productive work, life expectancy and, for the deceased, causes of death to establish any possible relationship between these terminal criteria for those with a history of exposure to ionizing radiation, internal and/or external, of varying intensities and duration with and without exposure to other specific industrial hazards with each other, with appropriate inplant and out of plant controls not known to have been exposed to any of these risks, through the control of extraneous variables such as age, sex, race, and any other known to us that appear to be associated with our terminal criteria of possible lasting harmful effects.

The Radiological Gradient: One of our concerns has been the extent to which the intensity of radiation exposure to ionizing radiation would be modified and altered if all other radiation exposures to which these same individuals had been exposed could be taken into consideration. We know no way to measure the influence that natural radiation would have on the gradient based solely on occupational exposure. We are inclined to believe the influence of this can be overlooked as

a random variable affecting equally those with varying amounts of occupational radiation and their controls without such radiation. With respect to radiation from medical diagnostic x-ray we found it feasible in Hanford to test empirically the effect of it on the occupational radiation gradient. The question we posed may be stated thus: to what extent would employees, graded or ranked solely on the basis of their occupational exposure to external radiation, alter their relative rank vis-a-vis one another if their medical diagnostic x-ray exposure was also taken into consideration? Data available at Hanford proved ideal in answering this question.

Richland was one of the communities brought to life by the Manhattan Engineer District (the U.S. Army organization responsible for the creation of the atomic bomb). Therefore, in the early years employees who worked at Hanford and their families were more or less completely separated from outside population groups. The Hanford population received all its medical services including diagnostic x-rays, from the plant's medical staff, in fact, from the Kadlec Hospital. It is believed that this closed situation continued until about the end of August 1956.

All the x-ray diagnostic films taken during these years had been preserved; there was a complete record of all of these examinations, except dental. The machine on which these x-rays had been taken was still available for the mock-up tests that were made to measure the radiation

exposure incident to each diagnostic procedure used. Some of the x-ray technicians of the Kadlec Methodist Hospital had joined the staff some years prior to 1956 and had taken many of the films used in this Study. The mock-up to measure radiation exposure for each diagnostic procedure was carried out with their help and advice to reproduce the circumstances which prevailed when these x-ray exposures occurred using the identical equipment that had been used. The comparative exposure from diagnostic medical x-ray with occupational exposure to external radiation was undertaken for the period January 1, 1946 through August 31, 1956 for employees who worked in Hanford for this entire period including those who died within the Study period. The total work force was 2,288 of whom 2,170 survived to the end of the Study period. This phase of the Study is described in Section V-D⁽¹⁰⁾, and at this time is unique for Hanford. The Study findings show little if any correlation between diagnostic x-ray exposure with occupational exposure to ionizing radiation. That is, a gradient based solely on occupational exposure to ionizing radiation is not significantly altered if the radiation from diagnostic x-ray were also taken into consideration. There is no doubt, however, that the use of occupational exposure only gives us an approximation of the total radiation to which the individuals were exposed; thus, adding another random element which can not be controlled, though we have shown that its influence does not eliminate the gradient based solely on occupational exposure to radiation.

The basic data collected for this test and the procedures used in measuring the radiation doses per plate for each procedure are described in Section V-D of the Hanford Report. (10)

The End Criteria: Earlier in passing we indicated the various criteria we are using to determine and measure any possible biologically harmful effects resulting from low-level ionizing radiation. More specifically stated, these criteria developed to date are as follows:

(a) The termination of gainful employment through disability, separating those granted disability benefits under Social Security from those that were disallowed such benefits. Negotiations are underway to obtain this information for all those included in the Study. This criterion will be used to compare out-of-plant controls with in-plant employees with respect to rates of disability claims application and rates of approved and denied claims, respectively. Again, these rates for employees with radiation exposure of varying intensities and durations with and without exposure to other industrial toxicants can be compared with one another and with in-plant controls with no known exposure to radiation and with out-of-plant controls for whom occupational radiation exposure risk is deemed to be negligible. It should be taken for granted, of course, that these comparisons would take into consideration age, sex, race and, at least, the year in which the employee first began work in an AEC installation.

(b) Causes of disability for all claimants and separately for allowed and disallowed claimants. Again, searching to determine whether there is any differential pattern among the various exposure groups and their non-exposed controls in-plant and out-of-plant, respectively.

(c) The termination of covered employment through retirement with receipt of an old age benefit or a mere dropping out from covered employment, differentiating the two. This is one measure of duration of productive life. The age when this withdrawal occurs will be determined for groups with radiation exposure history of varying intensities, durations and combinations with each other and with non-exposed groups both in-plant and those out-of-plant.

(d) Age-sex-race specific death rates for those in different exposure groups compared with one another and with in-plant and out-of-plant controls with no known exposure to radiation, and for in-plant groups with no known exposure to any other recognized industrial toxicants.

(e) Finally, a comparative analysis of causes of death, seeking for differentials between those with exposure to radiation of varying intensities and duration, with and without other potential industrial hazards among themselves and with other in-plant and out-of-plant controls with no known exposure to occupational radiation.

Controls: Throughout this discussion we have repeatedly referred to controls. In fact, controls are the crucial element in this inquiry since we have no absolute criterion as to what disability rate, what withdrawal rate or what death

rate to expect for a given subgroup. So each subgroup with specified characteristics of exposure or lack of exposure to specified industrial hazards or varying intensities of these hazards can be compared with many others with lesser or greater of these hazards, with a different combination of these hazards or combinations in a different time sequence, with those in-plant controls without these hazards, and out-of-plant controls whose hazards are not known except with respect to occupational radiation which is believed to be negligible. But aside from the literally infinite possible comparisons to test various hypotheses; a systematic design of controls is an integral part of the inquiry. To this end we have evolved the following out-of-plant controls, that is, controls by employees who have never worked in an AEC installation. It should be emphasized that all our controls are employed individuals since the follow-up for these individuals is possible only through the records of the Social Security Administration; using the social security number as the thread to follow the individuals included in the Study year after year until their death or their earlier withdrawal from covered employment for one reason or another. This limitation is believed to be a distinct advantage since gainful employment per se is a significant selective factor. All available evidence indicates a markedly lower age-sex specific death rate for the employed population as compared with the general population or those in the population who have dropped out of gainful employment. (21)

First of all we have two broad types of controls: in-plant controls and out-of-plant controls. In-plant controls are those AEC contractor employees who worked in the AEC installation, but they were never exposed to ionizing radiation in the course of their employment. There are two broad categories of these:

(a) Employees who were assigned to jobs and were so restricted in their requirements in the plant that it was deemed there was no probability that they would be exposed to any sort of ionizing radiation in their jobs. These employees were not monitored.

(b) Monitored employees whose badge readings have always indicated no measurable radiation exposure.

Then there are the out-of-plant controls: these are employees who never worked in an AEC installation. These controls are:

(a) Siblings of the same sex for each in-plant employee: the names of these were abstracted as one type of control. If the employee had more than one sibling of the same sex as the employee the information for all of them was abstracted. In the Hanford Report⁽¹⁰⁾ this is described in Section V-A, pp. 5-6. (See also IV, pp.4-5) Siblings were selected as one type of control to reduce, at least partly, genetic differences and differences in childhood environment, if any. To be sure, this type of control would be limited to only certain in-plant employees, since a significant fraction of employees have no siblings and others have no sibling of

the same sex as themselves. But actually our sample for controls of this type would be even more restricted. It would be limited to siblings for whom the Social Security Administration could find a social security account number for identification and follow-up. In order for the Social Security Administration to be able to identify the siblings for follow-up purposes, the Study provides to the Social Security Administration the name or names of the siblings involved, his year of birth, where that is available, the place of his birth, and the maiden name of the mother, if given. Information on parents and siblings is obtained in the Personnel Security Questionnaire, PSQ for short. Until recently, completing this format was essential for employment in an AEC installation. The security form used prior to 1947, when the AEC took over from the M.E.D., (Manhattan Engineer District) does not call for ages of the siblings. For a significant proportion of siblings of employees who entered on their jobs prior to 1947, age of the siblings can not be obtained. As a consequence most of these can not be identified by SSA for follow-up purposes. Another item of information is the maiden name of the mother which is often missing. For those siblings where this information is missing positive identification is more difficult, so a higher proportion of these can not be identified. Sometimes, even though an age is given, it is not the correct age; this also makes a positive identification difficult. It turns out, therefore, that only 50 percent or so of the siblings for whom a social security number is requested can be identified to be used in the Study. There is no reason to believe that this loss of siblings, whom we can

not use as controls because no social security number could be obtained for them, is in any sense biased for our use even though it is grossly incomplete. It would mean this type of control will be available for only about a third of all in-plant employees. It should be appreciated, of course, that siblings who never engaged in gainful work will not be likely to be included as controls since, by and large, such persons will not have a social security number. It is believed this exclusion is an advantage since siblings who never worked are more apt to be sickly individuals often with a shorter life expectancy and they should be excluded as proper controls.

(b) "Non-Starts": Since their inception all AEC installations (and installations set up by MED) have required a pre-employment health examination. Persons failing to meet certain minimum health standards could be disqualified. The disqualification criteria, no doubt, varied considerably from plant to plant and must have varied markedly over the years and with each change of medical personnel. What selective role this exclusion has played it is difficult to surmise but it might have had a small favorable selection, healthwise, for those accepted for employment. Such studies as have been made by insurance companies have led them to believe that the selective influence resulting from any medical examination disappears entirely after five years. It would seem safe to assume any favorable selection of employees in any of the AEC installations have probably been less rigorous than selection for insurance underwriting and, therefore, the selective influence would be less

lasting than five years. Nevertheless, to be sure to fully assess any possible favorable selection it was decided to use as controls those individuals who applied for a job and were found medically acceptable but they were never employed in an AEC installation because they were generally hired by some other employer before their appointment with an AEC contractor could come through. These are labeled for identification purposes as "Non-Starts". In Hanford we were able to identify them and had the same personnel information on them as for employees, so they were included in the Study population. They are referred to in Section V-A, p. 5.⁽¹⁰⁾ In Hanford there were some 2,500 of these. In Oak Ridge these records had not been preserved for the entire period, therefore, no attempt was made to include them in the Study. It should be observed, of course, that in a sense the non-monitored individuals as controls, theoretically at least, should be analogous to "Non-Starts".

(c) Matched controls A and B. To assure that every employee of an AEC contractor who is included in our Study group should have two independently selected matched controls, arrangements have been made with SSA to this end. The SSA has maintained a 1 percent sample of all those who have ever been issued a social security number since 1937 when the program was initiated. This is labeled as the Continuous Work History Sample (CWHS). Any individual who holds a social security number which has the following combination of

digits falls within this 1 percent sample:

The digits 2 or 7 in the 6th position from left to right and the combinations of any of the pairs of digits in positions 8 and 9 as 05, 20, 45, 70, and 95, respectively.

Procedure in Selecting the Matched Controls: For selecting the A and B matched controls every effort shall be made first to purge from the 1 percent CWHs all persons who have ever worked in an AEC installation. The purpose of this would be to avert the risk of matching a worker from Oak Ridge, let us say, with one from Hanford or from Los Alamos. This would be simple to do for those employees who are included in our Study, but is not simple for employees in the remaining AEC installations. We are searching for feasible approaches to this end. After this purging, employees in the Study, including the siblings and the "Non-Starts", will be matched with respect to (1) year of birth, (2) sex, (3) race, (4) year in which the social security number was issued, and (5) the State in which the social security number was issued, with two other individuals from the purged 1 percent Current Work History Sample labeled as controls A and B. These controls would be linked with the employees of AEC contractors included in the Study as well as with the siblings and "Non-Starts". Any comparative criterion for assessing possible pernicious effects from any occupational hazard would compare the group with other groups with lesser or greater hazard, with different hazards and those with no known hazards as well as with controls A and B who are

employees who never worked in an AEC installations and it may be assumed, therefore, that they were never exposed occupationally to any significant degree of low-level ionizing radiation.

Information with respect to different end criteria as described earlier would be obtained uniformly from the SSA records for all groups included in the Study, that is (1) all the employees of AEC contractors, (2) the identified siblings of the same sex of these employees, (3) the "Non-Starts" where available; and (4) the matched controls A and B.

Pattern of analysis: The analyses would be in terms of cohorts sub-divided into more or less homogeneous groups according to age, sex and race. Workers entering employment in each AEC installation in a specific year since operation began in the installations would represent a cohort. The sub-cohorts in terms of age, sex and race would be further subdivided on the basis of their exposure history to ionizing radiation, internal and external, and other potential industrial hazards and would be followed year by year, and their differences with respect to each of the end-criteria described earlier, would be tested for large numbers of paired groups with the view of isolating any biologically harmful effects associated with exposure to low-level ionizing radiation and from other potential industrial exposure for which information could be obtained

for employees of AEC contractors. This follow-up would be carried on for each cohort and sub-cohort, for each plant from the date that operation in the plant began until 1968 or 1969, and hopefully, as recommended, the follow-up would be pursued periodically until at least the early cohorts and their varied controls die out. We are also hopeful that the Study, as rapidly as resources would permit, could be extended to include all the AEC installations, since each installation could be regarded as a somewhat unique experimental setting. While the findings from different installations can be pooled to answer whether or not exposure to ionizing radiation of the levels that have prevailed in the different AEC installations has proven biologically harmful, only in a somatological sense, since our Study does not purport to extend itself, as of this time, to possible genetic consequences, it would be much more hazardous to deny the possible harmful effect in a specific plant on the basis of evidence derived from a study of a different plant.

The variances of sibs from their A and B controls, with respect to the various end-criteria used to assess biological effects, and that between "Non-Starts" and their A and B controls could be used as an additional guide line to determine how wide a variance one must have to attach any, even tentative, significance to differences that are certain to appear or, in the many paired and multiple sets of comparisons, to decide whether (1) higher disability

claim rates, (2) higher approved disability rate, (3) differential susceptibility to causes of disability, (4) shorter productive life, (5) reduced life expectancy and/or (6) differential causes of death characterize more often those employees with maximum exposure and longest exposure to occupational radiation. Of course, in making these judgments and in testing various hypotheses, various groupings and regroupings would be used throughout the analysis, and appropriate statistical tests of significance would be applied in interpreting the differences which would be certain to be found between the different sub-cohorts among the "exposed" and the lesser "exposed", and the "non-exposed".

Some Tentative Estimate of the Volume of Data: In terms of data that presently is being compiled the population of employees of AEC contractors would represent about 175,000 persons with an average follow-up period, i.e., from the date of first employment to the "present", of about 15 years, and a maximum follow-up period of nearly 25 years. The identified siblings we guesstimate might aggregate from 75,000 to 80,000. The "Non-Starts" could be as many as 5,000. So the total would be about 260,000, adding to these the A and B matched controls from the OASDHI Continuous Work History Sample would give us a total Study population of 780,000 or almost 800,000.

It is guesstimated that the number of deceased in this population could be close to 50,000, the number who filed

disability claims perhaps 45,000, of whom 25,000 to 30,000 were awarded a disability benefit. The number who are no longer in covered employment could be 200,000 with perhaps half drawing old-age benefits. It should be appreciated, of course, that these end-criteria are not independent, a person can be observed with two or more end-criteria. From data now at hand it is well nigh impossible to say the number that would have at least one end-criteria but, in all probability, this would exceed 150,000, that is, persons who had one of the risks i.e., disability claims, or withdrawal from covered labor force, if not death.

It should be appreciated that in terms of man-years of exposure to any one or a combination of these end-criteria would represent almost 12 million man-years of observation.

Of the 175,000 employees of AEC contractors perhaps as many as 40,000 might have measurable exposure to ionizing radiation internally or externally. Perhaps a quarter of these have data on exposure to other occupational hazards. Of the remainder with no radiation exposure perhaps three-fourths would have no record of exposure to any harmful toxicants. The latter could be used as in-plant controls on the basis of which to assess the possible harmful effects of various types of exposures singly and in different combinations, intensities and durations in terms of the differences in the occurrence of the different criteria used.

The maximum possible period of latency for which the Study in the near future can contribute any information would be 25 years, but the bulk of exposure would be for a maximum latency period of about 15 years. It is this limitation, if nothing else, that makes it almost imperative that this follow-up be continued at least for several decades to derive full value from the current inquiry.

Besides recommending the continuation of the present Study in the indefinite future, the University of Pittsburgh team has recommended the extension of the Study as rapidly as resources would permit to all other AEC installations. First of all such an extension will enhance the present inquiry. There is an indication that there has been considerable mobility of employees between different installations. While some effort is made to record the previous exposure history with respect to ionizing radiation, the information of the actual date when such exposure occurred is not available. Furthermore, this inquiry is initiated only if the employee reported, so it would not be surprising if it were found that the record is nowhere complete. Therefore, extension to other installations would unquestionably improve the quality of information on an individual's total lifetime exposure to ionizing radiation of an occupational nature.

As far as it is known, no attempt is made to record information of exposure to other possible occupational

toxicants for transferees from previous installations. These types of occupational hazards would be more completely documented were the Study to be extended to all other AEC installations.

Earlier, in describing the selection of A and B matched controls, we indicated the need to purge from the 1 percent Continuous Work History Sample before matching all employees of AEC contractors. If the Study were extended to other installations such purging might require some additional time but would present no inherent difficulty whatsoever.

But, of course, the most important reason for extending the Study to every installation is the uncertainty at present as to whether it would be justified to generalize the findings, whatever they might turn out to be from Hanford, Oak Ridge, and several of the early feed mills to all other AEC installations with their peculiar health hazards.

Perhaps another important rationale for including all AEC installations is the fear expressed by some experts that the population is too small for definitive findings.

The extension of the Study to all AEC population will not affect the maximum duration of observation, and it might actually reduce the average follow-up period below 15 years. But it would, at least, double the total man-years of observation. It might more than double the total

radiation exposure and more than double the information with respect to exposure to other occupational hazards.

Even with the present limited sample, unless there is a period of latency in excess of 20 years, this writer expects to demonstrate statistically valid life-shortening effects if the reduction has been as much as one month. If the Study does nothing more than to show that if there has been a life-shortening effect, such loss would be probably less than one month for those exposed to radiation, such a finding would be more informative than what we can infer now without such an empirical inquiry. This upper limit of uncertainty would be reduced markedly and progressively as the follow-up continues into the future and even more sharply and with greater certainty if the Study were extended to all the AEC installations.

The Hanford Report⁽¹⁰⁾ is a description of the foundation of this Study in one of the installations where the initial data collection is about completed. The procedures evolved, with minor modifications, can be adapted for use in any other AEC installation and unless this is undertaken soon there is the imminent danger that the earliest experience, which is, in some sense, of the greatest value, would be lost irretrievably because of the continued destruction of old files in the field, notwithstanding the instructions putting a moratorium on record destruction.

Causes of Death: In describing the preceding general design for the overall Study this writer did not stop to indicate the source of information on causes of death.

This information would be derived primarily from actual death certificates. Where available the death certificate information regarding causes of death would be supplemented by autopsy findings and any pathology reports. The Hanford Report⁽¹⁰⁾ in Section V-7 describes a procedure for getting these records. This procedure, with minor modifications, would be followed to send for death certificates, abstract and analyze the causes of death for all the 800,000 or so Study population with an anticipated total of some 50,000 deaths to start with, sometime in 1970. The initial information on all those in the Study population will come from SSA files, giving the name and social security number of those deceased, the approximate time of death and the place of death. On the basis of this information requests would be sent to State vital statistics agencies requesting copies of death certificates for all the deceased. Information with respect to all the other end-criteria needed in this Study will be obtained from the SSA records again for all the employees and controls included in the Study.

Table 1--Union Carbide Employee Roster Validation by Comparing It
with Social Security Employer Tax Reporting (Form 941-A)

Item	Number	Percentages	
Total cards punched from Form 941-A for 1st quarter of 1945	9,951		
Texas and New York Employees identi- fied as such	219		
Oak Ridge Carbide Employees 941-A	9,732		
Duplicate entries	140		
Unduplicated count of Carbide employees	9,592	100.00	
Employees that could not be matched	87*	.91	
Total number matched	9,505	99.09	100.00
Matched by machine--Social Security Number	9,180	95.70	96.58
No Social Security Number - matched by name	193	2.01	2.03
Social Security Number illegible matched by name	20	.21	.21
Matched by hand with names in "miss- ing" file.	112	1.17	1.18

* Additional effort will be made to match with all Carbide employees on the roster employed at any time in 1/1/45 - 3/31/45 to isolate those that do not match with names of Form 941-A. It may turn out that most if not all of the 87 that did not match could be matched on the basis of other characteristics which could be obtained from SSA (such as birth date)

Table 2--Comparison of Population Exposure Parameters of External Radiation
for the Three Plants of Oak Ridge and the one at Hanford
(1943-66) (1944-64)

Parameters	ORNL	Y-12	ORGDP	Hanford
Total number of people monitored for whole body radiation for all years of operation in Carbide records	13,279	6,930	3,448	23,397
Total number of people monitored who had only zeros	3,522	284	1,582	6,972
Total number of people, non-zero plant total in records	9,757	6,646	1,866	16,425
Total man-rem whole body radiation exposure for all years for which records exist:	19,083 to	4,841 to	724 to	37,178 to
Range of estimates	22,033	5,692	1,623	42,491
Most probable value	21,268	5,692	1,549	39,609
Average recorded cumulative plant total dose per person monitored, Rem	1.60 to 1.66	0.79 to 0.82	0.45 to 0.47	1.73 to 1.82
Average recorded cumulative plant total dose for persons having non-zero plant totals, Rem	1.96 to 2.06	0.73 to 0.85	0.39 to 0.54	2.26 to 2.33
Average annual dose reading per monitored individual, Rem/year	0.25	0.15	0.12	0.256
Average non-zero annual dose reading, 1943-1966 Rem/year for Oak Ridge and 1944-1964 Rem/year for Hanford	0.335	0.165	0.159	0.353
Average number of years of monitoring per monitored employees	6.5	5.1 to 5.4	3.8 to 3.9	6.8 to 7.0
Average number of years in which persons with non-zero plant totals received non-zero annual readings	5.8	4.4	2.4	6.4

Table 3--Preliminary data on the age and number of Union Carbide employees according to sex and color hired in different periods for X-10 in Oak Ridge divided into those separated and those still employed 1943-1968

Years in which hired	Employees no longer employed - age at hiring								
	White				Non-white				
	Male		Female		Male		Female		
	No.	Mean Age	No.	Mean Age	No.	Mean Age	No.	Mean Age	
1943-1948	1,343	35.7	619	27.8	52	43.3	30	34.9	
1949-1953	1,195	33.0	322	27.4	17	38.8	5	N.C.	
1954-1958	805	31.5	234	27.0	4	N.C.	1	43.5	
1959-1963	1,139	29.7	433	25.8	5	32.6	5	N.C.	
1964-1968	858	27.9	310	24.1	23	22.8	12	24.1	
Total	5,340	N.C.	1,918	N.C.	101	N.C.	53	N.C.	7,412
Employees still serving - age at hiring									
1943-1948	921	31.9	80	30.5	23	33.7	6	31.8	
1949-1953	922	30.9	99	30.7	27	33.1	1	28.5	
1954-1958	732	31.5	72	33.1	9	N.C.	1	23.5	
1959-1963	953	31.8	130	29.9	22	32.7	6	N.C.	
1964-1968	1,693	29.1	258	29.1	29	29.8	9	28.6	
Total	4,363	N.C.	639	N.C.	110	N.C.	23	N.C.	5,135
All employees - age at time of hiring									
1943-1948	2,264	32.2	699	28.1	75	40.4	36	34.4	
1949-1953	2,117	32.1	421	28.2	44	35.4	6	N.C.	
1954-1958	1,537	31.4	306	28.4	13	N.C.	2	33.5	
1959-1963	2,092	30.7	563	26.8	27	32.7	11	N.C.	
1964-1968	1,693	29.1	568	26.3	52	26.7	21	26.0	
Total	9,703	N.C.	2,557	N.C.	211	N.C.	76	N.C.	12,547

N.C. = Not computed, either because the frequencies were too small or there was no need for the purpose for which these computations were made.

