FINAL REPORT

STUDY OF MORTALITY AMONG FEMALE NUCLEAR WEAPONS WORKERS

Grant Numbers: 1R01 OHO3274, R01/CCR214546, R01/CCR61 2934-01
Sponsor: National Institute for Occupational Safety and Health,
Centers for Disease Control and Prevention

May 19, 2000

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TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

LIST OF ABBREVIATIONS

AWRE	Atomic Weapons Research Establishment
Be	beryllium
BEIR	Biological Effects of Ionizing Radiation
CER	Center for Epidemiologic Research
CEDR	Comprehensive Epidemiologic Data Resource
CI	confidence interval
CNS	central nervous system
cSv	centi-sieverts
DOE	Department of Energy
EMF	electromagnetic fields
ERI	Epidemiology Research Institute
Exp	expected
HWE	healthy workers effect
IARC	International Agency for Research in Cancer
ICD8	International Classification of Diseases, 8^{th} Revision
ID	identification
JEM	job exposure matrix
LANL	Los Alamos National Laboratory
LTAS	Life Table Analysis System
mSv	milli-sieverts
nCi	nanocuries
NDI	National Death Index
NIOSH	National Institute for Occupational Safety and Health
Obs	observed
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
PAH	polycyclic aromatic hydrocarbons
PNL	Pacific Northwest Laboratories
Ppm	parts per million
Pu	plutonium
RFA	Request For Applications
RR	relative risk
SAS	Statistical Analysis System
SEER	Surveillance, Epidemiology and End Results Program
SIR	standardized incidence ratio
SSA	Social Security Administration
SMR	standardized mortality ratio
TLD	thermo-luminescent dosimeter
UK	United Kingdom
U	uranium
U.S.	United States

LIST OF TABLES

LIST OF TABLES
(continued)

LIST OF TABLES
(continued)

LIST OF TABLES
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LIST OF TABLES
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SIGNIFICANT FINDINGS

A strong healthy worker effect, similar to that observed among male nuclear weapons workers is observed for the entire pooled cohort of female nuclear weapons workers, and for all of the individual subcohorts with the exception of Linde workers. Increased mortality from mental disorders (Standardized Mortality Ratio (SMR=147), certain genito-urinary system diseases (SMR =129), as well as symptoms and ill-defined conditions (SMR=163) is found compared with deaths expected based on U.S. death rates. For most causes of death, mortality among female nuclear workers is lower than expected.

The healthy worker effect is observed among workers who were badged and among those who were not badged for external radiation exposures. The SMR (observed/expected X 100) for all causes of death combined is 78 for unbadged and 69 for badged workers. Mortality is elevated among both badged and unbadged women for mental disorders. Increased mortality is experienced among unmonitored employees for deaths from symptoms and ill defined conditions, diseases of the genito-urinary system and for homicide. Among badged workers, deaths from ill defined conditions does not differ from that expected, and is less than expected for diseases of the genito-urinary system and homicide.

The healthy worker effect is also observed in analyses that compare survival time among badged and unbadged workers. For instance, when we assess whether the hazard differs among workers who were issued a radiation badge compared with workers who were not issued a badge, an increased relative risk estimate is observed for all causes of death among women who were not monitored (RR=1.25). This relative risk estimate was slightly lower for deaths from all cancers (RR=1.17). The relative risk for unbadged women who were not monitored is also elevated for lung cancer deaths (RR=1.49).

For the entire pooled cohort, the relative risk of death from leukemia increases with increasing cumulative dose of external radiation (RR/rem = 1.13, 95%CI=1.02-1.25). Suggestive increases are observed for all cancers (RR/rem = 1.03, 95%CI=0.99-1.06), breast cancer (RR/rem = 1.05, 95%CI=0.99-1.12), and for hematologic cancers (RR/rem = 1.08, 95%CI=0.99-1.17). Among the individual subcohorts, increased relative risks from all cancers and from radiation sensitive cancers combined are observed for female workers at the Savannah River Plant. Increased risks for hematologic cancers and for leukemia are observed among female workers at X-10.

Future research should investigate the influence on these estimates of potential effect modifiers or confounders such as socioeconomic status, age at exposure, time related biases, smoking behavior, chemical exposures and errors in radiation dosimetry.

USEFULNESS OF FINDINGS

These findings provide a useful baseline regarding mortality among female nuclear weapons workers from 12 U.S. weapons facilities. They can be used in future considerations of the health of female workers at these work sites. They also document the presence of the healthy worker effect, among the entire pooled population, among employees at individual weapons facilities, among women who were issued a radiation badge, and among those who were not issued a radiation badge.

Identification of the frequency of specific causes of death will be useful for planning future studies of female nuclear workers. For example, 644 cancer deaths among workers who were issued a radiation badge, and 3291 cancer deaths among women who were not issued a radiation badge are identified. This includes 134 and 699 cases of respiratory cancer, and 164 and 660 cases of breast cancer respectively.

Development of a qualitative job exposure matrix, based on major types of exposures encountered at the facilities investigated may prove useful in future studies of job-related mortality. Information relating exposures to specific hazards to specific plant areas and to specific individuals is lacking, however. These types of data will have to be developed as part of future dose reconstruction efforts and nested case-control studies.

We found data on internal radiation exposures to be so variable that it could not be used for pooled analyses in the present study. Differences in detection limits, dosimetry practices and modeling procedures lead us to conclude that misleading results could result if we attempted to develop risk estimates based on these data. Future dose reconstruction efforts need to be directed to assuring that internal dosimetry data are reliable, consistent and comparable between the nuclear weapons facilities. Furthermore, applicability of "standard man" models to female workers needs to be assessed.

In the analyses that we have completed, we find cumulative exposure to penetrating radiation to be associated with the occurrence of leukemia, and to be suggestively associated with the occurrence all cancers combined, breast cancer and all hematologic cancers combined. There is little evidence of an overall association between any of the other individual and grouped causes of death that we examined with increasing cumulative dose of external ionizing radiation.

The increased relative risk estimates for leukemia, breast cancer, all cancers combined and for the hematologic cancers warrant additional research. Likewise, the effect estimates for all cancers combined and for radiosensitive solid tumors among women at Savannah River, and for the occurrence of hematologic cancers and leukemia among X-10 female workers should be further investigated. Future research should take into account the potential influence of confounding from socio-economic status, smoking, radiation dosimetry errors, chemical exposures and other factors.

The increased risks from mental disorders and from ill-defined conditions that we have observed need to be further investigated. To our knowledge, these conditions have not been found to be associated with ionizing radiation exposures. Assuming these results are not spurious, we are concerned, however, that elevated risks of death from mental disorders may reflect the need for additional counseling and mental health programs for female workers. This concern needs to be ameliorated by the need to examine the specific types of mental disorders, the problem of relying on mortality rather than morbidity data, and the possible confounding effect of risk factors that we have been unable to measure in this study.

ABSTRACT

Although women have been employed in the nuclear weapons industry since its inception, little is known about the potential health effects that women may experience as a result of work related exposures to ionizing radiation and nonradiation hazards. Studies that have reported results for women have tended to suffer from small numbers of observations, short follow-up, young average age of cohort members and a lack of exposure information. Despite these shortcomings, suggestive but inconsistent elevations for several types of neoplasms have been reported including several known to be associated with ionizing radiation; and for several nonneoplastic conditions. This study attempted to overcome the shortcomings just mentioned by combining cohorts of female nuclear workers from 12 U.S. nuclear weapons facilities. These included: Los Alamos National Laboratory, Zia Company, Rocky Flats, Hanford, Mound, Savannah River, Oak Ridge X-10, Y-12 and K-25, Fernald, Linde and Pantex.

The specific aims of this study were to combine data for female employees from the 12 facilities described above, to estimate doses or exposures to individuals for radiation and nonradiation hazards, to estimate the relative risk of mortality from neoplastic and nonneoplastic diseases, to estimate the amount of uncertainty associated with these relative risk estimates, and to evaluate the feasibility of conducting nested case-control, case-cohort and morbidity studies among female nuclear workers. The results from this study help to fill a major gap in our knowledge regarding the health of female nuclear workers.

To accomplish these specific aims, a retrospective cohort mortality study of neoplastic and nonneoplastic health endpoints was conducted of female workers who were hired at the above facilities before 1980. The cohorts were assembled from roster files that had been developed by previously funded Department of Energy researchers at Pacific Northwest Laboratories (Hanford), Center for Epidemiologic Research (CER) at Oak Ridge Institute for Science and Education (ORISE (Fernald, Linde, K-25, Savannah River, X-10, Y-12)) and Los Alamos National Laboratory (Los Alamos, Mound, Pantex, Rocky Flats, Zia).

When available, additional information on job histories was obtained from the same sources and from directly contacting resource persons at the study facilities. In addition, researchers at the University of Colorado shared information on job titles and job histories that they had developed for Rocky Flats workers. Data for specific chemical exposures to specific employees was not available from any of the study sites. Information on types of chemicals and physical hazards other than ionizing radiation was sometimes available from contact persons at some study sites, and from previous hazards assessments for a few study sites such as Savannah River. Data on radiation exposures for workers at Fernald, K-25, Y-12, X-10 and Savannah River were obtained from researchers at ORISE, and updated by information obtained directly from Fernald. No data on radiation exposures are available for Linde workers. Radiation exposure data for Hanford workers were abstracted from a file that was compiled for a study conducted by the International Agency for Research in Cancer (IARC). Data on radiation exposures for

Pantex, Los Alamos, and Zia workers were obtained directly from health physicists at these facilities. Updated information on radiation exposures was not available for Mound workers. Radiation exposure data for Rocky Flats workers was made available to us from researchers at the University of Colorado.

In collaboration with researchers at the University of North Carolina, we developed questionnaires on radiation dosimetry practices and data resources, and on physico-chemical exposures, industrial hygiene practices and data resources. The radiation dosimetry questionnaire expanded on a questionnaire that had been previously devised by staff at the Department of Energy. These questionnaires were sent to designated contacts at the study facilities. Unfortunately, fewer than half of the questionnaires were completed and returned.

We constructed a job exposure matrix that relied heavily on the chemical questionnaires that were returned, contacts with industrial hygienists at the study sites, and available literature such as previous hazards assessments. Information that would allow linking specific individuals and job titles with specific exposures and locations in the plants where they worked proved impossible due to a lack of requisite information. The job exposure matrix that has been developed is an attempt to establish a mechanism that can be used to estimate in a qualitative manner potential exposures to possible hazards in the workplace across all study facilities.

Vital status ascertainment for the combined study cohort was completed by matching a roster of study subjects, who had not already been identified as deceased, with Social Security Administration Master Death Tapes. The matching process was conducted by the Epidemiology Research Institute in Boston using a matching algorithm they have developed. Death certificates were requested from state departments of health and vital statistics for individuals who were identified as deceased. They were then coded to the 8^{th} revision of the International Classification of Diseases by a qualified nosologist.

When mortality for the combined cohort is compared with U.S. death rates, fewer deaths than expected are observed for most causes of deaths. Exceptions are deaths from mental disorders (Standardized Mortality Ratio (SMR) =147)), certain genito-urinary system diseases (SMR=129), as well as symptoms and ill-defined conditions (SMR=163). Mortality from conditions that have in the past been found to be associated with exposures to ionizing radiation is not higher than expected, or was close to expectation.

A strong healthy worker effect is observed for the entire cohort and for each individual subcohort with the exception of Linde, in which case the observed number of deaths is similar to the number expected. The weaker healthy worker effect observed among Linde workers is largely due to more deaths than expected from ischemic heart disease.

The healthy worker effect is observed among workers who were monitored for external radiation exposures and among workers who were not monitored for external radiation exposures. The SMR (observed/expected deaths X 100) for all causes of death combined is 78 for unbadged and 69 for badged workers. More observed than expected deaths among both monitored and unmonitored women are evinced for mental disorders. Increased SMRs are observed among unmonitored employees for deaths from symptoms and ill defined conditions, diseases of the genito-urinary system and for homicide. Among badged workers, deaths from ill defined conditions is as expected, and lower than expected for diseases of the genito-urinary system and homicide.

We conducted failure time analyses employing proportional hazards modeling to assess whether survival differs among workers at different facilities, and to assess whether cumulative exposures to external penetrating radiation exposures are associated with mortality. The healthy worker effect is also observed in these analyses. For instance, when we assess whether the hazard differs among workers who were issued a radiation badge compared with workers who were not issued a badge, the relative risk among women for the combined cohort who were not monitored is elevated for all causes of death (RR=1.291). The effect estimate is similar for all cancer deaths (RR=1.238).

When time dependent proportional hazards analyses of cumulative penetrating doses for all monitored employees, regardless of length of employment, are performed for all facilities combined, the relative risk of death per rem increases with increasing cumulative penetrating dose for all leukemias combined (ICD8: 204.0-207.9) other than chronic lymphatic leukemia (ICD8: 204.1 (RR/rem=1.13, 95%CI=1.02-1.25)). Relative risk estimates per rem are suggestively elevated for all cancers combined (ICD8: 140-239.9 (RR=1.03, 95%CI=0.99-1.06)), breast cancer (ICD8: 174.0-174.9 (RR/rem=1.05, 95%CI=0.99-1.12)) and for all hematologic cancers combined (ICD8=200.0-209 (RR/rem=1.08, 95%CI=0.99-1.17)). Relative risk estimates do not increase per rem for any of the other groups of causes of death that we investigated (radiosensitive solid tumors: 150.0-150.9, 151.0-151.9, 153.0-153.9, 162.0-162.9, 174.0-174.9, 188.0-188.9, 189.0-189.9, 191.0-191.9, 192.0- 192.9, lung cancers: 162.1, ovarian cancers: 183.0-183.9, , brain cancers: 191.0-192.9, 225.0-225.9, and 238.1-238.9, thyroid cancers193.0-193.9). When data from individual facilities are analyzed, increased effect estimates from all cancers (RR/rem=1.131) and from radiosensitive solid tumors (RR/rem=1.16) are observed at Savannah River, and increased relative risks for hematologic cancers (RR/rem=1.25) and for leukemia (RR/rem=1.32) are observed at X-10. Inclusion of lag times, or length of employment in these models does not change the results.

In conclusion, we find that female nuclear weapons workers demonstrate a strong healthy worker effect as evinced by lower SMRs for all causes of death among workers compared with deaths expected based on U.S. death rates, and by higher relative risk estimates for all causes of death among unbadged workers compared with badged workers. This healthy worker effect appears to be present among the pooled study population and among individual subcohorts. For the entire pooled cohort, mortality from mental disorders, diseases of the genito-urinary system, and from ill-defined conditions is higher than expected. Exposures to the low levels of external ionizing radiation that female nuclear weapons workers who comprise this study received, appear to be associated with an increased relative risk for leukemia and are suggestively associated with increased relative risks for all cancers combined and for breast cancer. We do not find these exposures to be associated with increased mortality for other organ sites that are known to be sensitive to radiation exposures at higher doses.

These results should be interpreted with caution. Additional research is needed to evaluate the impact of potential confounders that we have been unable to account for in this study. These include potential confounders such as socio-economic status, smoking and other life style activities, time related factors, potential errors in radiation dosimetry, the influence of other work site exposures and other factors. Reliance on mortality data raises concerns especially regarding the increased occurrence of mortality observed for mental disorders. Although one may hypothesize stress related illness as a possible explanation, further evaluation of the specific diagnoses comprising this combined category of mental disorders is first required. Finally, the evaluation of associations between cause-specific mortality and cumulative doses suffers from a relatively small number of deaths, doses that are skewed toward the very low doses and few observations at higher doses.

SCIENTIFC REPORT

BACKGROUND AND LITERATURE REVIEW

Background

The results from a number of epidemiologic studies of U.S. nuclear workers have now been reported. For example, retrospective cohort mortality studies have been completed for several of the Oak Ridge facilities (Wing et al, 1991, 1993; Checkoway et al, 1985; 1988), Rocky Flats (Wilkinson et al, 1987), Hanford (Gilbert et al, 1989; Kneale & Stewart, 1993), Savannah River (Cragle et al, 1991), Mound (Reyes et al, 1991; Wiggs et al, 1991, 1992, 1994 and Rocketdyne workers (Ritz et al, 1999a, 1999b, 1999c, In Press). Because females have in the past comprised a relatively small proportion of the nuclear weapons work force, statistical precision was maximized by focusing on white males. Studies specific to large female cohorts have been limited to an unpublished study of Los Alamos National Laboratory (LANL) women (Wiggs, 1987), and to studies of cancer incidence at LANL (Acquavella et al, 1983) and Lawrence Livermore National Laboratory (Reynolds & Austin, 1985).

Although results for females have been reported along with results for males in several cohorts (Beral, et al, 1985,1988); Cardis et al, 1995; Carpenter et al, 1994; Fraser et al, 1993; Gilbert et al, 1989, 1993; Smith and Douglas, 1986), dose-response analyses were usually adjusted for sex with the exception of cancers of the female reproductive organs and breast. Further, results have been reported mainly for neoplastic disease, and only rarely for large combined categories of non-neoplastic diseases. The problems encountered in analyses of separate cohorts of White males, such as short average follow-up times, young average ages of the workers and small numbers of deaths, especially among subcohorts of radiation monitored workers, are even more serious among single cohorts of female nuclear workers. For example, a recent tabulation of LANL workers reports 6,803 females out of a total workforce of 23,240 and only 1,469 females out of a workforce of 15,309 for the Zia Company, a prime contractor for many years to LANL (USDOE, 1993). This means that only 30% and about 10% respectively of workers at these 2 facilities were female. These characteristics suggest that studies which combine workers from several facilities will be required to obtain a large enough cohort that will allow analyses of moderately elevated risks to be detected with sufficient statistical precision. At the same time, data on demographic characteristics, vital status, job type and individual exposures have been collected and computerized on enough U.S. female nuclear workers at a variety of nuclear weapons facilities to make a combined analysis feasible.

Studies of Female Nuclear Workers.

Results of epidemiologic studies regarding female nuclear workers are available primarily from investigations in the U.S. and in the U.K. In a study of male and female workers at the UK Atomic Energy Authority, Beral et al. (1985), reported breast cancer SMRs of 93 for women who had not been monitored for radiation, and 55 for women who had worn radiation badges. On the other hand, SMRs for uterine and ovarian cancers were 68 for unmonitored women and 185 for monitored women. SMRs for brain and CNS cancers, all blood and lymph cancers, Hodgkin's disease, and leukemia were also elevated, although the number of observed cause-specific cases was small. Dose response analyses were adjusted for sex for most causes of death, except for uterine/ovarian cancers, in which an SMR of 3.39 was reported for cumulative exposures between 20 and 30 mSv. No cases were observed among other dose categories except for <10 mSv. In a later publication which tried to account for missing radiation exposures and which considered nonfatal cancers, Beral et al (1986) reported Standardized Incidence Ratios (SIRs) for breast cancer of 0.8 for women without a radiation record, 1.9 for women with a radiation record and SIRs ranging from 0.8 for doses <10 mSv to 4.2 for doses 50-100 mSv. No cases were observed at doses ≥ 100 mSv and therefore a significant dose-response trend was not observed. In the most recent update of this cohort Fraser et al (1993) report elevated rate ratios among women with a radiation record for uterine (RR=4.28, 95% CI=1.03-5.33) and ovarian cancers (RR=1.9, 95% CI=0.68-5.33) for 10 or more years of latency. Breast cancer mortality was not elevated. Significant dose response trends were observed for all causes of death and for all cancers with no latency considered, for lung and for uterine cancers with both 0 and 10 years latency. Breast cancer was elevated at 10-20 mSv and at ≥100 mSv, and ovarian cancer was elevated at 20-50 mSv and 50-100 mSv, but dose response trends were not observed. In a separate study of workers at the U.K. Atomic Weapons Research Establishment (AWRE), which is the British equivalent of Los Alamos, Beral et al (1988) reported SMRs of 1.51 (95% CI=.51-4.46) for breast cancer, 3.10 (.06-51.66) for uterine cancer and 11.05 (.22-1311) for thyroid cancer among employees who had been monitored for any type of radiation. No cases of ovarian cancer were observed, and no sex specific analyses were reported by dose level or by type of radiation exposure. Smith and Douglas (1986) reported SMRs of 103 for breast cancer and 81 for ovarian cancer among female radiation workers at British Nuclear Fuels. Kendall et al (1992), report SMRs of 77 for breast cancer, 147 for uterine, 144 for ovarian and 303 for thyroid cancers with 10 years induction time for workers included in the UK radiation workers registry. Dose response analyses failed to reveal significant trends for these tumor sites; both observed and expected values were far below 1 in many dose categories.

In a combined study of 75,211 male and female workers from U.K. nuclear facilities (Atomic Energy Authority, Atomic Weapons Establishment, and Sellafield plant of British Nuclear Fuels Limited), Carpenter et al (1994) reported breast cancer SMRs of 99 for women who had never been monitored for radiation and 68 for women who had been monitored for radiation. However, they reported that all female genital cancer SMRs were 80 for unmonitored workers and 130 for monitored workers. In fact, mortality for cancers of the female genital tract in monitored workers was almost twice that of the unmonitored workers (RR=1.99, 95% CI 1.23-3.21). More specifically, uterine cancer SMRs were 71 for unmonitored workers and 157 for monitored workers. Likewise, cancers of the uterine corpus were 87 for unmonitored workers and 218 for monitored workers. Cervix uteri cancer SMRs were 64 for unmonitored workers and 87 for monitored workers. Finally, ovarian cancer SMRs were 91 for unmonitored workers and 102 for monitored workers.

Cardis et al (1995) conducted a combined cohort study of 95,673 male and female workers from 7 nuclear facilities in the U.S., the U.K., and Canada. The investigators used trend test statistics to examine the relationship between radiation dose and cause-specific mortality. They reported p-values of .308 for breast cancer, .266 for cervix uteri cancer, and .312 for ovarian cancer. The p-values for other uterine cancers were 0.092.

Results reported from studies of U.S. nuclear workers have tended to be restricted to white males. Results for female nuclear workers have been reported for Lawrence Livermore National Laboratory, Hanford and LANL workers. Reynolds and Austin (1985) reported significantly elevated SIRs among LLNL females of 20 for salivary gland tumors, 5.3 for rectal cancers, 5.2 for melanoma, and increased SIRs that were not statistically significant for all cancers (1.3), esophageal cancers (5.3), cancers of the floor of mouth (8.3), colon (2.5), pancreas (7.7), ovary (2.4), kidney (3.6), nervous system (2.5). Gilbert et al (1989, 1993) reported no evidence of increased cancer mortality among Hanford workers. Specifically, Gilbert et al (1993) reported an all cause SMR of 76 for women who were monitored and 82 for women who were not monitored. Similarly, SMRs for all cancers were 81 for women who were monitored and 87 for women who were not monitored. A recent report regarding breast cancer incidence among Hanford workers (Vaughan et al, 1993) that was based on a morbidity surveillance system identified 19 incident cases of breast cancer between 1984 and 1989. Comparison of nuclear with non-nuclear workers yielded an odds ratio of 6.0 (95% CI=0.7-71.8), and comparison of workers with dose equivalents of 10-19 mSv to those with < 10 mSv yielded an odds ratio of 2.0 (95% CI=.3-11.9) with a 1 year exposure lag. However, odds ratios for higher dose categories and for longer lag times were unremarkable.

In a study of cancer incidence among Los Alamos employees who were followed from 1969-1978, Acquavella et al (1983) reported elevated but not statistically significant SIRs among female employees for all cancers, melanoma, breast cancer, uterine cancer, other genital cancers (ICD8 183-184), cancer of the eye, thyroid cancer, brain cancer and lymphatic cancers. These findings were severely limited by the small number of observations upon which they were based. Wiggs (1987), in a detailed study of mortality among Los Alamos female employees, reported a number of interesting results. For example, elevated rate ratios from internal comparisons of women with cumulative whole body doses of $\geq$ 1 cSv compared with those with < 1 cSv were observed for all causes of death, all cancers, breast cancer, all genital cancers and for ovarian cancer. Analyses of women who had worked with plutonium were hampered by the small number who had been bioassayed and who were deceased during the follow-up period. Comparisons of those who had ever been bioassayed with those who had not, resulted in elevated rate ratios for all genital organs, cancer of the uterine corpus and all uterine cancers combined for induction times of 20 years. All of these results were imprecise due to the small number of observations. Consideration of those with any positive plutonium uptake resulted in elevated rate ratios for all causes of death and for all cancers with 15 years induction time. Evaluation of mortality from ovarian cancer among those with cumulative doses $\geq$ 1 cSv compared with those < 1 cSv, revealed rate ratios that increased from 1.8 to 5.7 with increasing induction times. It is unfortunate that the results of Wiggs' (1987) study are only contained in her dissertation and have not been published in the peer reviewed literature. It is interesting, however, that several types of cancers have been found to be elevated among both Livermore and Los Alamos females including those of the breast, ovary, thyroid, pancreas and melanoma.

Recent results for 274 female Rocketdyne workers who were monitored for external radiation indicate increased but statistically imprecise SMRs for a number of neoplastic and other causes of death based on few observations. Several increased SMRs were also observed for 79 female workers who were monitored for internal radiation, but again the numbers of observations are too few to be reliable (Morgenstern et al, 1997). When all workers were considered, age at exposure was found to modify the effect of low level radiation exposures for the blood and lymph cancers, lung cancer radiosensitive solid cancers and all cancers combined (Ritz, Morgenstern and Moncau, 1999a). Dose response trends for several cancer sites, especially the blood and lymph cancers were observed for external radiation (Ritz, Morgenstern, Froines, et al, 1999b) and for internal radiation (Ritz, Morgenstern Crawford-Brown, et al, In Press). Chemicals included in hydrazine rocket fuels were associated with increased lung, blood and lymph, and bladder cancer mortality (Ritz, Morgenstern, Froines et al, 1999c).

A recent unpublished study of cancer incidence among residents of Los Alamos County reported increased rates of breast, ovarian, thyroid and brain cancers, and non-Hodgkin's lymphoma compared with New Mexico and U.S. SEER rates (Athas and Key, 1993). Because of the small population size, and small number of observations, these comparisons tended to be statistically imprecise and variable over time. A lack of information on potential exposures and information regarding employment at the Laboratory hindered census tract specific analyses, distinguishing between occupational or residential exposures and interpretation of these results.

Other Relevant Studies

A large literature has developed over the years regarding increased risks for various female organ sites due to radiation exposures in a number of different settings. Studies of Japanese atomic bomb survivors have reported increased risks for leukemia, and more recently for a number of solid tumors and cardiovascular disease in females (Preston et al, 1987; Shimizu et al, 1987). Recent reports of the Japanese cohort (Tokunaga et al, 1994; Land, 1995) elaborate on the increased risk for breast cancer associated with increased radiation doses. An extensive literature exists regarding the radiation effects experienced by atomic bomb survivors that we will not attempt to summarize here.

Because some nuclear workers are exposed to plutonium and uranium, studies of internal emitters bear some relevance to the proposed study population. The effects of radium 224, radium 226, radium 228, and Thorotrast have long been of interest because of their applicability to plutonium workers. In a study of patients who received multiple injections of radium 224 for the treatment of ankylosing spondylitis, bone tuberculosis, and other diseases, Mays and Spiess (1984) reported that female and male patients were at an increased risk of bone sarcomas. Women who were employed in the radium dial industry were found to experience elevated risks of osteogenic sarcomas and adenocarcinomas of the sinuses (Rowland et al, 1978). Studies of female radium dial workers have also reported increased breast cancer incidence and mortality (e.g. Adams and Brues, 1980). Finally, Thorotrast, an alpha emitter used as a contrast medium, has been linked to elevated mortality (all cause SMR of 3.5, all cancer SMR of 4.8.) among female patients beginning three years after receiving Thorotrast injections (Anderson et al, 1993).

Significance

Elevated cancer mortality and cancer incidence for several sites (breast, ovary, uterus, thyroid, lung and bronchus, melanoma, as well as leukemia for both sexes) have been reported for a number of nuclear worker cohorts, but these results have been inconsistent. Several of these tumor sites are known to be radiation sensitive. Female nuclear workers may be at increased risk for these and other health endpoints due to occupational exposures to radioactive hazards. The extent to which these workers are at increased risk to nonradiation hazards is unknown.

The inconsistencies in the findings reported above may have resulted from short follow-up, relatively young average age, inadequate consideration of radiation and nonradiation exposures, small numbers of observed health events, as well as different operations and exposures at various facilities. It is anticipated this investigation will rectify the above shortcomings by pooling data on female workers from 12 U.S. nuclear weapons facilities, which will allow consideration of mortality by broad job categories, by potential exposures to major nonradiation hazards and by specific types of external and internal radiation exposures. More precise estimates will be possible due to the large size of the pooled cohort, aging of the population, and lengthy follow-up time. It will be the largest study of female nuclear workers to date.

Mortality among nuclear workers from nonneoplastic disease is largely unknown. Most studies have reported few results for conditions other than cancer, and those that have reported such results have tended to only consider large combined disease categories. Nonneoplastic diseases that may be of interest include respiratory diseases due to uranium, plutonium, beryllium and other dust exposures, kidney diseases due to uranium toxicity, and blood dyscrasias due to exposures to solvents such as benzene. This study will evaluate mortality from both neoplastic and nonneoplastic diseases.

The increased mortality from certain cancer sites that has been observed among female nuclear workers at times does not appear to be associated with radiation exposures. This study will consider occupational exposures (at least by job title) which will help to identify potential nonradiation hazards and which will allow evaluation of potential relationships between nonradiation hazards (as indicated by type of job) and cause-specific mortality.

Among U.S. women, significant increases (Ries et al, 1991) have been observed in recent years of breast cancer and in cancers of the lung and bronchus (both of which are radiation sensitive organs). At the same time, a small increase has been observed in ovarian cancer, a disease that is frequently fatal and difficult to diagnose. Increased rates that are not statistically significant have been observed for kidney and pelvic disease, and chronic myeloid leukemia (the latter is well known to be associated with radiation exposures). When these findings are considered together with the results from studies of female nuclear workers, they suggest that the mortality experience of female nuclear workers should be evaluated to see if they are at even higher risk for these and other health endpoints than are nonnuclear workers, or unexposed nuclear workers. Answers to public concerns regarding the long term effects of low dose exposures to ionizing radiation and other environmental hazards are more likely to be answered by studies of well characterized populations, such as workers, than is likely possible by studies of populations for whom individual dose estimates are not available, or by studies of treated populations who are already diseased and who are likely to have received large doses of radiation or chemo-therapeutic agents. Thus, an investigation of nuclear workers such as the current study is more likely to provide valid estimates of the effects from low dose exposures that can be used to estimate risks experienced by the general population than are studies of other groups.

In addition to exposure to ionizing radiation (internal and/or external), nuclear workers may have also suffered various chemical exposures, some toxic and/or carcinogenic, which may have been part of the various processes occurring at the particular DOE sites. These chemical exposures may interact, either additively or synergistically, with ionizing radiation to enhance radiation effects. A well-known example is the case of exposure to uranium plus asbestos, in which both would increase the risk of lung cancer. Uranium is also toxic to the kidneys and may increase the risk of hematopoietic cancers. The assessment of chemical exposures at various facilities is not a simple task, however, because of a variety of complications that will be discussed in later sections of this report.