Table 3--Preliminary data on the age and number of Union Carbide (cont'd) employees according to sex and color hired in different periods for Y-12 in Oak Ridge divided into those separated and those still employed 1943-1968

Years in which hired	Employees no longer employed - age at hiring								
	White				Non-white				
	Male		Female		Male		Female		
	No.	Mean Age	No.	Mean Age	No.	Mean Age	No.	Mean Age	
1943-1948	910	37.1	366	28.6	20	40.3	9	42.9	
1949-1953	1,824	35.7	416	27.2	22	30.2	9	N.C.	
1954-1958	907	32.6	122	26.2	6	N.C.	-	-	
1959-1963	811	32.7	144	24.7	4	N.C.	1	23.5	
1964-1968	136	25.7	11	27.4	3	N.C.	-	-	
Total	4,588	N.C.	1,059	N.C.	55	N.C.	19	N.C.	5,721
Employees still serving - age at hiring									
1943-1948	655	32.8	99	30.8	21	32.1	17	34.4	
1949-1953	1,576	33.2	83	30.9	26	35.1	4	N.C.	
1954-1958	748	31.6	24	34.4	1	28.3	-	-	
1959-1963	674	33.5	68	32.6	2	N.C.	2	N.C.	
1964-1968	608	35.6	65	28.5	14	N.C.	5	N.C.	
Total	4,261	N.C.	339	N.C.	64	N.C.	28	N.C.	4,692
All Employees - Age at time of hiring									
1943-1948	1,565	35.3	465	29.1	41	36.1	26	37.3	
1949-1953	3,400	34.5	499	27.8	48	32.8	13	N.C.	
1954-1948	1,655	32.1	146	27.6	7	N.C.	-	-	
1959-1963	1,485	33.1	212	27.2	6	N.C.	3	N.C.	
1964-1968	744	33.8	76	28.4	17	N.C.	5	N.C.	
Total	8,849	N.C.	1,398	N.C.	119	N.C.	47	N.C.	10,413

Table 3--Preliminary data on the age and number of Union Carbide (cont'd) employees according to sex and color hired in different periods for K-25 in Oak Ridge divided into those separated and those still employed 1943-1968

Years in which hired	Employees no longer employed - age at hiring								
	White				Non-white				
	Male		Female		Male		Female		
	No.	Mean Age	No.	Mean Age	No.	Mean Age	No.	Mean Age	
1943-1948	19,552	44.5	6,240	26.8	574	30.5	322	27.5	
1949-1953	2,493	31.7	480	27.3	19	27.3	1	33.5	
1954-1958	633	27.3	192	25.0	1	33.5	-	-	
1959-1963	355	28.3	109	24.2	-	-	1	19.5	
1964-1968	161	24.6	42	23.0	15	21.8	9	21.3	
Total	23,194	N.C.	7,063	N.C.	609	N.C.	333	N.C.	31,199
Employees still serving - age at hiring									
1943-1948	1,131	30.5	143	32.5	19	27.7	7	29.4	
1949-1953	440	21.3	66	31.0	5	N.C.	2	N.C.	
1954-1958	147	31.5	50	31.0	1	28.5	-	-	
1959-1963	236	34.1	42	27.3	1	23.5	-	-	
1964-1968	313	29.0	90	25.6	23	28.2	8	N.C.	
Total	2,267	N.C.	391	N.C.	49	N.C.	17	N.C.	2,724
All employees - age at time of hiring									
1943-1948	20,683	34.2	6,383	27.0	593	30.4	329	27.3	
1949-1953	2,933	30.2	546	27.7	24	32.7	3	N.C.	
1954-1958	780	28.1	242	26.2	2	N.C.	-	-	
1959-1963	591	30.6	151	25.0	1	23.5	1	19.5	
1954-1968	474	27.5	132	24.8	38	25.6	17	N.C.	
Total	25,461	N.C.	7,454	N.C.	658	N.C.	350	N.C.	33,923

Table 4--Estimates of Ionizing Radiation from Diagnostic Medical X-rays at Hanford Compared to Occupational Radiation Exposure (for employees who were at Hanford continuously from 1/1/46 through 8/31/56, including those who died within this period)

Year	Employee Population			Annual estimates of average radiation dose per person per year			
				Medical	Occupational		
	Total Exposed (1) (Man-years)	Employees Monitored in a given year	Employees with any occupational exposures (3)	All Employees (Rem/yr.)*	All Employees (Rem/yr.)	Monitored Employees (Rem/yr.)	Employees with any occupational exposure (Rem/yr.)
1946	2,284.0	1,533	1,374	0.052	0.102	0.151	0.169
1947	2,275.0	1,300	1,130	0.044	0.061	0.107	0.123
1948	2,268.5	1,465	1,007	0.033	0.035	0.054	0.179
1949	2,261.0	1,423	1,131	0.027	0.050	0.079	0.099
1950	2,249.0	1,206	962	0.032	0.057	0.105	0.132
1951	2,237.0	941	683	0.032	0.063	0.149	0.205
1952	2,229.5	1,382	952	0.047	0.097	0.156	0.227
1953	2,198.5	1,459	1,130	0.056	0.144	0.216	0.279
1954	2,190.0	1,397	978	0.042	0.059	0.202	0.289
1955	2,185.5	966	660	0.032	0.074	0.166	0.243
1956	1,448.7 (2)	833	396	0.029	0.069	0.179	0.144
Total	23,826.7	13,905	10,403	0.039	0.080	0.140	0.188

(1) Deaths in a given year are assumed to have been exposed on the average one half year.

(2) Adjusted in terms of 2/3rds of the people present being exposed the whole year.

(3) Anything above zero

* Calculated from KG-RAD per year by dividing by 70. See text.

Note: The numbers of digits carried do not necessarily indicate the number of significant digits. The standard errors of these estimates are still undetermined so far.

Table 5.--Hanford Population Exposure Parameters. Estimated from Hanford Data of 1944-1964, inclusive; on-site only.

(a) Total number of employees monitored for whole body radiation	<u>23,397</u> persons
(b) Total number of people monitored for whole body radiation who had only zero listed in their records	<u>6,972</u> persons
(c) Total man-rem whole body radiation exposure for all years, 1944-1964 inclusive 23,397 - 6,972 =	<u>16,425</u> man-rem
(d) Total man-rem whole body radiation exposure for all years, 1944-1964, estimated as follows:	
(1) 138,759 (0.10)* + 8,308 (0.75) + 6,485 (1.5) + 4,410 (2.5) + 382 (3.5) + 45 (4.5) + 3 (6.5) + 1 (10) + 1 (19.7) + 1 (43.5) =	
13,875.9 + 6,231.0 + 9,727.5 + 11,025.0 + 1,337.0 + 202.5 + 19.5 + 10.0 + 19.7 + 43.5 =	<u>42,491.6</u> man-rem

These frequencies are based on calculations such as are described in Table 1 reference 7 using Hanford data for on-site whole body penetrating radiation frequency distribution by years of exposure, 1944-64, similar in form to that presented in reference 7, tables 3-9.

(2) Under the assumption that all recorded zeros are truly zero (53,132 yearly readings) and the rest of the monitored employees have the same frequency distributions and assumed central values as in (1) above, we obtain a reduced total estimate.

$$138,759 - 53,132 = 85,627$$

$$8,562.7 + 6,231.0 + 9,727.5 + 11,025.0 + 1,337.0 + 202.5 + 19.5 + 10.0 + 19.7 + 43.5 =$$

37,178.4 man-rem

* Answers obtained are obviously very sensitive to the average dose assumed for this lowest-dose group. This value of 0.10 rem was taken as a more reasonable estimate (than 0.25) of the average exposure received by those persons in the 0.00-0.49 range, as mentioned in previous reports (6,7).

Table 5 (Cont'd)

Page 2 of 3

Deriving these estimated averages from the cumulative table, we get:

(3) Under the assumption that the average cumulative plant total dose of all employees in the 0.00-0.99 interval is about 0.34 rem:

$$17,267 (0.34) + 2,393 (1.5) + 1,442 (3.0) + 1,037 (6.0) + 651 (12.0) + 466 (20.5) + 2,642.7 + 533.1 =$$

$$5,870.8 + 3,589.5 + 4,326.0 + 6,222.0 + 7,812.0 + 9,553.0 + 2,642.7 + 533.1 =$$

40,569.1 man-rem

For individuals who has a cumulative dose of 25R or over, the sum was obtained for each individual. There were 142 such individuals with a cumulative total dose of 3,175.8 R's.

(4) Under the assumption that the average cumulative plant total dose of employees in the 0.00-0.99 interval with non-zero plant total is about 0.34 rem we have:

$$10,295 (0.34) + 3,589.5 + 4,326.0 + 6,222.0 + 7,812.0 + 9,553.0 + 2,642.7 + 553.1 =$$

$$3,500.3 + 3,589.5 + 4,326.0 + 6,222.0 + 7,812.0 + 9,553.0 + 2,642.7 + 553.1 =$$

38,198.6 man-rem

(e) Average recorded cumulative plant total dose per employee monitored from 1944 - 1964:

$$\frac{d (3)}{a} = \frac{40,569.1}{23,397} = 1.73;$$

$$\frac{d (1)}{a} = \frac{42,491.6}{23,397} = 1.82$$

1.73-1.82 rem

(f) Average recorded cumulative plant total dose per employee having a non-zero plant total, 1944 - 1964:

$$\frac{d (2)}{c} = \frac{37,178.4}{16,425} = 2.26;$$

$$\frac{d (4)}{c} = \frac{38,198.6}{16,425} = 2.33$$

2.26-2.33 rem

Table 5 (Cont'd)

Page 3 of 3

(g) Average annual dose reading per monitored employee:

$$\frac{40,569.1}{158,395} = 0.256; \quad \frac{42,491.6}{158,395} = 0.268 \quad \frac{0.256-0.268}{\text{year}} \text{ rem/}$$

(h) Average non-zero annual dose reading:

$$\frac{37,178.4}{105,263} = 0.353; \quad \frac{38,198.6}{105,263} = 0.363 \quad \frac{0.353-0.363}{\text{year}} \text{ rem/}$$

(i) Average number of years of monitoring per monitored employee:

$$\frac{158,395}{23,397} = \underline{6.8} \text{ years}$$

also

$$\frac{1.78}{0.262} \frac{\text{(from e)}}{\text{(from g)}} = \underline{6.8} \text{ years}$$

(j) Average number of years in which employees with non-zero plant totals received non-zero annual readings:

$$\frac{158,395-53,132}{16,425} = \frac{105,263}{16,425} = \underline{6.4} \text{ years}$$

also

$$\frac{2.30}{0.358} \frac{\text{(from f)}}{\text{(from h)}} = \underline{6.4} \text{ years}$$

Table 6.--Hanford Population Exposure Parameters. Estimated from Hanford Data of 1944-1964, inclusive; includes off-site exposure.*

(a) Total number of employees monitored for whole body radiation	<u>23,398</u> persons
(b) Total number of people monitored for whole body radiation who had only zero listed in their records	<u>6,968</u> persons
(c) Total man-rem whole body radiation exposure for all years, 1944-1964 inclusive 23,398-6,968 =	<u>16,530</u> man-rem
(d) Total man-rem whole body radiation exposure for all years, 1944-1964 estimated as follows:	
(1) $139,003 (0.10) + 8,337 (0.75) + 6,502 (1.5) + 4,418 (2.5) + 385 (3.5) + 48 (4.5) + 10 (6.5) + 4 (10.0) + 19.7 + 43.5 =$ $13,900.3 + 6,252.8 + 9,753.0 + 11,045.0 + 1,347.5 + 216.0 + 65.0 + 40.0 + 19.7 + 43.5 =$	<u>42,682.8</u> man-rem
These frequencies are based on calculations such as are described in Table 1 of reference 7 using Hanford data for on-site and off-site whole body penetrating radiation frequencies.	
(2) Under the assumption that all recorded zeros are truly zero (53,162 yearly readings) and the rest of the monitored employees have the same frequency distributions and assumed central values as in (1) above, we obtain a reduced total estimate=	
$139,003 - 53,162 = 85,841$ $8,584.1 + 6,252.8 + 9,753.0 + 11,045.0 + 1,347.5 + 216.0 + 65.0 + 40.0 + 19.7 + 43.5 =$	<u>37,366.6</u> man-rem

* Off-site exposure is entered as of the date when record is obtained and not when radiation occurred

Table 6 (Cont'd)

Page 2 of 3

Deriving these estimated averages from the cumulative table, we get:

(3) Under the assumption that the average cumulative plant total dose of all employees in the 0.00-0.99 interval is about 0.34 rem:

$$17,233 (0.34) + 2,397 (1.5) + 1,453 (3.0) + 1,048 (6.0) + 660 (12.0) + 466 (20.5) + 2,642.7 + 533.1 =$$

$$5,859.2 + 3,595.5 + 4,359.0 + 6,288.0 + 7,920.0 + 9,553.0 + 2,642.7 + 533.1 = \underline{40,750.5} \text{ man-rem}$$

Note: For individuals who had a cumulative dose of 25 R or over, the sum was obtained for each individual. The number of such individuals and their cumulative total dose was identical with that given previously for on-site exposure. In general, the off-site exposure is negligible as reflected in the different estimated totals, 42,491.6 man-rem vs 42,682.8 man-rem, a difference of 191.2 man-rem. Also, comparing cumulative figures we have:

40,569.1 man-rem vs 40,750.5, a difference of 181.4 man-rem.

(4) Under the assumption that the average cumulative plant total dose of employees in the 0.00-0.99 interval with non-zero plant total is about 0.34 rem, we have:

$$17,233 - 6,968 = 10,265$$

$$10,265 (0.34) + 3,595.5 + 4,359.0 + 6,288.0 + 7,920.0 + 9,553.0 + 2,642.7 + 533.1 = \underline{38,381.4} \text{ man-rem}$$

(e) Average recorded cumulative plant total dose per employee monitored from 1944 - 1964

$$\frac{d (3)}{a} = \frac{40,750.5}{23,398} = 1.74;$$

$$\frac{d (1)}{a} = \frac{42,682.8}{23,398} = 1.82$$

1.74-1.82 rem*

* It should be noted that these averages are not materially different from averages based solely on on-site exposure only.

Table 6 (Cont'd)
Page 3 of 3

- (f) Average recorded cumulative plant total dose per employee having a non-zero plant total, 1944 through 1964:

$$\frac{d(2)}{c} = \frac{37,366.6}{16,530} = 2.26;$$

$$\frac{d(4)}{c} = \frac{38,381.4}{16,530} = 2.32$$

2.26-2.32 rem

- (g) Average annual dose reading per monitored employee:

$$\frac{40,750.5}{158,711} = 0.256; \quad \frac{42,682.8}{158,711} = 0.269$$

0.256-0.269 rem/year

- (h) Average non-zero annual dose reading:

$$\frac{37,366.6}{105,549} = 0.354; \quad \frac{38,381.4}{105,549} = 0.364$$

0.354-0.364 rem/year

- (i) Average number of years of monitoring per monitored employee:

$$\frac{158,711}{23,398} =$$

6.8 years

also

$$\frac{1.78}{0.262} =$$

6.8 years

- (j) Average number of years in which employees with non-zero plant totals received non-zero annual readings:

$$\frac{105,549}{16,530} =$$

6.4 years

also

$$\frac{2.29}{0.359} =$$

6.4 years

Table 7.--Insured Workers Aged 62-64; Estimated Number Eligible for Retired-worker Benefit who Retire before Age 65 by Sex, Numbers (in Thousands) and Percent

Year	MALES*			FEMALES**			BOTH SEXES		
	Number Eligible	In Current Payment Status		Number Eligible	In Current Payment Status		Number Eligible	In Current Payment Status	
	(2)	No. (3)	% (4)	(5)	No. (6)	% (7)	(8)	No. (9)	% (10)
1957	-	-	-	723	113	15.6	723	113	15.6
1958	-	-	-	751	266	35.4	751	266	35.1
1959	-	-	-	771	313	40.6	771	313	40.6
1960	-	-	-	802	334	41.7	802	334	41.1
1961	-	-	-	951	357	37.6	951	357	37.6
1962	1,782	237	13.3	1,065	411	38.6	2,847	648	22.8
1963	1,827	408	22.3	1,100	465	42.3	2,927	873	29.8
1964	1,872	456	24.3	1,135	489	43.1	3,007	946	30.8
1965	1,910	480	25.1	1,187	518	43.6	3,097	998	32.2
1966	1,958	472	24.1	1,243	520	41.8	3,201	992	30.9
1967	2,011	484	24.1	1,300	544	41.8	3,311	1,028	31.1
1968	2,065	486	23.1	1,363	554	40.5	3,428	1,040	30.4

*Until July 1961 men could not retire prior to age 65 except for disability.

**From November 1956 women became eligible for retired-worker benefit at age 62, 65 before that.

Source: Social Security Bulletin, Annual Statistical Supplement, 1967, U.S. Dept. of Health, Education, and Welfare, Table 49, pp. 57.

Table 8.--Labor-force and work status by severity of disability and sex: Percentage distribution of noninstitutional population aged 18-64 by labor-force status, Spring 1966

Labor-force status	U.S. popula- tion (in thou- sands)	Nondis- abled	Severity of disability			
			Total dis- abled	Severe	Occupa- tional	Second- ary work limita- tion
MEN						
Number (in thousands)	48,980	40,550	8,430	2,300	2,420	3,710
Total percent.....	100.0	100.0	100.0	%100.0	%100.0	%100.0
Not in labor force <u>1</u> /.....	9.5	6.0	22.8	8.2	122.5	54.6
In labor force.....	90.5	94.0	73.7	352.0	99.0	105.9
Employed.....	87.4	91.4	68.3	133.9	104.2	108.1
Full time.....	79.2	83.7	57.7	204.3	117.4	102.6
Part time.....	8.2	7.7	10.6	43.3	50.0	248.3
Unemployed.....	3.1	2.7	5.2	54.0	40.3	66.3
Age 18-44						
Number (in thousands)	30,347	27,287	3,060	578	861	1,621
Total percent.....	100.0	100.0	100.0	100.0	100.0	100.0
Not in Labor force <u>1</u> /.....	9.4	8.4	18.7	12.5	95.4	127.2
In labor force.....	90.6	91.6	81.3	280.0	100.5	98.2
Employed.....	87.1	88.6	73.6	328.0	109.9	102.4
Full time.....	78.1	79.6	64.8	1561.0	107.7	97.8
Part time.....	9.0	9.0	8.8	41.3	136.4	173.2
Unemployed.....	3.5	3.0	7.5	52.6	30.3	43.5
Age 45-54						
Number (in thousands)	10,567	8,111	2,456	558	888	1,010
Total percent.....	100.0	100.0	100.0	100.0	100.0	100.0
Not in labor force <u>1</u> /.....	5.0	.5	20.1	6.8	25.0	70.6
In labor force.....	95.0	99.5	79.8	363.3	101.5	107.1
Employed.....	92.8	98.2	75.1	429.0	109.7	107.8
Full time.....	85.5	91.9	64.5	1314.0	128.3	102.2
Part time.....	7.3	6.3	10.6	39.4	35.2	525.6
Umemployed.....	2.2	1.5	4.3	33.4	20.8	88.3
Age 55-64						
Number (in thousands)	8,066	5,152	2,914	1,164	671	1,079
Total percent.....	100.0	100.0	100.0	100.0	100.0	100.0
Not in labor force <u>1</u> /.....	15.6	2.1	39.5	2.7	56.7	21.8
In labor force.....	84.4	97.9	60.5	23.4	96.3	78.3
Employed.....	81.5	95.3	57.1	18.5	94.3	75.6
Full time.....	75.1	92.3	44.6	2.2	71.1	74.0
Part time.....	6.4	3.0	12.5	16.3	23.2	1.6.
Unemployed.....	2.9	2.6	3.4	4.9	2.0	2.7

The footnote on next page.

(Continued)

Table 8.--Labor-force and work status by severity of disability and sex: Percentage distribution of noninstitutional population aged 18-64 by labor-force status, Spring 1966--Continued

Labor-force status	U.S. popula- tion (in thou- sands)	Nondis- abled	Severity of disability			
			Total dis- abled	Severe	Occupa- tional	Second- ary work limita- tion
WOMEN						
Number (in thousands)	54,105	44,781	9,324	3,800	2,594	2,930
Total percent.....	100.0	100.0	100.0	100.0	100.0	100.0
Not in labor force <u>1</u> /.....	54.6	51.9	67.4	85.3	62.8	48.1
In labor force.....	45.4	48.1	32.6	14.7	37.2	51.9
Employed.....	43.5	46.4	29.6	13.0	33.0	48.1
Full time.....	32.1	35.2	16.8	.3	16.0	38.9
Part time.....	11.5	11.2	12.8	12.7	17.0	9.3
Unemployed.....	1.9	1.7	2.9	1.6	3.9	3.5
Age 18-44						
Number (in thousands)	33,920	30,418	3,502	1,232	830	1,440
Total percent.....	100.0	100.0	100.0	100.0	100.0	100.0
Not in labor force <u>1</u> /.....	55.4	54.8	60.4	80.3	57.8	44.9
In labor force.....	44.6	45.2	39.6	19.7	42.2	55.1
Employed.....	42.4	43.1	35.9	16.9	38.7	50.7
Full time.....	31.1	32.0	23.0	.4	22.0	42.8
Part time.....	11.3	11.1	13.0	16.4	16.7	7.9
Unemployed.....	2.2	2.1	3.4	2.6	2.9	4.4
Age 45-54						
Number (in thousands)	11,329	8,712	2,617	957	899	760
Total percent.....	100.0	100.0	100.0	100.0	100.0	100.0
Not in labor force <u>1</u> /.....	48.9	44.5	63.6	81.6	60.4	44.7
In labor force.....	51.1	55.5	36.4	18.4	39.6	55.3
Employed.....	49.5	54.5	32.9	15.8	33.1	54.1
Full time.....	36.7	42.5	17.5	.6	15.3	41.3
Part time.....	12.8	12.1	15.3	14.9	17.8	12.7
Unemployed.....	1.6	1.0	3.5	2.6	6.4	1.2
Age 55-64						
Number (in thousands)	8,856	5,651	3,205	1,611	864	730
Total percent.....	100.0	100.0	100.0	100.0	100.0	100.0
Not in labor force <u>1</u> /.....	58.7	47.8	78.0	91.3	70.3	57.8
In labor force.....	41.3	52.2	22.0	8.7	29.7	42.2
Employed.....	40.2	51.7	20.1	8.4	27.5	37.0
Full time.....	29.8	41.4	9.5	.0	10.9	28.5
Part time.....	10.4	10.3	10.6	8.4	16.6	8.5
Unemployed.....	1.0	.7	1.7	.3	2.3	4.2

1/ Includes a small number of disabled adults not reporting labor force status.

Source: Reference 17.

Table 9.--Awards of Old-age Benefits to Retired Workers Under Social Security

Year	Number	Year	Number	Year	Number	Year	Number	Year	Number
1943	89,070	1948	275,903	1953	771,671	1958	1,041,668	1963	1,145,602
1944	110,097	1949	337,273	1954	749,911	1959	1,089,740	1964	1,041,807
1945	185,174	1950	567,131	1955	909,883	1960	981,717	1965	1,183,133
1946	258,980	1951	702,984	1956	934,033	1961	1,361,505	1966	1,647,618
1947	271,488	1952	531,206	1957	1,424,975	1962	1,347,268	1967	1,161,395
								Total	21,361,613

Source: Social Security Bulletin, Annual Statistical Supplement, 1967, Table 50, pp. 58, and Social Security Bulletin, Vol. 32, No. 5, May 1969, Table 14, pp. 39.

Table 10.--Percentage of Workers Eligible for Retired-Worker Benefit in Current Payment Status* by Broad Age Group** and Sex 1955-68

Year (1)	MALES			FEMALES			BOTH SEXES		
	Total 65+ (2)	65-71 (3)	72+ (4)	Total 65+ (5)	65-71 (6)	72+ (7)	Total 65+ (8)	65-71 (9)	72+ (10)
1955	70	58	89	75	69	88	71	61	89
1956	75	62	95	80	75	91	76	65	94
1957	71	58	90	77	71	90	73	62	90
1958	78	65	95	81	76	92	79	65	94
1959	81	69	97	85	79	95	82	72	97
1960	84	73	97	87	82	96	85	76	97
1961	85	74	97	87	80	97	85	76	97
1962	86	76	98	88	81	98	87	78	98
1963	89	79	99	89	82	99	89	80	99
1964	89	80	99	89	82	99	89	81	99
1965	89	79	100	89	80	100	89	80	100
1966	89	80	99	88	80	97	89	80	98
1967	90	80	100	90	82	100	90	81	100
1968	90	79	100	90	81	100	90	80	100

*"Current payment status" means that they are receiving retirement benefits.

**Age as of the beginning of the year

Source: Social Security Bulletin, Annual Statistical Supplement, 1967, U.S. Dept. of Health, Education, and Welfare, Table 48, pp.56.

Table 11.--Benefit Awards to Retired Workers: Number and Percentage Distribution by Year of Award in Relation to Year of Entitlement¹, 1962-67

Year of Award	Numbers						Percentages					
	Total	Same as Year of Award	1 Year Before	2 Years Before	3 Years Before	4 Years Before	Total	Same as Year of Award	1 Year Before	2 Years Before	3 Years Before	4 Years Before
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1962	1,347,268	617,732	665,922	61,286	1,167	1,161	100	49.5	49.4	4.5	0.1	0.1
1963	1,145,602	575,817	503,659	63,702	1,395	1,029	100	50.3	44.0	5.6	.1	.1
1964	1,041,807	571,892	420,324	46,916	1,710	965	100	54.9	40.3	4.5	.2	.1
1965	1,183,133	672,491	471,080	37,268	1,189	1,105	100	56.8	39.8	3.1	.1	.1
1966	1,647,524	743,746	749,052	152,320	1,010	1,396	100	45.1	45.5	9.2	.1	.1
1967	1,161,130	792,116	325,729	40,327	1,958	1,000	100	68.2	28.0	3.5	.2	.1

¹ Entitlement: The state or condition^{of} meeting the applicable requirements for receipt of benefits, including the filing of a claim. Entitlement can be retroactive and thus precede the date of award. Retroactivity can extend up to 12 months before the date of application for benefits but not beyond the minimum age requirement for the specified type of benefit.

Source: Social Security Bulletin, Annual Statistical Supplement, 1967, U.S. Dept. of Health, Education, and Welfare, Table 51, pp.58.

Table 12--Benefits Withheld from Retired workers on
Account of Earnings, at the end of 1967*

(1)	Total (2)	Males (3)	Females (4)
Earnings of Retired Workers	899,695	682,084	217,611
Aged 62-64	32,461	19,262	13,199
65-71	867,234	662,822	204,412

*In 1967 there were over 42,000 retired workers whose benefits were stopped completely for the entire year because of earnings.

Source: Social Security Bulletin, Annual Statistical Supplement, 1967, U.S. Dept. of Health, Education, and Welfare, Table 102, pp. 104.

Table 13--Magnitude and Severity of Reported Disability in
Non-institutional Population Aged 18-64, Spring 1966

Age (1)	United States Non-institutional Population		Percent				
			Non- Disabled	Disabled			
	Number (in thousands) (2)	% (3)	(4)	Total (5)	Severe (6)	Occupational (7)	Secondary Work Limitations (8)
White Males							
18-64	43,880	100.0	83.3	16.7	4.3	4.8	7.6
18-44	27,026	100.0	90.1	9.9	1.7	2.8	5.4
45-54	9,520	100.0	77.6	22.4	4.8	8.0	9.6
55-64	7,334	100.0	65.4	34.6	13.4	8.0	13.2
Non-white Males							
18-64	5,100	100.0	78.5	21.5	8.1	6.4	7.0
18-44	3,321	100.0	88.1	11.9	3.9	3.4	4.5
45-54	1,047	100.0	68.8	31.2	9.6	12.5	9.3
55-64	732	100.0	49.0	51.0	25.0	11.1	14.9

Source: L.D. Haber, "Demographic Correlates of Disability",
presented at April 1968 meetings of the Population
Association of America, Boston, Mass. From Table 2,
pp. 28-29.