Study Facilities

Although all of the facilities in this study engaged in operations associated with nuclear weapons production, specific activities differed between the plants. Workers at Fernald were engaged in processing uranium ore and uranium tetra-fluoride into metallic form, and in machining uranium and other metals. At K-25, the primary activity was the production of enriched uranium hexa-fluoride. Operations at X-10 included applied research and development in fission, fusion and energy technologies that often involved the use of isotopes of plutonium, uranium and other materials. Y-12 employees were involved in uranium enrichment and the manufacture of enriched uranium metal products. At the Linde Plant, the processing of pitchblende and uranium ore into uranium tetra-fluoride was conducted during the Second World War. The Plant closed shortly after the war ended. Mound workers were involved in the separation, chemistry and metallurgy of polonium 210 until the 1960's, after-which operations shifted to the processing of plutonium 238 for heat sources. Workers at the Hanford Works have been engaged in operations that involved the production of plutonium and nuclear power, nuclear reactor design as well as basic and weapons research and development. Savannah River Plant employees have engaged in the production of nuclear fuels, the separation and recovery of plutonium, and the reprocessing of spent reactor fuel. Rocky Flats workers have been responsible for the production of plutonium, beryllium, uranium and other metal components for nuclear warheads, plutonium recovery, and research and development activities. Los Alamos National Laboratory workers have been engaged in nuclear fission and nuclear fusion weapons design and assembly, reactor design as well as basic and weapons research and development. The Zia Company provided construction, maintenance and other kinds of support to Los Alamos National Laboratory operations. Finally, workers at the Pantex Plant have been involved in the fabrication of high explosives, the assembly and disassembly of nuclear weapons, the testing of weapons in the nuclear stockpile, and the retirement of old weapons.

As is evident from this description, workers at these facilities may have experienced a variety of exposures to radioactive elements, chemical and physical hazards. The mix of these exposures is likely to differ from facility to facility, depending on the operations that were conducted. The one potential exposure that at least some employees at any of these facilities may have experienced is external penetrating radiation.

METHODS AND PROCEDURES

Study Design

We conducted a historical cohort mortality study of all women employed at 12 Department of Energy nuclear weapons facilities (Hanford Works, Rocky Flats Plant, Los Alamos National Laboratory (LANL), Zia Company, Pantex Plant, Mound Facility, Fernald, Oak Ridge National Laboratory (X-10), Y-12, K-25, Savannah River Plant and Linde). Computerized data on demographic characteristics, vital status, exposures to external and internal ionizing radiation, and job histories (with the exception of LANL, ZIA, Rocky Flats and Pantex) for workers at these 12 facilities were obtained from the relevant contractors with the assistance of the National Institute for Occupational Safety and Health (NIOSH). Additional hard copy data were requested when required to complete computerized files, and for completion of quality control checks. Vital status was updated through December 31, 1994 using vital status search services of Epidemiology Research Institute supplemented by the National Death Index (NDI). Death certificates were obtained from State Departments of Health for deceased study subjects that were identified through these vital status search efforts and who had not been identified during previous searches. Death certificates were then coded to the 8th revision of the International Classification of Diseases (ICD) for underlying cause of death, contributing cause of death and any mention of cancer. Only underlying cause of death was used for the results of analyses described in this report.

Data regarding external and internal radiation exposures were obtained from computerized health physics records. Cumulative doses to external radiation were calculated for total penetrating radiation for each study subject who had been monitored. Internal exposures to radioisotopes of plutonium, uranium and other internal emitters were considered separately from external exposures. Exposures to nonradiation hazards were estimated by means of constructing a qualitative job-exposure matrix. Such a matrix took into account the type of job, potential exposures and length of time employed in each job.

Analyses were conducted comparing mortality among female workers with mortality rates for U.S. females while indirectly adjusting for age and calendar year. We also conducted direct comparisons between exposed and unexposed workers, monitored and unmonitored workers, workers with low or zero doses or exposure levels and workers with higher dose or exposure levels. All analyses were initially stratified by facility while adjusting for age and calendar year, and then pooled or adjusted, depending on results of the stratified analyses. Cause-specific risk estimates were modeled, using proportional hazards algorithms, to estimate the risk per unit dose or exposure level. More detailed discussion of the methods and procedures is presented, below.

Study Population

The base study population consists of all women who were employed for at least 1 day, since the start of operations through 1979, at any of the 12 DOE nuclear weapons facilities listed above, for whom information required to ascertain vital status was available.

At a minimum, complete last name, first initial, social security number, and date of birth are required to achieve a reasonable match with vital status databases, and to conduct a baseline analysis of mortality. The size of the total combined cohort of female employees who were eligible for inclusion in this study is 68,338 women with facility specific subcohorts ranging in size from 305 to 23,236 individuals. Some of the women in the total combined study population worked at more than one facility, and are counted more than once.

Data Collection

The majority of the data needed to conduct this investigation already existed in computerized and hard copy form at Oak Ridge Institute for Science and Education (ORISE), LANL, Battelle Pacific Northwest Laboratories (PNL) and in the DOE Comprehensive Epidemiologic Data Resource (CEDR).

Computerized Data. The original Request For Applications (RFA) stated that data necessary to conduct studies that were awarded funding would be provided by NIOSH. Unfortunately, this did not occur, and we found it necessary to approach individual study facilities ourselves. Whenever possible, we coordinated our data collection efforts with those of NIOSH investigators and other NIOSH funded study teams so as to reduce the burden on the staff at those facilities of meeting our requests. Machine readable data that were available included personnel and demographic information, vital status (including last date of follow-up for some facilities, cause of death for deceased workers, ICD code and version of ICD used), individual exposure and dosimetry data for external radiation and internal emitters, and sometimes information on other types of exposures, occupational and work history data. Although we had intended to computerize job history data for LANL, ZIA, Rocky Flats and Pantex, we had to limit our efforts to Pantex. Job history data for Rocky Flats were provided to us by NIOSH investigators from the University of Colorado and Colorado Department of Health. Only first and last job titles and associated dates were available.

Hard Copy Data. Some hard copy data were obtained. These included copies of death certificates for newly identified deaths and for deceased individuals who had been identified by previous investigators at Los Alamos, Zia, Rocky Flats, Pantex, Mound and Savannah River. Samples of death certificates that are stored at the Center for Epidemiologic Research, Oak Ridge Institute for Science and Education were reviewed and cross checked with computerized information that was in our possession. We also reviewed copies of some health physics, bioassay, body counter, industrial hygiene and work history records for workers at facilities where this information had not been computerized and where the records were easily accessible. Because much of the occupational medical records data are not available in machine readable form (especially for workers who were employed during the 40's, 50's and 60's), we reviewed the types of data that were available for some facilities. Given the sensitivity of medical records information and the resources that would be required to reduce these data to machine readable form, we decided to forgo the use of medical records.

Work Restriction

No minimum length of employment criteria was employed during the data collection phase of the study. Nevertheless, because short term male employees have been shown to differ from permanent employees in health and other characteristics (Gilbert and Marks, 1979; Wilkinson et al, 1987), differences associated with short versus long work histories were evaluated.

Follow-up of Vital Status

We conducted searches of vital status by submitting rosters of workers in this study, who had not already been identified as deceased, to Epidemiology Research Institute, who matched names we submitted to the Death Master Files they had obtained from the Social Security Administration (SSA). We decided to employ December 31,1994 as the end of study date so as to insure as complete a follow-up of vital status as was possible. A protocol was devised and followed to determine the likelihood of a correct match. A flow chart depicting this process is included in Appendix II. Briefly, when names and social security numbers matched exactly, individuals were considered to be deceased and death certificates were requested from departments of health and/or vital statistics in the state each individual was thought to reside at time of death. When the social security number and last name matched exactly, such individuals were also considered to be an exact match (and therefore deceased). Death certificates were also requested for these individuals. Decision criteria for inexact matches were followed depending on the closeness of the match. Once death certificates were received from state departments of health, they were compared with demographic data in our files, such as names, sex, and dates of birth to verify that a correct match had been made. Death certificates were then coded to the 8th revision of the International Classification of Diseases (ICD) by a trained nosologist for underlying cause of death, any mention of cancer and contributing causes of death. In the analyses comprising this report, we only used underlying cause of death.

Alternative Searches. Several (Wiggs, 1987; USDOE, 1993), have indicated that vital status searches are more difficult for female employees than for males. The proportion of females for whom vital status is determined after leaving employment may be less than that for males. This problem occurs, in part, because of name changes due to marriage, use of spouse's social security number, and because of the manner in which SSA benefits have been disbursed. Therefore, additional follow-up efforts, that are restricted to the period for which vital status is unknown, may be required for a subset of the study population. These additional efforts could include NDI searches, searches of motor vehicle department records, searches of retirement plan records, Internal Revenue Service records, credit agency tracking such as by EQUIFAX or similar organizations, or active tracing. In addition, those employed at LANL prior to 1979 did not have to belong to the social security system. These individuals would only be identified by follow-up efforts involving the National Death Index. Wiggs (1987) reports successfully identifying vital status for 86.9% of all women employed at LANL, and 93.1% for all white women employed at least 6 months using a combination of SSA, NDI, motor vehicle and active tracing methods. Because of resource limitations, and because the nuclear facilities in the present study are located throughout the United States, we limited our efforts at vital status ascertainment to use of information available through the SSA Death Master Files supplemented by the National Death Index. The NDI was used when we could not identify the states in which deceased individuals resided at the time of their death.

We successfully matched 4516 individuals with the Social Security death tapes. Of these, 90 were incorrect matches based on information contained in the death certificates. We were unable to locate the states in which study individuals had died for 159 matches, even after employing the NDI to search for this information. For the remaining matches, death certificates could not be found for 332 individuals, and 3935 death certificates were successfully obtained, coded and entered into the study data base for an 89 % success rate.

Demographic Data

Personal and demographic data, including complete job histories (when available), were obtained from computerized personnel records. Because the available data varied from cohort to cohort, we relied on only those data elements that were necessary and that were available for every facility. These included: names and identification numbers (SSA and facility) which were required to match various types of records, sex (to assure that only females were included in the study cohort), race (which sometimes was not available), dates of birth, hire and death for those who had already been identified as deceased. Some employees had not reached their employment termination date by the end of the study date (December 31, 1991). For these workers, the period of employment was considered right censored as of the end of study date. Employees were considered to be at risk from an exposure until the end of follow-up, or failure (death). Complete job histories, including job titles, dates each job was held and plant location for each job were obtained, when available. Job histories for Pantex employees were entered into the computer data base from hard copy records. A computer file containing job histories for Rocky Flats study members was obtained from University of Colorado and Colorado Department of Health researchers, who recorded job titles for September of each year. Only first and last job title had been computerized for LANL and Zia employees. Although we considered entering these data from hard copy records, the condition of the records, the working conditions under which study staff would have had to work, and the resources that would have been required precluded us from attempting that task.

Assignment of Gender to Zia Study Population

Upon reading the documentation on ZIA workers in the CEDR Catalog, we discovered there were 3,637 workers with an unknown gender. This left us with only 469 known females. We searched the available files and data we had obtained for ZIA employees and found two gender variables: la_sex from LANL and f_sex, a variable based on further analysis by the ZIA programming staff. After generating a list of the first names of those workers with no value for either la_sex or f_sex, the study team reviewed the first names in order to assign a gender designation in a systematic and reproducible manner. Each study team member was responsible for two lists of names with approximately 500 names per list. Duplicate sets were made so those members of the study team could make comparisons. Each reviewed their assigned list of names and flagged names that were thought to be female. The study team then met as a group, compared findings, discussed and resolved any discrepancies or disagreements. In addition, names defined as females, and names that could be either male or female were compared with several name lists available through the Internet.

The following guidelines were followed in establishing gender according to name.

1. Names that were ambiguous with regard to gender (e.g. Willie, Adrian, Donnie, Jessie etc.) were not defined as female.
2. No gender was assigned when only a first initial was available.
3. Hispanic names ending in an "a" were defined as female, those ending in an "o" were defined as male. In all instances, someone of Hispanic descent reviewed Hispanic names before a final decision regarding gender was made.
4. Finally, the list of names was compared with lists of first names published on the Internet.

This approach appears to have been accurate. We checked the gender classification on death certificates for the Zia cohort members who are deceased and found that our gender assignment has been consistent with gender on death certificates. At this time, however, we have no way of corroborating our approach to assigning gender for Zia cohort members who are not known to be deceased.

Health Physics Data

Data pertaining to individual exposures to internal and external forms of ionizing radiation were available in computerized form for most workers at most facilities with the exception of the years during and immediately following the Second World War (1943-1946). Exposure data for these years are inconsistent and of dubious quality. Although we had originally intended to check the quality of the health physics computerized data by comparing a 10 percent sample of computerized with hard copy health physics records for accuracy, we were unable to do so due to the late date that some of these data were received, difficult accessibility and the resources that would have been required. Updated health physics data were not available for the Mound subcohort (dose reconstructions for recent employees are underway). By the time we were so informed, it was too late to translate and incorporate Mound health physics data that had been used in previous studies (Wiggs et al, 1991a; 1991b), which existed in an incompatible computer format. Health physics data also were not available for workers at the Linde Plant, which closed in 1949. When available, relevant procedural manuals pertaining to the radiation monitoring practices at each individual facility were reviewed. We also developed a survey form designed to characterize health physics dosimetry practices at the study facilities and to determine the availability of relevant data.

Issues Regarding Exposure

Major concerns in this study pertain to the types of exposures that were experienced by the workers and the quality of existing exposure data. For example, at some facilities, workers were exposed to more than one, and sometimes to a complex mixture of both radioactive and nonradioactive hazards. Furthermore, because a number of different facilities with corresponding differing operations are involved in this study, the exposure mix varies between facilities. For example, workers at Rocky Flats may have been exposed to plutonium 239, americium, uranium, external radiation (including neutrons, gamma and beta radiation), beryllium, stainless steel dust and a variety of solvents. Workers at the Mound Laboratory, could have been exposed to polonium 210, plutonium 238, external radiation and a number of solvents. Major exposures at the X-10 Plant in Oak Ridge will have been to uranium, plutonium (during the war years and for a period thereafter), external radiation, mercury, hydrofluoric acid and other chemicals. The one type of exposure that crosscuts all facilities is external penetrating radiation. We attempted to take into account the mix of exposures and differences in the mix of exposures between facilities by means of a questionnaire, and informants familiar with operations at each facility. This was not possible for Linde, and many study facilities did not return the questionnaire.

Another issue concerns differences in record keeping practices and dosimetric techniques that were followed at each facility. These differences relate to administrative practices that were unique to each contractor administering each particular facility. Furthermore, they pertain to methods used to estimate internal doses to various isotopes of plutonium, methods of calculating penetrating radiation doses, measurement of neutrons and calculation of neutron doses. Sometimes, background exposures were included in estimates of penetrating dose and at other times background was excluded (these differences sometimes exist within the same facility - such as at Rocky Flats). Film badges were read at different intervals, for different types of workers and these practices may have differed by facility. At some point it will be necessary to assess the practicality of combining quarterly and/or annual exposure estimates from the study facilities. To do so may require reviewing the original health physics records and recalculating the film badge and TLD badge readings to obtain relatively uniform annual and cumulative whole body and bone marrow doses. We were unable to accomplish this task in this study.

Similar difficulties exist regarding internal exposures or dose estimates. Although most facilities used the basic Langham equation (Langham, et al., 1980) to estimate plutonium body burdens, other facilities used derivations or reformulations of this approach. Los Alamos National Laboratory, for example, constantly revised their method of estimating body burdens as the results of whole body autopsy studies were completed. Others, such as the X-10 facility at Oak Ridge, retained the original Langham approach. The Savannah River Plant only computerized positive uptakes of plutonium and Oak Ridge only has computerized plutonium exposure data since 1951. Readings prior to 1951 exist in hard copy form, unless these data have recently been computerized. Because of these and other differences, it will probably be necessary to review the original hard copy records on which reported activity levels for isotopes of plutonium and other internal emitters are recorded to develop relatively uniform estimates of exposure, such as body burden level, and organ dose estimates or dose equivalent estimates, if possible. We were unable to accomplish this in this study. Furthermore, because of differences in internal emitter dosimetry between study facilities, we decided not to consider internal emitter exposures in the pooled analyses. A health physics assessment of the feasibility of combining data for external doses and internal exposures or doses across most study facilities is included in Appendix I.

Development of A Job Exposure Matrix

A job exposure matrix was developed to estimate past exposures to nonradioactive hazards. To address past exposures to non-radioactive materials, a historical reconstruction of processes and materials utilized at all facilities in this study was attempted. Some of this effort had already been completed, especially for the facilities previously studied by the Oak Ridge Institute for Science and Education (ORISE), Center for Epidemiologic Research. This information was used to create a qualitative Job-Exposure Matrix (JEM) to provide for qualitative and (if possible) semi-quantitative estimates of exposure to nonionizing radiation and to chemicals such as heavy metal solvent exposures in the study population.

We created the JEM in the following manner. After hard copy data entry and transfer of machine readable information of all available data for the study sub-cohorts was completed, a list of all job names and departments was evaluated and collapsed to correspond with the job titles and department codes for each facility. Simultaneously, information was gathered from industrial hygiene records and any other pertinent data that were available to us to determine what compounds were utilized in each department, by time period. Whenever possible, categories of workers in departments were combined and assigned semi-quantitative values for likelihood and intensity of exposure by job title. The exposure categories include specific chemicals, metals, organic solvents and possibly electromagnetic fields (EMF). This information was maintained in a database separate from the demographic and health physics data bases.

Linkage Between Demographic Data, Facility, Vital Status, Job History Exposures and Death Certificate

The following steps were followed in linking various data elements. First, employee identification numbers and names were used to link demographic, vital status and work history data. Job title (first and last) and job history data were available either in computer form or on microfiche. In addition, either computerized data files, hard copy data or other documents provided information on departments and buildings for some (but not all) facilities. Finally, a limited amount of chemical exposure data existed for some facilities (See Table 1 below) either from industrial hygiene monitoring data, accident data, personal interviews, questionnaire responses, or progress reports/publications. All of these data were used in an attempt to link chemical exposures with employee job titles.

Similar to most industrial settings, individual exposure measures to nonradioactive hazards usually do not exist at the weapons facilities in this study. Job titles, plant locations and plant operations are usually all that can be relied on other than occasional area monitoring records. We developed a common job title index that also factors in potential exposures to chemicals and other nonradioactive hazards. Usually it was feasible to only identify whether or not an individual was potentially exposed to a chemical such as carbon tetrachloride, benzene or trichloroethylene and perhaps how long such an individual was potentially exposed.

Chemical Exposure Assessment and Interaction with Radiation Exposure for Female Nuclear Workers

The assessment of nonradiation hazards that female nuclear workers may have been exposed to while working at DOE facilities is subject to a number of difficulties. These include:

(1) The cohort is comprised of women at 12 facilities with differing operations and processes.
(2) The exposure is time-dependent because employees may have worked for as long as 50 years (1940's - present) and numerous process changes occurred at the various facilities; furthermore, work practices for females changed with time.
(3) The chemical exposure/industrial hygiene monitoring data have only been recently computerized.
(4) The data are often inadequate and not uniformly handled by various facilities.
(5) Questions of privacy and inter-agency ownership of data as well as security/economic considerations mitigate against timely receipt of certain crucial data.
(6) Job history data are sometimes incomplete or inaccurate.
(7) Linkage of workers to plants/departments where they have been exposed to radiation/chemicals is often impossible.
(8) Chemical exposures are multiple and vary with time and with area/department and facility.

One of the major tenants of toxicology/industrial hygiene is that exposure and effect are well-correlated both for an individual human or other biological organism, as well as for groups of humans or other organisms. Generally, the simplest case is for an exposure to one unique chemical and the response is some biological effect or parameter in the case of a single organism (e.g. blood pressure or heart rate), or a frequency such as mortality in the case of a group of organisms/humans (Trieff, 1980).

At low dose levels, the lower left-hand portion of the curve, there may either be a "threshold," in which there is no effect below some value "A" for dose or there is "no threshold," curve B, where the effect merely keeps declining with decreased dose, either linearly or non-linearly, but may be finite regardless of how low the dose is. It is believed that for carcinogenic or genetically toxic substances there is "no threshold." While there is no real proof for this existence, or lack of existence, the "non-threshold" is largely accepted as a prudent notion by public health officials and academic scientists for carcinogenic substances. Similarly, it is assumed by these same groups that a threshold, below which effects do not occur, characterizes most non-carcinogenic effects.

Table 1
Known Chemical Hazards By Study Facility

HAZARD	FACILITY NAME										
	FERNALD[#]	HANFORD	LANL	MOUND	ORNL X-10	K-25	Y-12	PANTEX	ROCKY FLATS	SAVANNAH RIVER	ZIA
Acetone	X		X	X				X			X
Asbestos	X	X	X	X	X	X			X	X	X
Beryllium			X	X	X	X	X	X	X	X	X
Carbon Tetrachloride	X		X	X		X		X	X		X
Fluoride	X			X		X			X	X	
Lithium							X				
Mercury	X	X	X		X	X	X	X		X	X
MOCA				X			X				
Phosgene							X				
Uranium	X					X	X	X		X	
Uranium Hexafluoride						X					
Plutonium	X								X		X
Cadmium	X		X	X	X	X		X			X
Lead		X	X	X	X		X	X	X		X
HNO_3		X	X	X		X	X	X	X	X	X
HCl, NO_2	X	X	X	X					X	X	
H_2SO_4, SO_2	X		X	X				X	X	X	X
Noise	X		X								X
RDX			X								X
TNT			X					X			X
TCE	X		X			X		X	X		X
PCE	X		X	X				X		X	X
CS2			X								X
Benzene	X		X	X				X		X	X
Ethyl Ether			X				X				
Silica	X		X								X

* Blank spaces denote that we have no data presently available regarding possible chemical exposures. Ø Chemical exposures are time and building dependent.
d Exposures listed are selected. Other toxic chemical exposures have also been documented, but have not been included because of space limitations.
[#]Incorporated facility's feedback on possible chemical exposures from the proposed job exposure matrix.

This relationship is often decribed by a sigmoidal curve where once the low slope portion of the curve is passed, the effect rises rapidly until a peak is reached, above which no further effects occur either in a single organ system of a particular organism or in the number of individual organisms/humans within a group that are affected. In the simplest case, the dose is for a single chemical, and usually for a single route of exposure, such as inhalation, dermal absorption, intravenous injection, ingestion, etc. Multiple chemical exposures and multiple routes of exposure complicate the question.

Exposure assessment, most desirably, is a quantitative estimate of weight (mass) of chemical absorbed per weight of human (organism), e.g. mg/kg or mg/kg-day in a case where daily dosing occurs. Ideally, such a level can be obtained from analyses of blood, tissue or urinary concentration.

An alternative approach, such as in the case of inhalation, is to determine the air concentration of the chemical in question in ppm (parts per million), v/v (volume of substance/million volumes of air) or in mg/m^3. The air concentration may be determined by personal monitoring in which the individual worker is monitored by using a personal monitor, either a charcoal tube and impinger pump or a personal diffusion monitor, or by measurement of workroom air through sampling and analysis with an appropriate measurement device such as spectrophotometer, gas chromatograph, total hydrocarbon analyzer, etc.

A more qualitative approach for exposure assessment is by classification into categories such as the following: 0 (non-exposed), 1 (moderately or intermittently exposed), or 2 (highly or frequently exposed). Such a classification can be performed if workers can be linked to certain buildings/areas of a plant or facility where certain chemicals were known to be used when an individual(s) was (were) working in this facility. Thus, the chemical exposure could be inferred. Exposure could then be determined semi-quantitatively for each worker and each chemical. If such linkage cannot be made, then a less precise qualitative approach must be used of utilizing the job title/description of determining exposure to each individual chemical or to chemicals as a group. A similar approach was used by Stewart et al (1991).

Because of the variability of the facilities and their record keeping procedures, exposure assessments vary greatly from facility to facility in degree of quantitation and, in certain facilities, groups of workers. For example, within certain specific facilities, some groups of workers were monitored for radiation and/or chemical exposure while others were not. Documentation of the rationale underlying such selectivity is often lacking. A brief protocol for assigning trichotomous potential exposure categories from job titles is described in Appendix II. The job exposure matrix that was developed from the efforts just described, and which is used in subsequent analyses, is described in Table 2 below.

Table 2

GENERATED EXPOSURES FOR DIFFERENT JOB CLASSES

1. Clerical – No exposures
2. Machinists/Mechanics – metal dusts, welding and soldering fumes, PAH's, solvents, noise.
3. Chemists/Biologists – metals, solvents, other chemicals including acidic gases, other irritating gases, etc.
4. Physicists/Nuclear/X-rays Technicians/Engineers - Be, U/Pu, ionizing radiation.
5. Construction/Carpentry/ Artisans – asbestos, silica, wood dust, solvents, metals, Pb, noise, welding & soldering fumes, PAH's
6. Electrical – electrical, noise, asbestos, solvents, metals
7. Kitchen – PAH's, cleaners, acrolein, and other irritating gases, heat
8. Sanitation/Laundry – acidic gases (Cl_2), detergents, PAH's
9. Transportation – gasoline fumes, diesel fumes, asbestos, oils and grease (PAH's)
10. Artist/Draftsmen/Photography – solvents, paints, photographic chemicals
11. Technical operators/maintenance, tech. – PAH's (grease, oils), solvents metal dusts, wood dusts, welding & soldering fumes, noise.
12. Medical/Doctors/Nurses – germicides, biological exposures
13. Police/Guards/Security – unexposed
14. Students/Coop – questionable exposures
15. Trainees/Inspectors – minimal exposures
16. Unknown – Job Titles Ambiguous – questionable exposures

Statistical Analyses

External Comparisons

Cause-specific standardized mortality ratios (SMRs) for neoplastic and nonneoplastic diseases are reported for each study facility and for the entire cohort using U.S. females as the external comparison. We assessed the number of African-American female workers that were available for analysis and concluded that race-specific analyses would be uninformative because of the small numbers of workers and the number of deaths among workers who are not white. Furthermore, several facilities did not record information on race during certain years. In those instances where race is unknown, the subject was assumed to be White. Both facility-specific and pooled risk estimates that adjust for age (at risk or end of study) and calendar year (in 5 years intervals) are reported. We used the Life Table Analysis System (LTAS) developed by NIOSH to calculate race, sex, age, calendar-year, cause-specific comparisons of observed and expected deaths (Cassinelli et al, 1998). The cause of death codes that are employed in these analyses are described in Appendices K and L of Cassinelli et al (1998). The formula used to calculate SMRs is also described in Cassinelli et al (1998). Associated 95% confidence intervals around the point estimates (SMRs) are calculated using Byar's approximation (Rothman and Boice, 1979) when the number of observed deaths is large, and exact confidence intervals when the number of observed events is less than five (Cassinelli et al, 1998).

Induction time (latency) is taken into consideration by discounting person-years and events that occur prior to the specified induction time criterion. For neoplastic diseases, induction times of two years for leukemia and bone cancers, five years for brain and thyroid cancers and 10 or more years for other solid tumors are often employed. Rothman (1986) argues that time windows which correspond to various induction times should be evaluated with respect to the exposure of interest. Assuming the exposure-disease relationship is causal, and assuming the study population is large, the time window that produces the largest relative risk estimate is the appropriate induction time for that exposure-disease relationship in that population. For reasons of economy, we employ induction times of 2 years for the hematologic cancers; 10, 20, 30 years for all other cancers and other causes of death in the external comparisons; 2 years for the hematologic cancers; and 10 years for all other cancers in the proportional hazards models.

Person-years for each study subject are calculated from the date of hire to the date of death or end of study date. When a work restriction is employed, person-years and events are discounted from the date of hire until the minimum employment criterion is met. Likewise, when induction time is evaluated, person-years and events prior to the minimum induction time criterion are discounted.

Proportional Hazards Models (External Radiation Exposures)

Analyses of external penetrating exposure were performed using the Cox model with time-dependent covariates. The time variable for these analyses was a person's age in years. Cox's proportional hazards model has the general form: $l(t) / l_0(t) = \exp(b_1X_1 + b_2X_2 + ... + bjXj)$, in which t refers to age; l(t) refers to the hazard function (death rate) at age t among those study subjects whose risk factors have the values $X_1, X_2, ..., X_j$ at that age; where $l_0(t)$ is the baseline hazard function at age t (Checkoway et al, 1989). Algorithms available in SAS (version 6.12) are used to model the increase in the risk of mortality per unit dose of penetrating radiation. The value of the risk factors for the external exposures are the cumulative penetrating doses to age t. In these analyses, each employee enters the cohort being analyzed with the Cox model at age of hire. The employee's status age was the age in years at which the person was a failure or censor. The age at failure was the person's age in years when the person died of the cause (or groups of causes) of interest in each analysis. Observations which were not failures were right censored at the person's age in years as of the end of study date, or the age at the person's death from causes other than those of interest in each analysis, whichever was earlier.

External penetrating doses were expressed as rem (cSvs). The value of the prognostic covariate at any age was the cumulative penetrating dose from the age when the person was hired to the person's age at each subsequent calendar year. The doses used at each facility are reported in the results section. For analyses in which the cumulative penetrating dose was "lagged" by 2 years, that cumulative dose was used in the analyses when the person was 2 years older. For analyses which in which the cumulative penetrating dose was "lagged" by 10 years, that cumulative dose was used in the analyses when the person was 10 years older. External penetrating dose data were not available for employees from Mound and Linde. Roster data from these two facilities could thus not be matched to exposure data to determine whether these employees were or were not monitored for external penetrating radiation exposures. In order to determine whether employees from the other ten facilities were or were not monitored, it was necessary to use only those employees in the roster file who had the form of identification which was used in the external penetrating exposure file for the same facility. For Fernald, K-25, X-10, and Y-12, the form of identification required was the Oak Ridge ID. When people in the roster file for these four facilities had an Oak Ridge ID which was missing or zero, it was thus not possible to determine whether or not they were monitored. The required form of identification for the other six facilities was the social security number. When people in the roster file for these six facilities had a social security number which was missing or zero, it was thus not possible to determine whether or not they were monitored. The number of people who had the required identification at each facility are listed in Table 20 of the section on Results. Since the time scale in the Cox model was the age of the person in years, people whose entry age and status age were the same contributed zero person years to the analysis, and are thus not included in the tables which are reported by the SAS PHREG procedure. For the analyses of the association between monitoring and failure, the numbers of people who contributed person years to the analysis at each facility are shown in Table 48 of the Results section.

Quality Control

Numerous quality control procedures have been employed. These include a comparison of a sample of computerized data with original records data, and implementation of range and logical checks of the computerized data (e.g., date of death cannot precede date of hire). The use of a trained nosologist to code death certificates assured accuracy in the assignment of ICD codes for specific causes of death. During development of the JEM, reviews of these efforts were solicited from contacts at the study facilities.

RESULTS

Two general approaches were employed in analyzing the data collected in this study. First, we conducted external comparisons comparing the number of deaths observed among female nuclear workers in our study population with the number of deaths that would be expected according to U.S. death rates. Second, internal comparisons of radiation exposed with unexposed workers were performed using proportional hazards modeling designed to estimate the relative risk of mortality associated with exposures to external ionizing radiation.

Healthy Worker And Healthy Survivor Effects

A major concern in studies of occupational cohorts is bias that exists when employed cohorts are compared with general populations. This bias, which causes relative risks to be underestimated, is usually referred to as the healthy worker effect (HWE). It is frequently present in studies of male workers. Questions we have been concerned with are the extent to which the healthy worker effect is present among cohorts of female workers, the characteristics of the healthy worker effect among female cohorts and differences in the healthy worker effect between male and female worker cohorts.

To pursue these questions, we first compared 44,154 male and female workers who were employed at Hanford between 1944-1986 by accessing data that were available for Hanford workers in the CEDR data base. We found the HWE to be present among both males and females. We also found that it was modified by race, age at hire, occupational class and length of employment; however, different patterns of modification appeared to exist between males and females (Baillargeon J, Wilkinson G, Rudkin L et al 1998) (See: Appendix IV and the Publications section of this report).

A second concern is the healthy survivor effect, which is a variant of the healthy worker effect. When present, bias results because workers must remain healthy to continue their employment. Continued employment is associated with increasing age and increasing exposure but not necessarily increasing risk of disease. Thus long term employees are long term survivors. Specific results are included in Appendix IV, and in the Publications section of this report (Baillargeon J, Wilkinson G, Rudkin L, et al 1999).

The extent of the healthy worker effect is further evinced by results of our completed analyses for the 12 cohorts comprising this study, which are described below.

Table 3

Distribution of Person-Years By Calendar Year and Age for All 12 Study Sites Combined

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	2011.78	7802.43	2040.06	1350.12	955.33	1151.35	1167.91	1909.80	183.84	0.00	0.00
20-24	3796.20	61080.93	21271.08	11862.92	7218.37	8252.39	8983.06	12645.42	6861.96	183.14	0.00
25-29	2075.49	41984.42	72670.03	27784.94	14765.13	10324.54	12329.59	16832.84	18148.38	6846.27	182.48
30-34	1403.22	23102.77	48331.55	76363.18	29312.46	16115.73	11976.33	16567.85	19895.10	18120.52	6438.72
35-39	958.04	15588.43	27216.12	50739.59	77401.96	30323.26	17239.87	14734.23	18277.38	19814.01	15000.77
40-44	528.03	9523.49	18373.81	28820.57	51493.44	77949.60	31121.60	19160.49	15880.59	18176.91	15879.67
45-49	259.62	4941.51	11021.90	19297.75	29144.08	51592.97	77842.81	32221.83	19857.43	15764.50	14185.82
50-54	126.51	2417.35	5726.26	11260.27	19328.56	28959.42	51091.13	77545.76	32280.65	19653.73	12451.62
55-59	48.41	1008.49	2661.07	5700.31	11130.11	18969.34	28276.27	50253.79	75971.26	31601.20	16050.32
60-64	14.84	318.05	1095.61	2611.09	5504.17	10739.53	18271.38	27107.19	48500.76	73557.77	26259.23
65-69	6.74	110.89	336.15	1032.73	2478.36	5191.39	9993.15	17118.64	25344.15	45790.14	58234.64
70-74	0.00	14.94	108.60	318.30	925.17	2235.92	4643.97	8994.37	15396.65	23119.27	31045.25
75-79	0.00	3.86	15.05	94.60	278.30	794.45	1870.86	3876.81	7745.94	13172.04	15475.41
80-84	0.00	0.00	3.86	12.99	81.87	220.00	572.47	1435.24	3050.06	6172.14	8064.21
85+	0.00	0.00	0.00	3.86	13.17	84.34	211.89	516.84	1336.64	2985.76	4778.29
TOTAL	11228.88	167897.56	210871.15	237253.23	250030.48	262904.23	275592.28	300921.11	308730.78	294957.39	224046.42

Table 3 (cont.)

AGES	1995+	TOTAL			
15-19	0.00	18572.64			
20-24	0.00	142155.47			
25-29	0.00	223944.12			
30-34	0.00	267627.44			
35-39	0.00	287293.65			
40-44	0.00	286908.20			
45-49	0.00	276130.21			
50-54	0.00	260841.25			
55-59	0.00	241670.56			
60-64	0.00	213979.63			
65-69	0.00	165636.98			
70-74	0.00	86802.44			
75-79	0.00	43327.31			
80-84	0.00	19612.84			
85+	0.00	9930.78	2544433.51	2	0.00

Comparisons With U.S. Rates

Although external comparisons are subject to bias, and although such comparisons are not informative with respect to estimating effects due to particular exposures, external comparisons do allow us to assess the influence of the healthy worker effect for the cohorts in which we are interested. They also provide an overview of the mortality experience for each cohort relative to a large reference population, in this case the U.S. population. And they provide clues as to the success of our vital status ascertainment.

The distribution of person-years by calendar year and age for all study subjects is presented in Table 3. A total of 2,544,433.51 person-years is observed in the combined cohort from the twelve study sites.

In Table 4 a total of 13,671 deaths are observed with 18,106 deaths expected among all study cohort members for all facilities combined from start of operations through 1994. Of these, 4,075 deaths from all cancers combined were observed and 5,390 deaths were expected. The associated SMRs are 76 for both of these cause of death categories. In addition, 3,625 deaths are observed and 5,537 deaths are expected for diseases of the heart. The SMR of 65 contributes greatly to the low SMR that we observed for all causes of death. However, it is interesting to note that the SMR for ischemic heart disease is almost identical (74), to the SMRs observed for all causes of death and for all cancers combined.

For most causes of death, the observed number of deaths is below the number of expected deaths. Exceptions include mortality from cancers of the tongue, skin and eye which are similar to what is expected according to U.S. mortality rates. Deaths from chronic and unspecified emphysema, diseases of the musculo-skeletal system and connective tissue, arthritis and spondylitis, transportation accidents, accidents other than transportation, poisoning or falls, and homicide are close to what is expected. Elevated SMRs are present for mortality from mental, psycho-neurotic and personality disorders, deaths from mental disorders other than the previous category, diseases of the genito-urinary system other than those of the female genital organs, and deaths due to symptoms and ill defined conditions. Deaths from other causes, which include those for which a death certificate could not be obtained and those with causes of death that fall outside of the cause of death categories defined by the Life Table Analysis System (LTAS), are also higher than expected. Cancer mortality from organ sites known to be sensitive to external radiation all appear to be lower than expected.

Table 4

Summary of Observed and Expected Deaths For Entire Pooled Study Population of Female Workers At All 12 Study Facilities

Cause of Death	Obs No Deaths	Exp No Deaths	Obs/Exp	95% CI
All Causes	13671	18106.58	76**	74- 76
All Cancers	4075	5389.93	76**	73- 77
Buccal & Pharynx	67	70.44	95	73-121
Lip	0	0.36	0	0-999
Tongue	19	16.47	115	69-180
Other Mouth	19	22.36	85	52-133
Pharynx	29	31.25	93	62-133
Dig Organs & Peritoneum	821	1215.28	68**	63- 72
Esophagus	43	52.53	82	59-110
Stomach	82	134.70	61**	48- 76
Colon	365	528.30	69**	62- 77
Rectum	61	99.87	61**	47- 79
Biliary, Liver, Gall Bladder	65	94.11	69**	53- 88
Unspec Liver	24	31.46	76	49-114
Pancreas	175	249.72	70**	60- 81
Peritoneum, Unspec Diges	6	24.58	24**	9- 53
Respiratory System	858	988.81	87**	81- 92
Larynx	15	18.62	81	45-133
Trachea, Bronchus, Lung	835	958.18	87**	81- 93
Other Resp.	8	12.01	67	29-132
Breast	862	1138.60	76**	71- 81
Female Genital	524	758.98	69**	63- 75
Cervix Uteri	154	199.36	77*	66- 91
Other & Unspec Uterus	93	175.74	53**	44- 65
Ovary, Fallopian Tube, Broad Ligament	267	362.26	74**	65- 83
Other Female Genital Organs	10	21.62	46*	22- 85
Urinary Organs	116	142.26	82*	67- 98
Kidney	73	82.71	88	69-111
Bladder and Other Urinary Organs	43	59.54	72*	52- 97

Table 4

Summary of Observed and Expected Deaths For Entire Pooled Study Population of Female Workers At All 12 Study Facilities (continued)

Cause of Death	Obs No Deaths	Exp No Deaths	Obs/Exp	95% CI
Other and Unspec Sites	481	626.99	77*	70- 84
Skin	76	72.17	105	83-132
Eye	4	3.73	107	29-274
Brain and Other Parts of Nervous System	101	136.48	74**	60- 90
Thyroid Gland	11	15.26	72	36-129
Bone	10	13.55	74	35-136
Connective Tissue and Soft Tissue	20	29.63	67	41-104
Other and Unspec Sites (Minor)	259	356.17	73**	64- 82
Neoplasms of Lymphatic & Hema-topoietic Tissue	346	448.56	77**	69- 86
Lymphosarcoma & Reticulosarcoma	54	60.42	89	67-117
Hodgkin's Disease	22	30.73	72	45-108
Leukemia & Aleukemia	118	166.78	71**	59- 85
Other Neoplasms of Lymphatic Hemato-poietic Tissue	152	190.63	80**	68- 93
Benign & Unspecified Neoplasms	54	94.10	57**	43- 75
Benign Neoplasms of Eye, Brain, Other Parts of Nervous Sys	12	18.07	66	34-116
Neoplasms of Eye, Brain, & Other Parts of Nervous Sys Unspec	19	33.83	56*	34- 88
Other Benign & Unspec Nature Neoplasms	23	42.19	55*	35- 82

Table 4

Summary of Observed and Expected Deaths For Entire Pooled Study Population of Female Workers At All 12 Study Facilities (continued)

Cause of Death	Obs No Deaths	Exp No Deaths	Obs/Exp	95% CI
Diabetes Mellitus	274	479.09	57**	51- 64
Diseases of Blood & Blood Forming Organs	48	72.6	66*	40-101
Pernicious Anemias	1	2.45	41	1-227
Anemias of Other & Unspecified Type	20	30.59	65	40-101
Coagulation Defects, Purpura, & Other Hemorrhagic Conditions	13	18.86	69	37-118
All Other Diseases of Blood Forming Organs	14	20.70	68	37-113
Mental, Psycho-neurotic, & Personality Disorders	166	126.14	132**	112-153
Alcoholism	31	34.19	91	62-129
Other Mental Disorders	135	91.95	147**	123-174
Diseases of Nervous System & Sense Organs	120	286.01	42**	35- 50
Multiple Sclerosis	18	41.21	44*	26- 69
Other Diseases of Nervous System & Sense Organs	102	244.81	42**	34- 51
Diseases of the Heart	3625	5536.95	65**	63- 68
Rheumatic Heart Disease, Fever	135	227.66	59**	50- 70
Ischemic Heart Disease	2922	3926.38	74**	72- 77
Chronic Disease of Endocardium	15	73.86	20**	11- 34
Other Myocardial Degeneration	20	51.84	39**	24- 60

Table 4

Summary of Observed and Expected Deaths For Entire Pooled Study Population of Female Workers At All 12 Study Facilities (continued)

Cause of Death	Obs No Deaths	Exp No Deaths	Obs/Exp	95% CI
Hypertension with Heart Disease	75	265.03	28**	22- 35
Other Diseases of the Heart	458	992.17	46**	42- 51
Other Diseases of Circulatory System	1513	1995.44	76**	48- 83
Hypertension without Heart Disease	53	83.31	64**	48- 83
Cerebrovascular Dis	1098	1445.18	76**	72- 81
Diseases of Arteries, Veins & Pulmonary Circulation	362	466.95	78**	70- 86
Diseases of the Respiratory System	990	1166.88	85**	
Tuberculosis	31	109.82	28**	19- 40
Resp. Tuberculosis	21	99.24	21**	13- 32
Other Tuberculosis	10	10.59	94	45-174
Acute Respiratory Infections Except Influenza & Pneu-Monia	8	8.17	98	42-193
Influenza	14	22.69	62	34-104
Pneumonia (Except Newborn)	348	429.46	81**	73- 90
Chronic & Unspec Bronchitis	38	33.49	113	80-156
Emphysema	110	122.27	90	74-108
Asthma	31	56.80	55*	37- 77
Pneumoconioses & Other Resp Diseases	441	494.02	89*	81- 98
Diseases of Diges Sys	619	844.37	73*	68- 79
Diseases of Stomach & Duodenum	59	73.07	81	61-104
Hernia & Intestinal Obstruction	44	67.01	66**	48- 88
Cirrhosis of Liver	277	358.39	77**	68- 87

Table 4

Summary of Observed and Expected Deaths For Entire Pooled Study Population of Female Workers At All 12 Study Facilities (continued)

Cause of Death	Obs No Deaths	Exp No Deaths	Obs/Exp	95% CI
Other Diseases of Dig System	239	345.91	69**	61- 78
Diseases of Genito-Urinary System	241	338.82	71**	62- 81
Acute Glomerulo-nephritis, Nephrotic Syndrome & Acute Renal Failure	15	28.53	53*	29- 67
Chronic & Unspec. Nephritis, Renal Failure & Other Renal Sclerosis	57	150.24	38**	29- 49
Infection of Kidney	34	44.24	77	53-107
Calculi of Urinary Sys	6	7.90	76	28-165
Diseases of the Breast	0	0.64	0	0-577
Diseases of Female Genital Organs	14	18.04	78	42-130
Other Genito-Urinary System Diseases	115	89.23	129**	106-155
Diseases of Skin & Subcutaneous Tissue	27	32.83	82	54-120
Infections of Skin & Subcutaneous Tissue	6	6.77	89	32-193
Other Diseases of Skin & Subcu-taneous Tissue	21	26.06	81	50-123
Diseases of Musculo-skeletal System & Connective Tissue	96	88.91	108	87-132
Arthritis & Spondylitis	34	33.40	102	70-142
Osteomyelitis & Periostitis	1	3.06	33	1-181
Other Diseases of MS System	61	52.45	116	89-149
Symptoms & Ill-Defined Conditions	296	181.63	163**	145-183

Table 4

Summary of Observed and Expected Deaths For Entire Pooled Study Population of Female Workers At All 12 Study Facilities (continued)

Cause of Death	Obs No Deaths	Exp No Deaths	Obs/Exp	95% CI
Accidents	564	603.22	93	60-102
Transportation Accidents	311	308.43	101	90-113
Accidental Poisoning	31	40.65	76	52-108
Accidental Falls	72	91.29	79	62- 99
Other Accidents	132	131.70	100	84-119
Medical Complications & Misadventure	18	31.17	58*	34- 91
Violence	272	298.71	91	81-103
Suicide	190	216.97	88	76-101
Homicide	82	81.74	100	80-125
Other Causes	660	461.10	143**	132-154

* Two-Sided P < 0.05 ** Two-Sided P < 0.01

Consideration of facility specific cohorts (Appendix III Tables 1-12) shows, that except for Linde, a strong healthy worker effect is present among female workers as evinced by the SMRs for all causes of death. The one exception, Linde, is an older cohort. Especially low SMRs for all causes of death are observed for Rocky Flats workers. SMRs are also low for Pantex and for LANL employees. For all three of these cohorts the SMRs are also very low for mortality from all heart diseases combined and for ischemic heart disease. The following table (Table 5) describes SMRs for all causes of death, all cancers, all heart diseases and ischemic heart disease by study facility.

Table 5

Facility Specific Standardized Mortality Ratios* For Selected Major Causes of Death Among White Females At Twelve DOE Weapons Facilities

Study Cohort	Cause of Death Categories			
	All Causes SMR (Obs)	All Cancers SMR (Obs)	All Heart SMR (Obs)	Ischemic Heart SMR (Obs)
Fernald	70 (75)	77 (29)	53 (14)	59 (11)
Hanford	75 (2004)	78 (608)	61 (511))	67 (406)
K-25	81 (2444)	77 (694)	76 (699)	86 (557)
Linde	97 (133)	92 (33)	91 (43)	114 (39)
Los Alamos	67 (1003)	70 (325)	48 (215)	57 (181)
Mound	73 (238)	89 (95)	65 (60)	72 (47)
Pantex	65 (64)	59 (20)	29 (7)	35 (6)
Rocky Flats	54 (85)	60 (33)	32 (12)	35 (9)
Savannah River	79 (221)	73 (74)	66 (42)	83 (36)
X-10	71 (580)	75 (197)	52 (116)	60 (93)
Y-12	76 (6138)	76 (1790)	68 (1719)	79 (1395)
Zia	74 (686)	71 (177)	59 (187)	62 (142)

* SMRs are reported as Observed/Expected X 100

Table 6 presents SMRs for cancers of the mouth and pharynx, digestive organs, respiratory system, and breast. With the exception of cancers of the mouth and pharynx, these cancers sites are frequently observed among females in the United States. Breast cancer, lung cancer and several cancers of digestive tract are known to be radiation sensitive. However, none of these causes of death have consistently elevated SMRs. For the most part SMRs tend to be below one. The one exception is cancers of the mouth and pharynx. SMRs above 100 are observed for K-25, Zia, X-10, Savannah River and especially for Linde workers. Cancers of the digestive system are increased only for Fernald workers. SMRs for respiratory cancers are all close to 100 for workers at all facilities. The occurrence of breast cancer is slightly increased only for Mound workers.

Table 6

Facility Specific Standardized Mortality Ratios* For Cancers of the Buccal Cavity & Pharynx, Digestive Organs, Respiratory System and Breast Among White Females At Twelve DOE Weapons Facilities

Study Cohort	Cancer Cause of Death Categories			
	Mouth & Pharynx SMR (Obs)	Digestive Organs SMR (Obs)	Respiratory System SMR (Obs)	Breast SMR (Obs)
Fernald	und (0)	152 (11)	65 (5)	69 (6)
Hanford	71 (7)	71 (126)	87 (121)	85 (142)
K-25	135 (16)	73 (148)	80 (133)	71 (135)
Linde	217 (1)	87 (8)	107 (6)	98 (7)
Los Alamos	83 (5)	54 (55)	72 (64)	80 (81)
Mound	72 (1)	85 (19)	76 (16)	128 (30)
Pantex	und (0)	46 (3)	119 (8)	25 (2)
Rocky Flats	und (0)	39 (4)	70 (8)	68 (9)
Savannah River	160 (2)	65 (12)	53 (11)	50 (12)
X-10	148 (5)	68 (37)	80 (41)	82 (48)
Y-12	83 (26)	66 (360)	95 (405)	73 (354)
Zia	125 (4)	63 (38)	93 (40)	70 (36)

* SMRs are reported as Observed/Expected X 100

Table 7 shows facility specific results for cancers of the reproductive organs, urinary organs, brain, and benign and unspecified neoplasms. Cancers of the reproductive organs are not elevated among workers at any of the facilities. Increased SMRs for cancers of the urinary organs are present among workers at Fernald and Linde, but in each case these increases are based on only two observed cases. SMRs somewhat above 100 are observed for Savannah River, X-10 and Mound workers. Standardized Mortality Ratios below 100 are observed for brain cancer among all workers with the exception of a slightly elevated SMR among Linde workers based on one observed case. In only two instances are SMRs for benign and unspecified neoplasms elevated. An SMR of 375 (95% CI= 77-1097) is present among Rocky Flats females based on 3 cases, and an SMR of 144 occurs among Linde workers based on one case.

Table 7

Facility Specific Standardized Mortality Ratios* For Cancers of the Reproductive Organs, Urinary Organs, Brain, and Benign & Unspecified Tumors Among White Females At Twelve DOE Weapons Facilities

Study Cohort	Cancer Cause of Death Categories Reproductive Organs SMR (Obs)	Urinary Organs SMR (Obs)	Brain SMR (Obs)	Benign & Unspecified SMR (Obs)
Fernald	60 (3)	228 (2)	92 (2)	und (0)
Hanford	68 (73)	58 (12)	79 (16)	38(5)
K-25	79 (100)	84 (20)	96 (22)	76 (12)
Linde	37 (2)	192 (2)	124 (1)	144 (1)
Los Alamos	65 (41)	49 (6)	72 (9)	67 (5)
Mound	90 (13)	112 (3)	70 (2)	und (0)
Pantex	22 (1)	und (0)	und (0)	und (0)
Rocky Flats	69 (5)	79 (1)	60 (1)	375 (3)
Savannah River	96 (13)	134 (3)	66 (2)	und (0)
X-10	66(24)	124 (8)	14 (1)	69 (3)
Y-12	68 (233)	84 (53)	79 (45)	58 (25)
Zia	47 (16)	85 (6)	16 (1)	und (0)

* SMRs are reported as Observed/Expected X 100

Table 8 reports SMRs for blood and lymph cancers. In most instances few cases are observed. A small increase in the SMR for all blood and lymph cancers combined (134) and a larger increase in the SMR for blood and lymph cancers other than leukemia (245) are observed for Linde workers. Zia workers reflect a small increase in the SMR for L-R sarcomas (130). Standardized mortality ratios for all leukemias combined of 125 for Savannah River employees and 120 for X-10 employees are also observed.

Table 9 describes results for mental, psychoneurotic and personality disorders including alcoholism. In two instances (Fernald and Linde) no deaths from these causes are observed. In addition to Fernald and Linde workers, no deaths from alcoholism are observed among workers at Mound, Rocky Flats and X-10. Standardized mortality ratios for deaths from mental disorders excluding alcoholism are elevated for workers at all facilities except for Savannah River (and Fernald & Linde with 0 deaths observed).

Table 8

Facility Specific Standardized Mortality Ratios* For Cancers of the Blood and Lymph Systems Among White Females At Twelve DOE Weapons Facilities

Study Cohort	Cancer Cause of Death Categories			
	All Blood & Lymph SMR (Obs)	Lymp-Ret. Sarcomas SMR (Obs)	All Leukemias SMR (Obs)	Other Blood & Lymph SMR (Obs)
Fernald	32 (1)	und (0)	86 (1)	und (0)
Hanford	86 (57)	100 (9)	20 (79)	80 (22)
K-25	70 (52)	8 (78)	14 (50)	26 (82)
Linde	134 (4)	und (0)	und (0)	245 (3)
Los Alamos	71 (28)	76 (4)	41 (6)	102 (17)
Mound	57 (5)	88 (1)	61 (2)	53 (2)
Pantex	35 (1)	und (0)	91 (1)	und (0)
Rocky Flats	22 (1)	und (0)	und (0)	52 (1)
Savannah River	96 (8)	und (0)	125 (4)	90 (3)
X-10	68 (15)	73 (2)	121 (10)	33 (3)
Y-12	81 (158)	99 (26)	76 (54)	82 (69)
Zia	75 (16)	130 (4)	74 (6)	68 (6)

* SMRs are reported as Observed/Expected X 100

Table 9

Facility Specific Standardized Mortality Ratios* For Deaths From All Mental Disorders Combined, Alcoholism, and Mental Disorders Other Than Alcoholism Among White Females At Twelve DOE Weapons Facilities

Study Cohort	Cause of Death Categories		
	All Mental Disorders SMR (Obs)	Alcoholism SMR (Obs)	Mental Disorders SMR (Obs)
Fernald	und (0)	und (0)	und (0)
Hanford	138 (27)	85 (4)	155 (23)
K-25	120 (25)	157 (9)	106 (16)
Linde	und (0)	und (0)	und (0)
Los Alamos	183 (19)	255 (7)	157 (12)
Mound	91 (2)	und (0)	136 (2)
Pantex	273 (2)	356 (1)	220 (1)
Rocky Flats	176 (2)	und (0)	296 (2)
Savannah River	100 (2)	110 (1)	91 (4)
X-10	105 (6)	und (0)	161 (6)
Y-12	124 (68)	54 (8)	150 (60)
Zia	188 (13)	79 (1)	212 (12)

* SMRs are reported as Observed/Expected X 100

Results for symptoms and ill-defined conditions, all accidents combined, suicide and homicide are described in Table 10. Elevated SMRs are observed for symptoms and ill-defined conditions at Linde, Pantex, Zia, K-25, X-10 and Y-12. The latter three facilities are all part of the Oak Ridge reservation. Mortality from all accidents combined is elevated for Linde and Zia workers. Suicide appears to be high among Mound and Los Alamos women. Homicide occurs more frequently than expected for Linde workers (1 observed case), K-25 and Savannah River employees. Homicide deaths are also somewhat more frequent than expected for Y-12 workers.

Table 10

Facility Specific Standardized Mortality Ratios* For Deaths From Symptoms &Ill-Defined Conditions, Accidents, Suicide and Homicide Among White Females At Twelve DOE Weapons Facilities

	Cause of Death Categories			
Study Cohort	Symptoms, Ill-Defined Conditions SMR (Obs)	Accidents SMR (Obs)	Suicide SMR (Obs)	Homicide SMR (Obs)
Fernald	86 (1)	82 (4)	47 (1)	und (0)
Hanford	48 (12)	106 (100)	115 (40)	49 (6)
K-25	194 (57)	95 (94)	87 (31)	144 (19)
Linde	150 (2)	187 (7)	und (0)	258 (1)
Los Alamos	66 (9)	96 (50)	142 (29)	84 (5)
Mound	61 (2)	74 (9)	163 (8)	59 (1)
Pantex	442 (5)	40 (2)	91 (2)	und (0)
Rocky Flats	und (0)	61 (5)	82 (3)	65 (1)
Savannah River	und (0)	68 (10)	76 (5)	135 (4)
X-10	188 (17)	97 (33)	102 (14)	101 (6)
Y-12	206 (175)	88 (217)	62 (51)	110 (37)
Zia	205 (16)	121 (33)	65 (6)	80 (2)

* SMRs are reported as Observed/Expected X 100

With the exception of the previously mentioned strong healthy worker effect, few consistent patterns for most causes of death are observed across each individual cohort. An elevated SMR for rectal cancer (SMR=523, 95%CI=108-1530) is observed for Fernald workers based on 3 observed deaths. SMRs of 196 (95% CI=71-426) for pneumoconioses and 500 (95% CI=61-1807) for diseases of the stomach and duodenum are also observed.

Among Hanford workers, SMRS of 155 (95% CI=98-233) for deaths from mental disorders other than alcoholism, 207 (95% CI=25-747) for skin infections, 155 (95% CI=104-222) for accidents other than transportation accidents, poisonings and falls are observed.

Interesting SMRs are observed among K-25 workers for cancer of the tongue (SMR=253, 95% CI=101-520), cancers of female genital organs other than the cervix, uterus and ovary (SMR=195, 95% CI=78-401), alcoholism (SMR=157, 95% CI=72-299), and symptoms and ill defined conditions (SMR=194, 95% CI=147-251).

Although a number of elevated but imprecise SMRs are present for Linde workers, in most cases these are based on only one or two observed cases. Among the more interesting and precise elevated estimates are SMRs of 152 (95% CI=56-331) for intestinal cancers, 245 (95% CI=51-717) for blood and lymph cancers other than leukemia, Hodgkin's disease and lympho-reticulo sarcomas, 185 (95% CI=50-474 for cirrhosis of the liver, 187 (95% CI=75-386) for all accidents combined, especially transportation accidents (SMR=301, 95% CI=97-704) and poisonings (SMR=951, 95% CI=115-3433).

Elevated SMRs for Los Alamos workers are observed for mental illnesses (SMR=183, 95% CI=110-286) including alcoholism (SMR=255, 95% CI=102-526) and mental disorders other than alcoholism (SMR=157, 95% CI=81-274). Deaths from influenza (SMR=297, 95% CI=96-695) and from violence (SMR=129, 95% CI=89-180), especially suicide (SMR=142, 95% CI=95-203) are also somewhat increased.

Similar to LANL workers, Mound female employees appear to experience elevated mortality from violence (SMR=136, 95% CI=62-258), particularly suicide (SMR=163, 95% CI=70-321). Mound workers also experience small increased SMRs for breast cancer (SMR=128, 95% CI=86-182) and diabetes (SMR=153, 95% CI=82-262).

Only 64 deaths have been identified among the cohort of female Pantex workers. Because of the small number of deaths, cause-specific analyses for Pantex workers are not very informative.

Small numbers of observed deaths also characterize Rocky Flats workers. Although SMRs are elevated for benign and unspecified cancers (SMR=375, 95% CI=77-1097) and for mental disorders (SMR=296, 95% CI=36-1070), these estimates are based on few cases, they are imprecise, and the confidence intervals include unity.

Female workers at the Savannah River Plant experience increased mortality from skin cancer (SMR=401, 95% CI=161-826). Interesting SMRs are also observed for cancer of the ovary (SMR=159, 95% CI=79-284), kidney cancer (SMR=199, 95% CI=41-582), and pneumonia (SMR=155, 95% CI=67-306).

Increased SMRs are observed for workers at the X-10 Plant for cancer of the esophagus (SMR=207, 95% CI=67-484), cancer of the kidney (SMR=151, 95% CI=55-328), and mental disorders (SMR=161, 95% CI=59-350). Mortality from symptoms and ill defined conditions is also elevated (SMR=188, 95% CI=110-301).

By far the largest number of deaths for any one study facility is observed for Y-12, with 6,138 deaths. SMRs are elevated for mortality from mental disorders other than alcoholism (SMR=150, 95% CI=114-192), chronic and unspecified bronchitis (SMR=149, 95% CI=94-226), diseases of the genito-urinary system other than nephritis, kidney infections, female genital organs (SMR=156, 95% CI=120-199), and of symptoms and ill defined conditions (SMR=206, 95% CI=176-239). A small increase in the SMR is present for diseases of the musculo-skeletal system other than arthritis and osteomyelitis (SMR=127, 95% CI=85-184).

Women who were employed by the Zia Company demonstrate elevated SMRs for mortality from mental disorders (SMR=212, 95% CI=109-370) and from symptoms and ill defined conditions (SMR=205, 95% CI=117-333). Interesting SMRs are also present for diseases of the skin (SMR=258, 95% CI=70-659), musculo-skeletal system (SMR=166 (95% CI=66-341), and for diseases of the genito-urinary system other than nephritis, kidney infections, female genital organs (SMR=145, 95% CI=58-299).

Work Restriction

We investigated the impact on SMR results of imposing work restrictions of 12 and 24 months. Table 11 presents results for all causes of death, all cancers, all heart diseases, and ischemic heart disease. Appendix III, Tables 14-17 provide detailed cause-specific results. In general, inclusion of a minimum length of employment criterion (12 months or 24 months) adds little new information. SMRs are similar for all causes of death and for all cancers. SMRS for heart diseases and especially for ischemic heart disease are lower among those who worked for longer periods of time. Overall, those who worked more than 12 months tended to be somewhat younger than those who worked less than 12 months. The small differences in the SMRs that are present may be due to this difference in the age distributions of these subcohorts.

Table 12 shows SMRs by length of employment category for mental, psychoneurotic and personality disorders including alcoholism. Most of the SMRs exceed 100, especially among those who where employed for greater than 12, and greater than 24 months.