Table 13--Magnitude and Severity of Reported Disability in Non-institutional
(cont'd) Population Aged 18-64, Spring 1966--Continued

Age (9)	United States Non-Institutional Population		Percent				
			Non- Disabled	Disabled			
	Number (in thousands) (10)	% (11)	(12)	Total (13)	Severe (14)	Occupational (15)	Secondary Work Limitations (16)
White Females							
18-64	48,081	100.0	84.0	16.0	6.2	4.7	5.2
18-44	29,840	100.0	90.7	9.3	3.0	2.3	4.0
45-54	10,185	100.0	78.7	21.3	7.1	7.8	6.4
55-64	8,056	100.0	65.8	34.2	16.5	9.8	7.9
Non-white Females							
18-64	6,024	100.0	73.2	26.8	13.9	5.6	7.3
18-44	4,080	100.0	82.5	17.5	8.0	3.7	5.8
45-54	1,144	100.0	60.7	39.3	20.2	9.4	9.6
55-64	800	100.0	44.0	56.0	35.3	9.5	11.2

Table 14--Magnitude of the Number of Workers with No Covered Employment Beyond the Specified Years by Insurance and Entitlement Status by Age Group and Sex, 1937-1960 Inclusive (1 Percent Sample)

Benefit Status, Insurance Status and Age in 1960 (1)	Total (2)	1937 (3)	1938-39 (4)	1940-50 (5)	1951-54 (6)	1955-56 (7)	1957-59 (8)	1960 [✓] (9)	1938- 1959 (10)
MALES									
Under 25--Total	100,090	-	1	24	323	751	9,262	91,727	8,363
Entitled	328	-	-	3	11	29	194	89	239
Living	15	-	-	1	-	1	3	10	5
Deceased	313	-	-	2	11	28	191	79	234
Non-entitled	99,762	-	1	21	312	722	7,068	91,638	8,124
Deceased	92	-	-	-	16	19	44	13	79
Living [✓]	99,670	-	1	21	296	703	7,024	91,625	8,045
Uninsured	33,888	-	1	21	280	595	4,905	28,086	5,802
Insured [†]	65,782	-	-	-	16	108	2,119	63,539	2,243
Insured for Disability	17,561	-	-	-	-	2	145	17,414	147
25-49--Total	327,859	1,895	2,436	23,980	10,137	8,100	21,026	260,125	67,734
Entitled	11,853	*109	235	4,483	2,141	1,308	2,494	925	10,928
Living	1,140	*3	-	142	166	131	416	279	861
Deceased	10,713	*106	235	4,341	1,975	1,177	2,078	646	10,067
Non-entitled	316,006	1,786	2,201	19,497	7,996	6,792	18,532	259,200	56,806
Deceased	846	7	15	571	138	43	55	17	829
Living	315,160	1,779	2,186	18,926	7,858	6,749	18,477	259,183	55,977

Uninsured	34,973	1,779	2,186	15,935	4,672	2,307	4,026	4,066	30,907
Insured	280,187	-	-	2,991	3,186	4,442	14,451	255,117	25,070
Fully	278,125	-	-	2,991	3,186	4,442	14,286	253,220	24,905
Currently Only	2,062	-	-	-	-	-	165	1,897	165
Insured for Disability	299,613	-	-	-	-	735	6,859	222,019	7,594
50-59--Total	107,849	1,425	1,625	11,263	5,172	3,946	9,487	74,858	32,991
Entitled	12,678	*140	312	3,612	2,439	1,679	3,391	1,034	11,644
Living	1,911	*1	1	123	225	232	941	381	1,530
Deceased °	10,767	*139	311	3,489	2,214	1,447	2,450	653	10,114
Non-entitled	95,171	1,285	1,313	7,651	2,733	2,267	6,096	73,824	21,347
Deceased	570	3	29	356	82	49	42	9	561
Living [∇]	94,601	1,282	1,284	7,295	2,651	2,218	6,054	73,815	20,786
Uninsured	11,355	1,282	1,284	4,934	1,188	650	1,107	909	10,446
Insured	83,246	-	-	2,361	1,463	1,568	4,947	72,906	10,340
Fully	82,536	-	-	2,361	1,463	1,568	4,883	72,260	10,276
Currently Only	710	-	-	-	-	-	64	646	64
Insured for Disability	71,438	-	-	-	-	405	2,948	68,085	3,353
60-61--Total	18,908	279	374	2,711	1,333	947	2,085	11,168	7,740
Entitled	3,664	*30	80	995	762	520	972	294	3,370
Living	649	-	-	28	75	111	320	114	535
Deceased	3,015	*30	80	967	687	409	652	180	2,835

Non-entitled	15,244	249	294	1,716	571	427	1,113	10,874	4,370
Deceased	215	1	8	144	29	13	15	5	210
Living [∇]	15,029	248	286	1,572	542	414	1,098	10,869	4,160
Uninsured	2,366	248	286	1,109	267	118	193	145	2,221
Insured	12,663	-	-	463	275	296	905	10,724	1,939
Fully	12,529	-	-	463	275	296	894	10,601	1,928
Currently Only	134	-	-	-	-	-	11	123	11
Insured for Disability	10,576	-	-	-	-	64	538	9,974	602
62-64--Total	26,089	374	533	4,042	2,033	1,471	3,193	14,420	11,669
Entitled	6,010	*55	132	1,699	1,210	814	1,597	483	5,527
Living	1,231	-	1	51	145	183	598	251	980
Deceased	4,779	*55	131	1,648	1,065	631	999	232	4,547
Non-entitled	20,079	319	401	2,343	823	657	1,596	13,937	6,142
Deceased	324	8	17	200	59	26	11	3	321
Living [∇]	19,755	311	384	2,143	764	631	1,585	13,934	5,821
Uninsured	3,129	311	384	1,480	333	194	243	184	2,945
Insured	16,626	-	-	663	431	437	1,342	13,750	2,876
Fully	16,438	-	-	663	431	437	1,325	13,579	2,859
Currently Only	188	-	-	-	-	-	17	171	17
Insured for Disability	13,733	-	-	-	-	119	860	12,754	979

65-69--Total	41,326	612	853	7,482	4,282	3,795	10,365	13,862	27,464
Entitled	31,143	*98	237	4,042	3,447	3,357	9,838	10,051	21,092
Living	21,896	*4	10	811	1,177	2,021	8,042	9,787	12,109
Deceased	9,247	*94	227	3,231	2,270	1,336	1,796	264	8,983
Non-entitled	10,183	514	616	3,440	835	438	527	3,811	6,372
Deceased	652	15	36	410	110	43	29	8	644
Living	9,531	499	580	3,030	725	395	498	3,803	5,728
Uninsured	4,289	499	542	2,150	449	223	229	196	4,093
Insured	5,242	-	38	880	276	172	269	3,607	1,635
Fully	5,173	-	38	880	276	172	264	3,543	1,630
Currently Only	69	-	-	-	-	-	5	64	5
70-71--Total	14,840	214	387	3,342	2,500	2,501	2,941	2,929	11,911
Entitled	12,248	43	155	2,056	2,265	2,391	2,844	2,468	9,780
Living	7,913	1	16	468	1,066	1,658	2,285	2,403	5,510
Deceased	4,335	42	139	1,588	1,199	733	559	65	4,270
Non-entitled	2,592	171	232	1,286	235	110	97	461	2,131
Deceased	229	6	11	168	28	8	7	1	228
Living	2,363	165	221	1,118	207	102	90	460	1,903
Uninsured	1,355	165	171	718	146	69	39	47	1,308
Insured [†]	1,008	-	50	400	61	33	51	413	595
72-74--Total	20,564	379	531	5,771	4,798	2,552	3,331	3,166	17,398
Entitled	17,238	75	212	3,738	4,500	2,434	3,195	3,048	14,190
Living	10,294	2	14	900	2,280	1,627	2,485	2,968	7,326

Deceased	6,944	73	198	2,838	2,220	807	710	80	6,864
Non-entitled	3,326	304	319	2,033	298	118	136	118	3,208
Deceased	335	16	17	256	23	16	7	-	335
Living [∇]	2,991	288	302	1,777	275	102	129	118	2,873
Uninsured	2,151	288	245	1,228	199	80	73	38	2,113
Insured [†]	840	-	57	549	76	22	56	80	760
75 & Over--Total	58,456	1,670	2,945	31,415	9,249	4,406	4,987	3,643	54,813
Entitled	45,150	347	1,145	22,575	8,533	4,127	4,808	3,477	41,673
Living	17,475	4	80	4,646	3,605	2,393	3,391	3,315	14,160
Deceased	27,675	343	1,065	17,929	4,928	1,734	1,417	162	27,513
Non-entitled	13,306	1,323	1,800	8,840	716	279	179	166	13,140
Deceased	1,787	64	187	1,380	91	50	14	1	1,786
Living [∇]	11,519	1,259	1,613	7,460	625	229	165	165	11,354
Uninsured	9,985	1,259	1,472	6,437	494	173	99	48	9,937
Insured [†]	1,534	-	141	1,023	131	56	66	117	1,417
All Ages--Total	715,981	6,848	9,685	90,030	39,827	28,469	64,677	475,898	240,083
Average Annual		6,848	4,842	9,003	9,957	14,234	21,559		

Table 14--Magnitude of the Number of Workers with No Covered Employment Beyond the Specified Years by
(cont'd) Insurance and Entitlement Status by Age Group and Sex, 1937-1960 Inclusive (1 Percent Sample)

Benefit Status, Insurance Status and age in 1960 (11)	Total (12)	1937 (13)	1938-39 (14)	1940-50 (15)	1951-54 (16)	1955-56 (17)	1957-59 (18)	1960 (19)	1938- 1959 (20)	1938-59 (21)
FEMALES						BOTH SEXES				
Under 25--Total	80,573	-	-	34	994	3,486	17,977	58,082	22,491	30,854
Entitled	51	-	-	-	2	6	27	16	35	274
Living	2	-	-	-	-	-	-	2	-	5
Deceased	49	-	-	-	2	6	27	14	35	269
Non-entitled	80,522	-	-	34	992	3,480	17,950	58,066	22,456	30,580
Deceased	23	-	-	-	3	2	13	5	18	97
Living [∇]	80,499	-	-	34	989	3,478	17,937	58,061	22,438	30,483
Uninsured	37,941	-	-	30	885	2,510	9,903	24,613	13,328	19,130
Insured [†]	42,558	-	-	4	104	968	8,034	33,448	9,110	11,353
Insured for Disability	7,105	-	-	-	-	2	727	6,376	729	876
25-49--Total	285,638	2,120	3,408	56,552	34,633	22,119	40,668	126,121	159,517	227,251
Entitled	2,997	*45	65	1,046	644	377	615	199	2,798	13,726
Living	328	-	1	43	48	56	124	55	273	1,134
Deceased	2,669	*45	64	1,003	596	321	491	144	2,525	12,592
Non-entitled	282,641	2,075	3,343	55,506	33,989	21,742	40,053	125,922	156,719	213,525
Deceased	542	5	16	297	107	56	52	9	533	1,362
Living	282,099	2,070	3,327	55,209	33,882	21,686	40,001	125,913	156,186	212,163

Uninsured	91,149	2,070	3,327	37,713	16,135	7,565	11,899	12,433	78,716	109,623
Insured	190,950	-	-	17,496	17,747	14,121	28,102	113,480	77,470	102,540
Fully	186,524	-	-	17,496	17,747	14,121	27,781	109,375	77,149	102,054
Currently Only	4,426	-	-	-	-	-	321	4,105	321	486
Insured for Disability	89,043	-	-	-	-	2,202	11,299	75,542	13,501	21,095
50-59--Total	76,981	1,067	1,561	15,291	6,667	4,497	8,782	39,107	37,874	70,865
Entitled	3,174	*26	67	911	681	455	820	209	2,965	14,609
Living	686	-	-	51	106	113	326	89	597	2,127
Deceased	2,488	*26	67	860	575	342	494	120	2,368	12,482
Non-entitled	73,807	1,041	1,494	14,380	5,986	4,042	7,962	38,898	34,909	56,256
Deceased	531	12	13	305	99	48	45	9	522	722
Living [∇]	73,276	1,029	1,481	14,075	5,887	3,994	7,917	38,889	34,387	55,173
Uninsured	23,425	1,029	1,481	10,106	3,281	1,798	2,881	2,847	20,578	31,024
Insured	49,851	-	-	3,969	2,606	2,196	5,036	36,042	13,809	24,149
Fully	48,266	-	-	3,969	2,606	2,196	4,917	34,576	13,690	23,966
Currently Only	1,585	-	-	-	-	-	119	1,466	119	183
Insured for Disability	31,223	-	-	-	-	411	2,458	28,354	2,869	6,222
60-61--Total	11,561	153	237	2,777	1,172	686	1,341	5,190	6,371	14,111
Entitled	737	*5	9	213	164	106	188	49	688	4,058
Living	181	-	-	11	32	33	79	26	155	690
Deceased	556	*5	9	202	132	73	109	23	533	3,368

Non-entitled	10,824	148	228	2,564	1,008	580	1,153	5,141	5,683	10,053
Deceased	117	3	7	69	24	5	8	1	116	326
Living [∇]	10,707	145	221	2,495	984	575	1,145	5,140	5,567	9,727
Uninsured	3,871	145	221	1,888	596	282	403	335	3,536	5,757
Insured	6,836	-	-	607	388	293	742	4,805	2,031	3,970
Fully	6,591	-	-	607	388	293	725	4,577	2,014	3,942
Currently Only	245	-	-	-	-	-	17	228	17	28
Insured for Disability	4,266	-	-	-	-	62	394	3,810	456	1,058
62-64--Total	15,684	200	345	3,830	1,591	1,066	2,471	6,166	9,518	21,187
Entitled	5,679	*8	33	865	675	542	1,555	1,990	3,689	9,216
Living	4,780	-	4	545	474	433	1,357	1,957	2,823	3,803
Deceased	899	*8	29	320	201	109	198	33	866	5,413
Non-entitled	10,005	192	312	2,965	916	524	916	4,176	5,829	11,971
Deceased	162	1	11	101	28	12	8	1	161	482
Living [∇]	9,843	191	301	2,864	888	512	908	4,175	5,668	11,489
Uninsured	4,681	191	291	2,383	662	340	491	321	4,360	7,305
Insured	5,162	-	10	481	226	172	417	3,854	1,308	4,184
Fully	4,973	-	10	481	226	172	394	3,688	1,285	4,144
Currently Only	189	-	-	-	-	-	23	166	23	40
Insured for Disability	3,279	-	-	-	-	24	134	3,121	158	1,137

65-69--Total	21,454	288	455	5,948	2,502	2,143	4,318	5,769	15,685	43,149
Entitled	13,308	*13	52	2,096	1,546	1,606	3,704	4,261	9,047	30,139
Living	11,663	*1	25	1,497	1,143	1,362	3,404	4,206	7,457	19,566
Deceased	1,645	*12	27	599	403	244	300	55	1,590	10,573
Non-entitled	8,146	275	403	3,852	956	537	614	1,508	6,638	13,010
Deceased	259	8	9	172	50	15	5	-	259	903
Living	7,887	267	394	3,680	906	522	609	1,508	6,379	12,107
Uninsured	5,212	267	349	2,988	666	361	343	237	4,975	9,068
Insured	2,675	-	45	692	240	161	266	1,271	1,404	3,039
Fully	2,667	-	45	692	240	161	265	1,264	1,403	3,033
Currently Only	8						1	7	1	6
70-71--Total	6,799	93	179	2,118	1,091	997	1,099	1,218	5,581	17,492
Entitled	4,663	3	24	913	825	878	972	1,044	3,619	13,399
Living	3,930	-	11	630	631	753	869	1,032	2,898	8,408
Deceased	733	3	13	283	194	125	103	12	721	4,991
Non-entitled	2,136	90	155	1,205	266	119	127	174	1,962	4,093
Deceased	78	5	4	57	8	2	2	-	78	306
Living	2,058	85	151	1,148	258	117	125	174	1,884	3,787
Uninsured	1,651	85	138	996	226	90	78	38	1,613	2,921
Insured [†]	407	-	13	152	32	27	47	136	271	866
72-74--Total	8,154	131	255	2,846	1,795	850	1,090	1,176	6,978	24,376
Entitled	5,668	9	56	1,321	1,511	744	974	1,044	4,624	18,814
Living	4,557	-	35	873	1,154	618	843	1,026	3,531	10,857
Deceased	1,111	9	21	448	357	126	131	18	1,093	7,957

Non-entitled	2,486	122	199	1,525	284	106	116	132	2,354	5,562
Deceased	110	3	5	77	18	4	3	-	110	445
Living [∇]	2,376	119	194	1,448	266	102	113	132	2,244	5,117
Uninsured	1,991	119	171	1,289	228	75	69	39	1,952	4,065
Insured [†]	385	-	23	159	38	27	44	93	292	1,052
75 & Over--Total	15,376	416	875	7,592	2,617	1,322	1,422	1,102	14,274	69,087
Entitled	10,134	15	219	4,268	2,187	1,162	1,291	963	9,171	50,844
Living	6,338	1	85	1,961	1,408	842	1,088	936	5,402	19,562
Deceased	3,796	14	134	2,307	779	320	203	27	3,769	31,299
Non-entitled	5,242	401	656	3,324	430	160	131	139	5,103	18,243
Deceased	334	16	50	230	22	13	2	1	333	2,119
Living [∇]	4,908	385	606	3,094	408	147	129	138	4,770	16,154
Uninsured	4,362	385	562	2,892	316	101	63	42	4,320	14,257
Insured [†]	546	-	44	202	92	46	66	96	450	1,867
All Ages--Total	522,220	4,468	7,315	96,988	53,062	37,166	79,168	243,931	278,289	518,372
Average Annual		4,468	3,658	8,817	13,266	18,583	26,389			

* Insurance status reflects military wage credits, railroad earnings, or earnings developed as a result of claims, but not shown in the table.

∇ It should be appreciated that these statistics were compiled from data showing 1960 as the last year of employment, therefore all those with covered earnings in 1960 had to show that year as the last year, however, were we able to follow these employees into 1961 we would have found about two-thirds of them continued in covered employment. Were it possible to add those who did not remain in covered employment after 1960, the total instead of 518,372 would probably well exceed 750,000. A small fraction of these will return to covered employment eventually in subsequent years, but a vast majority would not. We believe one of the multiple factors

contributing to the withdrawal from covered employment (unless they were transferring to non-covered employment) was the health status of the employee. In appraising the magnitude of the group withdrawing from covered employment the reader must remember that the above figures represent only 1 percent of the covered population; that those who have separated is increasing appreciably from year to year as indicated by the annualized totals on the last line of Table 14.

∇ Includes some workers not identified as deceased.

† Represents fully insured, currently insured the only category not applicable.

° Internally inconsistent in the original. The summed total comes to 10,703.

Source: Annual and Work History Statistics on Workers Under Social Security 1960, Employment, Earnings, Insurance Status Under Old-Age, Survivors, Disability and Health Insurance, U.S. Department of Health, Education and Welfare, Social Security Administration, Office of Research and Statistics. Tables IV-5a and 5b, pp. 176-179, Columns 10, 19, and 20. derived.

Definition of Terms: Entitled: "The state or condition of meeting the applicable requirements for receipt of benefits, including the filing of a claim."

Fully Insured: "Regular rule (prior to 1960 amendments [which further liberalized the requirements]): An individual who was alive on or after September 1, 1950, is fully insured if he has not less than one quarter of coverage for each two quarters elapsing after 1950 or after the quarter in which he attained age 21, whichever is later, and up to but not excluding the quarter in which he died or attained age 65 (age 62 for women, beginning November 1956). At least 6 months, but more than 40 quarters of coverage are required. [At present the requirement is one out of 4 quarters elapsed]. "For persons who died before September 1950, the period after 1936, rather than 1950, was used in determining required quarters of coverage."

Currently Insured: "A worker is currently insured if he has not less than 6 quarters of coverage during the 13-quarters period ending with the quarter of death, entitlement, or disability", Ibid., pp. 14.

Note: In the original document cells without frequencies are differentiated into those for which frequency could not have occurred and those for which this 1 percent sample had no frequency.

Table 15--Disability Claims Allowances and Denials
Under Social Security Program, 1955-1968

Year (1)	Disability		Total Appli- cations (4)	Ratio of Allowances to Total (2) to (4) (5)
	Allowance (2)	Denials (3)		
1955	57,221	36,310	95,531	0.5990
1956	149,823	155,875	305,698	0.4901
1957	165,003	125,720	290,723	0.5676
1958	184,476	204,110	388,586	0.4747
1959	178,952	146,325	325,277	0.5502
1960	179,419	113,195	292,614	0.6132
1961	241,060	192,435	433,495	0.5561
1962	286,434	146,640	433,074	0.6614
1963	224,229	146,325	370,554	0.6051
1964	209,475	175,815	385,290	0.5437
1965	267,738	201,477	469,215	0.5706
1966	259,101	206,894	465,995	0.5560
1967	282,130	274,638	556,768	0.5067
1968	299,061	354,185	653,246	0.4578
Total	2,984,122	2,479,944	5,464,066	0.5461

Source: Basic data for 1955-65 inclusive obtained from "Social Security Disability Applicant Statistics, 1965"; U.S. Department of Health, Education and Welfare, Social Security Administration Office of Research and Statistics, Table 1. Data for 1966-68 inclusive obtained through personal correspondence from the Bureau of Disability Benefits.

Table 16.--Number and Gross Termination Rates of Disabled Workers in Receipt of Monthly Disability Benefits from Death, Recovery, Attainment of Age 65 and Other Causes, 1958-1969

Year	Number of Terminations					Gross Termination Rates			
	Total	Death	Recovery	Age 65	Other	Total	Deaths	Recovery	Age 65
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1958 ¹	52,949	28,099	1,397	22,959	494	0.2868	0.1522	0.0076	0.1244
1959 ¹	87,982	42,771	3,228	35,664	319	0.2620	0.1367	0.0103	0.1140
1960	89,090	43,543	3,124	42,083	340	0.2349	0.1148	0.0083	0.1110
1961	115,546	60,538	2,936	51,370	702	0.2140	0.1121	0.0054	0.0951
1962	128,299	67,020	9,555	51,309	415	0.1874	0.0979	0.0140	0.0750
1963	137,850	73,344	12,931	50,664	911	0.1746	0.0929	0.0164	0.0642
1964	138,576	75,812	16,487	45,345	932	0.1599	0.0875	0.0190	0.0523
1965	156,648	79,823	18,441	56,966	1,418	0.1652	0.0842	0.0194	0.0601
1966	168,630	84,399	23,111	59,675	1,445	0.1600	0.0801	0.0219	0.0566
1967	208,899	92,084	37,151	76,887	2,777	0.1804	0.0795	0.0321	0.0664
Total	1,278,469	647,433	128,361	492,922					

¹For statistical purposes the years 1958 and 1959 were defined as covering the periods January 1, 1958 to November 30, 1958 and December 1, 1958 to December 31, 1959, respectively. However, the gross termination rates are shown after conversion to an annual basis.

Sources: Columns (3), (4), (8), and 9 are from the "Termination Experience of Disabled Worker Benefits Under OASDI, 1957-63" U.S. Dept. of Health, Education, and Welfare, Social Security Administration, Office of the Actuary, Actuarial Study No. 65, March 1969, Table 1, p. 9. Column (2) is from the Social Security Bulletin Annual Statistical Supplement, 1967 Table 105, p. 106, Columns (5) and (6) were obtained by private communication from the Bureau of Disability of Social Security Administration. Columns (7) and (10) were computed from the data available.

Table 17.--Estimated Disability Incidence Rate per 1,000 by age at Onset by Sex for 1957[√] and 1963*

Age at Onset [∇]	Men		Women	
	1957	1963	1957	1963
(1)	(2)	(3)	(4)	(5)
under 25	.8	.4	.2	.2
25-29	.8	.8	.3	.5
30-34	.8	1.1	.5	.8
35-39	1.0	1.7	.9	1.4
40-44	1.4	2.7	1.2	2.0
45-49	2.6	4.2	2.2	3.3
50-54	6.1	7.8	4.4	6.1
55-59	11.8	14.4	7.9	9.8
60-64	18.7	19.3	5.7	10.9
60-61	(17.0)	(22.4)	(7.3)	(14.1)
62-64 [†]	(20.2)	(16.2)	(3.6)	(6.4)

[√]Year in which cash benefits for those age 50 and over were paid.

*The latest year available.

[∇]Age on birthday in year of onset. Even though awards for cash benefits began in 1957 those becoming eligible included many who became disabled in prior years. This is demonstrated in the table.

[†]Includes the limited amount of experience before age 65 for persons who attain age 65 in the year of onset. In 1957 males were not eligible to retire on account of age prior to 65, they could do so in 1963.

Source: R.J. Meyers and F. Bayo, Disability Incidence Rates Under OASDI System for Disability Onset Occurring in 1956-1963, Actuarial Note No. 45, Aug. 1968, Table 4.

Table 18.--Disability Determination Awards in a Given Year by Year of Onset

Year of Disability Determination (1)	Year of Determination (2)	Year of Determination (3)	YEAR OF ONSET					
			1 Year Before (4)	2 Years Before (5)	3 Years Before (6)	4 Years Before (7)	5 Years Before (8)	6+Years Before (9)
1955	100%	2%	14%	13%	11%	10%	9%	40%
1956	100	1	14	19	16	11	8	32
1957	100	4	31	20	11	8	5	21
1958	100	10	39	19	8	5	4	15
1959	100	12	47	17	7	4	3	11
1960	100	12	52	17	7	3	2	7
1961	100	11	52	17	7	4	2	7
1962	100	16	49	17	6	3	2	6
1963	100	22	56	14	4	2	1	2
1964	100	22	58	14	2	1	$\frac{1}{2}$	2
1965	100	21	51	14	5	2	2	5
1955-65	100	14	46	16	7	4	3	10

$\frac{1}{2}$ Less than 1/2 percent.

Source: Myers, R.J. and Bayo, F., "Disability Incidence Rates Under OASDI System for Disability Onset Occurring in 1956-63"; Actuarial Note No. 45, August 1968, U. S. Department of Health, Education and Welfare, Social Security Administration, Table 1.

Table 19.--Graduated Death Termination Rates for OASDI Disability Beneficiaries in Selected Ages by Sex, 1957-63, Compared with Non-Disabled (Per thousands)

Nearest Age at Onset	Year of Onset 1 _y	Years After Onset					GENERAL POPULATION 2 _y	
							Attained Age	5 Years After
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
<u>MALES</u>								
20	37.6	49.7	26.0	16.4	13.5	11.5	1.69	1.75
25	41.4	51.5	30.5	21.7	20.1	18.5	1.75	1.81
30	44.3	52.2	35.4	27.3	26.1	24.9	1.81	2.40
35	51.7	60.3	42.8	35.9	34.5	33.8	2.40	3.73
40	62.0	76.3	54.8	49.0	47.9	46.4	3.73	6.05
45	72.9	93.5	68.0	62.3	61.5	60.4	6.05	10.14
50	75.1	104.8	80.9	73.7	73.4	74.2	10.14	15.49
55	71.8	107.9	88.1	83.2	85.0	86.5	15.49	23.50
60	67.3	108.7	91.1	89.4	91.0	-	23.50	34.74
<u>FEMALES</u>								
20	23.2	29.7	27.2	22.2	16.8	20.1	0.64	0.71
25	30.9	41.6	33.5	26.0	23.1	25.4	0.79	1.01
30	38.4	53.1	40.0	30.0	28.6	30.1	1.06	1.51
35	47.2	70.2	47.2	35.0	34.4	35.4	1.51	2.30
40	56.7	87.9	55.1	41.0	41.3	44.5	2.30	3.51
45	65.2	93.3	60.4	47.3	47.5	49.3	3.51	5.41
50	63.0	90.7	60.2	50.7	50.7	50.7	5.41	7.83
55	55.6	83.9	59.6	53.2	53.0	53.0	7.83	12.09
60	56.6	86.1	64.6	59.9	58.0	-	12.09	18.54

1/ This value represents the probability that a worker who became disabled at age X nearest birthday and who survived with the disability to the end of the 7th calendar month following the month of disability onset will die during the remaining 5 calendar months. All other rates are in terms of 12 months exposure.