Table 11

Standardized Mortality Ratios* For Selected Major Causes of Death Among The Entire Pooled Study Population of Female Workers At All 12 Study Facilities With 12 Months and 24 Months Minimum Lengths of Employment

	Cause of Death Categories			
Length of Employment	All Causes SMR (Obs)	All Cancers SMR (Obs)	All Heart SMR (Obs)	Ischemic Heart SMR (Obs)
< 12 Months	77 (6885)	74 (1950)	68 (1908)	77 (1523)
> 12 Months	74 (6786)	77 (2125)	62 (1717)	71 (1399)
< 24 Months	77 (9441)	75 (2727)	68 (2583)	78 (2080)
> 24 Months	73 (4230)	76 (1348)	60 (1042)	67 (842)

* SMRs are reported as Observed/Expected X 100

Table 12

Standardized Mortality Ratios* For Mental Disorders and Alcoholism Among The Entire Pooled Study Population of Female Workers At All 12 Study Facilities With 12 Months and 24 Months Minimum Lengths of Employment

	Cause of Death Categories		
Length of Employment	All Mental Disorders SMR (Obs)	Alcoholism SMR (Obs)	Mental Disorders SMR (Obs)
< 12 Months	111 (69)	96 (16)	116 (53)
> 12 Months	152 (97)	86 (15)	177 (82)
< 24 Months	121 (102)	83 (19)	135 (83)
> 24 Months	154 (64)	106 (12)	171 (52)

* SMRs are reported as Observed/Expected X 100

Induction Times

Induction times of 2, 5, 10, 20 and 30 years were evaluated for the pooled cohort by discounting person-years and deaths that occurred 2, 5, 10, 20 and 30 years after the date of hire. These results are described in Appendix III Tables 18-22. For many causes of death, SMRs increased by a small amount with increasing induction time. For examples, SMRs of 76 are observed for all causes of death and for all cancers with 5 years of induction time. With 30 years of induction time, SMRs of 81 for all causes of death and 80 for all cancers are observed.

Monitored and Not Monitored for External Radiation

Tables 13 and 14 present selected results for workers who were monitored, and for workers who were not monitored for external radiation. Standardized Mortality Ratios below 100 are observed for most causes of death for both radiation monitored and unmonitored female workers. In many instances SMRs for unmonitored workers are somewhat higher than those for badged employees. The only elevated SMRs are observed in Table 14. Mortality from mental disorders, is increased among both badged and unbadged workers. SMRs from symptoms and ill defined conditions, and from diseases of the genito-urinary system are also increased among unmonitored workers, but not among badged workers. A small increase in the SMRs is present for homicide among the unmonitored, whereas the SMR for homicide among badged workers is only 53.

Table 13

Standardized Mortality Ratios* For Mortality From All Causes of Death And From Selected Cancers Among Workers Monitored And Among Workers Not Monitored For External Radiation Within The Entire Pooled Study Population of Female Workers At All 12 Study Facilities

	External Radiation Exposure					
	Monitored			Not Monitored		
Cause of Death	Obs	Exp	SMR (95%CI)	Obs	Exp	SMR (95%CI)
All Causes	1971	2875	69 (66-72)	11301	14511	78 (77-79)
All Cancers	644	906	71 (66-77)	3291	4270	77 (74-80)
Mouth & Pharynx	7	11.5	61 (24-125)	58	56.2	103 (78-133)
Digestive Organs	119	191.1	62 (52-75)	673	977.6	69 (64-74)
Respiratory System	134	174.2	77 (65-91)	699	777.7	90 (83-97)
Breast	164	201.3	81 (70-95)	660	890.5	74 (69-80)
Reproductive Tract	70	121.4	58 (45-73)	438	606.3	72 (66-79)
Urinary Organs	18	22.9	79 (47-124)	93	113.9	82 (66-100)
Brain/Nervous Sys.	14	24.6	57 (31-96)	85	106.1	80 (64-99)
Thyroid	2	2.4	83 (10-301)	9	12.3	73 (34-139)
Connective & Soft Tissue	6	5.7	105 (38-228)	13	22.7	57 (30-98)
Blood & Lymph	56	76	73 (56-95)	278	354.1	79 (70-88)
Leukemia	22	28.8	76 (48-116)	126	151.1	83 (70-99)
Benign/Unspecified	4	14.1	28 (7-73)	49	75.9	65 (48-85)

* SMRs are reported as Observed/Expected X 100

Table 14

Standardized Mortality Ratios* For Mortality From Selected Causes of Death Other Than Cancer Among Workers Monitored And Among Workers Not Monitored For External Radiation Within The Entire Pooled Study Population of Female Workers At All 12 Study Facilities

	External Radiation Exposure					
	Monitored			Not Monitored		
Cause of Death	Obs	Exp	SMR (95%CI)	Obs	Exp	SMR (95%CI)
Blood/Blood Forming Organs	5	11.8	42 (14-99)	42	57.8	73 (52-98)
All Mental Disorders	27	21.4	126 (83-184)	137	99.5	138 (116-163)
Alcoholism	6	6.5	92 (34-200)	25	26.2	95 (62-141)
Mental Disorders	21	14.8	141 (88-216)	112	73.4	153 (126-184)
All Heart Disease	449	818.5	55 (50-60)	3066	4507	68 (66-70)
Ischemic Heart Dis.	354	580.9	61 (55-68)	2477	3197	77 (75-81)
Diseases of genito-Urinary system	12	13.4	90 (46-157)	100	72.5	138 (113-168)
Symptoms & Ill Defined Conditions	29	30.2	96 (65-138)	263	144.1	183(161-206)
Accidents	108	116.7	92 (76-112)	438	457.0	96 (87-105)
Violence	53	66.9	79 (59-104)	209	216.5	97 (84-111)
Suicide	42	46.3	92 (65-123)	141	159.5	88 (74-104)
Homicide	11	20.6	53 (27-96)	68	57.0	119 (93-151)

* SMRs are reported as Observed/Expected X 100

Internal Comparisons of Mortality By External Radiation Doses Using Proportional Hazards Modeling

Comparisons of the risk estimates for monitored and unmonitored employees were performed using the Cox proportional hazards method of analysis. Analyses of the risks associated with cumulative dose of external penetrating radiation exposure among the monitored employees were also performed using the Cox proportional hazards method of analysis but with time dependent covariates. Since the study facilities used different terms to describe the external penetrating exposures that were reported, it was first necessary to identify which measurements at each facility were comparable to each other. To assist us in this task, we consulted a health physicist to review the data from each facility for which we had health physics data at the time of her review (See Appendix I).

Table 15 reports the terms used to describe the external penetrating exposures at the various study facilities. Although there may be some differences, these differences appear to be minor (see Appendix I). One potential problem exists for those facilities where exposures to neutrons may have been experienced. Neutrons were not measured well until the past several decades. Therefore, for some sub-cohorts such as Rocky Flats, these dose estimates may contain errors for neutron exposures.

Table 15

External Radiation Exposures Reported at Various Nuclear Facilities

Facility	Years	External Exposure Used
Fernald	1952-1988	Gamma Dose
Hanford	1944-1989	Penetrating Radiation Dose
K-25	1946-1991	Penetrating Dose
Los Alamos	1945-1999	Deep (penetrating) Dose
Pantex	1957-1999	Whole-Body Total Dose
Rocky Flats	1953-1989	Annual total penetrating dose
Savannah Riv.	1952-1980	Shield (gamma) exposure
X-10	1943-1991	Penetrating Dose
Y-12	1950-1991	Penetrating Dose
Zia	1945-1999	Deep (penetrating) Dose

For each facility, Table 16 describes the number of women for whom a health physics record exists, the mean cumulative dose for women who were monitored for external radiation, the maximum cumulative dose for women who were monitored, the number of women with a health physics record for whom a dose greater than zero was recorded, the mean cumulative doses for these women, and the proportion of women with cumulative doses greater than zero. Mean cumulative doses range from a low of 0.065 rem at Fernald to a high of 0.966 rem at Savannah River. For people who have a reading above zero, mean cumulative doses range from a low of 0.114 rem at K-25 to a high of 1.37 rem at Savannah River.

Table 16

Lifetime Totals (in Rem)

				When Dose is > 0		
Facility	(n) People	Mean Total	Max Total	Women	Mean Total	Pct n >0
Fernald	408	0.065	5.100	123	0.215	30.1%
Hanford	8935	0.524	29.648	7099	0.660	79.5%
K-25	2054	0.082	6.070	1481	0.114	72.1%
Los Alamos	1866	0.360	42.010	797	0.842	42.7%
Pantex	355	0.516	8.550	194	0.944	54.6%
Rocky Flats	987	0.556	27.874	856	0.641	86.7%
Savannah	941	0.966	35.565	799	1.137	84.9%
X-10	4917	0.176	18.600	1965	0.441	40.0%
Y-12	2459	0.300	9.766	1825	0.404	74.2%
Zia	513	0.200	8.520	273	0.375	53.2%

Table 17 describes facility-specific person-years, mean and maximum annual total doses for all people who were monitored, and person-years, mean and maximum annual total doses for people with a recorded dose above zero. Mean annual doses range from a low of 0.012 rem at Fernald to a high of 0.16 rem at Savannah River. The highest maximum annual total doses are recorded at Los Alamos (41.93 rem). This reading is so different from other readings that further verification is needed to assure it does not result from some type of error. Among people with recorded doses greater than zero, the lowest is observed at K-25 (0.054 rem) and at Y-12 (0.072 rem), and the highest at Savannah River (0.246 rem).

Table 17

Annual Totals (in Rem)

Facility	(n) Person Years	Mean Total	Max Total	When Dose is >0 Person Years	Mean Total	Pct n >0
Fernald	2137	0.012	2.400	200	0.133	9.4%
Hanford	63793	0.073	4.370	32249	0.145	50.6%
K-25	16216	0.010	6.037	3146	0.054	19.4%
Los Alamos	11496	0.058	41.930	2956	0.227	25.7%
Pantex	3390	0.054	3.140	970	0.189	28.6%
Rocky	7747	0.071	7.232	4500	0.122	58.1%
Savannah	5673	0.160	3.005	3696	0.246	65.2%
X-10	39304	0.022	3.425	6960	0.125	17.7%
Y-12	21713	0.034	3.966	10267	0.072	47.3%
Zia	4314	0.024	5.220	809	0.126	18.8%

Table 18 describes the number of women who were issued a radiation badge, but who were not included in the rosters that we obtained for our study facilities. Y-12, Pantex, Zia and Savannah River have the largest proportion of study subjects who have a health physics record that includes an external radiation reading, but who could not be matched to their respective facility rosters. Overall, between five and six percent of the women who have been monitored for penetrating radiation do not have information identifying them as an employee of one of the study facilities. This category of women is probably largely comprised of visitors from other weapons facilities or government agencies. The health physics records for people who were monitored at K-25, X-10, Y-12, and Fernald were identified using an ORISE identification number. The records for people at other facilities were identified using a social security number. When the identifier for a person was missing or blank, it was not possible to determine whether or not the person was an employee, so such people are not included in this table.

Table 18

Identified Women With Penetrating Radiation Exposure Data
Who Do Not Have Roster Data

Facility	Women With Exposure Data	Not Matched To Roster Data Number	Percent
Fernald	408	3	0.74%
Hanford	8,935	55	0.62%
K-25	2,054	2	0.10%
Los Alamos	1,320	13	0.98%
Pantex	355	80	22.54%
Rocky	987	1	0.10%
Savannah	941	147	15.62%
X-10	4,917	339	6.89%
Y-12	2,459	616	25.05%
Zia	403	78	19.35%
Total	22,779	1,334	5.86%

Table 19 describes study subjects who were identified as employees of one of the study facilities, but who do not have a health physics record. Overall, slightly more than two-thirds of the female employees do not have a record of having been issued a radiation badge or of having been monitored for external radiation. This proportion varies from about thirteen percent of X-10 female employees to a high of ninety-one percent of Y-12 employees. Employees at K-25, X-10, Y-12, and Fernald were identified by their ORISE ID. Workers at other facilities were identified by their social security numbers. When the identifier for a person is missing or blank, it is not possible to determine whether or not that worker was monitored, so such workers are not included in this table. This table enumerates the cohort of 65,984 workers whose data are used in the analyses of external penetrating exposure. There are 25 of these workers for whom the age at hire and the age at status (death or censor) are equal. These workers contributed zero person years to the Cox model analyses, and are not included in the analyses comparing monitored and unmonitored workers. Table 48 tabulates the number of workers at each facility whose data contributed information to the likelihood in the Cox model analyses comparing monitored and unmonitored workers. The number of workers at these facilities who were monitored totals 21,440. The number of workers at each facility who were monitored is tabulated in Table 24. Facilities which had large numbers of women who worked only for a short period of time during World War II have a greater percentage of women who were not monitored.

Table 19

Identified Workers With Roster Data Who Do Not Have Penetrating Radiation Exposure Data

Facility	Women with Roster Data	Number Not Matched to Exposure Data	Percent Not Matched
Fernald	732	327	44.67%
Hanford	12,603	3,723	29.54%
K-25	10,585	8,533	80.61%
Los Alamos	6,411	5,104	79.61%
Pantex	1,047	772	73.73%
Rocky	1,561	575	36.84%
Savannah	2,541	1,747	68.75%
X-10	5,267	689	13.08%
Y-12	22,537	20,694	91.82%
Zia	2,700	2,375	87.96%
Total	65,984	44,539	67.50%

Cohort Characteristics

Tables 20-23 present data describing the characteristics of the ten cohorts for which we have health physics data on external penetrating radiation doses. These tables also include the same descriptive information for the Mound and Linde female workers who were not included in the analyses of external penetrating radiation for reasons previously described.

Overall the largest proportion of female workers in our combined cohort were hired during and shortly after the Second World War. In terms of absolute numbers of workers, by far the greatest number were employed at Y-12, or Tennessee Eastman, as it was known at that time. Four facilities (Fernald, Pantex, Rocky Flats and Savannah River) did not become operational until the cold war years. We do not include workers hired after 1979 in these analyses.

Table 20

Decade of Hire By Study Facility

Frequency Row Pct	1940-49	1950-59	1960-69	1970-79	Total
FERNALD	0 0.00	495 67.62	149 20.36	88 12.02	732
HANFORD	4171 33.10	3155 25.03	1476 11.71	3801 30.16	12603
K-25	7680 72.56	883 8.34	458 4.33	1564 14.78	10585
LOS ALAMOS	2201 34.33	1585 24.72	1050 16.38	1575 24.57	6411
PANTEX	0 0.00	241 23.02	273 26.07	533 50.91	1047
ROCKY FLATS	0 0.00	404 25.88	677 43.37	480 30.75	1561
SAVANNAH RIVER	1 0.04	1411 55.53	342 13.46	787 30.97	2541
X-10	1492 28.33	947 17.98	1176 22.33	1652 31.37	5267
Y-12	20348 90.29	831 3.69	427 1.89	931 4.13	22537
ZIA	1776 65.78	411 15.22	190 7.04	323 11.96	2700
MOUND	504 29.88	464 27.50	445 26.38	274 16.24	1687
LINDE	305 100.00	0 0.00	0 0.00	0 0.00	305
Total	38478 56.61	10827 15.93	6663 9.80	12008 17.67	67976 100.00

Table 21 shows the distribution of workers by year they terminated employment. The large number of workers who appear to have left work in 1994 reflects setting 1994 as the end of study date for those workers who are not known to be deceased or to have left employment.

Table 21

Year of Employment Termination By Study Facility

Frequency Row Pct	1940-49	1950-59	1960-69	1970-79	1980-89	1990-93	1994	Total
FER	0 0.00	301 41.12	251 34.29	100 13.66	30 4.10	2 0.27	48 6.56	732
HAN	2460 19.52	3320 26.34	1378 10.93	2597 20.61	2847 22.59	0 0.00	1 0.01	12603
K25	6779 64.04	916 8.65	432 4.08	563 5.32	620 5.86	95 0.90	1180 11.15	10585
LAN	1504 23.46	1346 21.00	973 15.18	1129 17.61	45 0.70	9 0.14	1405 21.92	6411
PAN	0 0.00	146 13.94	161 15.38	318 30.37	49 4.68	5 0.48	368 35.15	1047
RF	0 0.00	270 17.30	486 31.13	410 26.27	9 0.58	1 0.06	385 24.66	1561
SR1	0 0.00	827 32.55	443 17.43	356 14.01	187 7.36	5 0.20	723 28.45	2541
X10	880 16.71	788 14.96	1038 19.71	933 17.71	600 11.39	82 1.56	946 17.96	5267
Y12	19604 86.99	843 3.74	426 1.89	590 2.62	456 2.02	65 0.29	553 2.45	22537
ZIA	1369 50.70	684 25.33	229 8.48	193 7.15	171 6.33	0 0.00	54 2.00	2700
MOUND	328 19.44	266 15.77	297 17.61	254 15.06	0 0.00	0 0.00	542 32.13	1687
LINDE	303 99.34	0 0.00	1 0.33	0 0.00	0 0.00	0 0.00	1 0.33	305
Total	33227 48.88	9707 14.28	6115 9.00	7443 10.95	5014 7.38	264 0.39	6206 9.13	67976 100.00

Table 22 describes the number of years employed by study facility. It is noteworthy that more than forty percent of the Y-12 employees were employed for less than one year, and almost thirty percent were employed for one, but less than two years. Overall, more than fifty percent of the female workers in this combined cohort were employed at any one facility for less than two years.

Table 22

Number of Years Employed By Study Facility

Frequency Row Pct	0	1	2	3-9	10-29	30-39	40+	Total
FER	131 17.90	151 20.63	95 12.98	220 30.05	99 13.52	17 2.32	19 2.60	732
HAN	1982 15.73	2809 22.29	1486 11.79	3811 30.24	2113 16.77	376 2.98	26 0.21	12603
K25	3752 35.45	2310 21.82	981 9.27	1401 13.24	1665 15.73	304 2.87	172 1.62	10585
LAN	1337 20.85	1266 19.75	701 10.93	1134 17.69	1554 24.24	226 3.53	193 3.01	6411
PAN	146 13.94	139 13.28	106 10.12	220 21.01	400 38.20	28 2.67	8 0.76	1047
RF	238 15.25	328 21.01	196 12.56	333 21.33	395 25.30	53 3.40	18 1.15	1561
SR1	358 14.09	318 12.51	221 8.70	582 22.90	818 32.19	144 5.67	100 3.94	2541
X10	824 15.64	843 16.01	592 11.24	1228 23.31	1429 27.13	262 4.97	89 1.69	5267
Y12	9279 41.17	6617 29.36	2736 12.14	2488 11.04	1069 4.74	259 1.15	89 0.39	22537
ZIA	927 34.33	739 27.37	284 10.52	526 19.48	193 7.15	24 0.89	7 0.26	2700
Mound	260 15.41	259 15.35	147 8.71	321 19.03	421 24.96	233 13.81	46 2.73	1687
Linde	0 0.00	136 44.59	72 23.61	95 31.15	1 0.33	0 0.00	1 0.33	305
Total	19234 28.30	15915 23.41	7617 11.21	12359 18.18	10157 14.94	1926 2.83	768 1.13	67976 100.0

Table 23 cross-tabulates the number of years worked by decade for the combined cohort. Just under twenty-nine percent of the employees worked less than one year, and fifty-two percent worked less than two years. Since there are a considerable number of women who worked only for a short period of time during World War II, analyses of penetrating exposure were performed for all monitored women, as well as for monitored women who worked at least 2 years (730 days). Analyses which instead excluded women who never worked after the end of 1945 were also explored, but are not presented in this report. Such analyses might be of value to perform in future studies. Among the women who were monitored, excluding women who never worked after the end of 1945 led to almost the same remaining subcohort as that formed by excluding women who worked less than 2 years.

Table 23

Number of Years Employed By Decade of Hire

Including Mound and Linde

Frequency Row Pct	0	1	2	3-9	10-29	30-39	40+	Total
1940-49	15158 39.39	11200 29.11	4522 11.75	4976 12.93	1626 4.23	597 1.55	399 1.04	38478
1950-59	1503 13.88	2104 19.43	1307 12.07	2876 26.56	1749 16.15	919 8.49	369 3.41	10827
1960-69	960 14.41	1169 17.54	831 12.47	1592 23.89	1701 25.53	410 6.15	0 0.00	6663
1970-79	1613 13.43	1442 12.01	957 7.97	2915 24.28	5081 42.31	0 0.00	0 0.00	12008
Total	19234 28.30	15915 23.41	7617 11.21	12359 18.18	10157 14.94	1926 2.83	768 1.13	67976 100.00

Excluding Mound and Linde

(for analyses of external penetrating radiation)

Frequency Row Pct	0	1	2	3-9	10-29	30-39	40+	Total
1940-49	14995 39.81	10939 29.04	4411 11.71	4770 12.66	1601 4.25	590 1.57	363 0.96	37669
1950-59	1470 14.19	2044 19.72	1256 12.12	2787 26.89	1659 16.01	789 7.61	358 3.45	10363
1960-69	921 14.81	1121 18.03	789 12.69	1492 23.99	1581 25.43	314 5.05	0 0.00	6218
1970-79	1588 13.53	1416 12.07	942 8.03	2894 24.66	4894 41.71	0 0.00	0 0.00	11734
Total	18974 28.76	15520 23.52	7398 11.21	11943 18.10	9735 14.75	1693 2.57	721 1.09	65984 100.00

Proportional Hazards Models

Failure time analyses employing proportional hazards models were used to assess whether survival differs among workers at different facilities, and to assess whether cumulative exposures to external penetrating radiation exposures is associated with mortality. The results reported below include female workers from all of the study cohorts with the exception of workers from Linde and from Mound. As previously mentioned, exposure data do not exist for Linde workers. For Mound workers, we were informed too late that updated exposure data is not available to allow us to incorporate exposure data from previous studies of Mound workers into our study.

We performed one group of analyses to assess whether the hazard differed among workers who were issued a radiation badge compared with workers who were not issued a badge for each of the ten facilities by themselves and when combined. The relative risks for these analyses were expressed as the risks among workers who were not monitored, relative to those who were monitored. We performed another group of analyses that modeled the relative risk of death by external radiation dose among the badged workers. In these analyses, cumulative exposure to external radiation was treated as a continuous time-dependent variable expressed in rem units. The time variable for these analyses was the employee's age.

In these analyses, each employee enters the cohort being analyzed with the Cox model at age of hire. The employee's status age was the age in years at which the person was a failure or censor. The age at failure was the person's age in years when the person died of the cause (or groups of causes) of interest in each analysis. Observations which were not failures were right censored at the person's age in years as of the end of study date, or the age at the person's death from causes other than those of interest in each analysis, whichever was earlier. Failures were defined as specific causes of deaths, or as several combined cause of death categories including all causes, all cancers, and all radiosensitive solid tumors. Tables describing these proportional hazards models are summarized below.

Additional analyses that also included time period as a covariate were also explored, but are not presented in this report. Including time period would test whether the effect of 1 rem of external exposure differed during different time periods. Such analyses might be of value to perform in future studies.

The time-dependent Cox model analyses of cumulative penetrating dose were performed for all causes of death, and for nine groups of specific causes of death. Cancer deaths were all those with ICD8 codes between 140.0 and 239.9. Radiosensitive solid tumor deaths included those with ICD8 codes between 150.0 and 150.9, 151.0 and 151.9, 153.0 and 153.9, 162.0 and 162.9, 174.0 and 174.9, 188.0 and 188.9, 189.0 and 189.9, 191.0 and 191.9, and 192.0 and 192.9. This combined category is based on those cancers identified as radiation sensitive in the BEIR V report (Committee on the Biological Effects of Ionizing Radiations, 1990). Breast cancer deaths were those with ICD8 codes between 174.0 and 174.9. Lung cancer deaths were those with ICD8 code 162.1. Hematologic cancer deaths were those with ICD8 codes between 200.0 and 209.9. Ovarian cancer deaths were those with ICD8 codes between 183.0 and 183.9. Leukemia deaths were those with ICD8 codes between 204.0 and 207.9, except 204.1. Brain cancer deaths included those with ICD8 codes between 191.0 and 192.9, 225.0 and 225.9, and 238.1 and 238.9. Thyroid cancer deaths were those with ICD8 codes between 193.0 and 193.9.

The results of the time dependent Cox model analyses of cumulative penetrating dose for all monitored employees regardless of length of employment are presented in Tables 24-33. When data from all facilities are pooled, the risk of death does not increase with increasing cumulative penetrating dose for all causes of death. For most other groups of death, the results are consistent with either an increase or a decrease in the relative risk of death. Effect estimates are increased for leukemia and suggestively elevated for breast cancer, all blood and lymph cancers combined. When data from individual facilities are analyzed, increased risks of death from all cancers (RR/rem=1.134) and from radiosensitive solid tumors (RR/rem=1.155) are observed at Savannah River, and increased risks of death from hematologic cancers (RR/rem=1.254) and from leukemia (RR/rem=1.320) are observed at X-10.

To test whether there are substantial differences among facilities in the risks related to cumulative penetrating dose, only the eight facilities at which there are at least 10 deaths among monitored employees are included. These analyses are performed only for deaths from all causes, deaths from cancer, and deaths from radiosensitive solid tumors. For other groups of causes of death, the number of deaths is too small to perform these analyses. For these analyses, the Cox model used the same baseline hazard function for all eight facilities; thus the survivor function of age for those with no exposure is assumed to be the same for all eight facilities. The risk related to cumulative penetrating dose was allowed to be different for each facility. The test of whether there are differences between facilities was performed by testing the seven degrees of freedom hypothesis that the risks per rem are the same at all eight facilities. It is not possible to conclude that the effects related to cumulative penetrating dose differed among facilities for any of these three causes of death.

The same analyses were performed using data from only those employees whose length of employment was at least two years (730 days). The results of these analyses are presented in Tables 34-43. These results do not vary in any meaningful way from the results of the analyses that included all monitored employees regardless of length of employment.

Table 24

Cox Model Analyses
Cumulative Penetrating Dose, time dependent (RR per rem)
(Analyses limited to women who are monitored)
(Includes women with any number of years employed)

All Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	21440	1980	1.004	0.983	1.026	0.6823

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Separate	Fernald	405	40	1.347	0.195	9.300	0.7623
	Hanford	8879	1107	0.996	0.972	1.020	0.7176
	K-25	2052	92	1.168	0.599	2.277	0.6480
	LANL	1307	27	0.908	0.680	1.212	0.5119
	Pantex	275	4	0.004	<.001	472.14	0.3482
	Rocky	985	37	0.886	0.569	1.381	0.5941
	Savannah	794	35	1.067	0.998	1.140	0.0566
	X-10	4576	449	1.051	0.968	1.141	0.2396
	Y-12	1842	176	1.031	0.906	1.173	0.6460
	Zia	325	13	0.628	0.105	3.750	0.6098
	Total	21440	1980				

Combined analysis for 8 facilities with at least 10 deaths
to test if effect of 1 rem differs among facilities
(excludes Pantex and Zia)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Combined	All 8	20840	1963	1.005	0.984	1.026	0.6516	
	Fernald			1.697	0.337	8.368	0.5272	
	Hanford			1.003	0.980	1.026	0.8067	
	K-25			1.020	0.505	2.062	0.9554	
	LANL			0.710	0.478	1.053	0.0888	
	Rocky			0.636	0.405	0.998	0.0488	*
	Savannah			1.061	0.997	1.128	0.0608	
	X-10			1.049	0.969	1.135	0.2395	
	Y-12			1.022	0.915	1.142	0.7006	
	Difference between facilities (df=7)						0.1263	NS

Table 25

Cox Model Analyses
Cumulative Penetrating Dose, time dependent (RR per rem)
(Analyses limited to women who are monitored)
(Includes women with any number of years employed)

All Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Deaths	Risk Ratio	95% conf int Lower	Upper	p
Combined	All 10	21440	648	1.028	0.994	1.062	0.1095

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Deaths	Risk Ratio	95% conf int Lower	Upper	p	
Separate	Fernald	405	18	0.086	<.001	46.136	0.4441	
	Hanford	8879	339	1.023	0.985	1.062	0.2490	
	K-25	2052	35	1.186	0.422	3.336	0.7461	
	LANL	1307	7	0.739	0.214	2.543	0.6311	
	Pantex	275	3	<.001	<.001	>1000	0.4559	
	Rocky	985	19	0.611	0.224	1.667	0.3362	
	Savannah	794	9	1.134	1.044	1.231	0.0029	**
	X-10	4576	151	1.035	0.891	1.203	0.6510	
	Y-12	1842	63	0.991	0.764	1.285	0.9464	
	Zia	325	4	0.192	<.001	>1000	0.5007	
	Total	21440	648					

Combined analysis for 8 facilities with at least 10 deaths
to test if effect of 1 rem differs among facilities
(excludes Pantex and Zia)

Baseline Hazard	Facility	Number of Women	Deaths	Risk Ratio	95% conf int Lower	Upper	p	
Combined	All 8	20840	641	1.028	0.995	1.063	0.1015	
	Fernald			0.596	0.008	46.947	0.8163	
	Hanford			1.025	0.988	1.063	0.1825	
	K-25			1.125	0.412	3.068	0.8183	
	LANL			0.221	0.012	3.396	0.2867	
	Rocky			0.662	0.314	1.396	0.2780	
	Savannah			1.092	1.016	1.174	0.0174	*
	X-10			1.041	0.905	1.197	0.5742	
	Y-12			1.001	0.809	1.238	0.9932	
	Difference between facilities (df=7)						0.6497	NS

(Analyses limited to women who are monitored)

Table 26

Cox Model Analyses
Cumulative Penetrating Dose, time dependent (RR per rem)
(Analyses limited to women who are monitored)
(Includes women with any number of years employed)

Radiosensitive Solid Tumor Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	21440	394	1.013	0.965	1.062	0.6085

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Separate	Fernald	405	12	0.119	<.001	264.3	0.5885	
	Hanford	8879	205	1.010	0.957	1.065	0.7296	
	K-25	2052	22	1.355	0.483	3.800	0.5632	
	LANL	1307	2	0.115	<.001	>1000	0.7867	
	Pantex	275	1	-----	-----	-----	------	
	Rocky	985	12	0.770	0.270	2.200	0.6258	
	Savannah	794	4	1.155	1.043	1.280	0.0056	**
	X-10	4576	97	0.871	0.622	1.218	0.4179	
	Y-12	1842	36	0.874	0.564	1.356	0.5484	
	Zia	325	3	<.001	<.001	>1000	0.5625	
	Total	21440	394					

Combined analysis for 8 facilities with at least 10 deaths
to test if effect of 1 rem differs among facilities
(excludes Pantex and Zia)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Combined	All 8	20840	390	1.013	0.966	1.063	0.5827	
	Fernald			0.681	0.004	126.86	0.8856	
	Hanford			1.011	0.960	1.065	0.6727	
	K-25			1.273	0.464	3.492	0.6394	
	LANL			<.001	<.001	>1000	0.1908	
	Rocky			0.728	0.313	1.696	0.4622	
	Savannah			1.094	1.001	1.194	0.0463	*
	X-10			0.918	0.689	1.221	0.5553	
	Y-12			0.887	0.623	1.262	0.5052	
	Difference between facilities (df=7)						0.5434	NS

Table 27

Cox Model Analyses
Cumulative Penetrating Dose, time dependent (RR per rem)
(Analyses limited to women who are monitored)
(Includes women with any number of years employed)