2/ Source: The rates for disabled lives is from F. Bayo, "Termination Experience of Disabled Worker--Worker Benefits Under OASDI, 1957-63", U.S. Dept. of Health, Education and Welfare, Social Security Administration, Office of Actuary, Actuarial Study No. 65, March 1969, Table 4, pp. 12-13 and Table 5, pp. 14 and 15. The rates for general population is from United States Life Tables, 1959-61, Table 2, pp. 10 and 11, and Table 3, pp. 12-13. Since for disabled, the age is the one nearest to time of onset, the more appropriate rate for general population would have been the mid-point of the rates for age X and X+1. But this refinement was deemed unwarranted.

Table 20.--Comparison of Graduated Death Rates of OASDI Beneficiaries with the General Population for Males and Females, 1959-61

Age	MALES			FEMALES		
	OASDI Population	U.S. Population	Ratio (3)/(2)	OASDI Population	U.S. Population	Ratio (6)/(5)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
62	.02525	.02769	1.10	.01099	.01451	1.32
63	.02732	.02992	1.10	.01216	.01578	1.30
64	.02955	.03226	1.09	.01346	.01711	1.27
65	.03196	.03474	1.09	.01489	.01854	1.25
66	.03456	.03739	1.08	.01649	.02014	1.22
67	.03737	.04017	1.07	.01824	.02199	1.20
68	.04040	.04307	1.07	.02018	.02415	1.20
69	.04367	.04612	1.06	.02233	.02661	1.19
70	.04721	.04936	1.05	.02470	.02929	1.19
71	.05102	.05285	1.04	.02732	.03219	1.18
72	.05513	.05665	1.03	.03022	.03546	1.17
73	.05956	.06083	1.02	.03342	.03914	1.17
74	.06434	.06541	1.02	.03694	.04327	1.17
75	.06948	.07035	1.01	.04083	.04767	1.17
76	.07501	.07571	1.01	.04512	.05246	1.16
77	.08097	.08176	1.01	.04985	.05804	1.16
78	.08738	.08870	1.02	.05507	.06469	1.17
79	.09427	.09661	1.02	.06081	.07240	1.19
80	.10167	.10598	1.04	.06712	.08144	1.21
81	.10962	.11654	1.06	.07407	.09143	1.23
82	.11815	.12732	1.08	.08170	.10154	1.24
83	.12729	.13728	1.08	.09008	.11096	1.23
84	.13708	.14623	1.07	.09927	.11975	1.21
85	.14756	.15768	1.07	.10934	.13423	1.23
86	.15877	.17002	1.07	.12037	.15009	1.25
87	.17074	.18343	1.07	.13242	.16689	1.26
88	.18351	.19868	1.08	.14577	.18478	1.27
89	.19711	.21564	1.09	.15991	.20364	1.27
90	.21159	.23320	1.10	.17550	.22329	1.27
91	.22679	.25056	1.10	.19242	.24327	1.26
92	.24329	.26792	1.10	.21078	.26302	1.25
93	.26057	.28481	1.09	.23064	.28181	1.22
94	.27884	.30050	1.08	.25203	.29903	1.19
95	.29811	.31416	1.05	.27503	.31416	1.14

Source: F. Bayo and M.P. Glanz, Mortality Experience of Workers Entitled to Old-age Benefits under OASDI, 1941-1961, U.S. Department of Health, Education and Welfare, Social Security Administration, Division of the Actuary, Actuarial Study No. 60, August 1965, Table 10, pp. 27 and Table 11, pp. 28.

Table 21.--Comparative Incidence of Compensable Disability and Death for Working Men and Women

Age	Rate of Disability		Rate of Death		Relative Excess of Deaths	
	Male	Female	Male*	Female [✓]	Male	Female
Under 25	.0004	.0002	.00145	.00071	3.625	3.550
25-29	.0008	.0005	.00171	.00097	2.138	1.940
30-34	.0011	.0008	.00246	.00145	2.236	1.812
35-39	.0017	.0014	.00409	.00229	2.406	1.636
40-44	.0027	.0020	.00686	.00362	2.541	1.810
45-49	.0042	.0033	.01264	.00560	3.010	1.697
50-54	.0078	.0061	.01730	.00805	2.218	1.320
55-59	.0144	.0098	.02690	.01325	1.868	1.352
60-64	.0193	.0109	.03930	.02100	2.036	1.927

*From 1959-61, U.S. Life Table for white males 5 years advanced.

[✓]From 1959-61, U.S. Life Table for white females 5 years advanced.

For rates of disability see Table 17.

Table 22--Death Rates Per Thousand Population Based on Group Annuity Experience (GA-1951)
Compared with that of the General Population of the United States^{1/}

Age (1)	Males							Females						
	Death Rates Per 1000				Percentages			Death Rate per 1000				Percentages		
	GA- 1951 (2)	United States Population			(3) /(2) (4) /(2) (5) /(2) (6) (7) (8)			GA- 1951 (9)	United States Population			(13) (14) (15)		
		Total	White	Non- White					Total	White	Non- White			
		(3)	(4)	(5)					(10)	(11)	(12)			
40-44	2.5	4.6	4.1	8.8	184.0	164.0	352.0	1.6	2.7	2.3	6.6	168.8	143.8	412.5
45-49	4.6	7.4	6.9	11.8	160.9	150.0	256.5	2.4	4.2	3.6	8.8	175.0	150.0	366.7
50-54	7.9	12.3	11.6	18.5	155.7	146.8	234.2	3.6	6.4	5.6	13.9	177.8	155.6	386.1
55-59	12.3	18.1	17.3	25.9	147.2	140.7	210.6	5.6	9.1	8.0	19.8	162.5	142.9	353.6
60-64	18.4	27.7	26.9	35.5	150.5	146.2	192.9	9.8	14.5	13.2	27.8	148.0	134.7	283.7
65-69	30.1	40.2	39.3	49.5	133.6	130.6	164.5	16.5	22.0	21.0	33.0	133.3	127.3	200.0
70-74	47.5	56.7	56.2	61.8	119.4	118.3	130.1	30.5	35.5	34.6	46.2	116.4	113.4	151.5
75-79	75.1	81.8	82.7	70.4	108.9	110.1	93.7	55.1	58.0	58.3	55.1	105.3	105.8	100.0

^{1/}For each age group the death rate for midpoint for the age interval is used from the U.S. Life Tables.

Source: GA-1951, Ray M. Peterson, "Group Annuity Mortality," Society of Actuaries Transactions, Publication Year 1952, No. 4, pp. 246-307, Table 14, p. 271
U.S. Life Tables 1959-61, Vol. 1, No. 1, U.S. Dept. of Health, Education, and Welfare.

Table 23--Comparison of 1955 Death Rates for Male Workers Insured Under OASDI and of Total Male Population

Age	Death rate per 1,000				Death rate for insured male workers as percent of rate for total male population		
	Total male population	Insured male workers					
		Total	With 1955 earnings	With-out 1955 earnings	Total	With 1955 earnings	With-out 1955 earnings
All ages ¹ --	12.0	10.8	7.1	18.2	90	59	152
15-19 ² -----	1.3	1.1	1.2	1.0	85	92	77
20-24-----	2.0	1.9	1.7	2.2	95	85	110
25-29-----	1.8	1.7	1.2	3.6	95	67	200
30-34-----	2.0	1.9	1.6	3.4	95	80	170
35-39-----	3.0	2.8	2.2	5.3	93	73	177
40-44-----	4.6	4.2	3.0	9.7	91	65	211
45-49-----	7.6	7.0	5.6	13.5	92	74	178
50-54-----	12.2	10.5	8.7	18.7	86	71	153
55-59-----	18.3	16.5	11.9	37.1	90	65	203
60-64-----	27.9	23.6	15.0	52.9	85	54	190
65-69-----	42.2	37.3	22.0	56.7	88	52	134
70-74-----	58.7	54.2	32.1	67.5	92	55	115
75 and over ³ ---	105.0	101.1	50.3	116.3	96	48	111

¹ Rate for all ages determined by weighting age-specific rates by total number of insured workers in each age group.

² For insured workers, all under age 20 are assumed to be aged 15-19.

³ Rate for total population based on age distribution of total number of insured workers.

Source: Social Security Bulletin 24(7), Table 2, page 14, July 1961

Table 24--Comparison of 1955 Death Rates of Female Workers Insured Under OASDI and of Total Female Population

Age	Death rate per 1,000				Death rate for insured female workers as per- cent of rate for total female population		
	Total female popu- lation	Insured female workers			Total	With 1955 earnings	With- out 1955 earnings
		Total	With 1955 earnings	With- out 1955 earnings			
All ages ¹ --	5.0	3.4	2.1	4.9	68	42	98
15-19 ² -----	.6	.3	.2	.4	50	33	67
20-24-----	.8	.4	.4	.4	50	50	50
25-29-----	.9	.6	.5	.6	67	56	67
30-34-----	1.3	.8	.8	.8	62	62	62
35-39-----	1.9	1.3	1.1	1.5	68	58	79
40-44-----	2.9	2.0	1.1	3.1	69	38	107
45-49-----	4.3	3.1	2.0	4.9	72	47	114
50-54-----	6.6	4.4	2.9	7.4	67	44	112
55-59-----	9.7	6.4	3.7	11.9	66	38	123
60-64-----	15.2	10.3	6.7	16.7	68	44	110
65-69-----	25.5	17.6	11.7	22.7	69	46	89
70-74----- ³	37.9	26.3	10.7	33.2	69	28	88
75 and over --	78.1	59.5	22.2	70.6	76	28	90

¹ Rate for all ages determined by weighting age-specific rates by total number of insured workers in each age group.

² For insured workers, all under age 20 are assumed to be aged 15-19.

³ Rate for total population based on age distribution of total number of insured workers

Source: Social Security Bulletin, 24(7), Table 3, page 15, July 1961

Figure I

Phasing of AEC Health Study and Estimated Progress (Aug. 1969)

<u>Phase I</u>	<u>Phase II</u>	<u>Phase III</u>
Organizing project, development of cooperative arrangements with AEC contractor facilities, Social Security Administration, and other Federal and State agencies, visits to facilities, questionnaires on available data, searching for record sources, identification, sorting and uniform abstracting of appropriate records and conversion to master forms.	Data processing and programming, conversion of data to IBM cards and magnetic tape, Social Security processing to identify deceased and places of death, obtaining and checking death certificates from states, development of control populations, quality control checks on data.	Coding death data, interpretation of deaths with ADP file, statistical design and analysis, test runs on selected populations and exposure groups, final project analyses, interpretation and presentation of results.

FY 1966 6/1/65	FY 1967 6/1/66	FY 1968 6/1/67	FY 1969 8/1/68	FY 1970 8/1/69
I. <u>Personnel Data*</u> (Locating and abstracting personal employment data and work histories.)				
Hanford - General Electric and other Contractors' Employees (1944-1969)				POPULATION SIZE 35,000 Completion - 100% (including 2,350 "non-starts")
Oak Ridge Employees: (Carbide and all prior contractors-- a non-duplicated count of all personnel.)				POPULATION SIZE 103,123 Completion - 100%
Feed Mills and other Laboratories				
Mallinckrodt Chemical Company				POPULATION SIZE 3,782 Completion - 90%
National Lead Company				POPULATION SIZE 6,536 Completion - 95%
SAM (Columbia University)				POPULATION SIZE 3,585 Completion - 50%
Other Feed Mills as records permit (Harshaw, Linde Air, Lindsay Chemical Co., Middlesex Sampling Plant, Simonds Saw and Steel, Vitro Mfg. Co.)				POPULATION SIZE about 22,500 Completion - 10% (now underway)

*Work history data have also been recorded and work location data of Hanford and Oak Ridge (3 facilities) have been obtained during FY 1969. In addition, records for over 100,000 sibs of employees have been obtained and much of this data have been converted for use as one type of control population.

Figure I (cont'd)

Phase I		Phase II		Phase III	
FY 1966	FY 1967	FY 1968	FY 1969	FY 1970	
I. <u>Personnel Data</u>					
Manhattan Engineer District (MED) Security Record Card File: Key punched data from cards as a check source; included 192,000 employees of total of 420,000 names in security file			TOTAL MED POPULATION SIZE 192,000 Completion - 100%		
			TOTAL		
			TOTAL POPULATION OF EMPLOYEES IN PRESENT STUDY = 175,000		
			AVERAGE LENGTH OF ATOMIC ENERGY EMPLOYMENT = about 10 years		
II. <u>Radiation Data</u>					
Hanford, all contractors, external and all internal (bioassay) data available (1944 - present)			MONITORED POPULATION = 30,000 Completion - 100%		
Oak Ridge, all Carbide employees (1943 - present)			MONITORED POPULATION = 21,835 Completion - 100% (ORNL - 11,457; Y-12-) (6,930; ORGDP - 3,448)		
Oak Ridge, Monsanto at ORNL before 1948 - University of Chicago (1943 - 1947)			MONITORED POPULATION = 3,500 Completion - 100%		
Oak Ridge, Tennessee - Eastman Corp. at Y-12, uranium and other bioassay data only (1944-1946)			MONITORED POPULATION unknown (about 40,000 total employees) Completion - 20% (Records currently being abstracted)		

Figure I (cont'd)

<u>Phase I</u>		<u>Phase II</u>		<u>Phase III</u>
FY 1966	FY 1967	FY 1968	FY 1969	FY 1970
Feed Mills (Radiation and personnel data being abstracted together, radiation data spotty in early years.) (1943 -				MONITORED POPULATION unknown (about 10,000) Completion - About 30%
Hanford Special Study - Diagnostic Medical Exposure on Employees employed continuously (1946-1956)				MONITORED POPULATION = 2,300 (of the above total) (population at Hanford) Completion - 100%

III. Retrieval of Other Environmental Data and Work Histories

Oak Ridge - Retrieval of information related to environmental exposures from agents other than radiation, and work histories, from multiple sources including: log books, air sample data (more than one million records have been recorded), bioassay records, payroll records, etc. (1943 - present)	POPULATION given above Completion - 60%
Hanford - Retrieval of information related to environmental exposures and work, by reconstructing organizational charts, codes and activities of all job codes (1944-present)	POPULATION given above Completion - 95%

IV. Retrieval of Mortality Data from Social Security Administration and State Records

Social Security Administration develops matched control populations (two persons for each employee, matched by employment and demographic characteristics from the 1% national sample of workers covered by Social Security)	(Not yet begun)
Social Security Administration develops control populations from siblings of employees of Oak Ridge and Hanford, whose identities have been abstracted from PSQ records	(Not yet begun)

Figure I (cont'd)

Phase IPhase IIPhase III

FY 1966

FY 1967

FY 1968

FY 1969

FY 1970

Social Security Administration identifies and traces deaths of AEC contractor employees, sibling controls, and other controls; death certificates requested by project staff from states; death information coded and integrated into master files

Completion -
 (Hanford population-100%)
 (processed for deaths)
 (through Social Security)
 (Oak Ridge-to be processed)
 (through SSA 80-90% ready)
 (for processing)
 (Feed Mills - 20% ready)
 (for processing)

V. Analysis and Presentation of Project Results, Continuation
and Extension of Study to Increase Person-Years of Exposure

Test runs on grouping population according to various ranges of demographic, work history, and exposure characteristics

Completion - about 10%

Design of statistical methods for evaluating and presenting results

Completion - about 10%

Analysis of data, presentation of results, phasing into continuing studies by automatic methods

(Not yet begun)

Figure 2

MANCUSO PROJECT
DATA BASE

K-25 PLANT

		UNION CARBIDE CORPORATION																											
TYPE OF RECORD	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	
WORK HISTORY																													
EXTERNAL RADIATION (FILM BADGE)																													
INTERNAL RADIATION BIO-ASSAY W. BODY COUNTER																													
LABORATORY ANALYSIS (NON-RADIOACTIVE) MERCURY } LEAD (1) } ETC. (1) }																													
AIR DATA URANIUM } BERYLLIUM } MERCURY } CARBON-TET. } NICKEL }																													
PSQ DATA (SIBS) TERMINATED EMPLOYEES ACTIVE EMPLOYEES																													

RULED UNCLASSIFIED
2-25-69
READY FOR KEYPUNCHING

RULED UNCLASSIFIED
2-25-69
READY FOR KEYPUNCHING

(1) COMPLETE LIST CONTAINED
IN NYO-3394-5, APPENDIX G

ON MAGNETIC TAPE

KEYPUNCHING

EXTRACTING & TRANSCRIBING

Figure 2 (cont'd)

MANCUSO PROJECT
DATA BASE

Y-12 PLANT

	TEC						UNION CARBIDE CORPORATION																						
TYPE OF RECORD	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	
WORK HISTORY																													
EXTERNAL RADIATION (FILM BADGE)																													
INTERNAL RADIATION BIO-ASSAY																													
W BODY COUNTER																													
LABORATORY ANALYSIS (NON-RADIOACTIVE)																													
MERCURY																													
LEAD																													
AIR DATA																													
URANIUM																													
THORIUM																													
BERYLLIUM																													
MERCURY																													
LEAD																													
OTHER DATA																													
INSULATOR CHEST X-RAY																													
MERCURY RESTRICTION																													
BERYLLIUM RESTRICTION																													
WELDER X-RAY																													
PSQ DATA																													
TERMINATED EMPLOYEES																													
ACTIVE EMPLOYEES																													

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ON MAGNETIC TAPE

KEYPUNCHING

EXTRACTING & TRANSCRIBING

Figure 2 (cont'd)

MANCUSO PROJECT DATA BASE																													
URANIUM FEED PLANTS																													
TYPE OF RECORD	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	
MALLINCHRODT CHEM. (WELDON SPRING & DESTRAHAN)																													
WORK HISTORY & PSQ																													
INTERNAL RADIATION																													
EXTERNAL RADIATION (FILM BADGE, ETC.)																													
BREATH RADON																													
NATIONAL LEAD OF OHIO (FERNALD PLANT)																													
WORK HISTORY & PSQ																													
INTERNAL RADIATION																													
EXTERNAL RADIATION																													
DATA FROM NYO OPERATION, ETC.																													

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EXTRACTING & TRANSCRIBING

KEYPUNCHING

ON MAGNETIC TAPE

Figure 3

Sample Print-out of Y-12 Employee Work History

DEPARTMENT 2617, 2619 + 2793 EMPLOYEES

ADGE NAME

48533 T S ARNOLD

DATE		WORK AREAS
YR	QTR	
61	1	12AA, 12BA, 12CA, 14AA, 24AA
61	2	12AA, 12BA, 12CA, 14AA, 24AA
61	3	12AA, 12BA, 12CA, 14AA, 24AA, 12F
61	4	12AA, 12BA, 12CA, 14AA, 24AA, 12F
62	2	112AA, 12CA, 12DA, 24AA, 12F
62	3	12F
62	4	12AA, 12CA, 24AA, 12F
63	1	12AA, 12CA, 12DA, 24AA, 12F
63	2	12AA, 12CA, 12DA, 24AA, 12F
63	3	12AA, 12CA, 12DA, 12EA, 24AA, 12F
63	4	12AA, 12CA, 12DA, 12EA, 12F
64	1	12AA, 12CA, 12DA, 12EA, 12F
64	2	12AA, 12CA, 12DA, 12EA, 12F
64	3	12AA, 12BA, 12CA, 12DA, 12EA, 12F
64	4	12AA, 12BA, 12CA, 12DA, 12EA, 12F
65	1	12AA, 12BA, 12CA, 12DA, 12EA, 12F
65	2	10AA, 10BA, 11AA, 11BA, 11CA, 11DA, 11EA, 11FA, 11JA
65	3	10AA, 10BA, 11AA, 11BA, 11CA, 11DA, 11EA, 11FA, 11JA
65	4	10AA, 10BA, 11AA, 11BA, 11CA, 11DA, 11EA, 11FA, 11JA
66	1	10AA, 10BA, 11AA, 11BA, 11CA, 11DA, 11EA, 11FA, 11JA
66	2	10AA, 10BA, 11AA, 11BA, 11CA, 11DA, 11EA, 11FA, 11JA
66	3	10AA, 10BA, 11AA, 11BA, 11CA, 11DA, 11EA, 11FA, 11JA
66	4	10AA, 10BA, 11AA, 11BA, 11CA, 11DA, 11EA, 11FA, 11JA

*****COLUMN HEADINGS FOR TYPE (W) LINES*****

SOC. SEC. NUMBER	LAST NAME	FIRST-SEC NAME INT	BIRTH DATE	EMPLOYMENT DATES BEGIN END	DATE DECEASED
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*****COLUMN HEADINGS FOR TYPE (X) LINES*****

X-RAY YEAR	TYPE CODE	NO. OF PLATES	TOTAL MIDLINE (R)	TOTAL SURFACE (R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	
002014114							
46	C01	2	.390	5.500	4.0365	.3410	** W **
1946 TOTAL		2			4.0365	.3410	** X **
47	C01	2	.390	5.500	4.0365	.3410	** X **
1947 TOTAL		2			4.0365	.3410	
48	C01	1	.195	2.750	2.0183	.1705	** X **
1948 TOTAL		1			2.0183	.1705	
49	C01	1	.195	2.750	2.0183	.1705	** X **
49	C05	1	.010	.249	.2371	.0321	** X **
1949 TOTAL		2			2.2554	.2026	
51	C01	1	.195	2.750	2.0183	.1705	** X **
1951 TOTAL		1			2.0183	.1705	
52	C01	1	.195	2.750	2.0183	.1705	** X **
1952 TOTAL		1			2.0183	.1705	
54	C01	1	.195	2.750	2.0183	.1705	** X **
1954 TOTAL		1			2.0183	.1705	
EMPLOYEE TOTAL			10		18.4016	1.5666	

003012535							
46	C01	2	.390	5.500	4.0365	.3410	** W **
1946 TOTAL		2			4.0365	.3410	** X **
47	B07	1	.210	3.130	2.2344	.1941	** X **
47	B08	1	.230	8.182	2.4472	.5073	** X **
47	C01	1	.195	2.750	2.0183	.1705	** X **

Figure 5
REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE

REPORT HRM 0004

PAGE

1

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
A01	1946	29	6,815	113,854	65,5603	7,0586	24
A01	1947	31	7,285	121,706	70,0817	7,5454	27
A01	1948	40	9,400	157,040	90,4280	9,7360	22
A01	1949	20	4,700	78,520	45,2148	4,8480	15
A01	1950	47	11,045	184,522	106,2529	11,4398	34
A01	1951	84	19,740	329,784	189,8988	20,4460	49
A01	1952	105	24,675	412,230	237,3735	25,5574	71
A01	1953	68	15,980	266,968	153,7276	16,5519	16
A01	1954	61	14,335	239,486	137,9027	14,8480	19
A01	1955	43	10,105	168,818	97,2101	10,4666	12
A01	1956	25	5,875	98,150	56,5175	6,0853	7
TOTAL	A01	553	129,955	2,171,078	1,250,1671	134,6030	
A02	1947	13	3,055	51,038	29,3891	3,1643	4
A02	1949	21	4,935	82,446	47,4747	5,1115	8
A02	1950	10	2,350	39,260	22,6070	2,4341	4
A02	1951	18	4,230	70,668	40,6926	4,3814	3
A02	1952	6	1,410	23,556	13,5642	1,4604	3
A02	1953	7	1,645	27,482	15,8249	1,7039	3
A02	1954	3	1,705	11,778	6,7821	1,7302	1
A02	1955	29	6,815	113,854	65,5603	7,0590	5
TOTAL	A02	107	25,145	420,082	241,8949	26,0448	
B02	1947	6	1,420	5,946	2,2932	1,1368	1
B02	1948	6	1,420	5,946	2,2932	1,1368	2
B02	1949	8	1,560	7,928	3,0576	1,1824	2
B02	1950	10	1,700	9,910	3,8220	1,2280	5
B02	1951	66	4,620	65,406	25,2252	1,5047	23
B02	1952	437	30,590	433,067	167,0214	9,9621	99
B02	1953	528	36,960	523,248	201,8016	12,0379	122
B02	1954	399	27,930	395,409	152,4978	9,0967	90
B02	1955	309	21,630	306,219	118,0998	7,0449	71
B02	1956	119	8,330	117,929	45,4818	2,7128	31
TOTAL	B02	1,888	132,160	1,871,008	721,5936	43,0431	
B03	1947	2	1,420	6,260	4,4688	1,3882	2
B03	1950	5	1,050	15,650	11,1720	1,9704	3

**REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE**

REPORT HRM 0004							PAGE 2
TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
B03	1951	5	1,050	15,650	11,1720	,9703	3
B03	1952	12	2,520	37,560	26,8128	2,3288	4
B03	1953	15	3,150	46,950	33,5160	2,9111	8
B03	1954	2	,420	6,260	4,4688	,3882	2
B03	1956	4	,840	12,520	8,9376	,7762	1
TOTAL	B03	45	9,450	140,850	100,5480	8,7332	
B04	1951	4	,280	3,964	1,5288	,0912	2
B04	1952	22	1,540	21,802	8,4084	,5016	11
B04	1953	45	3,150	44,595	17,1990	1,0260	25
B04	1954	88	6,160	87,208	33,6336	2,0064	55
B04	1955	55	3,850	54,505	21,0210	1,2540	38
B04	1956	23	1,610	22,793	8,7906	,5244	10
TOTAL	B04	237	16,590	234,867	90,5814	5,4036	
B05	1946	3	,096	12,213	1,0215	,7572	2
B05	1947	1	,032	4,071	,3405	,2524	1
B05	1948	2	,064	8,142	,6810	,5048	2
B05	1949	5	,160	20,355	1,7025	1,2620	3
B05	1950	8	,256	32,568	2,7240	2,0192	8
B05	1951	20	,640	81,420	6,8100	5,0480	20
B05	1952	16	,512	65,136	5,4480	4,0384	16
B05	1953	13	,416	52,923	4,4265	3,2812	13
B05	1954	19	,608	77,349	6,4695	4,7956	19
B05	1955	22	,704	89,562	7,4910	5,5528	21
B05	1956	11	,352	44,781	3,7455	2,7764	11
TOTAL	B05	120	3,840	488,520	40,8600	30,2880	
B06	1946	2	,190	11,272	2,0216	,6988	2
B06	1947	5	,475	28,180	5,0540	1,7471	3
B06	1948	9	,855	50,724	9,0972	3,1446	9
B06	1949	24	2,280	135,264	24,2592	8,3858	22
B06	1950	16	1,520	90,176	16,1728	5,5904	16
B06	1951	37	3,515	208,532	37,3996	12,9285	29
B06	1952	39	3,705	219,804	39,4212	13,6276	27
B06	1953	63	5,985	355,068	63,6804	22,0128	53
B06	1954	33	3,135	185,988	33,3564	11,5306	29

REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE

REPORT HRM 0004

PAGE 3

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
B06	1955	30	2,850	169,080	30,3240	10,4823	27
B06	1956	13	1,235	73,268	13,1404	4,5423	12
TOTAL	B06	271	25,745	1,927,356	273,9268	94,6908	
B07	1946	37	7,770	115,810	82,6728	7,1814	33
B07	1947	47	9,870	147,110	105,0168	9,1225	45
B07	1948	77	16,170	241,010	172,0488	14,9440	54
B07	1949	105	22,050	328,650	234,6120	20,3766	56
B07	1950	200	42,000	626,000	446,8800	38,8126	87
B07	1951	243	51,030	760,590	542,9592	47,1571	102
B07	1952	327	68,670	1,023,510	730,6488	63,4585	120
B07	1953	357	74,970	1,117,410	797,6808	69,2817	157
B07	1954	235	49,350	735,550	525,0840	45,6056	98
B07	1955	204	42,840	638,520	455,8176	39,5894	85
B07	1956	79	16,590	247,270	176,5176	15,3313	39
TOTAL	B07	1,911	401,310	5,981,430	4,269,9384	370,8607	
B08	1946	33	7,590	270,006	80,7576	16,7409	26
B08	1947	43	9,890	351,826	105,2296	21,8139	36
B08	1948	76	17,480	621,832	185,9872	38,5547	43
B08	1949	98	22,540	801,836	239,8256	49,7152	40
B08	1950	215	49,450	1,759,130	526,1480	109,0681	70
B08	1951	253	58,190	2,070,046	619,1416	128,3437	76
B08	1952	329	75,670	2,691,878	805,1288	166,8968	94
B08	1953	345	79,350	2,822,790	844,2840	175,0163	111
B08	1954	220	50,600	1,800,040	538,3840	111,6042	69
B08	1955	191	43,930	1,562,762	467,4152	96,8931	60
B08	1956	75	17,250	613,650	183,5400	38,0472	27
TOTAL	B08	1,878	431,940	15,365,796	4,595,8416	952,6841	
B09	1946	2	,134	12,180	1,4258	,7552	2
B09	1947	5	,335	30,450	3,5644	1,8879	3
B09	1948	9	,603	54,810	6,4161	3,3984	9
B09	1949	22	1,474	133,980	15,6838	8,3072	21
B09	1950	20	1,340	121,800	14,2579	7,5519	18
B09	1951	35	2,345	213,150	24,9515	13,2160	29
B09	1952	39	2,613	237,510	27,8030	14,7263	28

**REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE**

REPORT HRM 0004

PAGE 4

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
B09	1953	63	4,221	383,670	44,9125	23,7886	54
B09	1954	36	2,412	219,240	25,6643	13,5935	30
B09	1955	30	2,010	182,700	21,3870	11,3280	27
B09	1956	13	,871	79,170	9,2677	4,9088	12
TOTAL	B09	274	18,358	1,668,660	195,3340	103,4618	
C01	1946	3,213	626,535	8,835,750	6,484,6389	547,8165	1,621
C01	1947	2,488	485,160	6,842,000	5,021,4084	424,2040	1,268
C01	1948	1,646	320,970	4,526,500	3,322,1169	280,6430	1,597
C01	1949	809	157,755	2,224,750	1,632,8039	137,9345	801
C01	1950	413	80,535	1,135,750	833,5575	70,4165	409
C01	1951	303	59,085	833,250	611,5448	51,6615	302
C01	1952	743	144,885	2,043,250	1,499,5966	126,6815	740
C01	1953	756	147,420	2,079,000	1,525,8341	128,8980	748
C01	1954	479	93,405	1,317,250	966,7654	81,6695	476
C01	1955	166	32,370	456,500	335,0373	28,3030	159
C01	1956	255	49,725	701,250	514,6661	43,4775	250
TOTAL	C01	11,271	2,197,845	30,995,250	22,747,9699	1,921,7055	
C02	1949	1	,010	,249	,2371	,0321	1
C02	1951	1	,010	,249	,2371	,0321	1
C02	1952	2	,020	,498	,4742	,0642	2
C02	1953	5	,050	1,245	1,1855	,1605	5
C02	1956	1	,010	,249	,2371	,0321	1
TOTAL	C02	10	,100	2,490	2,3710	,3210	
C03	1946	6	,330	2,898	7,5900	,2898	6
C03	1947	6	,330	2,898	7,5900	,2898	6
C03	1948	12	,660	5,796	15,1800	,5796	8
C03	1949	14	,770	6,762	17,7100	,6762	12
C03	1950	51	2,805	24,633	64,5150	2,4633	43
C03	1951	104	5,720	50,232	131,5600	5,0232	94
C03	1952	100	5,500	48,300	126,5000	4,8300	88
C03	1953	131	7,205	63,273	165,7150	6,3273	125
C03	1954	122	6,710	58,926	154,3300	5,8926	114
C03	1955	96	5,280	46,368	121,4400	4,6368	88
C03	1956	80	4,400	38,640	101,2000	3,8640	60
TOTAL	C03	722	39,710	348,726	913,5300	74,8724	

REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE

REPORT HRM 0004

PAGE 5

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
C04	1946	1	,055	,483	1,2650	,0483	1
C04	1947	1	,055	,483	1,2650	,0483	1
C04	1949	1	,055	,483	1,2650	,0483	1
C04	1950	6	,330	2,898	7,5900	,2898	5
C04	1951	3	,165	1,449	3,7950	,1449	3
C04	1952	14	,770	6,762	17,7100	,6762	14
C04	1953	21	1,155	10,143	26,5650	1,0143	20
C04	1954	58	3,190	26,014	73,3700	2,8014	57
C04	1955	43	2,365	20,769	54,3950	2,0769	42
C04	1956	42	2,310	20,286	53,1300	2,0286	41
TOTAL	C04	190	10,450	91,770	240,3500	9,1770	
C05	1946	302	3,020	75,198	71,6042	9,6942	293
C05	1947	379	3,790	94,371	89,8609	12,1660	370
C05	1948	294	2,940	73,206	69,7074	9,4374	284
C05	1949	1,037	10,370	258,213	245,8727	33,2877	1,025
C05	1950	1,091	10,910	271,659	258,6761	35,0212	1,083
C05	1951	827	8,270	205,923	196,0817	26,5467	813
C05	1952	929	9,290	231,321	220,2659	29,8210	907
C05	1953	1,020	10,200	253,980	241,8420	32,7423	1,003
C05	1954	1,224	12,240	304,776	290,2104	39,2905	1,198
C05	1955	902	9,020	224,598	213,8642	28,9544	880
C05	1956	667	6,670	166,083	158,1457	21,4111	645
TOTAL	C05	8,672	86,720	2,159,328	2,056,1312	278,3725	
C06	1946	8	,080	1,992	1,8968	,2568	5
C06	1947	24	,240	5,976	5,6904	,7705	12
C06	1948	20	,200	4,980	4,7420	,6420	10
C06	1949	10	,100	2,490	2,3710	,3210	5
C06	1950	14	,140	3,486	3,3194	,4494	7
C06	1952	2	,020	,498	,4742	,0642	1
C06	1954	2	,020	,498	,4742	,0642	1
C06	1955	2	,020	,498	,4742	,0642	1
TOTAL	C06	82	,820	20,418	19,4422	2,6323	
C07	1949	3	,030	,747	,7113	,0964	1
C07	1951	1	,010	,249	,2371	,0321	1

**REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE**

REPORT HRM 0004

PAGE 6

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
C07	1953	6	,060	1,494	1,4226	,1927	3
TOTAL	C07	10	,100	2,490	2,3710	,3212	
C08	1951	2	,110	,966	2,5300	,0966	1
C08	1953	1	,055	,483	1,2650	,0483	1
TOTAL	C08	3	,165	1,449	3,7950	,1449	
C09	1949	4	,080	1,992	1,8968	,2570	1
C09	1953	1	,020	,498	,4742	,0642	1
TOTAL	C09	5	,100	2,490	2,3710	,3212	
C11	1950	2	,068	1,296	,7963	,0920	1
C11	1951	8	,272	5,184	3,1851	,3680	2
C11	1952	3	,102	1,944	1,1944	,1380	1
C11	1953	5	,170	3,240	1,9907	,2300	2
C11	1954	3	,102	1,944	1,1944	,1380	1
C11	1955	4	,136	2,592	1,5925	,1840	2
TOTAL	C11	25	,850	16,200	9,9534	1,1500	
C12	1950	3	,204	3,888	2,3888	,2760	1
C12	1951	2	,136	2,592	1,5926	,1840	2
C12	1952	2	,136	2,592	1,5926	,1840	1
C12	1953	1	,068	1,296	,7963	,0920	1
C12	1954	1	,068	1,296	,7963	,0920	1
C12	1955	1	,068	1,296	,7963	,0920	1
TOTAL	C12	10	,680	12,960	7,9629	,9200	
C13	1947	1	,136	2,592	1,5926	,1840	1
C13	1950	1	,136	2,592	1,5926	,1840	1
C13	1951	5	,680	12,960	7,9628	,9202	2
C13	1952	3	,408	7,776	4,7777	,5521	1
C13	1953	6	,816	15,552	9,5554	1,1042	3
C13	1954	1	,136	2,592	1,5926	,1840	1
C13	1955	4	,544	10,368	6,3703	,7361	2
TOTAL	C13	21	2,856	54,432	33,4440	3,8646	
G01	1950	4	,900	18,532	6,8580	,9637	1

**REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE**

REPORT HRM 0004

PAGE

7

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
G01	1952	5	1,125	23,165	8,5725	1,2045	2
Q01	1953	4	,900	18,532	6,8580	,9637	1
G01	1954	10	2,250	46,330	17,1450	2,4091	3
G01	1955	1	,225	4,633	1,7145	,2409	1
TOTAL	G01	24	5,400	111,192	41,1480	5,7819	
G02	1956	1	,225	4,633	1,7145	,2409	1
TOTAL	G02	1	,225	4,633	1,7145	,2409	
G03	1946	102	22,950	472,566	174,8790	24,5735	20
G03	1947	89	20,025	412,337	152,5905	21,4414	22
G03	1948	84	18,900	389,172	144,0180	20,2369	21
G03	1949	61	13,725	282,613	104,5845	14,6957	17
G03	1950	190	42,750	880,270	325,7550	45,7740	45
G03	1951	263	59,175	1,218,479	450,9135	63,3606	70
G03	1952	318	71,550	1,473,294	545,2110	76,6099	85
G03	1953	301	67,725	1,394,533	516,0645	72,5134	87
G03	1954	165	37,125	764,445	282,8925	39,7494	51
G03	1955	157	35,325	727,381	269,1765	37,8225	48
G03	1956	114	25,650	528,162	195,4530	27,4636	34
TOTAL	G03	1,844	414,900	8,543,252	3,161,5380	444,2409	
H01	1946	20	4,800	53,300	20,0160	1,5460	11
H01	1947	17	4,080	45,305	17,0136	1,3138	8
H01	1948	17	4,080	45,305	17,0136	1,3141	9
H01	1949	5	1,200	13,325	5,0040	,3865	5
H01	1950	17	4,080	45,305	17,0136	1,3141	8
H01	1951	23	5,520	61,295	23,0184	1,7779	9
H01	1952	24	5,760	63,960	24,0192	1,8552	9
H01	1953	43	10,320	114,595	43,0344	3,3237	17
H01	1954	23	5,520	61,295	23,0184	1,7779	9
H01	1955	20	4,800	53,300	20,0160	1,5459	7
H01	1956	12	2,880	31,980	12,0096	,9275	4
TOTAL	H01	221	53,040	588,965	221,1768	17,0826	
H02	1946	13	1,690	16,068	10,3090	,8840	10
H02	1947	15	1,950	18,540	11,8950	1,0198	9

**REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE**

REPORT		HRM	0004					PAGE	8
TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE		
H02	1948	14	1,820	17,304	11,1020	,9520	9		
H02	1949	6	,780	7,416	4,7580	,4080	5		
H02	1950	14	1,820	17,304	11,1020	,9518	8		
H02	1951	20	2,600	24,720	15,8600	1,3598	9		
H02	1952	19	2,470	23,484	15,0670	1,2917	8		
H02	1953	41	5,330	50,676	32,5130	2,7871	15		
H02	1954	20	2,600	24,720	15,8600	1,3596	8		
H02	1955	16	2,080	19,776	12,6880	1,0878	8		
H02	1956	12	1,560	14,832	9,5160	,8158	5		
TOTAL	H02	190	24,700	234,840	150,6700	12,9174			
H04	1946	2	,080	,694	,4016	,0312	1		
H04	1948	2	,080	,694	,4016	,0312	1		
H04	1949	9	,360	3,123	1,8072	,1405	4		
H04	1950	7	,280	2,429	1,4056	,1093	2		
H04	1951	5	,200	1,735	1,0040	,0781	1		
H04	1952	4	,160	1,388	,8032	,0624	2		
H04	1953	2	,080	,694	,4016	,0312	1		
H04	1954	14	,560	4,858	2,8112	,2186	4		
H04	1955	2	,080	,694	,4016	,0312	1		
H04	1956	1	,040	,347	,2008	,0156	1		
TOTAL	H04	48	1,920	16,656	9,6384	,7493			
H05	1946	2	,130	1,944	,7462	,0680	1		
H05	1948	1	,065	,972	,3731	,0340	1		
H05	1950	2	,130	1,944	,7462	,0680	2		
H05	1951	1	,065	,972	,3731	,0340	1		
H05	1952	1	,065	,972	,3731	,0340	1		
H05	1953	2	,130	1,944	,7462	,0680	1		
H05	1954	3	,195	2,916	1,1193	,1020	3		
H05	1955	1	,065	,972	,3731	,0340	1		
H05	1956	1	,065	,972	,3731	,0340	1		
TOTAL	H05	14	,910	13,608	5,2234	,4760			
H06	1951	1	,270	3,394	1,6281	,1324	1		
H06	1952	2	,540	6,788	3,2562	,2648	2		
H06	1954	1	,270	3,394	1,6281	,1324	1		

REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE

REPORT HRM 0004

PAGE 9

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
H06	1956	1	,270	3,394	1,6281	,1324	1
TOTAL	H06	5	1,350	16,970	8,1405	,6420	
H07	1946	1	,240	2,665	1,0008	,0773	1
H07	1947	2	,480	5,330	2,0016	,1546	2
H07	1949	2	,480	5,330	2,0016	,1546	2
H07	1950	6	1,440	15,990	6,0048	,4637	2
H07	1951	2	,480	5,330	2,0016	,1546	1
H07	1952	20	4,800	53,300	20,0160	1,5458	5
H07	1954	1	,240	2,665	1,0008	,0773	1
H07	1955	5	1,200	13,325	5,0040	,3865	2
H07	1956	1	,240	2,665	1,0008	,0773	1
TOTAL	H07	40	9,600	106,600	40,0320	3,0917	
H08	1946	1	,130	1,236	,7930	,0680	1
H08	1947	1	,130	1,236	,7930	,0680	1
H08	1949	2	,260	2,472	1,5860	,1360	2
H08	1950	6	,780	7,416	4,7580	,4079	2
H08	1951	4	,520	4,944	3,1720	,2719	1
H08	1952	11	1,430	13,596	8,7230	,7479	4
H08	1954	2	,260	2,472	1,5860	,1360	1
H08	1955	4	,520	4,944	3,1720	,2720	2
H08	1956	2	,260	2,472	1,5860	,1360	1
TOTAL	H08	33	4,290	40,788	26,1690	2,2437	
H09	1946	10	,870	8,110	3,7497	,3650	3
H09	1948	7	,609	5,677	2,6248	,2555	3
H09	1953	1	,087	,811	,3750	,0365	1
H09	1954	9	,783	7,299	3,3747	,3285	4
TOTAL	H09	27	2,349	21,897	10,1242	,9855	
H10	1947	2	,070	1,454	,3521	,0509	1
H10	1948	1	,035	,727	,1761	,0254	1
H10	1949	2	,070	1,454	,3521	,0509	1
H10	1952	1	,035	,727	,1761	,0254	1
H10	1953	3	,105	2,181	,5282	,0763	2
H10	1954	5	,175	3,635	,8803	,1272	2

**REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE**

REPORT		HRM	0004					PAGE	10
TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE		
H10	1955	2	,070	1,454	,3521	,0509	1		
TOTAL	H10	16	,560	11,632	2,8170	,4070			
H11	1946	47	17,390	223,344	77,3855	6,4766	43		
H11	1947	25	9,250	118,800	41,1625	3,4450	23		
H11	1948	29	10,730	137,808	47,7485	3,9962	26		
H11	1949	17	6,290	80,784	27,9905	2,3426	17		
H11	1950	10	3,700	47,520	16,4650	1,3780	6		
H11	1951	15	5,550	71,280	24,6975	2,0670	12		
H11	1952	26	9,620	123,552	42,8090	3,5828	20		
H11	1953	19	7,030	90,288	31,2835	2,6182	18		
H11	1954	28	10,360	133,056	46,1020	3,8584	21		
H11	1955	8	2,960	38,016	13,1720	1,1024	8		
H11	1956	4	1,480	19,008	6,5860	,5512	4		
TOTAL	H11	228	84,360	1,083,456	375,4020	31,4184			
H12	1946	44	2,068	21,340	8,9142	,9594	42		
H12	1947	24	1,128	11,640	4,8623	,5233	22		
H12	1948	24	1,128	11,640	4,8623	,5233	23		
H12	1949	16	,752	7,760	3,2416	,3488	16		
H12	1950	8	,376	3,880	1,6207	,1745	7		
H12	1951	10	,470	4,850	2,0259	,2181	9		
H12	1952	24	1,128	11,640	4,8621	,5235	20		
H12	1953	19	,893	9,215	3,8494	,4142	19		
H12	1954	22	1,034	10,670	4,4571	,4797	21		
H12	1955	7	,329	3,395	1,4182	,1526	7		
H12	1956	5	,235	2,425	1,0130	,1090	5		
TOTAL	H12	203	9,541	98,455	41,1268	4,4264			
H13	1946	48	18,720	235,200	83,3040	6,8208	43		
H13	1947	29	11,310	142,100	50,3295	4,1209	22		
H13	1948	28	10,920	137,200	48,5940	3,9788	25		
H13	1949	24	9,360	117,600	41,6520	3,4104	20		
H13	1950	15	5,850	73,500	26,0325	2,1315	8		
H13	1951	16	6,240	78,400	27,7680	2,2736	9		
H13	1952	45	17,550	220,500	78,0975	6,3945	20		
H13	1953	44	17,160	215,600	76,3620	6,2524	22		

**REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE**

REPORT HRM 0004

PAGE 11

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
H13	1954	36	14,040	176,400	62,4780	5,1156	20
H13	1955	13	5,070	63,700	22,5615	1,0473	7
H13	1956	8	3,120	39,200	13,8840	1,1368	6
TOTAL	H13	306	119,340	1,499,400	531,0630	43,4826	
K01	1946	16	2,832	60,672	27,2439	3,7616	4
K01	1947	6	1,062	22,752	10,2164	1,4106	2
K01	1949	7	1,239	26,544	11,9191	1,6457	4
K01	1950	55	9,735	208,560	93,6506	12,9305	18
K01	1951	31	5,487	117,552	52,7849	7,2881	9
K01	1952	34	6,018	128,928	57,8931	7,9934	10
K01	1953	12	2,124	45,504	20,4329	2,8212	4
K01	1954	23	4,071	87,216	39,1629	5,4073	8
K01	1955	17	3,009	64,464	28,9466	3,9967	6
TOTAL	K01	201	35,577	762,192	342,2504	47,2551	
K02	1946	111	26,085	435,786	250,9377	27,0188	19
K02	1947	98	23,030	384,748	221,5486	23,8547	16
K02	1948	88	20,680	345,488	198,9416	21,4204	16
K02	1949	135	31,725	530,010	305,1945	32,8604	28
K02	1950	188	44,180	738,088	425,0116	45,7620	34
K02	1951	168	39,480	659,568	379,7976	40,8939	28
K02	1952	138	32,430	541,788	311,9766	33,5913	24
K02	1953	179	42,065	702,754	404,6653	43,5714	32
K02	1954	167	39,245	655,642	377,5369	40,6505	30
K02	1955	132	31,020	518,232	298,4124	32,1308	24
K02	1956	105	24,675	412,230	237,3735	25,5586	18
TOTAL	K02	1,509	354,615	5,924,334	3,411,3963	367,3128	
K03	1946	14	3,290	54,964	31,6498	3,4076	4
K03	1947	5	1,175	19,630	11,3035	1,2171	1
K03	1948	6	1,410	23,556	13,5642	1,4604	2
K03	1949	18	4,230	70,668	40,6926	4,3814	4
K03	1950	6	1,410	23,556	13,5642	1,4604	3
K03	1954	4	,940	15,704	9,0428	,9736	1
K03	1955	6	1,410	23,556	13,5642	1,4605	1
TOTAL	K03	59	13,865	231,634	133,3813	14,3610	

**REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE**

REPORT HRM 0004

PAGE 12

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
L01	1946	53	16,430	89,358	21,1947	1,6982	21
L01	1947	28	8,680	47,208	11,1972	,8972	13
L01	1948	27	8,370	45,522	10,7973	,8653	14
L01	1949	37	11,470	62,382	14,7963	1,1854	15
L01	1950	47	14,570	79,242	18,7953	1,5060	20
L01	1951	44	13,640	74,184	17,5956	1,4095	16
L01	1952	45	13,950	75,870	17,9955	1,4415	17
L01	1953	108	33,480	182,088	43,1892	3,4597	35
L01	1954	102	31,620	171,972	40,7898	3,2676	33
L01	1955	69	21,390	116,334	27,5931	2,2104	23
L01	1956	22	6,820	37,092	8,7978	,7048	8
TOTAL	L01	582	180,420	981,252	232,7418	18,6456	
L02	1946	6	,720	7,638	3,7224	,2901	3
L02	1947	19	2,280	24,187	11,7876	,9188	9
L02	1948	8	,960	10,184	4,9632	,3870	2
L02	1950	3	,360	3,819	1,8612	,1451	2
L02	1951	3	,360	3,819	1,8612	,1451	2
L02	1952	2	,240	2,546	1,2408	,0967	1
L02	1953	2	,240	2,546	1,2408	,0967	1
L02	1954	2	,240	2,546	1,2408	,0967	1
L02	1955	2	,240	2,546	1,2408	,0967	1
L02	1956	2	,240	2,546	1,2408	,0967	1
TOTAL	L02	49	5,880	62,377	30,3996	2,3696	
L03	1946	45	13,950	49,500	17,9955	,9405	19
L03	1947	36	11,160	39,600	14,3964	,7524	13
L03	1948	32	9,920	35,200	12,7968	,6688	13
L03	1949	25	7,750	27,500	9,9975	,5225	11
L03	1950	39	12,090	42,900	15,5961	,8151	14
L03	1951	42	13,020	46,200	16,7958	,8778	17
L03	1952	33	10,230	36,300	13,1967	,6897	13
L03	1953	44	13,640	48,400	17,5956	,9196	14
L03	1954	55	17,050	60,500	21,9945	1,1495	18
L03	1955	65	20,150	71,500	25,9935	1,3585	21
L03	1956	6	1,860	6,600	2,3994	,1254	2
TOTAL	L03	422	130,820	464,200	168,7578	8,8198	

**REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE**

REPORT HRM 0004

PAGE 13

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
L04	1946	5	,000	10,675	,0000	,2028	2
L04	1948	12	,000	25,620	,0000	,4867	5
L04	1949	12	,000	25,620	,0000	,4866	6
L04	1950	4	,000	8,540	,0000	,1622	2
L04	1951	9	,000	19,215	,0000	,3652	4
L04	1952	6	,000	12,810	,0000	,2434	2
L04	1953	5	,000	10,675	,0000	,2028	2
L04	1954	2	,000	4,270	,0000	,0811	1
L04	1955	1	,000	2,135	,0000	,0406	1
L04	1956	2	,000	4,270	,0000	,0811	1
TOTAL	L04	58	,000	123,830	,0000	2,3525	
L05	1946	4	,440	7,680	3,2868	,3456	3
L05	1947	1	,110	1,920	,8217	,0864	1
L05	1948	6	,660	11,520	4,9302	,5184	4
L05	1949	6	,660	11,520	4,9302	,5184	2
L05	1950	6	,660	11,520	4,9302	,5184	3
L05	1951	7	,770	13,440	5,7519	,6048	3
L05	1952	4	,440	7,680	3,2868	,3456	2
L05	1953	15	1,650	28,800	12,3255	1,2960	6
L05	1954	10	1,100	19,200	8,2170	,8640	6
L05	1955	21	2,310	40,320	17,2557	1,8144	8
L05	1956	3	,330	5,760	2,4651	,2592	2
TOTAL	L05	83	9,130	159,360	68,2011	7,1712	
L06	1946	49	5,243	29,988	12,6884	,8089	22
L06	1947	10	1,070	6,120	2,5895	,1650	5
L06	1948	20	2,140	12,240	5,1789	,3302	9
L06	1949	34	3,638	20,808	8,8041	,5613	14
L06	1950	53	5,671	32,436	13,7241	,8750	24
L06	1951	47	5,029	28,764	12,1706	,7758	21
L06	1952	44	4,708	26,928	11,3937	,7264	19
L06	1953	44	4,708	26,928	11,3936	,7264	18
L06	1954	45	4,815	27,540	11,6526	,7430	19
L06	1955	52	5,564	31,824	13,4652	,8586	22
L06	1956	49	5,243	29,988	12,6883	,8091	16
TOTAL	L06	447	47,829	273,564	115,7490	7,3797	

**REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE**

REPORT HRM 0004

PAGE 14

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
L07	1946	8	4,080	19,368	8,4456	,4456	4
L07	1947	41	20,910	99,261	43,2837	2,2834	18
L07	1948	26	13,260	62,946	27,4482	1,4482	13
L07	1949	8	4,080	19,368	8,4456	,4455	2
L07	1950	12	6,120	29,052	12,6684	,6684	6
L07	1951	8	4,080	19,368	8,4456	,4456	4
L07	1952	37	18,870	89,577	39,0609	2,0607	18
L07	1953	13	6,630	31,473	13,7241	,7240	6
L07	1954	35	17,850	84,735	36,9495	1,9489	11
L07	1955	10	5,100	24,210	10,5570	,5569	4
L07	1956	3	1,530	7,263	3,1671	,1671	2
TOTAL	L07	201	102,510	486,621	212,1957	11,1943	
L08	1946	21	6,510	23,100	8,3979	,4389	10
L08	1947	48	14,880	52,800	19,1952	1,0032	21
L08	1948	10	3,100	11,000	3,9990	,2090	5
L08	1949	10	3,100	11,000	3,9990	,2090	5
L08	1950	13	4,030	14,300	5,1987	,2717	7
L08	1951	25	7,750	27,500	9,9975	,5225	10
L08	1952	9	2,790	9,900	3,5991	,1881	4
L08	1953	34	10,540	37,400	13,5966	,7106	13
L08	1954	6	1,860	6,600	2,3994	,1254	2
L08	1955	50	15,500	55,000	19,9950	1,0450	18
L08	1956	10	3,100	11,000	3,9990	,2090	4
TOTAL	L08	236	73,160	259,600	94,3764	4,9324	
P01	1953	1	,444	5,406	4,9151	,3352	1
P01	1954	1	,444	5,406	4,9151	,3352	1
TOTAL	P01	2	,888	10,812	9,8302	,6704	
P02	1954	1	,406	22,132	3,9057	,8631	1
P02	1955	3	1,218	66,396	11,7172	2,5894	1
TOTAL	P02	4	1,624	88,528	15,6229	3,4525	
P03	1946	1	,120	2,649	1,3284	,1642	1
P03	1947	11	1,320	29,139	14,6124	1,8063	10
P03	1948	7	,840	18,543	9,2988	1,1496	5

**REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE**

REPORT HRM 0004

PAGE 15

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
P03	1949	1	.120	2,649	1,3284	.1642	1
P03	1950	4	.480	10,596	5,3136	.6568	4
P03	1951	5	.600	13,245	6,6420	.8211	3
P03	1952	2	.240	5,298	2,6568	.3285	1
P03	1953	5	.600	13,245	6,6420	.8212	2
P03	1954	7	.840	18,543	9,2988	1,1496	5
P03	1955	4	.480	10,596	5,3136	.6569	3
P03	1956	2	.240	5,298	2,6568	.3284	2
TOTAL	P03	49	5.880	129,801	65,0916	8,0468	
R01	1946	10	.340	6,480	3,9810	.4600	10
R01	1947	4	.136	2,592	1,5925	.1840	3
R01	1948	2	.068	1,296	.7962	.0920	2
R01	1949	4	.136	2,592	1,5925	.1840	3
R01	1950	8	.272	5,184	3,1849	.3680	7
R01	1951	16	.544	10,368	6,3701	.7360	10
R01	1952	17	.578	11,016	6,7681	.7820	13
R01	1953	25	.850	16,200	9,9531	1,1500	15
R01	1954	15	.510	9,720	5,9717	.6900	13
R01	1955	9	.306	5,832	3,5831	.4140	6
R01	1956	4	.136	2,592	1,5925	.1840	3
TOTAL	R01	114	3.876	73,872	45,3857	5,2440	
R02	1946	5	.150	1,025	1,2060	.0490	5
R02	1947	1	.030	.205	.2412	.0098	1
R02	1948	1	.030	.205	.2412	.0098	1
R02	1949	4	.120	.820	.9648	.0392	4
R02	1950	6	.180	1,230	1,4472	.0588	6
R02	1951	11	.330	2,255	2,6532	.1081	8
R02	1952	11	.330	2,255	2,6532	.1080	9
R02	1953	11	.330	2,255	2,6532	.1080	9
R02	1954	15	.450	3,075	3,6180	.1473	12
R02	1955	9	.270	1,845	2,1708	.0885	6
R02	1956	4	.120	.820	.9648	.0393	3
TOTAL	R02	78	2,340	15,990	18,8136	.7658	
R03	1946	5	1.150	16,270	12,3970	1,1063	3

**REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE**

REPORT HRM 0004

PAGE 16

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
R03	1948	2	.460	6,508	4,9588	.4425	1
R03	1950	5	1,150	16,270	12,3970	1,1063	3
R03	1951	3	.690	9,762	7,4382	.6638	2
R03	1952	6	1,380	19,524	14,8764	1,3277	4
R03	1953	5	1,150	16,270	12,3970	1,1064	4
R03	1954	8	1,840	26,032	19,8352	1,7702	3
R03	1955	3	.690	9,762	7,4382	.6639	3
R03	1956	6	1,380	19,524	14,8764	1,3277	5
TOTAL	R03	43	9.890	139,922	106.6142	9.5148	
R04	1948	1	.110	3,592	.9328	.1832	1
R04	1950	3	.330	10,776	2,7984	.5496	2
R04	1951	2	.220	7,184	1,8656	.3664	2
R04	1952	5	.550	17,960	4,6640	.9160	4
R04	1953	1	.110	3,592	.9328	.1832	1
R04	1954	7	.770	25,144	6,5296	1,2824	4
R04	1955	3	.330	10,776	2,7984	.5496	3
R04	1956	7	.770	25,144	6,5296	1,2824	6
TOTAL	R04	29	3.190	104,168	27.0512	5.3128	
R05	1948	2	.460	10,636	3,7628	.3297	1
R05	1952	2	.460	10,636	3,7628	.3297	1
TOTAL	R05	4	.920	21,272	7.5256	.6594	
R06	1948	2	.070	31,152	.4508	.7788	1
R06	1952	3	.105	46,728	.6762	1,1682	1
TOTAL	R06	5	.175	77,880	1,1270	1.9470	
S01	1946	9	1,242	6,147	7,1289	.3169	8
S01	1947	6	.828	4,098	4,7526	.2112	6
S01	1948	4	.592	2,732	3,1684	.1409	3
S01	1949	12	1,656	8,196	9,5052	.4227	9
S01	1950	12	1,656	8,196	9,5052	.4226	10
S01	1951	13	1,794	8,879	10,2973	.4578	11
S01	1952	16	2,208	10,928	12,6736	.5634	14
S01	1953	24	3,312	16,392	19,0105	.8452	19
S01	1954	19	2,622	12,977	15.0500	.6692	14

**REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE**

REPORT HRM 0004

PAGE 17

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
S01	1955	19	2,622	12,977	15,0499	,6693	14
S01	1956	8	1,104	5,464	6,3369	,2819	4
TOTAL	S01	142	19,596	96,986	112,4785	5,0011	
S02	1946	15	,780	5,610	3,9235	,2245	9
S02	1947	5	,260	1,870	1,3080	,0750	5
S02	1948	6	,312	2,244	1,5694	,0898	4
S02	1949	9	,468	3,366	2,3543	,1349	8
S02	1950	20	1,040	7,480	5,2313	,2993	9
S02	1951	13	,676	4,862	3,4006	,1948	9
S02	1952	19	,988	7,106	4,9701	,2847	15
S02	1953	54	2,808	20,196	14,1245	,8081	19
S02	1954	34	1,768	12,716	8,8933	,5089	14
S02	1955	38	1,976	14,212	9,9396	,5688	15
S02	1956	11	,572	4,114	2,8771	,1645	4
TOTAL	S02	224	11,648	83,776	58,5917	3,3533	
S03	1946	1	,190	1,376	1,2274	,0660	1
S03	1947	2	,380	2,752	2,4548	,1320	2
S03	1950	2	,380	2,752	2,4548	,1320	2
S03	1951	10	1,900	13,760	12,2740	,6602	8
S03	1952	13	2,470	17,888	15,9562	,8580	13
S03	1953	14	2,660	19,264	17,1836	,9241	13
S03	1954	13	2,470	17,888	15,9562	,8582	11
S03	1955	8	1,520	11,008	9,8192	,5280	8
S03	1956	2	,380	2,752	2,4548	,1320	2
TOTAL	S03	65	12,350	89,440	79,7810	4,2905	
S04	1946	2	,220	6,112	2,4002	,3789	1
S04	1947	1	,110	3,056	1,2001	,1895	1
S04	1951	3	,330	9,168	3,6003	,5684	2
S04	1953	5	,550	15,280	6,0005	,9473	3
S04	1955	2	,220	6,112	2,4002	,3789	1
S04	1956	1	,110	3,056	1,2001	,1895	1
TOTAL	S04	14	1,540	42,784	16,8014	2,6525	
S05	1946	1	,516	17,331	4,2415	,6759	1

REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE

REPORT HRM 0004

PAGE

18

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
S05	1951	2	1,032	34,662	8,4830	1,3518	2
S05	1952	1	.516	17,331	4,2415	.6759	1
S05	1953	3	1,548	51,993	12,7245	2,0277	3
S05	1955	1	.516	17,331	4,2415	.6759	1
S05	1956	1	.516	17,331	4,2415	.6759	1
TOTAL	S05	9	4,644	155,979	38,1735	6,0831	
S06	1946	11	2,365	30,096	24,4541	1,8657	10
S06	1947	1	.215	2,736	2,2231	.1696	1
S06	1948	7	1,505	19,152	15,5617	1,1873	6
S06	1949	16	3,440	43,776	35,5696	2,7139	12
S06	1950	7	1,505	19,152	15,5617	1,1873	6
S06	1951	8	1,720	21,888	17,7848	1,3568	8
S06	1952	9	1,935	24,624	20,0079	1,5264	9
S06	1953	28	6,020	76,608	62,2468	4,7496	16
S06	1954	14	3,010	38,304	31,1234	2,3750	8
S06	1955	20	4,300	54,720	44,4620	3,3925	14
S06	1956	13	2,795	35,568	28,9003	2,2052	8
TOTAL	S06	134	28,810	366,624	297,8954	22,7293	
S07	1946	11	4,125	58,619	39,1467	2,2859	10
S07	1947	1	.375	5,329	3,5588	.2078	1
S07	1948	9	3,375	47,961	32,0289	1,8705	6
S07	1949	21	7,875	111,909	74,7342	4,3644	13
S07	1950	4	1,500	21,316	14,2352	.8312	4
S07	1951	8	3,000	42,632	28,4704	1,6624	8
S07	1952	16	6,000	85,264	56,9404	3,3252	11
S07	1953	37	13,875	197,173	131,6742	7,6898	16
S07	1954	13	4,875	69,277	46,2640	2,7018	8
S07	1955	29	10,875	154,541	103,2045	6,0268	18
S07	1956	15	5,625	79,935	53,3815	3,1175	8
TOTAL	S07	164	61,500	873,956	583,6388	34,0833	
S08	1946	38	5,586	100,662	59,4358	6,2396	38
S08	1947	26	3,822	68,874	40,6666	4,2696	22
S08	1948	17	2,499	45,033	26,5896	2,7915	15
S08	1949	28	4,116	74,172	43,7947	4,5978	25

**REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE**

REPORT HRM 0004

PAGE 19

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
S08	1950	56	8,232	148,344	87,5896	9,1962	46
S08	1951	32	4,704	84,768	50,0512	5,2545	31
S08	1952	41	6,027	108,609	64,1281	6,7326	37
S08	1953	68	9,996	180,132	106,3584	11,1669	51
S08	1954	98	14,406	259,602	153,2812	16,0946	62
S08	1955	72	10,584	190,728	112,6146	11,8239	51
S08	1956	58	8,526	153,642	90,7173	9,5250	38
TOTAL	S08	534	78,498	1,414,566	835,2271	87,6922	
S09	1946	41	14,760	648,743	127,2312	25,3011	39
S09	1947	32	11,520	506,336	99,3024	19,7472	25
S09	1948	14	5,040	221,922	43,4448	8,6394	12
S09	1949	46	16,560	727,858	142,7472	28,3866	28
S09	1950	87	31,320	1,376,601	269,9784	53,6877	47
S09	1951	57	20,520	901,911	176,8824	35,1747	32
S09	1952	75	27,000	1,186,725	232,7400	46,2825	35
S09	1953	150	54,000	2,373,450	465,4800	92,5650	53
S09	1954	173	62,280	2,737,379	536,8536	106,7583	59
S09	1955	96	34,560	1,519,008	297,9072	59,2416	47
S09	1956	76	27,360	1,202,548	235,8432	46,8996	43
TOTAL	S09	847	304,920	13,402,081	2,628,4104	522,6837	
S10	1950	2	,492	23,910	5,2349	1,4824	1
S10	1952	1	,246	11,955	2,6174	,7412	1
S10	1953	2	,492	23,910	5,2348	1,4824	2
S10	1954	7	1,722	83,685	18,3220	5,1884	5
S10	1955	8	1,968	95,640	20,9395	5,9296	4
S10	1956	4	,984	47,820	10,4697	2,9648	2
TOTAL	S10	24	5,904	286,920	62,8183	17,7888	
S11	1955	8	1,720	26,584	16,6840	1,2760	1
TOTAL	S11	8	1,720	26,584	16,6840	1,2760	
S12	1948	5	4,200	285,540	40,4040	11,9926	4
S12	1949	5	4,200	285,540	40,4040	11,9925	5
S12	1950	16	13,440	913,728	129,2928	38,3761	14
S12	1951	3	2,520	171,324	24,2424	7,1955	3

REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE

REPORT HRM 0004

PAGE 20

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
S12	1952	14	11,760	799,512	113,1312	33,5792	12
S12	1953	35	29,400	1,998,780	282,8280	83,9482	24
S12	1954	46	38,640	2,626,968	371,7168	110,3319	32
S12	1955	31	26,040	1,770,348	250,5048	74,3539	23
S12	1956	10	8,400	571,080	80,8080	23,9851	9
TOTAL	S12	165	138,600	9,422,820	1,333,3320	395,7550	
S13	1946	3	,345	7,833	3,7191	,4856	1
S13	1949	1	,115	2,611	1,2397	,1619	1
S13	1951	3	,345	7,833	3,7191	,4856	1
S13	1952	3	,345	7,833	3,7191	,4857	2
S13	1953	8	,920	20,888	9,9176	1,2951	4
S13	1955	5	,575	13,055	6,1985	,8094	3
S13	1956	5	,575	13,055	6,1985	,8095	3
TOTAL	S13	28	3,220	73,108	34,7116	4,5328	
S14	1953	15	1,050	14,865	5,7330	,3420	3
S14	1955	8	,560	7,928	3,0576	,1823	1
TOTAL	S14	23	1,610	22,793	8,7906	,5243	
S15	1953	13	1,911	34,437	20,3330	2,1351	3
S15	1955	3	,441	7,947	4,6922	,4927	1
TOTAL	S15	16	2,352	42,384	25,0252	2,6278	
U01	1946	3	,126	2,163	,9600	,1233	3
U01	1947	1	,042	,721	,3200	,0411	1
U01	1948	1	,042	,721	,3200	,0411	1
U01	1949	1	,042	,721	,3200	,0411	1
U01	1952	5	,210	3,605	1,6001	,2055	3
U01	1953	2	,084	1,442	,6401	,0822	1
U01	1954	4	,168	2,884	1,2802	,1644	2
U01	1955	6	,252	4,326	1,9202	,2466	1
TOTAL	U01	23	,966	16,583	7,3606	,9453	
U03	1946	12	2,880	9,912	4,1472	,1884	6
U03	1947	44	10,560	36,344	15,2064	,6908	17
U03	1948	24	5,760	19,824	8,2944	,3768	11

**REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE**

REPORT HRM 0004

PAGE 21

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
U03	1949	30	7,200	24,780	10,3680	,4710	16
U03	1950	29	6,960	23,954	10,0224	,4553	12
U03	1951	17	4,080	14,042	5,8752	,2669	7
U03	1952	32	7,680	26,432	11,0592	,5024	15
U03	1953	27	6,480	22,302	9,3312	,4239	13
U03	1954	45	10,800	37,170	15,5520	,7065	19
U03	1955	20	4,800	16,520	6,9120	,3140	8
U03	1956	12	2,880	9,912	4,1472	,1884	3
TOTAL	U03	292	70,080	241,192	100,9152	4,5844	
U04	1946	146	36,500	143,956	52,5600	2,7371	69
U04	1947	90	22,500	88,740	32,4000	1,6873	44
U04	1948	94	23,500	92,684	33,8400	1,7623	46
U04	1949	81	20,250	79,866	29,1600	1,5183	39
U04	1950	100	25,000	98,600	36,0000	1,8746	46
U04	1951	61	15,250	60,146	21,9600	1,1434	27
U04	1952	113	28,250	111,418	40,6800	2,1180	48
U04	1953	128	32,000	126,208	46,0800	2,3988	53
U04	1954	124	31,000	122,264	44,6400	2,3237	50
U04	1955	83	20,750	81,838	29,8800	1,5558	37
U04	1956	38	9,500	37,468	13,6800	,7120	15
TOTAL	U04	1,058	264,500	1,043,188	380,8800	19,8313	
U05	1946	3	,960	2,064	1,3824	,0393	3
U05	1947	2	,640	1,376	,9216	,0262	2
U05	1948	2	,640	1,376	,9216	,0261	1
U05	1949	4	1,280	2,752	1,8432	,0524	4
U05	1950	4	1,280	2,752	1,8432	,0524	4
U05	1951	1	,320	,688	,4608	,0131	1
U05	1952	13	4,160	8,944	5,9904	,1703	13
U05	1953	21	6,720	14,448	9,6768	,2751	21
U05	1954	25	8,000	17,200	11,5200	,3274	24
U05	1955	19	6,080	13,072	8,7552	,2489	19
U05	1956	6	1,920	4,128	2,7648	,0785	5
TOTAL	U05	100	32,000	68,800	46,0800	1,3097	
U06	1946	2	,500	1,972	,7200	,0375	1

REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE

REPORT HRM 0004

PAGE

22

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
U06	1947	4	1,000	3,944	1,4400	,0750	2
U06	1948	17	4,250	16,762	6,1200	,3187	8
U06	1949	10	2,500	9,860	3,6000	,1874	4
U06	1950	6	1,500	5,916	2,1600	,1125	3
U06	1951	5	1,250	4,930	1,8000	,0937	2
U06	1952	11	2,750	10,846	3,9600	,2062	4
U06	1953	9	2,250	8,874	3,2400	,1686	4
U06	1954	16	4,000	15,776	5,7600	,2998	6
U06	1955	35	8,750	34,510	12,6000	,6558	12
U06	1956	4	1,000	3,944	1,4400	,0750	2
TOTAL	U06	119	29,750	117,334	42,8400	2,2302	
U07	1946	46	11,500	45,356	16,5600	,8625	23
U07	1947	45	11,250	44,370	16,2000	,8435	21
U07	1948	18	4,500	17,748	6,4800	,3374	8
U07	1949	28	7,000	27,608	10,0800	,5248	12
U07	1950	40	10,000	39,440	14,4000	,7498	19
U07	1951	27	6,750	26,622	9,7200	,5059	10
U07	1952	46	11,500	45,356	16,5600	,8621	20
U07	1953	55	13,750	54,230	19,8000	1,0304	25
U07	1954	46	11,500	45,356	16,5600	,8621	21
U07	1955	69	17,250	68,034	24,8400	1,2931	28
U07	1956	12	3,000	11,832	4,3200	,2248	4
TOTAL	U07	432	108,000	425,952	155,5200	8,0964	
U08	1946	4	1,280	2,752	1,8432	,0523	3
U08	1948	2	,640	1,376	,9216	,0261	1
U08	1949	1	,320	,688	,4608	,0131	1
U08	1951	1	,320	,688	,4608	,0131	1
U08	1952	11	3,520	7,568	5,0688	,1440	10
U08	1953	5	1,600	3,440	2,3040	,0655	5
U08	1954	14	4,480	9,632	6,4512	,1834	14
U08	1955	21	6,720	14,448	9,6768	,2748	15
U08	1956	3	,960	2,064	1,3824	,0392	2
TOTAL	U08	62	19,840	42,656	28,5696	,8115	
U09	1946	5	1,675	6,540	2,4120	,1243	2

REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE

REPORT HRM 0004

PAGE 23

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
U09	1947	54	18,090	70,632	26,0496	1,3424	15
U09	1949	2	,670	2,616	,9648	,0497	1
U09	1950	12	4,020	15,696	5,7888	,2982	4
U09	1953	3	1,005	3,924	1,4472	,0746	2
U09	1954	5	1,675	6,540	2,4120	,1243	2
U09	1956	4	1,340	5,232	1,9296	,0994	2
TOTAL	U09	85	28,475	111,180	41,0040	2,1129	
U10	1950	1	,042	,721	,3200	,0411	1
U10	1951	4	,168	2,884	1,2802	,1644	1
U10	1954	2	,084	1,442	,6401	,0822	1
TOTAL	U10	7	,294	5,047	2,2403	,2877	
U12	1946	21	,882	15,141	6,7204	,8631	17
U12	1947	23	,966	16,583	7,3608	,9453	11
U12	1948	39	1,638	28,119	12,4817	1,6029	17
U12	1949	34	1,428	24,514	10,8815	1,3974	17
U12	1950	36	1,512	25,956	11,5216	1,4796	12
U12	1951	61	2,562	43,981	19,5224	2,5071	21
U12	1952	51	2,142	36,771	16,3218	2,0961	17
U12	1953	69	2,898	49,749	22,0825	2,8359	20
U12	1954	44	1,848	31,724	14,0816	1,8084	14
U12	1955	26	1,092	18,746	8,3210	1,0686	9
U12	1956	21	,882	15,141	6,7207	,8631	8
TOTAL	U12	425	17,850	306,425	136,0160	17,4675	
U13	1946	26	6,500	25,636	9,3600	,4874	12
U13	1947	23	5,750	22,678	8,2800	,4311	11
U13	1948	25	6,250	24,650	9,0000	,4686	11
U13	1949	57	14,250	56,202	20,5200	1,0680	22
U13	1950	31	7,750	30,566	11,1600	,5809	10
U13	1951	17	4,250	16,762	6,1200	,3187	9
U13	1952	30	7,500	29,580	10,8000	,5622	9
U13	1953	23	5,750	22,678	8,2800	,4309	10
U13	1954	34	8,500	33,524	12,2400	,6372	15
U13	1955	28	7,000	27,608	10,0800	,5246	12
U13	1956	31	7,750	30,566	11,1600	,5809	12
TOTAL	U13	325	81,250	320,450	117,0000	6,0905	

REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE

REPORT HRM 0004

PAGE 24

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
U14	1947	1	,320	,688	,4608	,0131	1
U14	1948	4	1,280	2,752	1,8432	,0524	4
U14	1949	5	1,600	3,440	2,3040	,0655	5
U14	1950	4	1,280	2,752	1,8432	,0524	4
U14	1951	8	2,560	5,504	3,6864	,1048	8
U14	1952	5	1,600	3,440	2,3040	,0655	5
U14	1953	6	1,920	4,128	2,7648	,0785	5
U14	1954	11	3,520	7,568	5,0688	,1441	11
U14	1955	5	1,600	3,440	2,3040	,0653	3
U14	1956	4	1,280	2,752	1,8432	,0524	4
TOTAL	U14	53	16,960	36,464	24,4224	,6940	
Z01	1946	8	10,944	119,016	59,7544	2,7376	8
Z01	1947	11	15,048	163,647	82,1623	3,7642	11
Z01	1948	15	20,520	223,155	112,0395	5,1330	15
Z01	1949	23	31,464	342,171	171,7939	7,8706	23
Z01	1950	16	21,888	238,032	119,5088	5,4752	16
Z01	1951	31	42,408	461,187	231,5483	10,6082	31
Z01	1952	26	35,568	386,802	194,2018	8,8972	26
Z01	1953	57	77,976	847,989	425,7501	19,5054	57
Z01	1954	31	42,408	461,187	231,5483	10,6082	31
Z01	1955	27	36,936	401,679	201,6711	9,2394	27
Z01	1956	13	17,784	193,401	97,1009	4,4486	13
TOTAL	Z01	258	352,944	3,838,266	1,927,0794	88,2876	
Z02	1946	23	52,440	570,285	286,3224	13,1169	23
Z02	1947	37	84,360	917,413	460,6056	21,1011	37
Z02	1948	40	91,200	991,800	497,9520	22,8120	40
Z02	1949	43	98,040	1,066,185	535,2984	24,5229	43
Z02	1950	72	164,160	1,785,240	896,3136	41,0616	72
Z02	1951	70	159,600	1,735,650	871,4160	39,9210	70
Z02	1952	95	216,600	2,355,525	1,182,6360	54,1785	95
Z02	1953	108	246,240	2,677,860	1,344,4704	61,5924	108
Z02	1954	67	152,760	1,661,265	834,0696	38,2101	67
Z02	1955	58	132,240	1,438,110	722,0304	33,0774	58
Z02	1956	27	61,560	669,465	336,1176	15,3981	27
TOTAL	Z02	640	1,459,200	15,868,800	7,967,2320	364,9920	

**REPORT OF ANNUAL X-RAY DOSAGE
BY YEAR WITHIN TYPE**

REPORT HRM 0004

PAGE 25

TYPE	YEAR	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
Z03	1952	4	9,120	99,180	49,7952	2,2812	4
Z03	1953	5	11,400	123,975	62,2440	2,8515	5
Z03	1956	1	2,280	24,795	12,4488	,5703	1
TOTAL	Z03	10	22,800	247,950	124,4880	5,7030	
Z04	1946	2	4,560	49,590	24,8976	1,1406	2
Z04	1947	3	6,840	74,385	37,3464	1,7109	3
Z04	1949	1	2,280	24,795	12,4488	,5703	1
Z04	1950	1	2,280	24,795	12,4488	,5703	1
Z04	1951	2	4,560	49,590	24,8976	1,1406	2
Z04	1953	4	9,120	99,180	49,7952	2,2812	4
Z04	1954	1	2,280	24,795	12,4488	,5703	1
TOTAL	Z04	14	31,920	347,130	174,2832	7,9842	
Z05	1953	3	13,680	148,770	74,6928	3,4218	3
Z05	1955	3	13,680	148,770	74,6928	3,4217	1
TOTAL	Z05	6	27,360	297,540	149,3856	6,8435	
POP. TOTAL		41,986			65,110,3482	6,768,5851	