Breast Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	21440	164	1.052	0.990	1.118	0.1034

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Separate	Fernald	405	4	0.837	<.001	>1000	0.9687
	Hanford	8879	87	1.042	0.970	1.120	0.2600
	K-25	2052	9	1.587	0.514	4.898	0.4222
	LANL	1307	1	-----	-----	-----	------
	Pantex	275	0	-----	-----	-----	------
	Rocky	985	5	1.164	0.621	2.182	0.6356
	Savannah	794	1	1.379	0.947	2.006	0.0937
	X-10	4576	37	0.528	0.198	1.409	0.2022
	Y-12	1842	18	0.963	0.530	1.750	0.9012
	Zia	325	2	-----	-----	-----	------
	Total	21440	164				

Table 28

Cox Model Analyses
Cumulative Penetrating Dose, time dependent (RR per rem)
(Analyses limited to women who are monitored)
(Includes women with any number of years employed)

Lung Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	21440	92	0.967	0.855	1.094	0.5976

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Separate	Fernald	405	3	0.021	<.001	>1000	0.6797
	Hanford	8879	31	0.982	0.850	1.135	0.8094
	K-25	2052	8	1.332	0.220	8.087	0.7551
	LANL	1307	1	0.335	<.001	>1000	0.8342
	Pantex	275	1	-----	-----	-----	------
	Rocky	985	4	0.025	<.001	8.625	0.2160
	Savannah	794	1	1.183	0.976	1.435	0.0866
	X-10	4576	31	0.852	0.471	1.543	0.5977
	Y-12	1842	11	0.712	0.281	1.800	0.4726
	Zia	325	1	0.341	<.001	>1000	0.8691
	Total	21440	92				

Table 29

Cox Model Analyses
Cumulative Penetrating Dose, time dependent (RR per rem)
(Analyses limited to women who are monitored)
(Includes women with any number of years employed)

Hematologic Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	21440	57	1.075	0.991	1.166	0.0813

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Separate	Fernald	405	0	-----	-----	-----	------	
	Hanford	8879	31	1.007	0.873	1.162	0.9213	
	K-25	2052	2	1.759	0.278	11.134	0.5484	
	LANL	1307	1	-----	-----	-----	------	
	Pantex	275	0	-----	-----	-----	------	
	Rocky	985	1	1.042	0.126	8.602	0.9698	
	Savannah	794	2	1.177	0.997	1.389	0.0537	
	X-10	4576	13	1.254	1.071	1.468	0.0049	**
	Y-12	1842	6	0.307	0.017	5.391	0.4194	
	Zia	325	1	-----	-----	-----	------	
	Total	21440	57					

Table 30

Cox Model Analyses
Cumulative Penetrating Dose, time dependent (RR per rem)
(Analyses limited to women who are monitored)
(Includes women with any number of years employed)

Ovarian Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	21440	49	1.043	0.938	1.159	0.4392

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Separate	Fernald	405	2	-----	-----	-----	------
	Hanford	8879	26	1.040	0.924	1.169	0.5182
	K-25	2052	3	0.036	<.001	>1000	0.6934
	LANL	1307	1	-----	-----	-----	------
	Pantex	275	0	-----	-----	-----	------
	Rocky	985	0	-----	-----	-----	------
	Savannah	794	2	<.001	<.001	>1000	0.3764
	X-10	4576	9	1.134	0.750	1.713	0.5513
	Y-12	1842	6	1.355	0.900	2.039	0.1457
	Zia	325	0	-----	-----	-----	------
	Total	21440	49				

Table 31

Cox Model Analyses
Cumulative Penetrating Dose, time dependent (RR per rem)
(Analyses limited to women who are monitored)
(Includes women with any number of years employed)

Leukemia Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Combined	All 10	21440	17	1.127	1.016	1.251	0.0243	*

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Separate	Fernald	405	0	-----	-----	-----	------	
	Hanford	8879	7	0.000	0.000	61.530	0.1639	
	K-25	2052	0	-----	-----	-----	------	
	LANL	1307	0	-----	-----	-----	------	
	Pantex	275	0	-----	-----	-----	------	
	Rocky	985	0	-----	-----	-----	------	
	Savannah	794	1	6.413	<.001	>1000	0.9925	
	X-10	4576	6	1.320	1.125	1.549	0.0007	**
	Y-12	1842	3	0.189	0.001	42.122	0.5462	
	Zia	325	0	-----	-----	-----	------	
	Total	21440	17					

Table 32

Cox Model Analyses
Cumulative Penetrating Dose, time dependent (RR per rem)
(Analyses limited to women who are monitored)
(Includes women with any number of years employed)

Brain Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	21440	16	0.890	0.522	1.516	0.6679

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Separate	Fernald	405	1	<.001	<.001	>1000	0.9943
	Hanford	8879	7	0.703	0.188	2.627	0.6008
	K-25	2052	1	1.638	0.156	17.159	0.681
	LANL	1307	0	-----	-----	-----	------
	Pantex	275	0	-----	-----	-----	------
	Rocky	985	1	1.191	0.370	3.834	0.7697
	Savannah	794	0	-----	-----	-----	------
	X-10	4576	3	1.004	0.303	3.332	0.9948
	Y-12	1842	3	1.071	0.269	4.261	0.9225
	Zia	325	0	-----	-----	-----	------
	Total	21440	16				

Table 33

Cox Model Analyses
Cumulative Penetrating Dose, time dependent (RR per rem)
(Analyses limited to women who are monitored)
(Includes women with any number of years employed)

Thyroid Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	21440	2	1.017	0.593	1.745	0.9502

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Separate	Fernald	405	0	-----	-----	-----	------
	Hanford	8879	2	0.989	0.567	1.725	0.9685
	K-25	2052	0	-----	-----	-----	------
	LANL	1307	0	-----	-----	-----	------
	Pantex	275	0	-----	-----	-----	------
	Rocky	985	0	-----	-----	-----	------
	Savannah	794	0	-----	-----	-----	------
	X-10	4576	0	-----	-----	-----	------
	Y-12	1842	0	-----	-----	-----	------
	Zia	325	0	-----	-----	-----	------
	Total	21440	2				

Table 34

Cox Model Analyses
Cumulative Penetrating Dose, time dependent (RR per rem)
(Analyses limited to women who are monitored)
(Analyses limited to women employed 2 years or more)

All Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	15984	1455	1.008	0.987	1.030	0.4544

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Separate	Fernald	272	35	1.177	0.157	8.825	0.8737
	Hanford	6100	768	1.000	0.976	1.025	0.9877
	K-25	1873	85	1.267	0.670	2.306	0.4674
	LANL	1161	24	0.917	0.691	1.218	0.5499
	Pantex	266	4	0.004	<.001	466.34	0.3476
	Rocky	704	27	0.920	0.583	1.451	0.7196
	Savannah	766	34	1.068	1.000	1.141	0.0503
	X-10	3154	312	1.055	0.970	1.148	0.2137
	Y-12	1464	159	1.017	0.889	1.163	0.8075
	Zia	224	7	0.785	0.172	3.594	0.7554
	Total	15984	1455				

Combined analysis for 8 facilities with at least 10 deaths
to test if effect of 1 rem differs among facilities
(excludes Pantex and Zia)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Combined	All 8	15494	1444	1.008	0.987	1.030	0.4430	
	Fernald			1.910	0.420	8.680	0.4022	
	Hanford			1.006	0.983	1.029	0.6349	
	K-25			1.239	0.676	2.268	0.4883	
	LANL			0.724	0.493	1.063	0.0997	
	Rocky			0.639	0.403	1.013	0.0567	
	Savannah			1.065	1.002	1.132	0.0427	*
	X-10			1.055	0.974	1.143	0.1912	
	Y-12			1.034	0.926	1.154	0.5565	
	Difference between facilities (df=7)						0.0981	NS

Table 35

Cox Model Analyses
Cumulative Penetrating Dose, time dependent (RR per rem)
(Analyses limited to women who are monitored)
(Analyses limited to women employed 2 years or more)

All Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	15984	491	1.029	0.995	1.064	0.0976

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Separate	Fernald	272	16	0.044	<.001	35.053	0.3597	
	Hanford	6100	245	1.021	0.982	1.061	0.2912	
	K-25	1873	34	1.292	0.497	3.359	0.5995	
	LANL	1161	5	0.795	0.253	2.498	0.6946	
	Pantex	266	3	<.001	<.001	>1000	0.4561	
	Rocky	704	13	0.713	0.263	1.933	0.5067	
	Savannah	766	9	1.133	1.044	1.231	0.0029	**
	X-10	3154	108	1.059	0.923	1.215	0.4149	
	Y-12	1464	57	0.951	0.719	1.259	0.7264	
	Zia	224	1	0.192	<.001	>1000	0.8258	
	Total	15984	491					

Combined analysis for 8 facilities with at least 10 deaths
to test if effect of 1 rem differs among facilities
(excludes Pantex and Zia)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Combined	All 8	15494	487	1.029	0.995	1.063	0.0973	
	Fernald			0.676	0.010	44.285	0.8543	
	Hanford			1.024	0.987	1.063	0.2013	
	K-25			1.299	0.553	3.055	0.5482	
	LANL			0.203	0.010	3.991	0.2939	
	Rocky			0.636	0.290	1.395	0.2583	
	Savannah			1.093	1.017	1.175	0.0158	*
	X-10			1.059	0.929	1.206	0.3919	
	Y-12			0.990	0.797	1.231	0.9304	
	Difference between facilities (df=7)						0.5769	NS

Table 36

Cox Model Analyses
Cumulative Penetrating Dose, time dependent (RR per rem)
(Analyses limited to women who are monitored)
(Analyses limited to women employed 2 years or more)

Radiosensitive Solid Tumor Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	15984	302	1.012	0.965	1.062	0.6245

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Separate	Fernald	272	11	0.045	<.001	191.6	0.4678	
	Hanford	6100	152	1.005	0.951	1.062	0.8707	
	K-25	1873	21	1.442	0.535	3.889	0.4697	
	LANL	1161	1	-----	-----	-----	------	
	Pantex	266	1	-----	-----	-----	------	
	Rocky	704	7	1.058	0.493	2.270	0.8845	
	Savannah	766	4	1.155	1.043	1.280	0.0057	**
	X-10	3154	72	0.900	0.652	1.242	0.5200	
	Y-12	1464	32	0.812	0.496	1.331	0.4092	
	Zia	224	1	0.192	<.001	>1000	0.8258	
	Total	15984	302					

Combined analysis for 8 facilities with at least 10 deaths
to test if effect of 1 rem differs among facilities
(excludes Pantex and Zia)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Combined	All 8	15494	300	1.012	0.965	1.062	0.6238	
	Fernald			0.727	0.005	116.79	0.9022	
	Hanford			1.007	0.955	1.062	0.7896	
	K-25			1.384	0.546	3.506	0.4933	
	LANL			-----	-----	-----	------	
	Rocky			0.693	0.284	1.691	0.4207	
	Savannah			1.093	1.001	1.194	0.0466	*
	X-10			0.942	0.718	1.235	0.6665	
	Y-12			0.852	0.586	1.239	0.4033	
	Difference between facilities (df=7)						------	NS

Table 37

Cox Model Analyses
Cumulative Penetrating Dose, time dependent (RR per rem)
(Analyses limited to women who are monitored)
(Analyses limited to women employed 2 years or more)

Breast Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Deaths	Risk Ratio	95% conf int Lower	Upper	p
Combined	All 10	15984	129	1.047	0.984	1.115	0.1451

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Deaths	Risk Ratio	95% conf int Lower	Upper	p
Separate	Fernald	272	4	0.379	<.001	>1000	0.8448
	Hanford	6100	67	1.031	0.957	1.110	0.4176
	K-25	1873	9	1.636	0.564	4.749	0.3650
	LANL	1161	1	-----	-----	-----	------
	Pantex	266	0	-----	-----	-----	------
	Rocky	704	3	1.285	0.663	2.488	0.4575
	Savannah	766	1	1.378	0.947	2.006	0.0939
	X-10	3154	28	0.418	0.123	1.418	0.1617
	Y-12	1464	16	0.861	0.420	1.764	0.6821
	Zia	224	0	-----	-----	-----	------
	Total	15984	129				

Table 38

Cox Model Analyses
Cumulative Penetrating Dose, time dependent (RR per rem)
(Analyses limited to women who are monitored)
(Analyses limited to women employed 2 years or more)

Lung Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	15984	74	0.964	0.850	1.093	0.5628

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Separate	Fernald	272	3	0.005	<.001	>1000	0.6033
	Hanford	6100	24	0.975	0.837	1.136	0.7472
	K-25	1873	8	1.443	0.290	7.168	0.6541
	LANL	1161	0	-----	-----	-----	------
	Pantex	266	1	-----	-----	-----	------
	Rocky	704	3	0.059	<.001	14.460	0.3127
	Savannah	766	1	1.183	0.976	1.435	0.0869
	X-10	3154	23	0.894	0.514	1.557	0.6929
	Y-12	1464	10	0.694	0.262	1.835	0.4616
	Zia	224	1	0.192	<.001	>1000	0.8258
	Total	15984	74				

Table 39

Cox Model Analyses
Cumulative Penetrating Dose, time dependent (RR per rem)
(Analyses limited to women who are monitored)
(Analyses limited to women employed 2 years or more)

Hematologic Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline		Number of		Risk	95% conf int		
Hazard	Facility	Women	Deaths	Ratio	Lower	Upper	p
Combined	All 10	15984	41	1.073	0.988	1.165	0.0954

Separate analyses for 10 facilities

Baseline		Number of		Risk	95% conf int			
Hazard	Facility	Women	Deaths	Ratio	Lower	Upper	p	
Separate	Fernald	272	0	-----	-----	-----	------	
	Hanford	6100	22	0.990	0.874	1.156	0.8949	
	K-25	1873	2	1.821	0.333	9.953	0.4889	
	LANL	1161	0	-----	-----	-----	------	
	Pantex	266	0	-----	-----	-----	------	
	Rocky	704	1	0.937	0.085	10.281	0.9576	
	Savannah	766	2	1.177	0.997	1.389	0.0539	
	X-10	3154	10	1.258	1.077	1.470	0.0038	**
	Y-12	1464	4	0.471	0.033	6.672	0.5774	
	Zia	224	0	-----	-----	-----	------	
	Total	15984	41					

Table 40

Cox Model Analyses
Cumulative Penetrating Dose, time dependent (RR per rem)
(Analyses limited to women who are monitored)
(Analyses limited to women employed 2 years or more)

Ovarian Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	15984	34	1.065	0.963	1.177	0.2214

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Separate	Fernald	272	1	<.001	<.001	>1000	0.9948
	Hanford	6100	15	1.077	0.963	1.206	0.1933
	K-25	1873	3	0.029	<.001	>1000	0.6989
	LANL	1161	1	-----	-----	-----	------
	Pantex	266	0	-----	-----	-----	------
	Rocky	704	0	-----	-----	-----	------
	Savannah	766	2	<.001	<.001	>1000	0.3764
	X-10	3154	6	1.155	0.799	1.669	0.4447
	Y-12	1464	6	1.323	0.866	2.021	0.1955
	Zia	224	0	-----	-----	-----	------
	Total	15984	34				

Table 41

Cox Model Analyses
Cumulative Penetrating Dose, time dependent (RR per rem)
(Analyses limited to women who are monitored)
(Analyses limited to women employed 2 years or more)

Leukemia Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Combined	All 10	15984	11	1.130	1.019	1.254	0.0207	*

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Separate	Fernald	272	0	-----	-----	-----	------	
	Hanford	6100	4	0.001	0.000	92.541	0.2305	
	K-25	1873	0	-----	-----	-----	------	
	LANL	1161	0	-----	-----	-----	------	
	Pantex	266	0	-----	-----	-----	------	
	Rocky	704	0	-----	-----	-----	------	
	Savannah	766	1	6.413	<.001	>1000	0.9925	
	X-10	3154	5	1.310	1.112	1.543	0.0012	**
	Y-12	1464	1	1.216	0.126	11.772	0.8660	
	Zia	224	0	-----	-----	-----	------	
	Total	15984	11					

Table 42

Cox Model Analyses
Cumulative Penetrating Dose, time dependent (RR per rem)
(Analyses limited to women who are monitored)
(Analyses limited to women employed 2 years or more)

Brain Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	15984	10	0.909	0.554	1.492	0.7061

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Separate	Fernald	272	0	-----	-----	-----	------
	Hanford	6100	5	0.710	0.196	2.567	0.6017
	K-25	1873	0	-----	-----	-----	------
	LANL	1161	0	-----	-----	-----	------
	Pantex	266	0	-----	-----	-----	------
	Rocky	704	1	1.141	0.306	4.245	0.8445
	Savannah	766	0	-----	-----	-----	------
	X-10	3154	2	1.065	0.373	3.042	0.9067
	Y-12	1464	2	1.209	0.315	4.636	0.7819
	Zia	224	0	-----	-----	-----	------
	Total	15984	10				

Table 43

Cox Model Analyses
Cumulative Penetrating Dose, time dependent (RR per rem)
(Analyses limited to women who are monitored)
(Analyses limited to women employed 2 years or more)

Thyroid Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	15984	2	0.985	0.540	1.796	0.9615

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Separate	Fernald	272	0	-----	-----	-----	------
	Hanford	6100	2	0.950	0.504	1.789	0.8740
	K-25	1873	0	-----	-----	-----	------
	LANL	1161	0	-----	-----	-----	------
	Pantex	266	0	-----	-----	-----	------
	Rocky	704	0	-----	-----	-----	------
	Savannah	766	0	-----	-----	-----	------
	X-10	3154	0	-----	-----	-----	------
	Y-12	1464	0	-----	-----	-----	------
	Zia	224	0	-----	-----	-----	------
	Total	15984	2				

Analyses were performed with the effect of cumulative penetrating dose on radiosensitive solid tumor deaths lagged by 10 years, and with the effect of cumulative penetrating dose on hematologic cancer deaths lagged by 2 years. These analyses are presented in tables 44-47. The results of these analyses do not vary in any meaningful way from the results of the analyses in which the effects of the exposures were not lagged.

Table 44

Cox Model Analyses
Cumulative Penetrating Dose, time dependent
(Analyses limited to women who are monitored)
(Includes women with any number of years employed)

Radiosensitive Solid Tumor Deaths (effect lagged 10 years)

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	21440	394	1.015	0.962	1.071	0.5803

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Separate	Fernald	405	12	0.001	<.001	>1000	0.3425	
	Hanford	8879	205	1.010	0.950	1.073	0.7539	
	K-25	2052	22	0.844	0.058	12.195	0.9012	
	LANL	1307	2	<.001	<.001	>1000	0.7758	
	Pantex	275	1	-----	-----	-----	------	
	Rocky	985	12	1.013	0.373	2.754	0.9795	
	Savannah	794	4	1.162	1.046	1.291	0.0053	**
	X-10	4576	97	0.865	0.608	1.232	0.4219	
	Y-12	1842	36	0.818	0.452	1.483	0.5089	
	Zia	325	3	-----	-----	-----	------	
	Total	21440	394					

Table 45

Cox Model Analyses
Cumulative Penetrating Dose, time dependent
(Analyses limited to women who are monitored)
(Includes women with any number of years employed)

Hematologic Cancer Deaths (effect lagged 2 years)

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	21440	57	1.078	0.994	1.169	0.0705

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Separate	Fernald	405	0	-----	-----	-----	------	
	Hanford	8879	31	1.010	0.876	1.164	0.8942	
	K-25	2052	2	1.774	0.289	10.876	0.5354	
	LANL	1307	1	-----	-----	-----	------	
	Pantex	275	0	-----	-----	-----	------	
	Rocky	985	1	1.083	0.118	9.972	0.9440	
	Savannah	794	2	1.177	0.998	1.389	0.0531	
	X-10	4576	13	1.255	1.072	1.469	0.0048	**
	Y-12	1842	6	0.317	0.017	5.979	0.4434	
	Zia	325	1	-----	-----	-----	------	
	Total	21440	57					

Table 46

Cox Model Analyses
Cumulative Penetrating Dose, time dependent
(Analyses limited to women who are monitored)
(Analyses limited to women employed 2 years or more)

Radiosensitive Solid Tumor Deaths (effect lagged 10 years)

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	15984	302	1.014	0.960	1.070	0.6191

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Separate	Fernald	272	11	<.001	<.001	355.2	0.2542	
	Hanford	6100	152	1.003	0.942	1.069	0.9146	
	K-25	1873	21	0.987	0.057	17.244	0.9930	
	LANL	1161	1	-----	-----	-----	------	
	Pantex	266	1	-----	-----	-----	------	
	Rocky	704	7	1.333	0.588	3.021	0.4913	
	Savannah	766	4	1.162	1.045	1.291	0.0054	**
	X-10	3154	72	0.896	0.638	1.258	0.5257	
	Y-12	1464	32	0.775	0.411	1.460	0.4297	
	Zia	224	1	<.001	<.001	>1000	0.9925	
	Total	15984	302					

Table 47

Cox Model Analyses
Cumulative Penetrating Dose, time dependent
(Analyses limited to women who are monitored)
(Analyses limited to women employed 2 years or more)

Hematologic Cancer Deaths (effect lagged 2 years)

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	15984	41	1.075	0.990	1.167	0.0853

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Separate	Fernald	272	0	-----	-----	-----	------	
	Hanford	6100	22	0.992	0.849	1.158	0.9166	
	K-25	1873	2	1.835	0.346	9.744	0.4759	
	LANL	1161	0	-----	-----	-----	------	
	Pantex	266	0	-----	-----	-----	------	
	Rocky	704	1	0.968	0.082	11.404	0.9794	
	Savannah	766	2	1.177	0.998	1.389	0.0533	
	X-10	3154	10	1.259	1.078	1.471	0.0037	**
	Y-12	1464	4	0.471	0.031	7.119	0.5871	
	Zia	224	0	-----	-----	-----	------	
	Total	15984	41					

The relative risks of death for employees who were not monitored for penetrating radiation are presented on tables 48 through 57. These are expressed as the relative risks for unmonitored employees compared with monitored employees. When data from all facilities are pooled, the relative risk for the women who were not monitored is elevated for all causes of death (RR=1.251), and this risk is slightly less elevated for all cancer deaths (RR=1.171). The relative risk for people who were not monitored is also elevated for lung cancer deaths (RR=1.487). There are substantial differences among facilities in the risk of deaths from the specific causes of death that we investigated.

Table 48

Cox Model Analyses
Relative risk for women who are not monitored
(Includes women with any number of years employed)

All Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Combined	All 10	65959	13341	1.251	1.193	1.313	0.0001	**

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Separate	Fernald	730	73	0.864	0.544	1.374	0.5387	
	Hanford	12599	2007	1.155	1.057	1.261	0.0014	**
	K-25	10583	2455	1.591	1.289	1.964	0.0001	**
	LANL	6409	986	3.667	2.497	5.386	0.0001	**
	Pantex	1046	64	2.237	0.801	6.242	0.1242	
	Rocky	1559	85	1.435	0.932	2.210	0.1012	
	Savannah	2541	225	1.241	0.861	1.788	0.2473	
	X-10	5264	588	1.301	1.075	1.575	0.0069	**
	Y-12	22529	6168	1.201	1.033	1.395	0.0170	*
	Zia	2699	690	1.972	1.135	3.427	0.0159	*
	Total	65959	13341					

Combined analysis for 8 facilities
to test if effect of monitoring differs among facilities
(excludes Pantex and Zia)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Combined	All 8	62214	12587	1.245	1.186	1.307	0.0001	**
	Fernald			0.080	0.644	1.281	0.5839	
	Hanford			1.263	1.167	1.367	0.0001	**
	K-25			1.315	1.238	1.396	0.0001	**
	LANL			1.165	1.079	0.000	0.0888	**
	Rocky			0.903	0.678	1.203	0.4862	
	Savannah			1.193	1.028	1.385	0.0201	*
	X-10			1.330	1.120	1.580	0.0011	**
	Y-12			1.237	1.175	1.302	0.0001	**
	Difference between facilities (df=7)						0.0041	**

Table 49

Cox Model Analyses
Relative risk for women who are not monitored
(Includes women with any number of years employed)

All Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Combined	All 10	65959	4009	1.171	1.076	1.275	0.0002	**

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Separate	Fernald	730	29	0.642	0.303	1.362	0.2484	
	Hanford	12599	613	1.191	1.015	1.397	0.0322	
	K-25	10583	708	1.334	0.947	1.881	0.0993	
	LANL	6409	322	5.102	2.408	10.809	0.0001	**
	Pantex	1046	20	1.056	0.302	3.686	0.9323	
	Rocky	1559	36	0.982	0.510	1.892	0.9561	
	Savannah	2541	75	1.594	0.789	3.217	0.1935	
	X-10	5264	202	1.434	1.043	1.971	0.0265	*
	Y-12	22529	1825	1.017	0.791	1.309	0.8934	
	Zia	2699	179	1.903	0.704	5.150	0.2050	
	Total	65959	4009					

Combined analysis for 8 facilities
to test if effect of monitoring differs among facilities
(excludes Pantex and Zia)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Combined	All 8	62214	3810	1.172	1.076	0.004	0.0003	**
	Fernald			0.871	0.480	1.581	0.6493	
	Hanford			1.254	1.088	1.445	0.0018	**
	K-25			1.179	1.058	1.315	0.0029	**
	LANL			1.192	1.042	1.365	0.0107	*
	Rocky			0.905	0.559	1.465	0.6843	
	Savannah			1.165	0.904	1.501	0.2387	
	X-10			1.482	1.114	1.971	0.0069	**
	Y-12			1.153	1.053	1.263	0.0021	**
	Difference between facilities (df=7)						0.4580	

Table 50

Cox Model Analyses
Relative risk for women who are not monitored
(Includes women with any number of years employed)

Radiosensitive Solid Tumor Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	65959	2311	1.085	0.973	1.210	0.1417

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Separate	Fernald	730	20	0.684	0.279	1.678	0.4064	
	Hanford	12599	359	1.103	0.894	1.360	0.3612	
	K-25	10583	402	1.161	0.752	1.792	0.5003	
	LANL	6409	190	11.104	2.753	44.789	0.0007	**
	Pantex	1046	11	1.647	0.204	13.296	0.6396	
	Rocky	1559	18	0.533	0.200	1.423	0.2091	
	Savannah	2541	38	1.803	0.636	5.113	0.2675	
	X-10	5264	122	1.097	0.706	1.705	0.6795	
	Y-12	22529	1051	1.001	0.717	1.396	0.9965	
	Zia	2699	100	1.393	0.439	4.419	0.5740	
	Total	65959	2311					

Combined analysis for 8 facilities
to test if effect of monitoring differs among facilities
(excludes Pantex and Zia)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 8	62214	2200	1.087	0.974	1.213	0.1375
	Fernald			1.028	0.510	2.071	0.9381
	Hanford			1.150	0.954	1.386	0.1429
	K-25			1.081	0.938	1.245	0.2830
	LANL			1.158	0.973	1.378	0.0993
	Rocky			0.522	0.233	1.169	0.1138
	Savannah			0.977	0.688	1.388	0.8968
	X-10			1.183	0.790	1.773	0.4152
	Y-12			1.078	0.959	1.213	0.2090
	Difference between facilities (df=7)						0.6445

Table 51

Cox Model Analyses
Relative risk for women who are not monitored
(Includes women with any number of years employed)

Breast Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	65959	825	0.962	0.810	1.143	0.6592

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Separate	Fernald	730	6	0.533	0.097	2.919	0.4685	
	Hanford	12599	142	0.969	0.691	1.360	0.8572	
	K-25	10583	135	1.093	0.551	2.166	0.7998	
	LANL	6409	81	10.036	1.394	72.260	0.0220	*
	Pantex	1046	2	>1000	<.001	>1000	0.9941	
	Rocky	1559	9	0.887	0.237	3.318	0.8587	
	Savannah	2541	12	2.317	0.296	18.102	0.4232	
	X-10	5264	48	1.314	0.669	2.580	0.4279	
	Y-12	22529	354	0.718	0.446	1.155	0.1718	
	Zia	2699	36	0.829	0.197	3.485	0.7985	
	Total	65959	825					

Table 52

Cox Model Analyses
Relative risk for women who are not monitored
(Includes women with any number of years employed)

Lung Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Combined	All 10	65959	746	1.487	1.195	1.851	0.0004	**

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Separate	Fernald	730	5	0.733	0.122	4.393	0.7342	
	Hanford	12599	54	1.016	0.592	1.744	0.9535	
	K-25	10583	129	0.893	0.434	1.835	0.7581	
	LANL	6409	60	6.671	0.922	48.265	0.0602	*
	Pantex	1046	7	0.858	0.098	7.485	0.8894	
	Rocky	1559	6	0.496	0.091	2.708	0.4179	
	Savannah	2541	10	1.908	0.241	15.135	0.5408	
	X-10	5264	42	1.457	0.731	2.902	0.2847	
	Y-12	22529	394	1.158	0.636	2.110	0.6319	
	Zia	2699	39	1.610	0.219	11.839	0.6397	
	Total	65959	746					

Table 53

Cox Model Analyses
Relative risk for women who are not monitored
(Includes women with any number of years employed)

Hematologic Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	65959	347	1.149	0.864	1.530	0.3398

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Separate	Fernald	730	1	>1000	<.001	>1000	0.9939
	Hanford	12599	58	1.322	0.788	2.220	0.2905
	K-25	10583	53	1.586	0.382	6.592	0.5295
	LANL	6409	25	2.306	0.307	17.298	0.4164
	Pantex	1046	1	>1000	<.001	>1000	0.9938
	Rocky	1559	1	<.001	<.001	>1000	0.9940
	Savannah	2541	9	0.715	0.140	3.655	0.6871
	X-10	5264	17	1.348	0.439	4.142	0.6019
	Y-12	22529	166	0.981	0.434	2.221	0.9637
	Zia	2699	16	0.567	0.072	4.488	0.5912
	Total	65959	347				

Table 54

Cox Model Analyses
Relative risk for women who are not monitored
(Includes women with any number of years employed)

Ovarian Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	65959	258	0.976	0.714	1.336	0.8813

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Separate	Fernald	730	3	0.564	0.051	6.224	0.6402
	Hanford	12599	45	1.104	0.609	2.001	0.7437
	K-25	10583	46	1.179	0.361	3.847	0.7854
	LANL	6409	22	2.847	0.381	21.300	0.3082
	Pantex	1046	1	>1000	<.001	>1000	0.9928
	Rocky	1559	1	>1000	<.001	>1000	0.9939
	Savannah	2541	11	0.945	0.200	4.459	0.9431
	X-10	5264	13	1.844	0.566	6.012	0.3099
	Y-12	22529	107	0.579	0.254	1.321	0.1939
	Zia	2699	9	>1000	<.001	>1000	0.9934
	Total	65959	258				

Table 55

Cox Model Analyses
Relative risk for women who are not monitored
(Includes women with any number of years employed)

Leukemia Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	65959	96	1.093	0.645	1.854	0.7411

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Separate	Fernald	730	1	>1000	<.001	>1000	0.9939
	Hanford	12599	17	2.204	0.834	5.823	0.1109
	K-25	10583	12	>1000	<.001	>1000	0.9943
	LANL	6409	3	>1000	<.001	>1000	0.9921
	Pantex	1046	1	>1000	<.001	>1000	0.9938
	Rocky	1559	0	-----	-----	-----	------
	Savannah	2541	4	0.707	0.071	7.021	0.7670
	X-10	5264	8	1.532	0.309	7.600	0.6017
	Y-12	22529	45	0.538	0.166	1.744	0.3012
	Zia	2699	5	>1000	<.001	>1000	0.9936
	Total	65959	96				

Table 56

Cox Model Analyses
Relative risk for women who are not monitored
(Includes women with any number of years employed)

Brain Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	65959	128	1.717	1.014	2.907	0.0444

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Separate	Fernald	730	1	<.001	<.001	>1000	0.9940
	Hanford	12599	18	2.400	0.926	6.224	0.0717
	K-25	10583	27	1.797	0.240	13.449	0.5683
	LANL	6409	12	>1000	<.001	>1000	0.9922
	Pantex	1046	0	-----	-----	-----	------
	Rocky	1559	2	1.044	0.065	16.757	0.9755
	Savannah	2541	2	>1000	<.001	>1000	0.9940
	X-10	5264	3	<.001	<.001	>1000	0.9924
	Y-12	22529	62	0.805	0.251	2.577	0.7150
	Zia	2699	1	>1000	<.001	>1000	0.9937
	Total	65959	128				

Table 57

Cox Model Analyses
Relative risk for women who are not monitored
(Includes women with any number of years employed)

Thyroid Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	65959	11	0.876	0.189	4.062	0.8661

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Separate	Fernald	730	0	-----	-----	-----	------
	Hanford	12599	2	<.001	<.001	>1000	0.9916
	K-25	10583	3	>1000	<.001	>1000	0.9940
	LANL	6409	0	-----	-----	-----	------
	Pantex	1046	0	-----	-----	-----	------
	Rocky	1559	0	-----	-----	-----	------
	Savannah	2541	0	-----	-----	-----	------
	X-10	5264	0	-----	-----	-----	------
	Y-12	22529	6	>1000	<.001	>1000	0.9930
	Zia	2699	0	-----	-----	-----	------
	Total	65959	11				

The relative risks of death for employees who were not monitored for penetrating radiation are presented in tables 58 through 67. These analyses exclude people who were employed for less than 2 years (730 days). The effect estimates, restricted to women who were employed for at least two years, are expressed as relative risks for unmonitored employees compared with monitored employees. When data from all facilities are pooled, the relative risks for the women who were not monitored is elevated for all causes of death (RR=1.291), and slightly less elevated for all cancer deaths (RR=1.238). These results are similar to those reported earlier (Tables 48-57) which included all employees, regardless of how long they were employed.

Table 58

Cox Model Analyses
Relative risk for women who are not monitored
(Analyses limited to women employed 2 years or more)

All Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Combined	All 10	27004	4086	1.291	1.210	1.377	0.0001	**

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Separate	Fernald	393	48	0.799	0.421	1.514	0.4909	
	Hanford	6971	1010	1.207	1.044	1.396	0.0111	*
	K-25	3940	606	1.554	1.227	1.969	0.0003	**
	LANL	3455	469	3.995	2.639	6.048	0.0001	**
	Pantex	698	27	1.294	0.431	3.882	0.6461	
	Rocky	889	51	2.126	1.217	3.714	0.0081	**
	Savannah	1765	169	1.389	0.946	2.040	0.0933	
	X-10	3304	344	1.540	1.068	2.220	0.0207	*
	Y-12	4715	1155	1.188	1.003	1.406	0.0454	*
	Zia	874	207	2.128	0.989	4.579	0.0533	
	Total	27004	4086					

Combined analysis for 8 facilities
to test if effect of monitoring differs among facilities
(excludes Pantex and Zia)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Combined	All 8	25432	3852	1.303	1.221	1.392	0.0001	**
	Fernald			0.977	0.566	1.686	0.9325	
	Hanford			1.299	1.133	1.490	0.0002	**
	K-25			1.381	1.249	1.527	0.0001	**
	LANL			1.219	1.096	1.356	0.0003	**
	Rocky			1.283	0.857	1.921	0.2259	
	Savannah			1.362	1.141	1.625	0.0006	**
	X-10			1.578	1.111	2.240	0.0107	*
	Y-12			1.297	1.196	1.408	0.0001	**
	Difference between facilities (df=7)						0.5110	

Table 59

Cox Model Analyses
Relative risk for women who are not monitored
(Analyses limited to women employed 2 years or more)

All Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Deaths	Risk Ratio	95% conf int Lower	Upper	p	
Combined	All 10	27004	1299	1.238	1.106	1.386	0.0002	**

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Deaths	Risk Ratio	95% conf int Lower	Upper	p	
Separate	Fernald	393	20	0.537	0.179	1.609	0.2667	
	Hanford	6971	317	1.209	0.929	1.574	0.1574	
	K-25	3940	192	1.379	0.943	2.017	0.0976	
	LANL	3455	144	6.692	2.732	16.393	0.0001	**
	Pantex	698	9	0.612	0.149	2.509	0.4851	
	Rocky	889	22	1.709	0.728	4.009	0.2182	
	Savannah	1765	58	1.807	0.878	3.722	0.1084	
	X-10	3304	116	1.151	0.560	2.362	0.7023	
	Y-12	4715	371	1.112	0.837	1.477	0.4637	
	Zia	874	50	4.567	0.623	33.461	0.1350	
	Total	27004	1299					

Combined analysis for 8 facilities
to test if effect of monitoring differs among facilities
(excludes Pantex and Zia)

Baseline Hazard	Facility	Number of Women	Deaths	Risk Ratio	95% conf int Lower	Upper	p	
Combined	All 8	25432	1240	1.260	1.124	1.414	0.0001	**
	Fernald			0.818	0.306	2.187	0.6884	
	Hanford			1.282	1.000	1.644	0.0497	*
	K-25			1.285	1.073	1.538	0.0063	**
	LANL			1.163	0.963	1.405	0.1176	*
	Rocky			1.352	0.699	2.615	0.3695	
	Savannah			1.355	1.010	1.819	0.0427	*
	X-10			1.196	0.595	2.406	0.6149	
	Y-12			1.285	1.114	1.482	0.0006	**
	Difference between facilities (df=7)						0.9498	

Table 60

Cox Model Analyses
Relative risk for women who are not monitored
(Analyses limited to women employed 2 years or more)

Radiosensitive Solid Tumor Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	27004	739	1.088	0.939	1.261	0.2625

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Separate	Fernald	393	13	0.391	0.086	1.770	0.2231	
	Hanford	6971	192	1.082	0.763	1.534	0.6578	
	K-25	3940	107	1.225	0.750	2.001	0.4174	
	LANL	3455	71	17.593	2.437	127.03	0.0045	**
	Pantex	698	4	0.746	0.076	7.299	0.8014	
	Rocky	889	10	0.992	0.255	3.854	0.9905	
	Savannah	1765	30	2.040	0.703	5.917	0.1897	
	X-10	3304	75	0.651	0.205	2.067	0.4661	
	Y-12	4715	212	1.133	0.776	1.653	0.5173	
	Zia	874	25	2.300	0.305	17.341	0.4190	
	Total	27004	739					

Combined analysis for 8 facilities
to test if effect of monitoring differs among facilities
(excludes Pantex and Zia)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 8	25432	710	1.113	0.958	1.293	0.1621
	Fernald			0.656	0.163	2.636	0.5524
	Hanford			1.164	0.836	1.620	0.3688
	K-25			1.135	0.893	1.443	0.3017
	LANL			0.950	0.732	1.233	0.6993
	Rocky			0.729	0.234	2.272	0.5855
	Savannah			1.161	0.777	1.733	0.4669
	X-10			0.729	0.234	2.273	0.5860
	Y-12			1.195	0.992	1.440	0.0609
	Difference between facilities (df=7)						0.7286

Table 61

Cox Model Analyses
Relative risk for women who are not monitored
(Analyses limited to women employed 2 years or more)

Breast Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Deaths	Risk Ratio	95% conf int Lower	Upper	p
Combined	All 10	27004	287	0.980	0.776	1.239	0.8690

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Deaths	Risk Ratio	95% conf int Lower	Upper	p
Separate	Fernald	393	5	0.550	0.061	4.957	0.5937
	Hanford	6971	82	0.970	0.553	1.700	0.9155
	K-25	3940	43	1.237	0.580	2.638	0.5820
	LANL	3455	27	7.117	0.959	52.806	0.0550
	Pantex	698	1	>1000	<.001	>1000	0.9934
	Rocky	889	5	1.740	0.284	10.224	0.5600
	Savannah	1765	7	1.727	0.201	14.817	0.6181
	X-10	3304	29	0.596	0.081	4.384	0.6115
	Y-12	4715	80	0.871	0.502	1.511	0.6223
	Zia	874	8	>1000	<.001	>1000	0.9939
	Total	27004	287				

Table 62

Cox Model Analyses
Relative risk for women who are not monitored
(Analyses limited to women employed 2 years or more)

Lung Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	27004	195	1.160	0.867	1.551	0.3175

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Separate	Fernald	393	3	<.001	<.001	>1000	0.9942	
	Hanford	6971	28	0.638	0.221	1.840	0.4055	
	K-25	3940	23	0.399	0.162	0.983	0.0457	*
	LANL	3455	21	>1000	<.001	>1000	0.9915	
	Pantex	698	3	0.499	0.044	5.664	0.5748	
	Rocky	889	4	0.689	0.071	6.682	0.7478	
	Savannah	1765	10	2.854	0.359	22.697	0.3216	
	X-10	3304	24	0.694	0.094	5.139	0.7204	
	Y-12	4715	71	1.151	0.588	2.252	0.6810	
	Zia	874	8	0.628	0.075	5.265	0.6678	
	Total	27004	195					

Table 63

Cox Model Analyses
Relative risk for women who are not monitored
(Analyses limited to women employed 2 years or more)

Hematologic Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Deaths	Risk Ratio	95% conf int Lower	Upper	p
Combined	All 10	27004	117	1.352	0.922	1.981	0.1221

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Deaths	Risk Ratio	95% conf int Lower	Upper	p
Separate	Fernald	393	0	-----	-----	-----	------
	Hanford	6971	30	1.470	0.653	3.306	0.3519
	K-25	3940	19	2.051	0.462	9.102	0.3449
	LANL	3455	10	>1000	<.001	>1000	0.9921
	Pantex	698	0	-----	-----	-----	------
	Rocky	889	1	<.001	<.001	>1000	0.9924
	Savannah	1765	5	0.559	0.084	3.707	0.5468
	X-10	3304	11	1.614	0.206	12.641	0.6487
	Y-12	4715	35	1.527	0.537	4.341	0.4272
	Zia	874	6	>1000	<.001	>1000	0.9933
	Total	27004	117				

Table 64

Cox Model Analyses
Relative risk for women who are not monitored
(Analyses limited to women employed 2 years or more)

Ovarian Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	27004	92	1.343	0.876	2.059	0.1756

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Separate	Fernald	393	2	2.119	0.132	33.894	0.5955
	Hanford	6971	18	0.844	0.243	2.930	0.7890
	K-25	3940	17	1.774	0.497	6.332	0.3775
	LANL	3455	15	4.265	0.556	32.720	0.1630
	Pantex	698	0	-----	-----	-----	------
	Rocky	889	0	-----	-----	-----	------
	Savannah	1765	8	0.865	0.167	4.480	0.8626
	X-10	3304	7	2.633	0.316	21.914	0.3705
	Y-12	4715	21	0.486	0.187	1.263	0.1386
	Zia	874	4	>1000	<.001	>1000	0.9934
	Total	27004	92				

Table 65

Cox Model Analyses
Relative risk for women who are not monitored
(Analyses limited to women employed 2 years or more)

Leukemia Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Deaths	Risk Ratio	95% conf int Lower	Upper	p
Combined	All 10	27004	30	1.278	0.606	2.697	0.5197

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Deaths	Risk Ratio	95% conf int Lower	Upper	p
Separate	Fernald	393	0	-----	-----	-----	------
	Hanford	6971	8	3.748	0.936	15.004	0.0619
	K-25	3940	4	>1000	<.001	>1000	0.9916
	LANL	3455	2	>1000	<.001	>1000	0.9938
	Pantex	698	0	-----	-----	-----	------
	Rocky	889	0	-----	-----	-----	------
	Savannah	1765	2	0.401	0.022	7.264	0.5361
	X-10	3304	5	<.001	<.001	>1000	0.9948
	Y-12	4715	7	1.251	0.150	10.447	0.8359
	Zia	874	2	>1000	<.001	>1000	0.9938
	Total	27004	30				

Table 66

Cox Model Analyses
Relative risk for women who are not monitored
(Analyses limited to women employed 2 years or more)

Brain Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p	
Combined	All 10	65959	36	2.146	1.030	4.475	0.0416	*

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Separate	Fernald	393	0	-----	-----	-----	------
	Hanford	6971	7	1.765	0.340	9.163	0.4992
	K-25	3940	6	>1000	<.001	>1000	0.9925
	LANL	3455	6	>1000	<.001	>1000	0.9928
	Pantex	698	0	-----	-----	-----	------
	Rocky	889	2	2.492	0.155	39.994	0.5190
	Savannah	1765	2	>1000	<.001	>1000	0.9931
	X-10	3304	2	<.001	<.001	>1000	0.9938
	Y-12	4715	11	1.036	0.221	4.854	0.9642
	Zia	874	0	-----	-----	-----	------
	Total	27004	36				

Table 67

Cox Model Analyses
Relative risk for women who are not monitored
(Analyses limited to women employed 2 years or more)

Thyroid Cancer Deaths

Combined analysis for 10 facilities
(no external exposure data from Linde or Mound)

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Combined	All 10	27004	4	0.596	0.084	4.257	0.6063

Separate analyses for 10 facilities

Baseline Hazard	Facility	Number of Women	Number of Deaths	Risk Ratio	95% conf int Lower	95% conf int Upper	p
Separate	Fernald	393	0	-----	-----	-----	------
	Hanford	6971	2	<.001	<.001	>1000	0.9933
	K-25	3940	1	>1000	<.001	>1000	0.9926
	LANL	3455	0	-----	-----	-----	------
	Pantex	698	0	-----	-----	-----	------
	Rocky	889	0	-----	-----	-----	------
	Savannah	1765	0	-----	-----	-----	------
	X-10	3304	0	-----	-----	-----	------
	Y-12	4715	1	>1000	<.001	>1000	0.9943
	Zia	874	0	-----	-----	-----	------
	Total	27004	4				

DISCUSSION

We were, and continue to be concerned that operations and consequent exposure differences between facilities are so great as to make pooling of workers from all work sites subject to error. Future analyses should consider this issue by grouping facilities according to similarities in operations (for example, all those involving uranium operations). An alternative may be to separately pool all workers monitored for uranium, or all workers monitored for various isotopes of plutonium across facilities to estimate isotope specific risks relative to exposure or dose level. Such efforts would require, however, comparable exposure data.

Our finding of a strong healthy worker effect among the pooled results and facility specific results is similar to our findings regarding previous follow-up of male and female Hanford workers (Baillargeon et al, 1998, 1999), and it is similar to other studies of male nuclear workers.

The very low SMRs from all causes of death for some facilities raise the concern of under-ascertainment. If we take the recently published results from the comparison of Hanford males and females as a reference, we would expect overall SMRs for all causes of death to be approximately 80. The low SMRs that are also observed for heart disease, and especially for ischemic heart disease, however, imply that under-ascertainment (although always present to some extent) may not be the complete explanation for these low SMRs. Decreased heart disease is often thought to contribute to the healthy worker effect, especially among younger workforces. This may be partly due to the assiduous screening that nuclear workers undergo, and partly due to the acute impacts that heart disease can have on daily living. The low SMRs that we observe for all causes of death tend to be due in part to the lack of heart disease observed among these populations. Thus, these findings tend to be consistent with the interpretation that a particularly strong healthy worker effect may be present among some of these work forces. Additional follow-up using alternative means of vital status ascertainment (such as the National Death Index), and active means of follow-up (such as the Social Security Administration) appear to be warranted. The use of driver's license records is probably less feasible due to the nation-wide distribution of the nuclear weapons plants and their workforces that comprise this study.

Leukemia, with the exception of chronic lymphatic leukemia (CLL), and to a lesser extent the lymphatic cancers (with the exception of Hodgkin's disease) are of particular interest with regard to radiation related effects. Numerous studies have reported an association between exposure to ionizing radiation and the occurrence of leukemia. We find no evidence of increased risks from the blood and lymph cancers among the combined cohort, nor among the facility specific subcohorts of female workers when compared with mortality expected based on U.S. death rates.

Although SMRs for cancers of the urinary organs are increased for several facilities, no consistent pattern appears to exist. Also, the highest SMRs tend to be based on few observed deaths.

The elevated SMRs for deaths from mental diseases and from homicide that are observed for some facilities are unexpected. These causes of death are unlikely to be related to either radiation exposures or to chemical exposures. This interpretation is supported by the results of analyses that consider radiation-monitored workers separately from workers who were not monitored. Although elevated SMRs are observed for mental disorders among both groups, the unmonitored workers appear to reflect somewhat higher and more precise SMRs than do badged workers. This interpretation should be approached with caution, however, as the underlying age structures may differ between these sub-cohorts, and the confidence intervals overlap to a great extent. On the other hand, mortality from homicide is increased among women who were not monitored for external radiation, but not among badged workers. These results may reflect stressful working conditions that may have existed in the weapons facilities in the past, or other unmeasured factors. Alternatively, these results may be spurious.

Increased SMRs for symptoms and ill defined conditions was previously observed by Cragle et al (1992). This phenomenon appears to be a characteristic of the manner in which deaths are recorded by local coroners. It is interesting to note that in the present study, this increase occurs among those who were not monitored for radiation exposures, whereas the SMR for badged workers is approximately equal to what would be expected. The question arises as to why deaths among unbadged workers are more likely to be classified in this manner whereas deaths among badged workers are not as likely to be so classified.

A minimum length of employment criterion does not seem to be particularly important except for mortality from the mental disorders. Those who worked more than one and more than two years demonstrate the highest SMRs for this outcome. This finding suggests that women who work in the nuclear weapons facilities for extended periods of time may be at increased risk for mental illness. However, additional research needs to be conducted to determine if this is a spurious finding, or if it is the result of an unmeasured confounder.

Consideration of induction times also appears to be of little consequence in this study. SMRs tend to increase slightly with increasing induction time; however, no excesses are observed.

An advantage of investigating potential radiogenic health effects among women is they comprise a smaller population than do males, who over the years have experienced a far greater range and frequency of exposures as a group, than have women. The smaller size of the female worker population allows an investigator to assess the feasibility of combining dosimetry measurements from different weapons facilities. Based on an assessment of the dosimetry data that were available to us, we conclude that combining exposure and dose data for penetrating radiation, although subject to some error, is reasonable, especially for deep doses comprised mainly of gamma radiation exposures. Neutron exposures are a potential source of error for those populations that engaged in plutonium-related and other operations where neutron exposures were not well measured or recorded during the early decades of nuclear weapons production. This comparability, however, does not extend to available dosimetry for internal alpha emitters such as polonium, or various isotopes of plutonium and uranium. Enough uncertainty appears to exist regarding differences in bioassay procedures, detection limits and models employed to estimate doses over time and between facilities, that we decided to limit our consideration of radiation exposures to penetrating radiation. Although some may consider our approach too conservative, we feel that additional dose reconstruction activities are necessary before an analysis that pools populations from various facilities is attempted. These reconstruction efforts should involve collaboration between study investigators and health physicists who are familiar with internal radiation dosimetry practices at the weapons facilities from which the populations being studied are derived.

The failure time analyses using proportional hazards modeling that we conducted focused on mortality from causes of death that are known to be associated with ionizing radiation. Thus, although in these analyses we investigated all causes of death combined, our main interest is in nine groups or specific types of radiation-sensitive cancer deaths. These causes of death were selected because of known radiation sensitivity from population and/or experimental studies, and for which some degree of biological plausibility is available. For example, cancer of the female breast is known to be associated with relatively high doses of penetrating radiation, such as has been observed among women irradiated for post partum mastitis, women who received multiple fluoroscopic examinations, and atomic bomb survivors (BEIR V, 1990). However, inconsistent evidence exists regarding increased risks for breast cancer among women who are exposed to low levels of ionizing radiation such as those received in the workplace. Unfortunately, most relevant cohorts or study populations have been too small to detect with acceptable statistical precision the moderate increases in risk that are likely to result from low doses, if an increased risk is indeed present.

Approximately one third of the women in our combined study cohort were issued radiation badges. The range of recorded exposures experienced by these women is severely skewed toward very low cumulative dose levels. The mean total cumulative doses among monitored women ranged from a low of 0.065 rem to a high of 0.966 rem. Thus, many of these mean cumulative doses are less than the annual background doses that many of these workers would have experienced. If risks are present at such low dose levels, they would be very difficult to detect with any degree of precision.

Even so, we do find a small increased risk per rem for all cancers combined among the pooled cohort and for Savannah River employees. This elevated risk is largely due to the contribution from Savannah River, K-25, Hanford and X-10 workers. Individual risk estimates vary widely by facility. Increased risks for radiosensitive tumors are observed for Savannah River workers, but not for the pooled cohort or other facilities, with the possible exception of K-25 workers. A small increase in the risk of breast cancer is present among the entire pooled cohort. Wide variation in the facility-specific risk estimates for breast cancer is observed, and all of the lower bounds of the confidence intervals fall below one. The risk estimates for the blood and lymph cancers are increased for the combined study population, and for X-10 and for Savannah River workers. Leukemia risk is also increased for the pooled cohort, and for X-10 workers.

At the same time we find the hazard for several types of death to be elevated among workers who were not monitored for radiation compared with those who were monitored. Both the pooled estimates and all of the facility-specific effect estimates except one are elevated or suggestively elevated for all causes of death. A test of whether monitoring for external radiation modifies the risk from all causes of death indicates that this is indeed the case. This finding is consistent with other findings that support the influence of the healthy workers effect.

It would be very difficult to find a rationale for proposing that monitoring employees for radiation exposures directly reduces their risks of death. It would be more reasonable to interpret these findings as suggesting that the increased risks for women who were not monitored could be due to ethnic and socioeconomic differences between women in radiation or nonradiation jobs. Another possibility is the effectiveness of the process of screening employees so that women who were less healthy were not assigned to jobs, which involved potential radiation exposures, which in turn would require monitoring for exposures.

Future research efforts need to be directed toward evaluating the modifying and/or confounding effects of factors we have not been able to address in this project. For instance, the possible bias exerted by under-ascertainment should be evaluated by comparing various methods of vital status ascertainment. Misclassification of health endpoints and of exposures also should be considered. The possible influence of socio-economic status, smoking behavior, chemical and other exposures, exposure measurement error and other factors needs to be assessed.

In conclusion, among the entire pooled cohort, we find the relative risk of death from leukemia to increase with increasing cumulative dose of external radiation (RR/rem = 1.13, 95%CI=1.02-1.25). Suggestive increases are also observed for all cancers combined (RR/rem = 1.03, 95%CI=0.99-1.06), breast cancer (RR/rem = 1.05, 95%CI=0.99-1.12), and for all hematologic cancers combined (RR/rem = 1.08, 95%CI=0.99-1.17). Increased relative risks from all cancers and from radiation sensitive cancers are observed for female workers at the Savannah River Plant. Increased risk estimates for hematologic cancers and for leukemia are observed among female workers at X-10. On the other hand, we find little evidence of an association between mortality from other deaths known to be radiogenic with increasing doses of external ionizing radiation. This conclusion is made with the caveat that doses among this study population were heavily skewed and the range of doses was very narrow. We do find evidence of a strong healthy worker effect, similar to that found for male workers. Furthermore, the healthy worker effect is manifested not only among the overall population of female workers when compared with the U.S. population, but also among populations of women who were monitored and among those who were not monitored for radiation exposures. In addition, comparison of badged with unbadged women on survival time further supports the presence of a strong healthy worker effect as evinced by a number of increased risk estimates observed among the unmonitored.

These findings need to be interpreted cautiously for the many reasons that have been cited above. Future research should be directed toward verifying these results and toward evaluating the modifying and/or confounding effects of factors previously described.

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ACKNOWLEDGEMENTS

The participation of the individuals listed below is gratefully acknowledged.

Numerous individuals have helped us along the way. They are far too numerous to list here. However, we are particularly indebted to the following: Steve Wing, Susan Wolf and their staff at the University of North Carolina; Jim Ruttenber at the University of Colorado and Margaret Schoenfeld at the Colorado Department of Health; Donna Cragle and the staff at the Center for Epidemiologic Research in Oak Ridge; Tony Andrade and particularly John Voltin at Los Alamos National Laboratory; John Campbell at Pantex; Jeff Gorsuch at the DOE Mound Operations Office; Gerald Petersen at DOE in Germantown; Ann Fidler, David Utterback, Larry Elliot and numerous others at NIOSH, Cincinnatti; and many others.

The following have served as members of the study team.

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PUBLICATIONS

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Appendix I

An Assessment of Radiation Dosimetry

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May 12, 1999

Historical perspective on the beginnings of Radiation Protection:

Almost as soon as the parallel discoveries of x-rays and radioactivity at the end of the 19^{th} century , the need for measurement of and protection from these discoveries became apparent. Public interest was spawned by the invisible ray with the ability to pass through solid matter. Scientific interests surrounded the new radiation with a shorter wavelength than light. Both the public and the scientific communities were enthusiastic about the potential applications for this new ray in the fields of medicine and surgery.

Widespread and unrestrained use of x-rays led to injuries that were not immediately attributed to the x-rays being used. At the time, there was no reason to suspect that the x-rays were the cause of the injury. One of the first to link the symptoms to x-rays was Thomas Edison who reported eye irritation from experimenting with x-rays and fluorescent substances. Soon, other reports of symptoms similar to that of severe sunburn became widespread. With these reports becoming so frequent, an American physicist, Elihu Thomson, deliberately exposed his little finger of his left hand to an x-ray tube for several days, for about half an hour per day. The result of this exposure was pain, swelling, stiffness, erythema and blistering. Even with this convincing evidence, many were still not convinced.

By 1900 it was apparent to most of the medical and scientific community that x-ray exposure could produce skin burn, depending on the frequency and intensity of it's use. The most obvious ways in which to avoid the harmful effects would be to limit the exposure time and frequency to patients and scientists. Malpractice lawsuits provided further impetus to considering patient protection standards. Even though the basic knowledge of radiation protection was available, it wasn't until the 1940's that it became a science of it's own with the development of the Manhattan Engineering District Program.

Early monitoring methods:

It became apparent that within ten years of the discovery of radioactivity, there was a need for detecting and quantifying radiation exposure. The first type of monitoring practice used small pieces of photographic film. The film was usually placed in a coat pocket and most workers followed their own guidelines for self-protection. During the 1930's, standard dental film packets were widely used, but only scrutinized under visual inspection. There was no standardization of the assessment of exposure seen on the films.

The Manhattan Engineering District Program gave rise to all types of monitoring, Scientists of all kinds came together with the same objective of studying and implementing radiation protection practices. At this time, the first health physicists emerged. There was a rush to develop the proper instruments to measure ambient exposure levels and dosimetry to evaluate doses to workers. It became important to develop ways in which to quantify exposures. Photographic film became the most easily and widely used way in which to monitor individuals working in varying radiation fields. It was purchased in bulk batch form and stored in freezers. Each batch was individually calibrated and developed. The densitometers that were used to read the film were also under continuous evaluation. The photographic film became the backbone of personnel monitoring throughout the atomic bomb project laboratories. The first film badge program was described in 1944 in an MDDC report by Pardue, Goldstein and Wollan.

A supplement to the film badge was, and still is, the pocket electroscope. The "pocket dosimeter" is a self-reading electroscope that can be used in several ways. It is often used to obtain an immediate assessment of exposure following a particular procedure. It can also be used on a daily basis to ensure that film is processed quickly after reaching a pre-determined action level. A third way in which it is used, is to quickly and frequently assess doses received in high radiation fields. This, in conjunction with the photographic film is still the basis of many personnel monitoring programs.

In the 1950's, energy dependence correction was developed and researched. Film badge holders became more elaborate and included filters to correct for the energy of incident radiation. Also the interpretation of beta and neutron responses were developed. Further radiation detectors were developed following the second world war. Diodes, semiconductors and chemical systems were all developed to detect and quantify radiation. In a naval research laboratory, a silver activated metaphosphate glass was developed that was used as a radio thermoluminescent detector. These glass rods were the precursers to the TLD or thermoluminescent dosimeter. Recently, the TLD has experienced continuing improvement in both the detector element and TLD readers. Commercially available systems have proven to be reliable, convenient and largely energy independent. It is currently the most often type of personnel dosimetry chosen to assess exposure to photons.

All of these methods discussed so far are used to detect external exposure to radiation. During the early atomic energy era, analytical tools for assessing internal exposure were developed. Throughout the 1950's in-vivo whole-body counters with large detectors were used to assess dose from gamma emitters. "Phoswich-sandwich" detectors were used to detect the low energy photons from ^{241}Americim. Since ^{241}Amenicim is the daughter of ^{141}Plutonium, and ^{141}Plutomium is generally found with ^{239}plutonium, exposure from ^{239}Plutonium can be indirectly measured. More recently, intrinsic germanium detectors are used to measure low Plutonium levels and it's distribution throughout the lung[2].

Principles of Dosimetry:

When ionizing radiation comes in contact with a piece of photographic film, the silver halide contained in the film is exposed in the emulsion. This results in a darkening of the film. The degree of film darkening is called the optical density of the film. The optical density can be measured directly by using a machine called a densitometer. It is qualitatively related to the magnitude of the exposure of the film. By comparing the optical density of the film to that of film exposed to a known amount of radiation, exposure to the personnel film can be determined. Each batch of films is calibrated separately because a small variation in the film could result in a change in the qualitative response. Photographic film is largely energy independent except in the low range of less than 0.2 MeV. It's maximum sensitivity is at the 30 to 40 keV range. Unless the energy dependence is compensated for, it is of little use at the less than 200 keV x-ray range.

In order to compensate for this energy dependence at the low energy ranges, a series of filters placed in front of the film is used. The photographic film is contained in a plastic film holder that contains several filters. The filters differ by the type of radiation to be measured and consist of aluminum, tin, silver, lead, copper and cadmium. The evaluation of exposure is made based on the ratios of film density under each of the filters.

Fast neutrons can be measured by using what is called "track film". Proton recoil tracks that result from elastic collisions with hydrogen are counted. Since the hydrogen in the film is in the same proportion as hydrogen in tissue, an approximate tissue equivalent is obtained. The number of tracks is proportional to the absorbed dose in tissue.

Thermoluminescent dosimeters are crystals consisting of lithium fluoride (LIF) or calcium fluoride (CaF,Mn). Many crystals emit light when heated after being exposed to radiation. When radiation comes in contact with the crystal, energy is absorbed into the crystal structure. This produces free electrons and holes in the crystal. The energy is trapped by impurities, such as manganese, and imperfections in the crystalline lattice. The excitation energy is then locked into the crystal. When the crystal is heated up, the energy is released. The energy released is in the form of light emitted from the crystal. The total amount of light is proportional to the number of trapped and excited electrons. The number of trapped and excited electrons is proportional to the energy absorbed from the radiation. A crystal of lithium fluoride has an effective atomic number of 8.1 which closely matches the effective atomic number of tissue of 7.4. Because of this similarity, it provides a close estimate of the dose delivered to the tissue. Most TLD's are energy independent from 100 keV to 1.3 MeV[3].