Figure 6.
REPORT OF ANNUAL X-RAY DOSAGE
BY TYPE WITHIN YEAR

REPORT HRM 0003

PAGE

1

YEAR	TYPE	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
1946	A01	29	6,815	113,854	65,5603	7,0586	24
1946	B05	3	,096	12,213	1,0215	,7572	2
1946	B06	2	,190	11,272	2,0216	,6988	2
1946	B07	37	7,770	115,810	82,6728	7,1814	33
1946	B08	33	7,590	270,006	80,7576	16,7409	26
1946	B09	2	,134	12,180	1,4258	,7552	2
1946	C01	3,213	626,535	8,835,750	6,484,6389	547,8165	1,621
1946	C03	6	,330	2,898	7,5900	,2898	6
1946	C04	1	,055	,483	1,2650	,0483	1
1946	C05	302	3,020	75,198	71,6042	9,6942	293
1946	C06	8	,080	1,992	1,8968	,2568	5
1946	G03	102	22,950	472,566	174,8790	24,5735	20
1946	H01	20	4,800	53,300	20,0160	1,5460	11
1946	H02	13	1,690	16,068	10,3090	,8840	10
1946	H04	2	,080	,694	,4016	,0312	1
1946	H05	2	,130	1,944	,7462	,0680	1
1946	H07	1	,240	2,665	1,0008	,0773	1
1946	H08	1	,130	1,236	,7930	,0680	1
1946	H09	10	,870	8,110	3,7497	,3650	3
1946	H11	47	17,390	223,344	77,3855	6,4766	43
1946	H12	44	2,068	21,340	8,9142	,9594	42
1946	H13	48	18,720	235,200	83,3040	6,8208	43
1946	K01	16	2,832	60,672	27,2439	3,7616	4
1946	K02	111	26,085	435,786	250,9377	27,0188	19
1946	K03	14	3,290	54,964	31,6498	3,4076	4
1946	L01	53	16,430	89,358	21,1947	1,6982	21
1946	L02	6	,720	7,638	3,7224	,2901	3
1946	L03	45	13,950	49,500	17,9955	,9405	19
1946	L04	5	,000	10,675	,0000	,2028	2
1946	L05	4	,440	7,680	3,2868	,3456	3
1946	L06	49	5,243	29,988	12,6884	,8089	22
1946	L07	8	4,080	19,368	8,4456	,4456	4
1946	L08	21	6,510	23,100	8,3979	,4389	10
1946	P03	1	,120	2,649	1,3284	,1642	1
1946	R01	10	,340	6,480	3,9810	,4600	10
1946	R02	5	,150	1,025	1,2060	,0490	5
1946	R03	5	1,150	16,270	12,3970	1,1063	3

**REPORT OF ANNUAL X-RAY DOSAGE
BY TYPE WITHIN YEAR**

REPORT HRM 0003

PAGE

2

YEAR	TYPE	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
1946	S01	9	1,242	6,147	7,1289	,3169	8
1946	S02	15	,780	5,610	3,9235	,2245	9
1946	S03	1	,190	1,376	1,2274	,0660	1
1946	S04	2	,220	6,112	2,4002	,3789	1
1946	S05	1	,516	17,331	4,2415	,6759	1
1946	S06	11	2,365	30,096	24,4541	1,8657	10
1946	S07	11	4,125	58,619	39,1467	2,2859	10
1946	S08	38	5,586	100,662	59,4358	6,2396	38
1946	S09	41	14,760	648,743	127,2312	25,3011	39
1946	S13	3	,345	7,833	3,7191	,4856	1
1946	U01	3	,126	2,163	,9600	,1233	3
1946	U03	12	2,880	9,912	4,1472	,1884	6
1946	U04	146	36,500	143,956	52,5600	2,7371	69
1946	U05	3	,960	2,064	1,3824	,0393	3
1946	U06	2	,500	1,972	,7200	,0375	1
1946	U07	46	11,500	45,356	16,5600	,8625	23
1946	U08	4	1,280	2,752	1,8432	,0523	3
1946	U09	5	1,675	6,540	2,4120	,1243	2
1946	U12	21	,882	15,141	6,7204	,8631	17
1946	U13	26	6,500	25,636	9,3600	,4874	12
1946	Z01	8	10,944	119,016	59,7544	2,7376	8
1946	Z02	23	52,440	570,285	286,3224	13,1169	23
1946	Z04	2	4,560	49,590	24,8976	1,1406	2
TOTAL	1946	4,712			8,326,9766	734,6560	

1947	A01	31	7,285	121,706	70,0817	7,5454	27
1947	A02	13	3,055	51,038	29,3891	3,1643	4
1947	B02	6	,420	5,946	2,2932	,1368	1
1947	B03	2	,420	6,260	4,4688	,3882	2
1947	B05	1	,032	4,071	,3405	,2524	1
1947	B06	5	,475	28,180	5,0540	1,7471	3
1947	B07	47	9,870	147,110	105,0168	9,1225	45
1947	B08	43	9,890	351,826	105,2296	21,8139	36
1947	B09	5	,335	30,450	3,5644	1,8879	3
1947	C01	2,488	485,160	6,842,000	5,021,4084	424,2040	1,268
1947	C03	6	,330	2,898	7,5900	,2898	5
1947	C04	1	,055	,483	1,2650	,0483	1

REPORT OF ANNUAL X-RAY DOSAGE
BY TYPE WITHIN YEAR

REPORT HRM 0003

PAGE

3

YEAR	TYPE	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MYR)	NO. OF PEOPLE
1947	C05	379	3,790	94,371	89,8609	12,1660	370
1947	C06	24	,240	5,976	5,6904	,7705	12
1947	C13	1	,136	2,592	1,5926	,1840	1
1947	G03	89	20,025	412,337	152,5905	21,4414	22
1947	H01	17	4,080	45,305	17,0136	1,3138	8
1947	H02	15	1,950	18,540	11,8950	1,0198	9
1947	H07	2	,480	5,330	2,0016	,1546	2
1947	H08	1	,130	1,236	,7930	,0680	1
1947	H10	2	,070	1,454	,3521	,0509	1
1947	H11	25	9,250	118,800	41,1625	3,4450	23
1947	H12	24	1,128	11,640	4,8623	,5233	22
1947	H13	29	11,310	142,100	50,3295	4,1209	22
1947	K01	6	1,062	22,752	10,2164	1,4106	2
1947	K02	94	23,030	384,748	221,5486	23,8547	16
1947	K03	5	1,175	19,630	11,3035	1,2171	1
1947	L01	28	8,680	47,208	11,1972	,8972	13
1947	L02	19	2,280	24,187	11,7876	,9188	9
1947	L03	36	11,160	39,600	14,3964	,7524	13
1947	L05	1	,110	1,920	,8217	,0864	1
1947	L06	10	1,070	6,120	2,5895	,1650	5
1947	L07	41	20,910	99,261	43,2837	2,2834	18
1947	L08	48	14,880	52,800	19,1952	1,0032	21
1947	P03	11	1,320	29,139	14,6124	1,8063	10
1947	R01	4	,136	2,592	1,5925	,1840	3
1947	R02	1	,030	,205	,2412	,0098	1
1947	S01	6	,828	4,098	4,7526	,2112	6
1947	S02	5	,260	1,870	1,3080	,0750	5
1947	S03	2	,380	2,752	2,4548	,1320	2
1947	S04	1	,110	3,056	1,2001	,1895	1
1947	S06	1	,215	2,736	2,2231	,1696	1
1947	S07	1	,375	5,329	3,5588	,2078	1
1947	S08	26	3,822	68,874	40,6666	4,2696	22
1947	S09	32	11,520	506,336	99,3024	19,7472	25
1947	U01	1	,042	,721	,3200	,0411	1
1947	U03	44	10,560	36,344	15,2064	,8908	17
1947	U04	90	22,500	88,740	32,4000	1,6873	44
1947	U05	2	,640	1,376	,9216	,0262	2

REPORT OF ANNUAL X-RAY DOSAGE BY TYPE WITHIN YEAR

REPORT HRM 0003

PAGE 4

YEAR	TYPE	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
1947	U06	4	1,000	3,944	1,4400	,0750	2
1947	U07	45	11,250	44,370	16,2000	,8435	21
1947	U09	54	18,090	70,632	26,0496	1,3424	15
1947	U12	23	,966	16,583	7,3608	,9453	11
1947	U13	23	5,750	22,678	8,2800	,4311	11
1947	U14	1	,320	,688	,4608	,0131	1
1947	Z01	11	15,048	163,647	82,1623	3,7642	11
1947	Z02	37	84,360	917,415	460,6056	21,1011	37
1947	Z04	3	6,840	74,385	37,3464	1,7109	3
TOTAL	1947	3,976			6,940,8513	608,1216	
1948	A01	40	9,400	157,040	90,4280	9,7360	22
1948	B02	6	,420	5,948	2,2932	,1368	2
1948	B05	2	,064	8,142	,6810	,5048	2
1948	B06	9	,855	50,724	9,0972	3,1446	9
1948	B07	77	16,170	241,010	172,0488	14,9440	54
1948	B08	76	17,480	621,832	185,9872	38,5547	43
1948	B09	9	,603	54,810	6,4161	3,3984	9
1948	C01	1,646	320,970	4,526,500	3,322,1169	280,6430	1,597
1948	C03	12	,660	5,796	15,1800	,5796	8
1948	C05	294	2,940	73,206	69,7074	9,4374	284
1948	C06	20	,200	4,980	4,7420	,6420	10
1948	G03	84	18,900	389,172	144,0180	20,2369	21
1948	H01	17	4,080	45,305	17,0136	1,3141	9
1948	H02	14	1,820	17,304	11,1020	,9520	9
1948	H04	2	,080	,694	,4016	,0312	1
1948	H05	1	,065	,972	,3731	,0340	1
1948	H09	7	,609	5,677	2,6248	,2555	3
1948	H10	1	,035	,727	,1761	,0254	1
1948	H11	29	10,730	137,808	47,7485	3,9962	26
1948	H12	24	1,128	11,640	4,8623	,5233	23
1948	H13	28	10,920	137,200	48,5940	3,9788	25
1948	K02	88	20,680	345,488	198,9416	21,4204	16
1948	K03	6	1,410	23,556	13,5642	1,4604	2
1948	L01	27	8,370	45,522	10,7973	,8653	14
1948	L02	8	,960	10,184	4,9632	,3870	2
1948	L03	32	9,920	35,200	12,7968	,6688	13

REPORT OF ANNUAL X-RAY DOSAGE
BY TYPE WITHIN YEAR

REPORT HRM 0003

PAGE

5

YEAR	TYPE	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
1948	L04	12	,000	25,620	,0000	,4867	5
1948	L05	6	,000	11,520	4,9302	,5184	4
1948	L06	20	2,140	12,240	5,1789	,3302	9
1948	L07	26	13,260	62,946	27,4482	1,4482	13
1948	L08	10	3,100	11,000	3,9990	,2090	5
1948	P03	7	,840	18,543	9,2988	1,1496	5
1948	R01	2	,068	1,296	,7962	,0920	2
1948	R02	1	,030	,205	,2412	,0098	1
1948	R03	2	,460	6,508	4,9588	,4425	1
1948	R04	1	,110	3,592	,9328	,1832	1
1948	R05	2	,460	10,636	3,7628	,3297	1
1948	R06	2	,070	31,152	,4508	,7788	1
1948	S01	4	,552	2,732	3,1684	,1409	3
1948	S02	6	,312	2,244	1,5694	,0898	4
1948	S06	7	1,505	19,152	15,5617	1,1873	6
1948	S07	9	3,375	47,961	32,0289	1,8705	6
1948	S08	17	2,499	45,033	26,5896	2,7915	15
1948	S09	14	5,040	221,522	43,4448	8,6394	12
1948	S12	5	4,200	285,540	40,4040	11,9926	4
1948	U01	1	,042	,721	,3200	,0411	1
1948	U03	24	5,760	19,824	8,2944	,3768	11
1948	U04	94	23,500	92,684	33,8400	1,7623	46
1948	U05	2	,640	1,376	,9216	,0261	1
1948	U06	17	4,250	16,762	6,1200	,3187	8
1948	U07	18	4,500	17,748	6,4800	,3374	8
1948	U08	2	,640	1,376	,9216	,0261	1
1948	U12	39	1,638	28,119	12,4817	1,6029	17
1948	U13	25	6,250	24,650	9,0000	,4686	11
1948	U14	4	1,280	2,752	1,8432	,0524	4
1948	Z01	15	20,520	223,155	112,0395	5,1330	15
1948	Z02	40	91,200	991,800	497,9520	22,8120	40
TOTAL	1948	2,993			5,311,6534	483,5181	
1949	A01	20	4,700	78,520	45,2140	4,8680	15
1949	A02	21	4,935	82,446	47,4747	5,1115	8
1949	B02	8	,560	7,928	3,0576	,1824	2
1949	B05	5	,160	20,355	1,7025	1,2620	3

REPORT OF ANNUAL X-RAY DOSAGE
BY TYPE WITHIN YEAR

REPORT HRM 0003

PAGE

6

YEAR	TYPE	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
1949	B06	24	2,280	135,264	24,2592	8,3858	22
1949	B07	105	22,050	328,650	234,6120	20,3766	56
1949	B08	98	22,540	801,836	239,8256	49,7152	40
1949	B09	22	1,474	133,980	15,6838	8,3072	21
1949	C01	809	157,755	2,224,750	1,632,8039	137,9345	801
1949	C02	1	,010	,249	,2371	,0321	1
1949	C03	14	,770	6,762	17,7100	,6762	12
1949	C04	1	,055	,483	1,2650	,0483	1
1949	C05	1,037	10,370	258,213	245,8727	33,2877	1,025
1949	C06	10	,100	2,490	2,3710	,3210	5
1949	C07	3	,030	,747	,7113	,0964	1
1949	C09	4	,080	1,992	1,8968	,2570	1
1949	G03	61	13,725	282,613	104,5845	14,6957	17
1949	H01	5	1,200	13,325	5,0040	,3865	5
1949	H02	6	,780	7,416	4,7580	,4080	5
1949	H04	9	,360	3,123	1,8072	,1405	4
1949	H07	2	,480	5,330	2,0016	,1546	2
1949	H08	2	,260	2,472	1,5860	,1360	2
1949	H10	2	,070	1,454	,3521	,0509	1
1949	H11	17	6,290	80,784	27,9905	2,3426	17
1949	H12	16	,752	7,760	3,2416	,3488	16
1949	H13	24	9,360	117,600	41,6520	3,4104	20
1949	K01	7	1,239	26,544	11,9191	1,6457	4
1949	K02	135	31,725	530,010	305,1945	32,8604	28
1949	K03	18	4,230	70,668	40,6926	4,3814	4
1949	L01	37	11,470	62,382	14,7963	1,1854	15
1949	L03	25	7,750	27,500	9,9975	,5225	11
1949	L04	12	,000	25,620	,0000	,4866	6
1949	L05	6	,660	11,520	4,9302	,5184	2
1949	L06	34	3,638	20,808	8,8041	,5613	14
1949	L07	8	4,080	19,368	8,4456	,4455	2
1949	L08	10	3,100	11,000	3,9990	,2090	5
1949	P03	1	,120	2,649	1,3284	,1642	1
1949	R01	4	,136	2,592	1,5925	,1840	3
1949	R02	4	,120	,820	,9648	,0392	4
1949	S01	12	1,656	8,196	9,5052	,4227	9
1949	S02	9	,468	3,366	2,3543	,1349	8

**REPORT OF ANNUAL X-RAY DOSAGE
BY TYPE WITHIN YEAR**

REPORT HRM 0003

PAGE 7

YEAR	TYPE	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
1949	S06	16	3,440	43,776	35,5696	2,7139	12
1949	S07	21	7,875	111,909	74,7342	4,3644	13
1949	S08	28	4,116	74,172	43,7947	4,5978	25
1949	S09	46	16,560	727,858	142,7472	28,3866	28
1949	S12	5	4,200	285,540	40,4040	11,9925	5
1949	S13	1	1,115	2,611	1,2397	1,1619	1
1949	U01	1	1,042	1,721	1,3200	1,0411	1
1949	U03	30	7,200	24,780	10,3680	1,4710	16
1949	U04	81	20,250	79,866	29,1600	1,5183	39
1949	U05	4	1,280	2,752	1,8432	1,0524	4
1949	U06	10	2,500	9,860	3,6000	1,1874	4
1949	U07	28	7,000	27,608	10,0800	1,5248	12
1949	U08	1	1,320	1,688	1,4608	1,0131	1
1949	U09	2	1,670	2,616	1,9648	1,0497	1
1949	U12	34	1,428	24,514	10,8815	1,3974	17
1949	U13	57	14,250	56,202	20,5200	1,0680	22
1949	U14	5	1,600	3,440	2,3040	1,0655	5
1949	Z01	23	31,464	342,171	171,7939	7,8706	23
1949	Z02	43	98,040	1,066,185	535,2984	24,5229	43
1949	Z04	1	2,280	24,795	12,4488	1,5703	1
TOTAL 1949		3,065			4,280,7316	427,2667	
1950	A01	47	11,045	184,522	106,2529	11,4398	34
1950	A02	10	2,350	39,260	22,6070	2,4341	4
1950	B02	10	1,700	9,910	3,8220	1,2280	5
1950	B03	5	1,050	15,650	11,1720	1,9704	3
1950	B05	8	1,256	32,568	2,7240	2,0192	8
1950	B06	16	1,520	90,176	16,1728	5,5904	16
1950	B07	200	42,000	626,000	446,8800	38,8126	87
1950	B08	215	49,450	1,759,130	526,1480	109,0681	70
1950	B09	20	1,340	121,800	14,2579	7,5519	18
1950	C01	413	80,535	1,135,750	833,5575	70,4165	409
1950	C03	51	2,805	24,633	64,5150	2,4833	43
1950	C04	6	1,330	2,898	7,5900	1,2898	5
1950	C05	1,091	10,910	271,659	258,6761	35,0212	1,083
1950	C06	14	1,140	3,486	3,3194	1,4494	7
1950	C11	2	1,068	1,296	1,7963	1,0926	1

REPORT OF ANNUAL X-RAY DOSAGE
BY TYPE WITHIN YEAR

REPORT HRM 0003

PAGE 8

YEAR	TYPE	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
1950	C12	3	1,204	3,888	2,3888	1,2760	1
1950	C13	1	1,136	2,592	1,5926	1,1840	1
1950	G01	4	1,900	18,532	6,8580	1,9637	1
1950	G03	190	42,750	880,270	325,7550	45,7740	45
1950	H01	17	4,080	45,305	17,0136	1,3141	8
1950	H02	14	1,820	17,304	11,1020	1,9518	8
1950	H04	7	1,280	2,429	1,4056	1,1093	2
1950	H05	2	1,130	1,944	1,7462	1,0680	2
1950	H07	6	1,440	15,990	6,0048	1,4637	2
1950	H08	6	1,780	7,416	4,7580	1,4079	2
1950	H11	10	3,700	47,520	16,4650	1,3780	6
1950	H12	8	1,376	3,880	1,6207	1,1745	7
1950	H13	15	5,850	73,500	26,0325	2,1315	8
1950	K01	55	9,735	208,560	93,6506	12,9305	18
1950	K02	188	44,180	738,088	425,0116	45,7820	34
1950	K03	6	1,410	23,556	13,5642	1,4604	3
1950	L01	47	14,570	79,242	18,7953	1,5860	20
1950	L02	3	1,360	3,819	1,8612	1,1451	2
1950	L03	39	12,090	42,900	15,5961	1,8151	14
1950	L04	4	1,000	8,540	1,0000	1,1622	2
1950	L05	6	1,660	11,520	4,9302	1,5184	3
1950	L06	53	5,671	32,436	13,7241	1,8750	24
1950	L07	12	6,120	29,052	12,6684	1,6684	6
1950	L08	13	4,030	14,300	5,1987	1,2717	7
1950	P03	4	1,480	10,596	5,3136	1,6568	4
1950	R01	8	1,272	5,184	3,1849	1,3680	7
1950	R02	6	1,180	1,230	1,4472	1,0588	6
1950	R03	5	1,150	16,270	12,3970	1,11063	3
1950	R04	3	1,330	10,776	2,7984	1,5496	2
1950	S01	12	1,656	8,196	9,5052	1,4226	10
1950	S02	20	1,040	7,480	5,2313	1,2993	9
1950	S03	2	1,380	2,752	2,4548	1,1320	2
1950	S06	7	1,505	19,152	15,5617	1,1873	6
1950	S07	4	1,500	21,316	14,2352	1,8312	4
1950	S08	56	8,232	148,344	87,5896	9,1962	46
1950	S09	87	31,320	1,376,601	269,9784	53,6877	47
1950	S10	2	1,492	23,910	5,2349	1,4824	1

REPORT OF ANNUAL X-RAY DOSAGE
BY TYPE WITHIN YEAR

REPORT HRM 0003

PAGE

9

YEAR	TYPE	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
1950	S12	16	13,440	913,728	129,2928	38,3761	14
1950	U03	29	6,960	23,954	10,0224	1,4553	12
1950	U04	100	25,000	98,600	36,0000	1,8746	46
1950	U05	4	1,280	2,752	1,8432	0,524	4
1950	U06	6	1,500	5,916	2,1600	0,1125	3
1950	U07	40	10,000	39,440	14,4000	0,7498	19
1950	U09	12	4,020	15,696	5,7888	0,2982	4
1950	U10	1	0,42	0,721	0,3200	0,0411	1
1950	U12	36	1,512	25,956	11,5216	1,4796	12
1950	U13	31	7,750	30,566	11,1600	0,5809	10
1950	U14	4	1,280	2,752	1,8432	0,524	4
1950	Z01	16	21,888	238,032	119,5088	5,4752	16
1950	Z02	72	164,160	1,785,240	896,3136	41,0616	72
1950	Z04	1	2,280	24,795	12,4488	0,5703	1
TOTAL	1950	3,401			5,032,7895	567,3162	
1951	A01	84	19,740	329,784	189,8988	20,4460	49
1951	A02	18	4,230	70,668	40,6926	4,3814	3
1951	B02	66	4,620	65,406	25,2252	1,5047	23
1951	B03	5	1,050	15,650	11,1720	0,9703	3
1951	B04	4	1,280	3,964	1,5288	0,0912	2
1951	B05	20	1,640	81,420	6,8100	5,0480	20
1951	B06	37	3,545	208,532	37,3996	12,9285	29
1951	B07	243	51,030	760,590	542,9592	47,1571	102
1951	B08	253	58,190	2,070,046	619,1416	128,3437	76
1951	B09	35	2,345	243,150	24,9515	13,2160	29
1951	C01	303	59,085	833,250	611,5448	51,6615	302
1951	C02	1	0,010	0,249	0,2371	0,0321	1
1951	C03	104	5,720	50,232	131,5600	5,0232	94
1951	C04	3	0,165	1,449	3,7950	0,1449	3
1951	C05	827	8,270	205,923	198,0817	26,5467	813
1951	C07	1	0,010	0,249	0,2371	0,0321	1
1951	C08	2	0,110	0,966	2,3300	0,0966	1
1951	C11	8	0,272	5,184	3,1851	0,3680	2
1951	C12	2	0,136	2,592	1,5926	0,1840	2
1951	C13	5	0,680	12,960	7,9628	0,9202	2
1951	G03	263	59,175	1,218,479	450,9135	63,3606	70

REPORT OF ANNUAL X-RAY DOSAGE
BY TYPE WITHIN YEAR

REPORT HRM 0003

PAGE 10

YEAR	TYPE	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
1951	H01	23	5,520	61,295	23,0184	1,7779	9
1951	H02	20	2,600	24,720	15,8600	1,3998	9
1951	H04	5	,200	1,735	1,0040	,0781	1
1951	H05	1	,065	,972	,3731	,0340	1
1951	H06	1	,270	3,394	1,6281	,1324	1
1951	H07	2	,480	5,330	2,0016	,1546	1
1951	H08	4	,520	4,944	3,1720	,2719	1
1951	H11	15	5,550	71,280	24,6975	2,0670	12
1951	H12	10	,470	4,850	2,0259	,2181	9
1951	H13	16	6,240	78,400	27,7680	2,2736	9
1951	K01	31	5,487	117,552	52,7849	7,2881	9
1951	K02	168	39,480	659,568	379,7976	40,8939	28
1951	L01	44	13,640	74,184	17,5956	1,4095	16
1951	L02	3	,360	3,819	1,8612	,1451	2
1951	L03	42	13,020	46,200	16,7958	,8778	17
1951	L04	9	,000	19,215	,0000	,3652	4
1951	L05	7	,770	13,440	5,7519	,6048	3
1951	L06	47	5,029	28,764	12,1706	,7758	21
1951	L07	8	4,080	19,368	8,4456	,4456	4
1951	L08	25	7,750	27,500	9,9975	,5225	10
1951	P03	5	,600	13,245	6,6420	,8211	3
1951	R01	16	,544	10,368	6,3701	,7360	10
1951	R02	11	,330	2,255	2,6532	,1081	8
1951	R03	3	,690	9,762	7,4382	,6638	2
1951	R04	2	,220	7,184	1,8656	,3864	2
1951	S01	13	1,794	8,879	10,2973	,4578	11
1951	S02	13	,676	4,862	3,4006	,1948	9
1951	S03	10	1,900	13,760	12,2740	,6602	8
1951	S04	3	,330	9,168	3,6003	,5684	2
1951	S05	2	1,032	34,662	8,4830	1,3518	2
1951	S06	8	1,720	21,888	17,7848	1,3568	8
1951	S07	8	3,000	42,632	28,4704	1,6624	8
1951	S08	32	4,704	84,768	50,0512	5,2545	31
1951	S09	57	20,520	901,911	176,8824	35,1747	32
1951	S12	3	2,520	171,324	24,2424	7,1955	3
1951	S13	3	,345	7,833	3,7191	,4856	1
1951	U03	17	4,080	14,042	5,8752	,2669	7