In order to determine internal deposition of radioactive substances, bioassays are performed. Bioassays are used to estimate the body burden of a radioactive material and the distribution among different organs that may follow internal deposition. They can be done by direct measurement, called in-vivo bioassay, or by indirect measurement, called in-vitro bioassay. Baseline data is usually obtained at the beginning of the worker's job assignment. Routine measurement are scheduled to assess radiation safety and work habits, to evaluate general exposure conditions throughout the facility, and as a check of air sampling programs. It also serves as a legal record of exposure levels before and after the assignment of a new job.

When an in-vivo measurement is taken, emissions from internally deposited materials are measured externally, This is the most direct method of measurement. In vitro measurements are used when the radioactive materials do not have enough penetrating power to be detected outside of the body. Collection of samples excreted or removed from the body is performed on a routine or special need basis. The samples are then evaluated using counting instruments. Results are reported as body burdens, with some assumptions being made. Because of physiologic differences between individuals, the metabolism may not exactly match the metabolic models used to infer the body burden[4].

Overview:

There are three facilities at Oak Ridge, namely X-10, K-25, and Y-12. Other facilities include Fernald, Mound, Hanford, and Pantex. Each facility began their monitoring program during different years and each had different reporting styles. Each facility's radiation protection program was under the guidance of individual safety officers. This made each program unique to that facility.

Summary of records:

In 1943, the Oak Ridge facilities were under the direction of the University of Chicago working on the atomic pile project and production of plutonium. In 1948, the facility changed to one of research and applied technology. Personnel working in the laboratories had the potential to be exposed to external radiation, plutonium, uranium dust, and a variety of metals and chemicals[4]. In general, monitoring for radiation exposure was only provided to those individuals likely to be exposed. Those workers or other staff that were not likely to come in contact with radioactive hazards were not monitored. Occasionally, an area monitor was used to ensure that these work areas were indeed areas of low exposure potential[5].

Table I is a summary of each facility's external personnel dosimetry program. Each facility monitored workers on a quarterly basis, using film, TLD or both. During the early years, film was the dosimeter of choice. Later, TLD's became more frequently used. Reporting styles also differ from facility to facility and from year to year. X-10's early reports recorded simply skin and whole body doses from film badge readings. In later years, when the dosimeters changed to TLD's, the records show reporting of beta exposure, gamma, skin, penetrating, and neutron dose. The records from Y-12 show the actual readings from each filter in the film badge holder.

Internal dosimetry records are as varied as the external dosimetry records. Table 2 summarizes these records. X-10 has internal dosimetry results from urinalysis and whole body counting of nuclides listed by EDP code with units of disintegrations per minute. K-25 and Y- 12 both have limited reports of urinalyses and whole body counts,

The Feed Materials Production Center in Fernald, Ohio processed and concentrated uranium compounds recycled from other stages of nuclear weapons production. The exteral dosimetry data from this facility begins in 1950 and is complete through 1989. Beta and gamma dose, and cumulative gamma doses are reported. Internal dosimetry records have results from urinalysis screening for uranium in units of mg/L.

The U.S. Department of Energy's Hanford site was established in southeastem Washington during the 1940's to produce plutonium for nuclear weapons. Records from this site contain exposure records from both internal and external radiation. External radiation dosimetry is reported as penetrating dose, neutron dose, tritium dose, whole body dose, x-ray and extremity dose. Internal exposures are recorded from whole body bioassays of uranium and plutonium.

The Pantex. plant in Texas originally loaded conventional ammunition and bombs. During the 1950's, it was rehabilitated to assemble nuclear weapons using the plutonium from the Hanford plant. External exposures are recorded as whole body shallow, gamma, neutron, tritium and whole body total. Internal exposures from ^{238}U, $^{228/232}Th$, and ^{239}Pu are resultant from whole body counts.

The Mound plant has the least explicit records of all the sites. The external dosimetry records show annual exposure data in the form of neutron, tritium, and whole body exposures. Internal exposure results from urine bioassays are reported in counts per minute. Internal exposure results from whole body measurements are recorded as body burdens.

Summary:

From the summary tables, it is very apparent that the data contained in the exposure records from these facilities vary greatly. The goal of cross-comparison of all facilities is to combine the exposure data in order to increase the number of members in the cohort. Several assumptions need to be made in order to combine external exposures. When considering surface exposure, such as β and skin dose, it can be assumed that these terms are equivalent to the dose to the skin. It can also be assumed that the γ and penetrating dose are equivalent and can be combined. For neutron exposures, the quality factor used to compute absorbed dose must be known. Since the quality factor for x, β and γ is equal to one, it is not necessary to take into consideration.

When considering internal exposures, the situation becomes more complicated. The results recorded by each facility differ by isotope measured, method of measurement and reporting units. For example, if results from urinalyses are recorded as counts per minute (cpm), then the efficiency of the counting instrument must be known in order to calculate the disintegrations per minute (dpm) and μCi of intake. Also, the metabolic models used to calculate the analysis results must be known for inter-facility comparison. Certain isotopes may need to be assessed and compiled separately in order to ascertain doses delivered to specific organs, especially those that are radiation sensitive.

External Dosimetry Summary

Oak Ridge:			
X-10			Badge Type
	1943-1985	skin (mRem)	Film
		wbody(mRem)	
	1986-1988	skin	TLD
		pen	
	1989-1991	skin	TLD
		pen	
		neutron	
K-25			
	1945-1988	β (mRad)	Film
		γ (mRad)	
		skin (mRem)	TLD
		pen (mRem)	
	1986-1991	skin	TLD
		pen	
		neutron	
Y-12			
	1950-1980	β (mRad)	Film
		γ (mRad)	
		skin (mRem)	TLD
		pen (mRem)	
		neutron	
	1981-1988	β	TLD
		γ	
		skin	
		pen	
	1989-1991	skin	TLD
		pen	
		neutron	
Fernald			
	1950-1989	β,γ	
		γ (cumulative)	
Pantex		wb shallow (mRem)	
		wb γ	
		wb neutron	
		wb total	
		tritium	
Hanford		pen	
		neutron	
		tritium	
		total whole body	
		x-ray	
		extremity	

Internal Dosimetry Summary

	Urinalysis	Whole Body
Oak Ridge:		
X-10 1979-1988	dpm mg/L	lung burden, nCi
K-25 1948-1991	unknown units	lung burdens
Y-12 1950-1991	dpm mg/L	lung burden
Fernald	mg/L	
Pantex		^{238}U, $^{228/232}Th$, ^{239}Pu
Hanford		U, Pu
Mound	cpm	body burden

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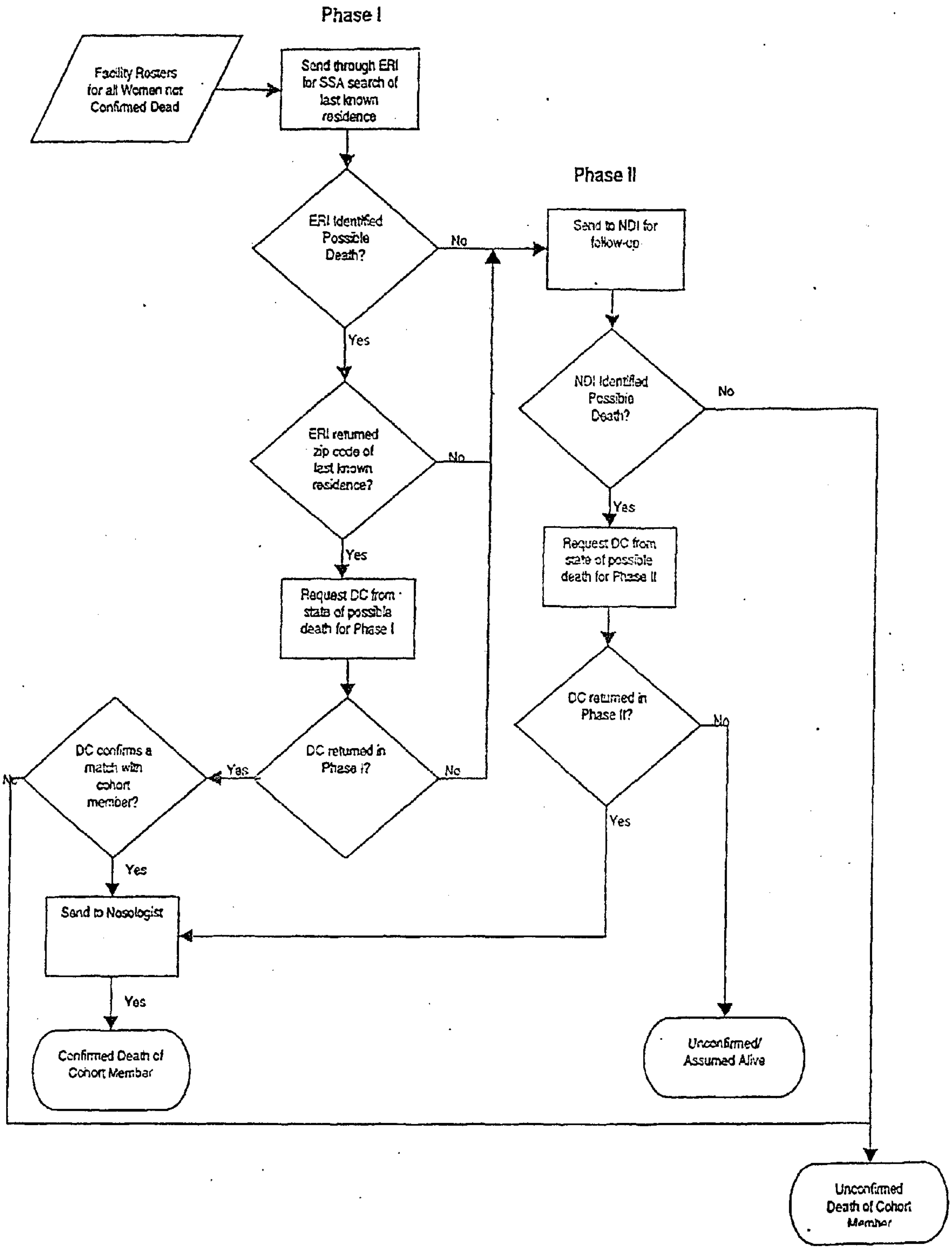
Two-Phase Protocol for Updating Vital Status Among Women



PROPORTION OF EMPLOYEES EXPOSED TO NON-RADIATION HAZARDS
ACCORDING TO FIRST AND LAST JOB CLASSES BY STUDY FACILITY

Facility	% Exposed (Non-clerical) to all Hazardous Chemicals		% Exposed (Non-clerical) to Carcinogenic Chemicals		% Questionable/ Missing Data*	
	First Job Class	Last Job Class	First Job Class	Last Job Class	First Job Class	Last Job Class
Oak Ridge Y12	64.1	59.7	13.2	37.7	4.4	7.1
Oak Ridge K25	46.8	45.7	19.6	22.8	1.6	1.6
Linde	38.2	36.9	24.5	21.6	7.5	7.5
Rocky Flats	31.0	33.8	23.3	29.2	1.1	4.0
Oak Ridge X10	29.6	31.1	23.6	27.0	4.9	5.5
Hanford	28.5	28.5	18.1	19.7	4.8	4.5
Fernald	26.5	27.1	14.9	15.6	15.7	15.9
Mound	25.8	26.6	20.6	21.2	33.2	33.2
Los Alamos	17.6	18.9	13.7	14.3	10.4	15.7
Savannah River	15.8	16.8	15.2	16.1	67.5	66.7
Zia	15.8	16.7	15.2	16.1	67.5	66.8
Pantex	5.6	5.4	2.4	2.8	46.7	46.8

*Data was either missing or ambiguous job title in the job history files obtained therefore no job class assigned.

Job exposure matrices (JEMs) are a *f*(facility, job class)

- Facility variation → variation in background chemical classes because of different processes occurring at the different DOE sites.
- Job class will be the primary controller of exposures although one would expect some variation from facility to facility as well as with time for each facility.
- Job classes are either categorized as: clerical (no exposure) or as non-clerical (exposure).

However, the type of exposure will vary with the non-clerical job classes.

The table above lists details based on first and last job classes about each of the sites including
(1) % of workers exposed (non-clerical) to all hazardous chemicals
(2) % of workers exposed (non-clerical) to carcinogenic chemicals
(3) % of workers missing job histories

JOB EXPOSURE MATRIX

General Protocol For Job Exposure Matrix (JEM) Development

1. From chemical questionnaires returned from DOE facilities and onsite interviews:
   Derive a list of chemicals and other exposures (**Table 1**) representing background exposures at each DOE facility.
2. From job titles:
   Classify job titles into categories (Table 2) according to potential exposures to chemical or physical agents.
3. For potentially exposed categories:
   A list is derived of chemical and other exposures "generated" by or attributable to a particular job title. This list is also based on an assessment by the project's industrial hygienist, and on guidance available in Key et al. (1997).
4. The exposures in **Table 1** are essentially "background" chemical and physical exposures for all employees at the facility in question. The more important exposures are those "generated" or attributable to a particular job. The reason these exposures are more important is that the workers at a particular job site (Group A) are closer to these generated exposures, i.e., in a particular department or building, rather than for those individuals in another building, further away from the process (processes) generating the exposures. For the latter workers (Group B) the exposures are "background" exposures while for Group A workers the exposures are generated. (See below for further discussion.)
5. Each job category/class leads to both generated and background exposures with, as noted above, the generated exposures being more important. The sum of both generated and background exposures related to a job category at a particular DOE study site is the job-exposure matrix for the specific job category/DOE facility.
6. The Job-Exposure Matrix (JEM) in item 5 above for each job category/DOE facility was distributed to an appropriate contact person(s) (generally one or more industrial hygienists) for comments on the validity of the JEM's and for suggestions of appropriate modifications/changes.

Issues

There are significant limitations to the method utilized for generating these qualitative job-exposure matrices for all facilities. Because of the unavailability of across-the-board industrial hygiene data or even linkages of employees with buildings for which environmental monitoring data is available, it is necessary to rely on the job titles as surrogates for exposures. The investigators are well aware of the limitations and vagueness of this approach. Nevertheless, this is the most feasible approach that the available data permits us.

As noted under the general protocol, each job can be connected to a series of generated exposure classes. Furthermore, each facility has a "background" list of exposures. Consequently, the facility and the job title both influence the likely exposure that the individual holding that job title at a particular facility would have. It may be expected that a job category at each DOE facility might be somewhat different and therefore, comparison of the job title at two different facilities might lead to an expectation that while the spectra of exposures would be fairly similar, nevertheless some differences would emerge due to different job practices or, in fact, different job descriptions for the same job category. Furthermore, even at the same facility differences in exposures would occur through the years due to changes in processes at the facility or changes in job practices. However, in general, it is not an unreasonable assumption that the exposures for a particular job in a given facility can be represented by (1) the exposures "generated" or attributed to the particular job category plus, (2) the exposures in the facility (background). Such exposures assigned to a specific category at a specific DOE facility then represent the qualitative Job Exposure Matrix (JEM) for that particular job category.

Examples:

Two examples of this process are described below:

A. Machinist at Rocky Flats:

Exposures = (Heavy/radioactive metals + welding/soldering fumes + PAH's + solvents + noise) generated + (acidic gases + asbestos + heavy/radioactive metals + beryllium + solvents) background

B. Artist/draftsman at LANL:

Exposures = (solvents/paints) generated + (asbestos + silica + acidic gases + heavy/radioactive metals + Beryllium + solvents + RDX + TNT + noise) background

A sample chemical questionnaire from Fernald is described in Appendix . An example (Fernald) of JEM's developed for the sites is described in Appendix XIII.

Database Development: Protocol for Employee Job Class/Exposure Category Assignment

Assignment of Job Class/Exposure Category

A. Unique Job Titles

All job titles from employee job files were extracted and collapsed for the available study sites Fernald, Hanford, K25, LANL, Linde, Mound, SRS, X10, Y12, Zia **to serve as a representative sample for assignment** a job class/exposure category across all sites. Job history data for Pantex had to be entered from job cards and for Rocky Flats data was requested from the University at Colorado, both of which were incorporated at a later time. In the collapsed Excel file (allsitesjob or "Job Class Crosswalk file"), job classes were manually entered as the variable "area". This file serves as a master job file for all sites. The area variable represents the job classes listed below:

AREA	JOB CLASS
"Clerical"	Clerical
"Mach"	Machinist/Mechanics
"Chem"	Chemists/Biologist
"Nuclear"	Physicist/Nuclear/X-Ray/engineers/Industrial Hygienist
"Constr"	Construction/Carpentry/Artisans
"Elect"	Electricians
"Kitchen"	Kitchen
"Sanitation"	Sanitation/Laundry
"Art"	Artists/Draftsmen/Photography
"Medical"	Medical/Doctors/Nurses
"Security"	Police/Guards/Security
"Stud"	Students/Coop
"Train"	Trainees/Inspectors
"Trans"	Transportation
"Tech"	Technical/Operators/Maintenance/Technicians
"Unk"	Unknowns

B. Facility Report
A report was created by study site listing job titles assigned to their job classes and possible exposures, both generated and background. The facility report and job exposure matrix documentation was sent to the facilities for their feedback on the job class/exposure category assignment.

C. Facility Feedback
Feedback received was incorporated into the collapsed file (allsitesjob) and reports. This is the file that was used to assign the job class/exposure category to the individuals in the job history files.

II. Application of Job Class Assignment to Job Files:

A. Job title (Crude Approach)
Data were sorted by "job title" within the file that contains all employees and their respective job titles/dates. Job class/exposure category (Generated job exposures + background exposures) was assigned solely on the basis of job title by an Industrial Hygienist. A list of the job class/exposure categories containing the job titles in each class was sent to the facilities for feedback and has been incorporated in this assignment of job class/exposure category where appropriate.

B. Employee Job History
Following Part A, data were sorted by employee ID numbers and job dates. Where there was an ambiguous job title with regard to job class/job

exposure category, i.e., exposed or unexposed, the remainder of the employee job history for the person was examined. Then, on the basis of the remainder of the job titles the job class/exposure category could be delineated and the ambiguous job titles, e.g., trainee or helper, could be assigned to the most recent job class/exposure category. If a job class/exposure category in this step was changed due to the employee job history, then it was flagged in the database (chngflg=1).

C. Quality Control of Job Class/Exposure Category Assignment
The study team at UTMB met and discussed the problems/issues with the data and job class/exposure category assigning protocol (See below for Fernald). All first and last job classes were printed out where job class changed for the review of the job class assignment. This step warranted additional review of the employee histories due to frequent "XXXXXXX" entries as last job title or a job class of "unknown". It was decided to replace the unknown job class with the most recent job class prior to "unknown" or "XXXXXXX" entries. These changes of job class/exposure category were also flagged in the database (chngflg=1).

D. Frequencies of Job Class
Using a SAS algorithm, the employee job files were read in (id, facility, job date, job title, job code, area, chngflag) and frequencies were determined. For Fernald, there were 90 job classes changed based on the criteria listed above. When we evaluated the first and last job classes for Fernald workers (excluding unknown class), 95.6% remained in the same job class.

<u>Problems And Points of Information Regarding Fernald's Job Data Base</u>

The following are issues pertaining to the JEM constructed for Fernald employees: 1) The title trainee occurred frequently but *only* once for an employee ID number or trainee occurred multiple times for the same employee ID number and did not contain additional job titles for assignment of job class/exposure category. In both of these instances it was impossible to assign a job class/exposure category without additional job titles. 2) Unknown job titles occurred frequently when facility job titles were listed as "XXXXXXX". In most cases these had an associated job code. We have been unsuccessful in obtaining the files defining the job codes/job titles. Correspondence Phil Wallace (ORISE) indicated the "XXXXXXX" were added to the data by him to replace missing values. In cases where additional job history information was present for the employee, the "most recent" job class replaced the unknown job class. 3) An interesting trend in job titles was observed: Laborer (technical) tended to be followed by Chemical Operator (chemical). 4) The job title "Stamper" is usually contained in a technical employee job history, not as part of a clerical history as was first assigned by us. Therefore, a stamper is currently classified as a non-clerical, technical position with generated exposures rather than as a clerical job with no exposures. 5) The job title "Inspector" is usually contained in a technical employee history. Whereas we first classified inspectors as unknown with respect to potential exposures, we changed this job title to a non-clerical, technical position with generated exposures. 6) Instructional Technology was first classified as a technical job. We redefined instructional technology as a clerical position without generated exposures. 7) Technical Assistants were assigned to either a clerical or non-clerical area based on the employee's job history.

Carcinogenicity of Various Job Class Exposures

In an attempt to further define the influence of Job Title/Job Class in depicting non-ionizing radiation exposures, we formulated a paradigm (Table II) which lists the "generated" exposures associated with different job classes. This paradigm should be applicable across all study facilities with the caveat that some misclassification may occur because of duties and processes that are facility specific. An industrial hygienist on the basis of duties believed to be associated with the different job classes, as noted above, defined the generated exposures. Consequently, the jobs with high carcinogenic potential with regard to "generated" exposures are: machinists/mechanics (by virtue of metal dusts, welding fumes, PAH's and solvents); chemists/biologists (by virtue of metals, solvents, other chemicals including acidic and other irritating gases which may be cancer promoters); physicists/nuclear/x-ray technicians/engineers (by virtue of isotopes, beryllium and uranium/plutonium); construction/carpentry/artisans(exposures to asbestos, silica, wood dust, solvents, welding fumes, metals and PAH's); electricians (exposures to asbestos, solvents and metals); transportation workers (gasoline/diesel fumes, asbestos, oils and greases (PAH's); artists/draftsmen/photographers (solvents and paints); technical operators/maintenance/technicians (exposure to greases and oils (PAH's), solvents, metal and wood dusts, welding fumes, and asbestos. Lesser exposures to carcinogens apply to kitchen workers, sanitation/laundry workers, trainee/inspectors and medical/doctors/nurses. Finally, those with either questionable or minimal exposures include police/guards/security and students/co-op workers.

Our definitions of high exposure job classes are similar to those described by Monson (Monson, 1998) and by others. Thus, artists, bakers, chemists and chemical workers, solvent or paint-exposed workers, lead workers, non-ionizing radiation-exposed workers, plumbers, truck drivers, welders, and woodworkers and printing workers have all been reported to have an excess risk for cancer (Monson, 1990, Table 7, 3, pp.155-6). While these job classes are not all precisely the same ones that we have identified, there is enough overlap to indicate that carcinogenic exposures are at least possible for the job classes we have noted.

Thus, in terms of investigating the effects of job classes on the non-ionizing radiation generated exposures, we could perform comparisons between high carcinogenic exposure potential job classes and low/minimal or questionable carcinogenic potential with regard to mortality from all causes and from radiosensitive cancers in specific facilities as well as across facilities.

Further Discussion of JEM Methodology

Job-exposure matrices (JEMs) have been developed in this study for female nuclear workers employed during the time period, from opening of each facility (during the 1940's) through the end of study date (December 31, 1994), when available. These JEMs have been based on qualitative information derived from chemical questionnaires, on-site inspections, some historical records and, most importantly, job titles for the individual female nuclear workers.

Limitations. Although data regarding non-ionizing or physico-chemical exposures are scarce, we have developed an approach that possesses considerable validity. Nevertheless, this qualitative approach suffers from a number of limitations, which are discussed below.

Lack of exposure data and lack of computerized data at most sites. Most, of the sites lack monitoring data, either plant-wise or for individuals, regarding physical and chemical agent exposures other than radiation exposures. Previously, and especially in early war and post WWII years, little attention was paid to nonradiation exposures. The main focus of health protection efforts was on ionizing radiation exposures which were routinely monitored by personal dosimeters for external radiation) or by bioassays for internal radiation exposures. While there are some limitations regarding radiation exposure data, which will be discussed elsewhere, the monitoring of physico-chemical exposures is poor by comparison. The approach, as noted above under Methods, for dealing with non-ionizing radiation exposures has identified background physico-chemical exposures at each of the facilities included in this report.

This tabulation of physico-chemical exposures, based on site visits and/or interviews and/or study of processes at the facilities, was put in the form of chemical classes and some physical exposures and classified as a "chemical questionnaire" that consisted of probable background exposures at the particular DOE facility to which all workers would be subjected to, to varying degrees. The chemical questionnaires were sent to contact persons at the DOE facilities, usually industrial hygienists for, validation. Responses were not received from all facilities. For those that did respond, replies varied in completeness from quite complete to negligible.

The basic point of this methodology is that exposures to the individual workers consist of (a) background exposures and (b) "generated exposures", which are exposures believed, on the basis of job characterization and industrial hygiene knowledge (of one of the authors, NMT), to be associated with the identified job titles.

Ambiguities in Job Titles

Because of the important role of job title in assessing exposure, ambiguities with regard to the titles, i.e., lack of understanding of what the title means or lack of preciseness of what duties/tasks the workers had, would lead to ambiguity or lack of precision/accuracy regarding the assessment of exposures. Detailed and accurate job descriptions would certainly minimize such ambiguity. As far as we are aware, few facilities, with the exception of Fernald, have any sort of detailed job description.

Another ambiguity relates to the list of successive job titles for individual workers as a function of time. Clearly, if each of the job titles is in the same job class, there is no ambiguity. However, in some instances, job titles were in several different job classes, some of which were "exposed" (i.e., generated exposures) and some of which were "unexposed" (i.e., clerical, etc., not generating exposures). In these cases we consider the person to be exposed if the preponderance of job titles were in "exposed" job classes and vice versa.

Finally, a further ambiguity resides in the fact that some job titles are completely generic, e.g., trainee or supervisor etc. In at least some of these instances, the person can be categorized as "exposed" or "unexposed" by looking at a previous job title, which could be machinist or laboratory worker, making that person "exposed" or typist, putting her in an "unexposed" category.

Lack of Linkage between Employee and Department (Building or Process)

If employees could be linked to a department/building or process during their employment years at a DOE facility, such linkage would lead to a knowledge of the physical and chemical exposures assuming that such processes were isolated geographically. Unfortunately, there appears to be no easily identified linkage at any of the DOE facilities we have investigated.. Clearly, such linkage is really essential to improve the validity of relating physical and chemical exposures to mortality.

Significant fraction of Female Nuclear Workers are unexposed or slightly exposed.

While the percentage of clerical, kitchen, administrative and other "unexposed" workers varies from facility to facility, in general the fraction of unexposed: exposed + unexposed is fairly high, about 2/3. Thus, about 1/3 tend to be "exposed", i.e., have generated exposures. The others would only have background exposures. As a consequence, it is obvious that the number of nuclear workers exposed to non-ionizing radiation exposures is considerably less than the total number of female nuclear workers.

Congruence between Ionizing Radiation and Physico-chemical Exposures

While we have not yet performed a detailed analysis of a correlation between radiation and chemical exposures, it seems likely that there should be congruence. Thus, clerical workers are not likely to be monitored for radiation exposure. Therefore, although some facilities monitor clerical employees for radiation exposures, these workers are considered unlikely to be exposed to physical and chemical hazards that are significantly elevated above background levels.

Conclusions Regarding Development Of JEM'S

(1) JEMs have been developed for various DOE facilities based on qualitative techniques in which "chemical questionnaires" indicate background physico-chemical exposures

at various sites and job titles imply certain physico-chemical or non-radiation exposures. These JEMS can then be used to approximate a non-ionizing radiation exposure assessment for each individual female nuclear worker.

(2) Numerous limitations of this methodology, which have been described above, exist. These limitations must be taken into account when interpreting the results of this study.