REPORT OF ANNUAL X-RAY DOSAGE
BY TYPE WITHIN YEAR

REPORT HRM 0003

PAGE 11

YEAR	TYPE	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
1951	U04	61	15,250	60,146	21,9600	1,1434	27
1951	U05	1	,320	,688	,4608	,0131	1
1951	U06	5	1,250	4,930	1,8000	,0937	2
1951	U07	27	6,750	26,622	9,7200	,5059	10
1951	U08	1	,320	,688	,4608	,0131	1
1951	U10	4	,168	2,884	1,2802	,1644	1
1951	U12	61	2,582	43,981	19,5224	2,5071	21
1951	U13	17	4,250	16,762	6,1200	,3187	9
1951	U14	8	2,580	5,504	3,6864	,1048	8
1951	Z01	31	42,408	461,187	231,5483	10,6082	31
1951	Z02	70	159,600	1,735,650	871,4160	39,9210	70
1951	Z04	2	4,580	49,590	24,8976	1,1406	2
TOTAL	1951	3,259			5,079,0906	558,0113	
1952	A01	105	24,675	412,230	237,3735	25,5574	71
1952	A02	6	1,410	23,556	13,5642	1,4604	3
1952	B02	437	30,590	433,067	167,0214	9,9621	99
1952	B03	12	2,520	37,560	26,8128	2,3288	4
1952	B04	22	1,540	21,802	8,4084	,5016	11
1952	B05	16	,512	65,136	5,4480	4,0384	16
1952	B06	39	3,705	219,804	39,4212	13,6276	27
1952	B07	327	68,670	1,023,510	730,6488	63,4585	120
1952	B08	329	75,670	2,891,878	805,1288	166,8968	94
1952	B09	39	2,613	237,510	27,8030	14,7263	28
1952	C01	743	144,885	2,043,250	1,499,5966	126,6815	740
1952	C02	2	,020	,498	,4742	,0642	2
1952	C03	100	5,500	48,300	126,5000	4,8300	88
1952	C04	14	,770	6,762	17,7100	,6762	14
1952	C05	929	9,290	231,321	220,2659	29,8210	907
1952	C06	2	,020	,498	,4742	,0642	1
1952	C11	3	,102	1,944	1,1944	,1380	1
1952	C12	2	,136	2,592	1,5926	,1840	1
1952	C13	3	,408	7,776	4,7777	,5521	1
1952	G01	5	1,125	23,165	8,5725	1,2045	2
1952	G03	318	71,550	1,473,294	545,2110	76,6099	85
1952	H01	24	5,760	63,960	24,0192	1,8552	9
1952	H02	19	2,470	23,484	15,0670	1,2917	8

REPORT OF ANNUAL X-RAY DOSAGE
BY TYPE WITHIN YEAR

REPORT HRM 0003

PAGE 12

YEAR	TYPE	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
1952	H04	4	,160	1,388	,8032	,0624	2
1952	H05	1	,065	,972	,3731	,0340	1
1952	H06	2	,540	6,788	3,2562	,2648	2
1952	H07	20	4,800	53,300	20,0160	1,5458	5
1952	H08	11	1,430	13,596	8,7230	,7479	4
1952	H10	1	,035	,727	,1761	,0254	1
1952	H11	26	9,620	123,552	42,8090	3,5828	20
1952	H12	24	1,128	11,640	4,8621	,5235	20
1952	H13	45	17,550	220,500	78,0975	6,3945	20
1952	K01	34	6,018	128,928	57,8931	7,9934	10
1952	K02	138	32,430	541,788	311,9766	33,5913	24
1952	L01	45	13,950	75,870	17,9955	1,4415	17
1952	L02	2	,240	2,546	,12408	,0967	1
1952	L03	33	10,230	36,300	13,1967	,6897	13
1952	L04	6	,000	12,810	,00000	,2434	2
1952	L05	4	,440	7,680	3,2868	,3456	2
1952	L06	44	4,708	26,928	11,3937	,7264	19
1952	L07	37	18,870	89,577	39,0609	2,0607	18
1952	L08	9	2,790	9,900	3,5991	,1881	4
1952	P03	2	,240	5,298	2,6568	,3285	1
1952	R01	17	,578	11,016	6,7681	,7820	13
1952	R02	11	,330	2,255	2,6532	,1080	9
1952	R03	6	1,380	19,524	14,8764	1,3277	4
1952	R04	5	,550	17,960	4,6640	,9160	4
1952	R05	2	,460	10,636	3,7628	,3297	1
1952	R06	3	,105	46,728	,6762	1,1682	1
1952	S01	16	2,208	10,928	12,6736	,5634	14
1952	S02	19	,988	7,106	4,9701	,2847	15
1952	S03	13	2,470	17,888	15,9562	,8580	13
1952	S05	1	,516	17,331	4,2415	,6759	1
1952	S06	9	1,935	24,624	20,0079	1,5264	9
1952	S07	16	6,000	85,264	56,9404	3,3252	11
1952	S08	41	6,027	108,609	64,1281	6,7326	37
1952	S09	75	27,000	1,186,725	232,7400	46,2825	35
1952	S10	1	,246	11,955	2,6174	,7412	1
1952	S12	14	11,760	799,512	113,1312	33,5792	12
1952	S13	3	,345	7,833	3,7191	,4857	2

REPORT OF ANNUAL X-RAY DOSAGE
BY TYPE WITHIN YEAR

REPORT HRM 0003

PAGE 13

YEAR	TYPE	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
1952	U01	5	.210	3,605	1,6001	.2055	3
1952	U03	32	7,680	26,432	11,0592	.5024	15
1952	U04	113	28,250	111,418	40,6800	2,1180	48
1952	U05	13	4,160	8,944	5,9904	.1703	13
1952	U06	11	2,750	10,846	3,9600	.2062	4
1952	U07	46	11,500	45,356	16,5600	.8621	20
1952	U08	11	3,520	7,568	5,0688	.1440	10
1952	U12	51	2,142	36,771	16,3218	2,0961	17
1952	U13	30	7,500	29,580	10,8000	.5622	9
1952	U14	5	1,600	3,440	2,3040	.0655	5
1952	Z01	26	35,568	386,802	194,2018	8,8972	26
1952	Z02	95	216,600	2,355,525	1,182,6360	54,1785	95
1952	Z03	4	9,120	99,180	49,7952	2,2812	4
TOTAL	1952	4,678			7,254,0051	779,3924	
1953	A01	68	15,980	266,968	153,7276	16,5519	16
1953	A02	7	1,645	27,482	15,8249	1,7039	3
1953	B02	528	36,960	523,248	201,8016	12,0379	122
1953	B03	15	3,150	46,950	33,5160	2,9111	8
1953	B04	45	3,150	44,595	17,1990	1,0260	25
1953	B05	13	4,416	52,923	4,4265	3,2812	13
1953	B06	63	5,985	355,068	63,6804	22,0128	53
1953	B07	357	74,970	1,117,410	797,6808	69,2817	157
1953	B08	345	79,350	2,822,790	844,2840	175,0163	111
1953	B09	63	4,221	383,670	44,9125	23,7886	54
1953	C01	756	147,420	2,079,000	1,525,8341	128,8980	748
1953	C02	5	.050	1,245	1,1855	.1605	5
1953	C03	131	7,205	63,273	165,7150	6,3273	125
1953	C04	21	1,155	10,143	26,5650	1,0143	20
1953	C05	1,020	10,200	253,980	241,8420	32,7423	1,003
1953	C07	6	.060	1,494	1,4226	.1927	3
1953	C08	1	.055	.483	1,2650	.0483	1
1953	C09	1	.020	.498	.4742	.0642	1
1953	C11	5	.170	3,240	1,9907	.2300	2
1953	C12	1	.068	1,296	.7963	.0920	1
1953	C13	6	.816	15,552	9,5554	1,1042	3
1953	G01	4	.900	18,532	6,8580	.9637	1

REPORT OF ANNUAL X-RAY DOSAGE
BY TYPE WITHIN YEAR

REPORT HRM 0003

PAGE 14

YEAR	TYPE	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
1953	G03	301	67,725	1,394,533	516,0645	72,5134	87
1953	H01	43	10,320	114,595	43,8344	3,3237	17
1953	H02	41	5,330	50,676	32,5130	2,7871	15
1953	H04	2	.080	.694	.4016	.0312	1
1953	H05	2	.130	1,944	.7462	.0680	1
1953	H09	1	.087	.811	.3750	.0365	1
1953	H10	3	.105	2,181	.5282	.0763	2
1953	H11	19	7,030	90,288	31,2835	2,6182	18
1953	H12	19	.893	9,215	3,8494	.4142	19
1953	H13	44	17,160	215,600	76,3620	6,2524	22
1953	K01	12	2,124	45,504	20,4329	2,8212	4
1953	K02	179	42,065	702,754	404,6653	43,5714	32
1953	L01	108	33,480	182,088	43,1892	3,4597	35
1953	L02	2	.240	2,546	1,2408	.0967	1
1953	L03	44	13,640	48,400	17,5956	.9196	14
1953	L04	5	.000	10,675	.0000	.2028	2
1953	L05	15	1,650	28,800	12,3255	1,2960	8
1953	L06	44	4,708	26,928	11,3936	.7264	18
1953	L07	13	6,630	31,473	13,7241	.7240	6
1953	L08	34	10,540	37,400	13,5966	.7106	13
1953	P01	1	.444	5,406	4,9151	.3352	1
1953	P03	5	.600	13,245	6,6420	.8212	2
1953	R01	25	.850	16,200	9,9531	1,1500	15
1953	R02	11	.330	2,255	2,6532	.1080	9
1953	R03	5	1,150	16,270	12,3970	1,1064	4
1953	R04	1	.110	3,592	.9328	.1832	1
1953	S01	24	3,312	16,392	19,0105	.8452	19
1953	S02	54	2,808	20,196	14,1245	.8081	19
1953	S03	14	2,660	19,264	17,1836	.9241	13
1953	S04	5	.550	15,280	6,0005	.9473	3
1953	S05	3	1,548	51,993	12,7245	2,0277	3
1953	S06	28	6,020	76,608	62,2468	4,7496	16
1953	S07	37	13,875	197,173	131,6742	7,6898	16
1953	S08	68	9,996	180,132	106,3584	11,1669	51
1953	S09	150	34,000	2,373,450	465,4800	92,5850	53
1953	S10	2	.492	23,910	5,2348	1,4824	2
1953	S12	35	29,400	1,998,780	282,8280	83,9482	24

REPORT OF ANNUAL X-RAY DOSAGE
BY TYPE WITHIN YEAR

REPORT HRM 0003

PAGE

15

YEAR	TYPE	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
1953	S13	8	.920	20,888	9,9176	1,2951	4
1953	S14	15	1,050	14,865	5,7330	1,3420	3
1953	S15	13	1,911	34,437	20,3330	2,1351	3
1953	U01	2	.084	1,442	.6401	.0822	1
1953	U03	27	6,480	22,302	9,3312	1,4239	13
1953	U04	128	32,000	126,208	46,0800	2,3988	53
1953	U05	21	6,720	14,448	9,6768	.2751	21
1953	U06	9	2,250	8,874	3,2400	.1686	4
1953	U07	55	13,750	54,230	19,8000	1,0304	25
1953	U08	5	1,600	3,440	2,3040	.0655	5
1953	U09	3	1,005	3,924	1,4472	.0746	2
1953	U12	69	2,898	49,749	22,0825	2,8359	20
1953	U13	23	5,750	22,678	8,2800	.4300	10
1953	U14	6	1,920	4,128	2,7648	.0785	5
1953	Z01	57	77,976	847,989	425,7501	19,5054	57
1953	Z02	108	246,240	2,677,860	1,344,4704	61,5924	108
1953	Z03	5	11,400	123,975	62,2440	2,8515	5
1953	Z04	4	9,120	99,180	49,7952	2,2812	4
1953	Z05	3	13,680	148,770	74,6928	3,4218	3
TOTAL	1953	5,421			8,682,8202	954,2455	
1954	A01	61	14,335	239,486	137,9027	14,8480	19
1954	A02	3	.705	11,778	6,7821	.7302	1
1954	B02	399	27,930	395,409	152,4978	9,0967	90
1954	B03	2	.420	6,260	4,4688	.3882	2
1954	B04	88	6,160	87,208	33,6336	2,0064	55
1954	B05	19	.608	77,349	6,4695	4,7956	19
1954	B06	33	3,135	185,988	33,3564	11,5306	29
1954	B07	235	49,350	735,550	525,0840	45,6056	98
1954	B08	220	50,600	1,800,040	538,3840	111,6042	69
1954	B09	36	2,412	219,240	25,6643	13,5935	30
1954	C01	479	93,405	1,317,250	966,7654	81,6695	476
1954	C03	122	6,710	58,926	154,3300	5,8928	114
1954	C04	58	3,190	28,014	73,3700	2,8014	57
1954	C05	1,224	12,240	304,776	290,2104	39,2905	1,198
1954	C06	2	.020	.498	.4742	.0642	1
1954	C11	3	.102	1,944	1,1944	.1380	1

REPORT OF ANNUAL X-RAY DOSAGE
BY TYPE WITHIN YEAR

REPORT HRM 0003

PAGE 16

YEAR	TYPE	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
1954	C12	1	.068	1,296	.7963	.0920	1
1954	C13	1	.136	2,592	1,5926	.1840	1
1954	G01	10	2,250	46,330	17,1450	2,4091	3
1954	G03	165	37,125	764,445	282,8925	39,7494	51
1954	H01	23	5,520	61,295	23,0184	1,7779	9
1954	H02	20	2,600	24,720	15,8600	1,3596	8
1954	H04	14	.560	4,858	2,8112	.2186	4
1954	H05	3	.195	2,916	1,1193	.1020	3
1954	H06	1	.270	3,394	1,8281	.1324	1
1954	H07	1	.240	2,665	1,0008	.0773	1
1954	H08	2	.260	2,472	1,5860	.1360	1
1954	H09	9	.783	7,299	3,3747	.3285	4
1954	H10	5	.175	3,635	.8803	.1272	2
1954	H11	28	10,360	133,056	46,1020	3,8584	21
1954	H12	22	1,034	10,870	4,4571	.4797	21
1954	H13	36	14,040	176,400	62,4780	5,1156	20
1954	K01	23	4,071	87,216	39,1629	5,4073	8
1954	K02	167	39,245	655,642	377,5369	40,6505	30
1954	K03	4	.940	15,704	9,0428	.9736	1
1954	L01	102	31,620	171,972	40,7898	3,2676	33
1954	L02	2	.240	2,546	1,2408	.0967	1
1954	L03	55	17,050	60,500	21,9945	1,1495	18
1954	L04	2	.000	4,270	.0000	.0811	1
1954	L05	10	1,100	19,200	8,2170	.8640	6
1954	L06	45	4,815	27,540	11,6526	.7430	19
1954	L07	35	17,850	84,735	36,9495	1,9489	11
1954	L08	6	1,860	6,600	2,3994	.1254	2
1954	P01	1	.444	5,406	4,9151	.3352	1
1954	P02	1	.406	22,132	3,9057	.8631	1
1954	P03	7	.840	18,543	9,2988	1,1496	5
1954	R01	15	.510	9,720	5,9717	.6900	13
1954	R02	15	.450	3,075	3,6180	.1473	12
1954	R03	8	1,840	26,032	19,8352	1,7702	3
1954	R04	7	.770	25,144	6,5296	1,2824	4
1954	S01	19	2,622	12,977	15,0500	.6692	14
1954	S02	34	1,768	12,716	8,8933	.5089	14
1954	S03	13	2,470	17,888	15,9562	.8582	11

REPORT OF ANNUAL X-RAY DOSAGE
BY TYPE WITHIN YEAR

REPORT HRM 0003

PAGE

17

YEAR	TYPE	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
1954	S06	14	3,010	38,304	31,1234	2,3750	8
1954	S07	13	4,875	69,277	46,2640	2,7018	8
1954	S08	88	14,406	259,602	153,2812	16,0946	62
1954	S09	173	62,280	2,737,379	536,8536	106,7583	59
1954	S10	7	1,722	83,685	18,3220	5,1884	5
1954	S12	46	38,640	2,626,968	371,7168	110,3319	32
1954	U01	4	1188	2,884	1,2802	1,1644	2
1954	U03	45	10,800	37,170	15,5520	1,7065	19
1954	U04	124	31,000	122,264	44,6400	2,3237	50
1954	U05	25	8,000	17,200	11,5200	1,3274	24
1954	U06	18	4,000	15,776	5,7600	1,2998	6
1954	U07	46	11,500	45,356	16,5600	1,8621	21
1954	U08	14	4,480	9,632	6,4512	1,1834	14
1954	U09	5	1,675	6,540	2,4120	1,1243	2
1954	U10	2	1,084	1,442	1,6401	1,0822	1
1954	U12	44	1,848	31,724	14,0816	1,8084	14
1954	U13	34	8,500	33,524	12,2400	1,6372	15
1954	U14	11	3,520	7,568	5,0688	1,1441	11
1954	Z01	31	42,408	461,187	231,5483	10,6082	31
1954	Z02	67	152,760	1,661,265	834,0696	38,2101	67
1954	Z04	1	2,280	24,795	12,4488	1,5903	1
TOTAL 1954		4,716			6,432,1233	764,2867	
1955	A01	43	10,105	168,818	97,2101	10,4666	12
1955	A02	29	6,815	113,854	65,5803	7,0390	5
1955	B02	309	21,630	306,219	118,0998	7,0449	71
1955	B04	55	3,850	54,505	21,0210	1,2540	38
1955	B05	22	704	89,562	7,4910	5,5528	21
1955	B06	30	2,850	169,080	30,3240	10,4823	27
1955	B07	204	42,840	638,520	455,8176	39,5894	85
1955	B08	191	43,930	1,562,762	467,4152	96,8931	60
1955	B09	30	2,010	182,700	21,3870	11,3280	27
1955	C01	166	32,370	456,500	335,0373	28,3030	159
1955	C03	96	5,280	46,368	121,4400	4,6368	88
1955	C04	43	2,365	20,769	54,3950	2,0769	42
1955	C05	902	9,020	224,598	213,8642	28,9544	880
1955	C06	2	1020	1,498	1,4742	1,0642	1

REPORT OF ANNUAL X-RAY DOSAGE
BY TYPE WITHIN YEAR

REPORT HRM 0003

PAGE 18

YEAR	TYPE	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MHR)	NO. OF PEOPLE
1955	C11	4	.136	2,592	1,5925	.1840	2
1955	C12	1	.068	1,296	.7963	.0920	1
1955	C13	4	.544	10,368	6,3703	.7361	2
1955	G01	1	.225	4,633	1,7145	.2409	1
1955	G03	157	35,325	727,381	269,1765	37,8225	48
1955	H01	20	4,800	53,300	20,0160	1,5459	7
1955	H02	16	2,080	19,776	12,6880	1,0878	8
1955	H04	2	.080	.694	.4016	.0312	1
1955	H05	1	.065	.972	.3731	.0340	1
1955	H07	5	1,200	13,325	5,0040	.3865	2
1955	H08	4	.520	4,944	3,1720	.2720	2
1955	H10	2	.070	1,454	.3521	.0509	1
1955	H11	8	2,960	38,016	13,1720	1,1024	8
1955	H12	7	.329	3,395	1,4182	.1526	7
1955	H13	13	5,070	63,700	22,5615	1,8473	7
1955	K01	17	3,009	64,464	28,9466	3,9967	6
1955	K02	132	31,020	518,232	298,4124	32,1308	24
1955	K03	6	1,410	23,556	13,5642	1,4605	1
1955	L01	69	21,390	116,334	27,5931	2,2104	23
1955	L02	2	.240	2,546	1,2408	.0967	1
1955	L03	65	20,150	71,500	25,9935	1,3585	21
1955	L04	1	.000	2,135	.0000	.0406	1
1955	L05	21	2,310	40,320	17,2557	1,8144	8
1955	L06	52	5,564	31,824	13,4652	.8586	22
1955	L07	10	5,100	24,210	10,5570	.5569	4
1955	L08	50	15,500	55,000	19,9950	1,0450	18
1955	P02	3	1,218	66,396	11,7172	2,5894	1
1955	P03	4	.480	10,596	5,3136	.6569	3
1955	R01	9	.306	5,832	3,5831	.4140	6
1955	R02	9	.270	1,845	2,1708	.0885	6
1955	R03	3	.690	9,762	7,4382	.6639	3
1955	R04	3	.330	10,776	2,7984	.5496	3
1955	S01	19	2,622	12,977	15,0499	.6693	14
1955	S02	38	1,976	14,212	9,9396	.5688	15
1955	S03	8	1,520	11,008	9,8192	.5280	8
1955	S04	2	.220	6,112	2,4002	.3789	1
1955	S05	1	.516	17,331	4,2415	.6759	1

REPORT OF ANNUAL X-RAY DOSAGE BY TYPE WITHIN YEAR

REPORT HRM 0003

PAGE 19

YEAR	TYPE	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
1955	S06	20	4,300	54,720	44,4620	3,3925	14
1955	S07	29	10,875	154,541	103,2045	6,0268	18
1955	S08	72	10,584	190,728	112,6146	11,8239	51
1955	S09	96	34,560	1,519,008	297,9072	59,2416	47
1955	S10	8	1,968	95,640	20,9395	5,9296	4
1955	S11	8	1,720	26,584	16,6840	1,2760	1
1955	S12	31	26,040	1,770,348	250,5048	74,3539	23
1955	S13	5	,575	13,055	6,1985	,8094	3
1955	S14	8	,560	7,928	3,0576	,1823	1
1955	S15	3	,441	7,947	4,6922	,4927	1
1955	U01	6	,252	4,326	1,9202	,2466	1
1955	U03	20	4,800	16,520	6,9120	,3140	8
1955	U04	83	20,750	81,838	29,8800	1,5558	37
1955	U05	19	6,080	13,072	8,7552	,2489	19
1955	U06	35	8,750	34,510	12,6000	,6558	12
1955	U07	69	17,250	68,034	24,8400	1,2931	28
1955	U08	21	6,720	14,448	9,6768	,2748	15
1955	U12	26	1,092	18,746	8,3210	1,0686	9
1955	U13	28	7,000	27,608	10,0800	,5246	12
1955	U14	5	1,000	3,440	2,3040	,0653	3
1955	Z01	27	36,936	401,679	201,6711	9,2394	27
1955	Z02	58	132,240	1,438,110	722,0304	33,0774	58
1955	Z05	3	13,680	148,770	74,6928	3,4217	1
TOTAL	1955	3,571			4,873,7889	568,1585	
1956	A01	25	5,875	98,150	56,5175	6,0853	7
1956	B02	119	8,330	117,929	45,4818	2,7128	31
1956	B03	4	,840	12,520	8,9376	,7762	1
1956	B04	23	1,610	22,793	8,7906	,5244	10
1956	B05	11	,352	44,781	3,7455	2,7764	11
1956	B06	13	1,235	73,268	13,1404	4,5423	12
1956	B07	79	16,590	247,270	176,5176	15,3313	39
1956	B08	75	17,250	613,650	183,5400	38,0472	27
1956	B09	13	,871	79,170	9,2677	4,9088	12
1956	C01	255	49,725	701,250	514,6661	43,4775	250
1956	C02	1	,010	,249	,2371	,0321	1
1956	C03	80	4,400	38,640	101,2000	3,8640	60

REPORT OF ANNUAL X-RAY DOSAGE BY TYPE WITHIN YEAR

REPORT HRM 0003

PAGE 20

YEAR	TYPE	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
1956	C04	42	2,310	20,286	53,130	2,0286	41
1956	C05	667	6,670	166,083	158,145	21,4111	645
1956	G02	1	,225	4,633	1,7145	,2409	1
1956	G03	114	25,650	528,162	195,4530	27,4636	34
1956	H01	12	2,880	31,980	12,0096	,9275	4
1956	H02	12	1,560	14,832	9,5160	,8158	5
1956	H04	1	,040	,347	,2008	,0156	1
1956	H05	1	,065	,972	,3731	,0340	1
1956	H06	1	,270	3,394	1,6281	,1324	1
1956	H07	1	,240	2,665	1,0008	,0773	1
1956	H08	2	,260	2,472	1,5860	,1360	1
1956	H11	4	1,480	19,008	6,5860	,5512	4
1956	H12	5	,235	2,425	1,0130	,1090	5
1956	H13	8	3,120	39,200	13,8840	1,1368	6
1956	K02	105	24,675	412,230	237,3735	25,5586	18
1956	L01	22	6,820	37,092	8,7978	,7048	8
1956	L02	2	,240	2,546	1,2408	,0967	1
1956	L03	6	1,860	6,600	2,3994	,1254	2
1956	L04	2	,000	4,270	,0000	,0811	1
1956	L05	3	,330	5,760	2,4651	,2592	2
1956	L06	49	5,243	29,988	12,6883	,8091	16
1956	L07	3	1,530	7,263	3,1671	,1671	2
1956	L08	10	3,100	11,000	3,9990	,2090	4
1956	P03	2	,240	5,298	2,6568	,3284	2
1956	R01	4	,138	2,592	1,5925	,1840	3
1956	R02	4	,120	,820	,9648	,0393	3
1956	R03	6	1,380	19,524	14,8764	1,3277	5
1956	R04	7	,770	25,144	6,5296	1,2824	6
1956	S01	8	1,104	5,464	6,3369	,2819	4
1956	S02	11	,572	4,114	2,8771	,1645	4
1956	S03	2	,380	2,752	2,4548	,1320	2
1956	S04	1	,110	3,056	1,2001	,1895	1
1956	S05	1	,516	17,331	4,2415	,8759	1
1956	S06	13	2,795	35,568	28,9003	2,2052	8
1956	S07	15	5,625	79,935	53,3815	3,1175	8
1956	S08	58	8,526	153,642	90,7173	9,5250	38
1956	S09	76	27,360	1,202,548	235,8432	46,8996	43

REPORT OF ANNUAL X-RAY DOSAGE
BY TYPE WITHIN YEAR

REPORT HRM 0003

PAGE 21

YEAR	TYPE	PLATE COUNT	TOTAL MIDLINE (MAN-R)	TOTAL SURFACE (MAN-R)	INTEGRAL BODY (KG-R)	INTEGRAL SURFACE (MMR)	NO. OF PEOPLE
1956	S10	4	,984	47,820	10,4697	2,9648	2
1956	S12	10	8,400	571,080	80,8080	23,9851	9
1956	S13	5	,575	13,055	6,1985	,8095	3
1956	U03	12	2,880	9,912	4,1472	,1884	3
1956	U04	38	9,500	37,468	13,6800	,7120	15
1956	U05	6	1,920	4,128	2,7648	,0785	5
1956	U06	4	1,000	3,944	1,4400	,0750	2
1956	U07	12	3,000	11,832	4,3200	,2248	4
1956	U08	3	,960	2,064	1,3824	,0392	2
1956	U09	4	1,340	5,232	1,9296	,0994	2
1956	U12	21	,882	15,141	6,7207	,8631	8
1956	U13	31	7,750	30,566	11,1600	,5809	12
1956	U14	4	1,280	2,752	1,8432	,0524	4
1956	Z01	13	17,784	193,401	97,1009	4,4486	13
1956	Z02	27	61,560	669,465	336,1176	15,3981	27
1956	Z03	1	2,280	24,795	12,4488	,5703	1
TOTAL	1956	2,174			2,895,5177	323,6121	

POP. TOTAL 41,986

65,110,3482

6,768,5851

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