SITE: FERNALD **Job Class: Clerical**

Background Exposures:

Fibres	Y	**Fumes/ dust**	Y
Acidic Gases	Y	**PAH's**	Y
Heavy/ Radioactive Metals (Primarily Thorium & Plutonium)	Y	**Wood dust**	Y
		Metal dust/ fumes	Y
Solvents (TBP, xylenes, & CCl4) / Paints	Y	**Other irritating gases**	Y
Noise	Y	**Electricity**	Y
PCBs	Y	**Heat**	Y
		Gases/ Diesel/ Emissions	Y
		Germicides	Y

Generated Exposures:

Unexposed

Related Job Titles:

ACCOUNTANT I,II,CLERK,ASST I,I
ADMINISTRATIVE
ANALY LAB QLTY ASSU SUPV
BUYER,ASST. BUYER
CLERICAL TYPIST
CLERK I YOP,TRAINEE
CLERK, TRAINEE, FILE,REC,INV,C
COMPUTER OPERATOR II
DATA ENTRY OPERATOR
DATA REPORTING COORD
DISPATCHER
EDITOR, ASST. ED, ASST TECH ED
EMPLOYMENT INTERVIEWER
FORMS ANALYST
KEY PUNCH OPERATOR
LIBRARIAN, A, B, C, ASST.
MANAGE INFO COORDINATOR
NUCLR MTL RPT ACCT SUPT
OFFICE ASSISTANT
PAYROLL CLERK I, II, SENIOR
PERSONNEL CLERK,SR
PLANNER ESTIMATOR
PROD RECORDS SPECIALIST
PROGRAMMER,I,II,ANALYST,SR.ANA
PROJECT COORDINATOR
RECEPTIONIST,I, II,III
RECORDS MANAGER
SCHEDULER
SECRETARY, SENIOR, STENO
STAMPER
STATISTICIAN,STATISTICAL ASST.
STENOGRAPHER, STENO POOL
STOREKEEPER
STORES WAREHOUSE ATTN
SWITCHBOARD OPERATOR,A,B,C
TABULATING MACH OPER I
WAGE AND SALARY ADM

SITE: FERNALD **Job Class: Machinists**

Background Exposures:

Fibres	Y	**Fumes/ dust**	Y
Acidic Gases	Y	**PAH's**	Y
Heavy/ Radioactive Metals (Primarily Thorium & Plutonium)	Y	**Wood dust**	Y
		Metal dust/ fumes	Y
Solvents (TBP, xylenes, & CCl4) / Paints	Y	**Other irritating gases**	Y
Noise	Y	**Electricity**	Y
PCBs	Y	**Heat**	Y
		Gases/ Diesel/ Emissions	Y
		Germicides	Y

Generated Exposures:

Metal Dusts	Y
Welding and soldering fumes	Y
PAH's	Y
Solvents	Y
Noise	Y

Related Job Titles:

MACHINE TOOL OPERATOR
MECH VAC SERV

SITE: FERNALD **Job Class: Chemists**

Background Exposures:

Fibres	Y	**Fumes/ dust**	Y
Acidic Gases	Y	**PAH's**	Y
Heavy/ Radioactive Metals (Primarily Thorium & Plutonium)	Y	**Wood dust**	Y
		Metal dust/ fumes	Y
Solvents (TBP, xylenes, & CCl4) / Paints	Y	**Other irritating gases**	Y
Noise	Y	**Electricity**	Y
PCBs	Y	**Heat**	Y
		Gases/ Diesel/ Emissions	Y
		Germicides	Y

Generated Exposures:

Metals	Y
Solvents	Y
Other Chemicals:	
Acidic Gases	Y
Irritating Gases	Y

Related Job Titles:

ANALYST
CHEMICAL OPERATOR, HELPER
CHEMIST, ASST. CHEMIST
SUPERVISOR CHEM METALS

SITE: FERNALD **Job Class: Physicists \ Nuclear \ X-Ray \ Engineers**

Background Exposures:

Fibres	Y	**Fumes/ dust**	Y
Acidic Gases	Y	**PAH's**	Y
Heavy/ Radioactive Metals (Primarily Thorium & Plutonium)	Y	**Wood dust**	Y
		Metal dust/ fumes	Y
Solvents (TBP, xylenes, & CCl4) / Paints	Y	**Other irritating gases**	Y
Noise	Y	**Electricity**	Y
PCBs	Y	**Heat**	Y
		Gases/ Diesel/ Emissions	Y
		Germicides	Y

Generated Exposures:

Uranium/Plutonium	Y
Ionizing Radiation	Y

Related Job Titles:

XRAY TECHNICIAN B
CHIEF OF NUCLEAR SAFETY
ENGINEER I,II,SENIOR
ENGINEERING SPECIALIST

SITE: FERNALD

Job Class: Construction \ Carpentry \ Artisans

Background Exposures:

Fibres	Y	Fumes/ dust	Y
Acidic Gases	Y	PAH's	Y
Heavy/ Radioactive Metals (Primarily Thorium & Plutonium)	Y	Wood dust	Y
		Metal dust/ fumes	Y
Solvents (TBP, xylenes, & CCl4) / Paints	Y	Other irritating gases	Y
Noise	Y	Electricity	Y
PCBs	Y	Heat	Y
		Gases/ Diesel/ Emissions	Y
		Germicides	Y

Generated Exposures:

Asbestos	Y
Silica	Y
Wood dust	Y
Solvents	Y
Metals	Y
Noise	Y
PAH's	Y
Welding & Soldering fumes	Y

Related Job Titles:

SITE: FERNALD **Job Class: Electrical**

Background Exposures (Very Limited):

Fibres	Y	**Fumes/ dust**	Y
Acidic Gases	Y	**PAH's**	Y
Heavy/ Radioactive Metals (Primarily Thorium & Plutonium)	Y	**Wood dust**	Y
		Metal dust/ fumes	Y
Solvents (TBP, xylenes, & CCl4) / Paints	Y	**Other irritating gases**	Y
Noise	Y	**Electricity**	Y
PCBs	Y	**Heat**	Y
		Gases/ Diesel/ Emissions	Y
		Germicides	Y

Generated Exposures:

Electrical	Y
Noise	Y
Asbestos	Y
Solvents	Y
Metals	Y
Ionizing Radiologic Material (Primarily Uranium/Thorium)	

Related Job Titles:

SITE: FERNALD **Job Class: Kitchen**

Background Exposures:

Fibres	Y	**Fumes/ dust**	Y
Acidic Gases	Y	**PAH's**	Y
Heavy/ Radioactive Metals (Primarily Thorium & Plutonium)	Y	**Wood dust**	Y
		Metal dust/ fumes	Y
Solvents (TBP, xylenes, & CCl4) / Paints	Y	**Other irritating gases**	Y
Noise	Y	**Electricity**	Y
PCBs	Y	**Heat**	Y
		Gases/ Diesel/ Emissions	Y
		Germicides	Y

Generated Exposures:

PAH's	Y
Cleaners	Y
Acrolein	Y
Other irritating gases	Y
Heat	Y

Related Job Titles:

CAFETERIA HELP, MANAGER, SUPVERVISOR
CASHIER
CHECKER
COOK, ASST.COOK, BAKER
COUNTER HELP I, II

SITE: FERNALD **Job Class: Sanitation \ Laundry**

Background Exposures:

Fibres	Y	**Fumes/ dust**	Y
Acidic Gases	Y	**PAH's**	Y
Heavy/ Radioactive Metals (Primarily Thorium & Plutonium)	Y	**Wood dust**	Y
		Metal dust/ fumes	Y
Solvents (TBP, xylenes, & CCl4) / Paints	Y	**Other irritating gases**	Y
Noise	Y	**Electricity**	Y
PCBs	Y	**Heat**	Y
		Gases/ Diesel/ Emissions	Y
		Germicides	Y

Generated Exposures:

Acidic Gases (Cl2)	Y
Detergents	Y
PAH's	Y

Related Job Titles:

MAID
PORTER

SITE: FERNALD **Job Class: Transportation**

Background Exposures:

Fibres	Y	**Fumes/ dust**	Y
Acidic Gases	Y	**PAH's**	Y
Heavy/ Radioactive Metals (Primarily Thorium & Plutonium)	Y	**Wood dust**	Y
		Metal dust/ fumes	Y
Solvents (TBP, xylenes, & CCl4) / Paints	Y	**Other irritating gases**	Y
Noise	Y	**Electricity**	Y
PCBs	Y	**Heat**	Y
		Gases/ Diesel/ Emissions	Y
		Germicides	Y

Generated Exposures:

Gasoline fumes	Y
Diesel fumes	Y
Asbestos	Y
Oils and Greases (PAH's)	Y

Related Job Titles:

INDUSTRIAL TRUCK OPERATOR
CONTRACTOR TRUCK DIRIVER
FORK LIFT OPERATOR

SITE: FERNALD **Job Class: Artists \ Draftsmen \ Photography**

Background Exposures:

Fibres	Y	Fumes/ dust	Y
Acidic Gases	Y	PAH's	Y
Heavy/ Radioactive Metals (Primarily Thorium & Plutonium)	Y	Wood dust	Y
Solvents (TBP, xylenes, & CCl4) / Paints	Y	Metal dust/ fumes	Y
Noise	Y	Other irritating gases	Y
PCBs	Y	Electricity	Y
		Heat	Y
		Gases/ Diesel/ Emissions	Y
		Germicides	Y

Generated Exposures:

Solvents	Y
Paints	Y
Photographic Chemical	Y

Related Job Titles:

DRAFTING TECHNICIAN, SENIOR DRAFTSMAN
PHOTOGRAPHIC TECHNICIAN

SITE: FERNALD

Job Class: Technical operators \ Maintenance \ Technicians

Background Exposures:

Fibres	Y	**Fumes/ dust**	Y
Acidic Gases	Y	**PAH's**	Y
Heavy/ Radioactive Metals (Primarily Thorium & Plutonium)	Y	**Wood dust**	Y
		Metal dust/ fumes	Y
Solvents (TBP, xylenes, & CCl4) / Paints	Y	**Other irritating gases**	Y
Noise	Y	**Electricity**	Y
PCBs	Y	**Heat**	Y
		Gases/ Diesel/ Emissions	Y
		Germicides	Y

Generated Exposures:

Oils & Greases (PAH's)	Y
Solvents	Y
Metal dusts	Y
Wood dusts	Y
Welding & Soldering fumes	Y
Noise	Y

Related Job Titles:

ANALYTICAL LAB TECH,B,C,D
BOILER OPERATOR
CLINICAL LAB TECH A, B, C,SUPERVISOR
CONTROL OPER
LAB TECHNICIAN
PRODUCTION SPECIALIST
PROD CONTROL SUPV
PRODUCTION SUPERVISOR
PUMP OPERATOR
TECHNICAL ASSISTANT,A,B,
TECHNICIAN A, B, C, D
TECHNICIAN ASST
TECHNICIAN I, II, III
TECHNOLOGIST,I, II, III, B,C
UTILITY WORKER

SITE: FERNALD

Job Class: Medical \ Doctors \ Nurses

Background Exposures:

Fibres			
Acidic Gases	Y	Fumes/ dust	Y
Heavy/ Radioactive Metals	Y	PAH's	Y
(Primarily Thorium & Plutonium)	Y	Wood dust	Y
Solvents (TBP, xylenes, & CCl4) / Paints		Metal dust/ fumes	Y
Noise	Y	Other irritating gases	Y
PCBs	Y	Electricity	Y
	Y	Heat	Y
		Gases/ Diesel/ Emissions	Y
		Germicides	Y

Generated Exposures:

Germicides	
	Y

Related Job Titles:

NURSE, INDUSTRIAL, SUPERVISOR, SENIOR
EMT

SITE: FERNALD **Job Class: Police \ Guards \ Security**

Background Exposures:

Fibres			
Acidic Gases	Y	Fumes/ dust	Y
Heavy/ Radioactive Metals	Y	PAH's	Y
(Primarily Thorium & Plutonium)	Y	Wood dust	Y
Solvents (TBP, xylenes, & CCl4) / Paints		Metal dust/ fumes	Y
Noise	Y	Other irritating gases	Y
PCBs	Y	Electricity	Y
	Y	Heat	Y
		Gases/ Diesel/ Emissions	Y
		Germicides	Y

Generated Exposures:

Unexposed

Related Job Titles:

POLICE SERGEANT
SECURITY POLICE OFFICER

SITE: FERNALD **Job Class: Trainees \ Inspectors**

Background Exposures:

Fibres			
Acidic Gases	Y	**Fumes/ dust**	Y
Heavy/ Radioactive Metals	Y	**PAH's**	Y
(Primarily Thorium & Plutonium)	Y	**Wood dust**	Y
Solvents (TBP, xylenes, & CCl4) / Paints		**Metal dust/ fumes**	Y
Noise	Y	**Other irritating gases**	Y
PCBs	Y	**Electricity**	Y
	Y	**Heat**	Y
		Gases/ Diesel/ Emissions	Y
		Germicides	Y

Generated Exposures:

Questionable ??

Related Jc INSPECTOR
TRAINEE
TRAINEE YOP

SITE: FERNALD **Job Class: Students \ Co-op**

Background Exposures:

Fibres			
Acidic Gases	Y	**Fumes/ dust**	Y
Heavy/ Radioactive Metals	Y	**PAH's**	Y
(Primarily Thorium & Plutonium)	Y	**Wood dust**	Y
Solvents (TBP, xylenes, & CCl4) / Paints		**Metal dust/ fumes**	Y
Noise	Y	**Other irritating gases**	Y
PCBs	Y	**Electricity**	Y
	Y	**Heat**	Y
		Gases/ Diesel/ Emissions	Y
		Germicides	Y

Generated Exposures:

Questionable ??

Related Job Titles:

DEPT HEAD TECH
GENERAL HELPER
LABORER
PORTER
WAREHOUSE SUPV

FERNALD (Prototype*): Job Exposure Matrix Development

Task	Scope	Status
Chemical Questionnaire Sent to I.H. at Site	Purpose: The questionnaire identified chemical processes, buildings or areas of chemical process, and time frame of the respective process. Response: Respondent had no detailed knowledge of processes for periods before 1976-1995, but responded that the report he provided may have taken place before this time frame. His report had listed all processes by a plant number(s) or building number(s), chemicals used, number of sample, and first and last dates following 1975.	Returned Complete
Chemical Summary	Purpose: From the chemical questionnaire, a summary provided a list of chemicals for the facility which were grouped into chemical categories used across all facilities. Response: A summary was developed by the Industrial Hygienist for the development of chemical classes. The chemical classes (background exposures) for this facility were identified as (1) fibers, (2) acidic gases, (3) heavy/radioactive metals (primarily Thorium & Plutonium), (4) solvents (TBP, xylenes, & CCl_4)/paints, (5) noise, (6) PCBs, (7) Fumes/dust, (8) PAHs, (9) wood dust, (10) metal dust/ fumes, (11) other irritating gases, (12) electricity, (13) gases/diesel emissions, and (14) germicides.	Complete
Electronic Job History Data Requested	Purpose: Identified all job titles and their respective job dates for individual employees during the entire operation of the facility. Procedure: Job class data was manually entered in this file for all entries of job titles.	Received Complete
Job Class Assignment	Purpose: In managing the large amounts of job data, job titles were grouped into similar areas of work (job class) for the ease of comparisons across all facilities. All facilities available at this stage (Linde, Fernald, Mound, Hanford, X10, K25, Y12, SRS, LANL, Zia) were lumped into one file by unique job titles for assignment of job class by the Industrial Hygienist. This master job file served as a representative sample of job titles and their respective job classes for all facilities. Procedure: The job classes were manually entered into the electronic job history file for each employee's job title entry and or change during their employment. The job data was first sorted by job titles and job classes assigned based solely on the title. Next, job data was sorted by the employee's job history which ambiguous job titles was assigned a job class based on the most frequent job class or previous job class. The latter changes were flagged in the data. Also, data were reviewed for first and last job classes to identify the percent of employees that changed job classes. Stats: The breakdown of the generated/not generated exposures based on the assigned first and last job class categories were as follows: First Job Class (No Gen. Exp. 57.8%; Generated Exp. 26.5%; Quest. Exp. 15.7%) and Last Job Class (No Gen. Exp. 57.1%; Generated Exp. 27.1%; Quest. Exp. 15.9%). A small number of employees (N=49, 4.2%) that did not remain in the same class from first to last job class.	Complete
Problems/Issues with Job Class Assignment	Purpose: To identify limitations of the assignment of job classes based on these methods. Problems/Issues: The job history electronic file had "XXXXX"'s (14.1% of the entire file) for job title. A call was made to ORISE to follow-up on this problem, they identified that these occurrences were added by ORISE to hold places for blank job titles.	Complete
Assessment of Exposures for Different Job Class Sent to I.H. at Site	Purpose: Gathered feedback and an estimate of correctness of the job exposure matrix from the facility on the combined background and generated exposures with all related job titles that were thought to be in the respective job class listed. Response: Respondent suggested that the job class "Trainees\Students\Co-op\Inspectors" be split into "Student\Co-op" and "Trainees\Inspectors" due to the differing chemical exposures. The trainee\inspectors were thought to have some generated exposures, therefore we added that category to the exposure group. Other minor changes of job titles and chemicals were incorporated in the matrix based on their feedback.	Returned Complete
Analyses of Job Exposure Matrix	Approach: In SAS, a proportional hazard model (Cox Regression) was used for all twelve facilities combined, broken down by job classes generating exposures. The facility combined job classes analyzed for generated exposures were the chemists/biologists, kitchen, medical/doctors/nurses, physicist/nuclear/x-ray technicians/engineers, and sanitation/laundry job classes in proportional-hazards modeling, due to a lack of sample size and statistical power.	Complete

*Data from this site was the most complete and received in a timely manner therefore used as the forerunner to other sites.

MOUND: Job Exposure Matrix Development

Task	Scope	Status
Chemical Questionnaire Sent to I.H. at Site	Purpose: The questionnaire identified chemical processes, buildings or areas of chemical process, and time frame of the respective process. Response: Respondent reported that no industrial hygiene records available before 1975. His report had listed chemicals used, building of chemicals used, types of monitoring, and monitoring results after 1982 for females.	Returned Complete
Chemical Summary	Purpose: From the chemical questionnaire a summary provided a list of chemicals for the facility which were grouped into chemical categories used across all facilities. Response: A summary was developed by the Industrial Hygienist for the development of chemical classes. The chemical classes (background exposures) for this facility were identified as (1) fibers, (2) acidic gases, (3) heavy/radioactive metals, (4) solvents/paints, (5) other emissions (chromic acid/sodium dichromate, freon glutaraldehyde, helium, MOCA, phenol, potassium ferricyanide, sodium hydroxide), (6) fumes/dust, (7) PAHs-oils, greases, (8) metal dust/ fumes, (9) other irritating gases, (10) electricity, (11) heat, (12) gasoline/diesel/emissions, and (13) germicides.	Complete
Electronic Job History Data Requested	Purpose: Identified all job titles and their respective job dates for individual employees during the entire operation of the facility. Procedure: Job class data was manually entered in this file for all entries of job titles.	Received Complete
Job Class Assignment	Purpose: In managing the large amounts of job data, job titles were grouped into similar areas of work (job class) for the ease of comparisons across all facilities. All facilities available at this stage (Linde, Fernald, Mound, Hanford, X10, K25, Y12, SRS, LANL, Zia) were lumped into one file by unique job titles for assignment of job class by the Industrial Hygienist. This master job file served as a representative sample of job titles and their respective job classes for all facilities. Procedure: The job classes were manually entered into the electronic file for each employee's job title entry and or change during their employment. The job data was first sorted by job titles and job classes assigned based solely on the title. Next, job data was sorted by the employee's job history which ambiguous job titles was assigned a job class based on the most frequent job class or previous job class. The latter changes were flagged in the data. Also, data were reviewed for first and last job classes to identify the percent of employees that changed job classes. Stats: The breakdown of the generated/not generated exposures based on the assigned first and last job class categories were as follows: First Job Class (No Gen. Exp. 40.9%; Generated Exp. 25.8%; Quest. Exp. 33.2%) and Last Job Class (No Gen. Exp. 40.2%; Generated Exp. 26.6%; Quest. Exp. 33.2%). It was found that only 5.1 % of the employees changed classes from the first to the last job class.	Complete
Problems/Issues with Job Class Assignment	Purpose: To identify limitations of the assignment of job classes based on these methods. Problems/Issues: The electronic job history file had a large amount of unknowns (n=699, 14.0%) and invalid dates (n=735, 14.8%). The job dates created a complication in understanding the job profile of an employee by time within the dataset. Once the invalid dates were incorporated as missing, the dataset was sorted by that job date for each employee which automatically chose the missing date as the first job.	Complete
Assessment of Exposures for Different Job Class Sent to I.H. at Site	Purpose: Gathered feedback and an estimate of correctness of the job exposure matrix from the facility on the combined background and generated exposures with all related job titles that were thought to be in the respective job class listed. Response: Respondent suggested minor changes among few job titles that he thought were included in the wrong job class. His feedback was incorporated.	Returned Complete
Analyses of Job Exposure Matrix	Approach: In SAS, a proportional hazard model (Cox Regression) was used for all twelve facilities combined, broken down by job classes generating exposures. The facility combined job classes analyzed for generated exposures were the chemists/biologists, kitchen, medical/doctors/nurses, physicist/nuclear/x-ray technicians/engineers, and sanitation/laundry job classes in proportional-hazards modeling, due to a lack of sample size and statistical power.	Complete

SAVANNAH RIVER PLANT: Job Exposure Matrix Development

Task	Scope	Status
Chemical Questionnaire Sent to I.H. at Site	Purpose: The questionnaire identified chemical processes, buildings or areas of chemical process, and time frame of the respective process. Response: Respondent sent in place of chemical questionnaire the appendices from the ?Hicks Report? that outlined chemical substances inventory, job activity and locations coded by designated exposure. No indication of the time frame on these appendices.	Returned Complete
Chemical Summary	Purpose: From the chemical questionnaire a summary provided a list of chemicals for the facility which were grouped into chemical categories used across all facilities. Response: Response: A summary was developed by the Industrial Hygienist for the development of chemical classes. The chemical classes (background exposures) for this facility were identified as (1) fibers, (2) acidic gases, (3) heavy/radioactive metals, (4) solvents/paints, (5) other emissions (RDX, TNT, MOCA), (6) fumes/dust, (7) PAHs, (8) electricity, (9) heat, (10) gasoline/diesel/emissions, and (11) germicides.	Complete
Electronic Job History Data Requested	Purpose: Identified all job titles and their respective job dates for individual employees during the entire operation of the facility. Procedure: Job class data was manually entered in this file for all entries of job titles.	Received Complete
Job Class Assignment	Purpose: In managing the large amounts of job data, job titles were grouped into similar areas of work (job class) for the ease of comparisons across all facilities. All facilities available at this stage (Linde, Fernald, Mound, Hanford, X10, K25, Y12, SRS, LANL, Zia) were lumped into one file by unique job titles for assignment of job class by the Industrial Hygienist. This master job file served as a representative sample of job titles and their respective job classes for all facilities. Procedure: The job classes were manually entered into the electronic file for each employee's job title entry and or change during their employment. The job data was first sorted by job titles and job classes assigned based solely on the title. Next, job data was sorted by the employee's job history which ambiguous job titles was assigned a job class based on the most frequent job class or previous job class. The latter changes were flagged in the data. Also, data were reviewed for first and last job classes to identify the percent of employees that changed job classes. Stats: The breakdown of the generated/not generated exposures based on the assigned first and last job class categories were as follows: First Job Class (No Gen. Exp. 16.7%; Generated Exp. 15.8%; Quest. Exp. 67.5%) and Last Job Class (No Gen. Exp. 16.5%; Generated Exp. 16.8%; Quest. Exp. 66.7%). It was found that only 9.2% of the employees changed classes from the first to the last job class.	Complete
Problems/Issues with Job Class Assignment	Purpose: To identify limitations of the assignment of job classes based on these methods. Problems/Issues: The electronic file was developed by us from hard copy job cards copied from ORISE and the facility roster. The job cards that were available and copied did not amount to all female employees listed in the roster file. Therefore, there were a large percentage (N=3417, 52.1%) of employees that did not have a job history.	Complete
Assessment of Exposures for Different Job Class Sent to I.H. at Site	Purpose: Gathered feedback and an estimate of correctness of the job exposure matrix from the facility on the combined background and generated exposures with all related job titles that were thought to be in the respective job class listed. Response: No response.	Not Returned Complete
Analyses of Job Exposure Matrix	Approach: In SAS, a proportional hazard model (Cox Regression) was used for all twelve facilities combined, broken down by job classes generating exposures. The facility combined job classes analyzed for generated exposures were the chemists/biologists, kitchen, medical/doctors/nurses, physicist/nuclear/x-ray technicians/engineers, and sanitation/laundry job classes in proportional-hazards modeling, due to a lack of sample size and statistical power.	Complete

LANL: Job Exposure Matrix Development

Task	Scope	Status
Chemical Questionnaire Sent to I.H. at Site	Purpose: The questionnaire identified chemical processes, buildings or areas of chemical process, and time frame of the respective process. Response: No response on chemical questionnaire, but site visit meetings among industrial hygienists were used along with documented resources for the assessment of chemicals used.	Not Returned Complete
Chemical Summary	Purpose: From meetings and documentation, a summary provided a list of chemicals for the facility which were grouped into chemical categories used across all facilities. Response: Response: A summary was developed by the Industrial Hygienist for the development of chemical classes. The chemical classes (background exposures) for this facility were identified as (1) fibers, (2) acidic gases, (3) heavy/radioactive metals, (4) solvents/paints, (5) noise, (6) other emissions (RDX, TNT), (7) fumes/dust, (8) PAHs—greases/oils, (9) other irritating gases, (10) electricity, (11) heat, (12) gasoline/diesel/emissions, and (13) germicides.	Complete
Electronic Job History Data Requested	Purpose: Identified all job titles and their respective job dates for individual employees during the entire operation of the facility. Procedure: Job class data was manually entered in this file for all entries of job titles.	Received Complete
Job Class Assignment	Purpose: In managing the large amounts of job data, job titles were grouped into similar areas of work (job class) for the ease of comparisons across all facilities. All facilities available at this stage (Linde, Fernald, Mound, Hanford, X10, K25, Y12, SRS, LANL, Zia) were lumped into one file by unique job titles for assignment of job class by the Industrial Hygienist. This master job file served as a representative sample of job titles and their respective job classes for all facilities. Procedure: The job classes were manually entered into the electronic file for each employee's job title entry and or change during their employment. The job data was first sorted by job titles and job classes assigned based solely on the title. Next, job data was sorted by the employee's job history which ambiguous job titles was assigned a job class based on the most frequent job class or previous job class. The latter changes were flagged in the data. Also, data were reviewed for first and last job classes to identify the percent of employees that changed job classes. Stats: The breakdown of the generated/not generated exposures based on the assigned first and last job class categories were as follows: First Job Class (No Gen. Exp. 72.0%; Generated Exp. 17.6%; Quest. Exp. 10.4%) and Last Job Class (No Gen. Exp. 65.4%; Generated Exp. 18.9%; Quest. Exp. 10.4%). It was found that 14.9 % of the employees changed classes from the first to the last job class.	Complete
Problems/Issues with Job Class Assignment	Purpose: To identify limitations of the assignment of job classes based on these methods. Problems/Issues: The electronic job file did not have dates for the employees but only had first and last job titles per social security number. Therefore, one job class would either be the first or last at random. This problem in the data effects the history of employee throughout time of employment. Also, there were a few social security numbers (N=344, 5.1%) that were listed as all zeros, in those cases, merging of first and last job classes were made on first and last names to lessen this problem.	Complete
Assessment of Exposures for Different Job Class Sent to I.H. at Site	Purpose: Gathered feedback and an estimate of correctness of the job exposure matrix from the facility on the combined background and generated exposures with all related job titles that were thought to be in the respective job class listed. Response: No response.	Not Returned Complete
Analyses of Job Exposure Matrix	Approach: In SAS, a proportional hazard model (Cox Regression) was used for all twelve facilities combined, broken down by job classes generating exposures. The facility combined job classes analyzed for generated exposures were the chemists/biologists, kitchen, medical/doctors/nurses, physicist/nuclear/x-ray technicians/engineers, and sanitation/laundry job classes in proportional-hazards modeling, due to a lack of sample size and statistical power.	Complete

ZIA: Job Exposure Matrix Development

Task	Scope	Status
Chemical Questionnaire Sent to I.H. at Site	Purpose: The questionnaire identified chemical processes, buildings or areas of chemical process, and time frame of the respective process. Response: No response on chemical questionnaire, but site visit meetings among industrial hygienists were used along with documented resources for the assessment of chemicals used.	Not Returned Complete
Chemical Summary	Purpose: From meetings and documentation, a summary provided a list of chemicals for the facility which were grouped into chemical categories used across all facilities. Response: Response: A summary was developed by the Industrial Hygienist for the development of chemical classes. The chemical classes (background exposures) for this facility were identified as (1) fibers, (2) acidic gases, (3) heavy/radioactive metals, (4) solvents/paints, (5) noise, (6) other emissions (RDX, TNT), (7) fumes/dust, (8) PAHs—greases/oils, (9) other irritating gases, (10) electricity, (11) heat, (12) gasoline/diesel/emissions, and (13) germicides.	Complete
Electronic Job History Data Requested	Purpose: Identified all job titles and their respective job dates for individual employees during the entire operation of the facility. Procedure: Job class data was manually entered in this file for all entries of job titles.	Received Complete
Job Class Assignment	Purpose: In managing the large amounts of job data, job titles were grouped into similar areas of work (job class) for the ease of comparisons across all facilities. All facilities available at this stage (Linde, Fernald, Mound, Hanford, X10, K25, Y12, SRS, LANL, Zia) were lumped into one file by unique job titles for assignment of job class by the Industrial Hygienist. This master job file served as a representative sample of job titles and their respective job classes for all facilities. Procedure: The job classes were manually entered into the electronic file for each employee's job title entry and or change during their employment. The job data was first sorted by job titles and job classes assigned based solely on the title. Next, job data was sorted by the employee's job history which ambiguous job titles was assigned a job class based on the most frequent job class or previous job class. The latter changes were flagged in the data. Also, data were reviewed for first and last job classes to identify the percent of employees that changed job classes. Stats: The breakdown of the generated/not generated exposures based on the assigned first and last job class categories were as follows: First Job Class (No Gen. Exp. 16.7%; Generated Exp. 15.8%; Quest. Exp. 67.5%) and Last Job Class (No Gen. Exp. 17.3%; Generated Exp. 15.2%; Quest. Exp. 67.5%). It was found that 9.2 % of the employees changed classes from the first to the last job class.	Complete
Problems/Issues with Job Class Assignment	Purpose: To identify limitations of the assignment of job classes based on these methods. Problems/Issues: The electronic job file did not have dates for the employees but only had first and last job titles per social security number. Therefore, one job class would either be the first or last at random. This problem in the data effects the history of employee throughout time of employment. In addition, a large number of employees had a blank entry for one of the two job titles. Due to the consistency of low percentages among differences in first and last job classes, job classes were assigned to the same class. Also, there were a few social security numbers (N=88, 1.4%) that were listed as all zeros or nines, in those cases, merging of first and last job classes were made on first and last names to lessen this problem. The large missing job classes stemmed mainly from ambiguous job titles for this site.	Complete
Assessment of Exposures for Different Job Class Sent to I.H. at Site	Purpose: Gathered feedback and an estimate of correctness of the job exposure matrix from the facility on the combined background and generated exposures with all related job titles that were thought to be in the respective job class listed. Response: No response.	Not Returned Complete
Analyses of Job Exposure Matrix	Approach: In SAS, a proportional hazard model (Cox Regression) was used for all twelve facilities combined, broken down by job classes generating exposures. The facility combined job classes analyzed for generated exposures were the chemists/biologists, kitchen, medical/doctors/nurses, physicist/nuclear/x-ray technicians/engineers, and sanitation/laundry job classes in proportional-hazards modeling, due to a lack of sample size and statistical power.	Complete

OAK RIDGE K-25: Job Exposure Matrix Development

Task	Scope	Status
Chemical Questionnaire Sent to I.H. at Site	Purpose: The questionnaire identified chemical processes, buildings or areas of chemical process, and time frame of the respective process. Response: Respondent listed detailed knowledge for all time periods for processes, building(s) , and chemicals used. It was noted that monitoring prior to 1976 was not computerized therefore due to the laborious task they were unable to include that information.	Returned Complete
Chemical Summary	Purpose: From the chemical questionnaire, a summary provided a list of chemicals for the facility which were grouped into chemical categories used across all facilities. Response: Response: A summary was developed by the Industrial Hygienist for the development of chemical classes. The chemical classes (background exposures) for this facility were identified as (1) fibers, (2) acidic gases, (3) heavy/radioactive metals, (4) solvents/paints, (5) noise, (6) other emissions (RDX, TNT), (7) fumes/dust, (8) PAHs—greases/oils, (9) other irritating gases, (10) electricity, (11) heat, (12) gasoline/diesel/emissions, and (13) germicides.	Complete
Electronic Job History Data Requested	Purpose: Identified all job titles and their respective job dates for individual employees during the entire operation of the facility. Procedure: Job class data was manually entered in this file for all entries of job titles.	Received Complete
Job Class Assignment	Purpose: In managing the large amounts of job data, job titles were grouped into similar areas of work (job class) for the ease of comparisons across all facilities. All facilities available at this stage (Linde, Fernald, Mound, Hanford, X10, K25, Y12, SRS, LANL, Zia) were lumped into one file by unique job titles for assignment of job class by the Industrial Hygienist. This master job file served as a representative sample of job titles and their respective job classes for all facilities. Procedure: The job classes were manually entered into the electronic file for each employee's job title entry and or change during their employment. The job data was first sorted by job titles and job classes assigned based solely on the title. Next, job data was sorted by the employee's job history which ambiguous job titles was assigned a job class based on the most frequent job class or previous job class. The latter changes were flagged in the data. Also, data were reviewed for first and last job classes to identify the percent of employees that changed job classes. Stats: The breakdown of the generated/not generated exposures based on the assigned first and last job class categories were as follows: First Job Class (No Gen. Exp. 51.7%; Generated Exp. 46.8%; Quest. Exp. 1.6%) and Last Job Class (No Gen. Exp. 52.8%; Generated Exp. 45.7%; Quest. Exp. 1.6%). It was found that 17.5 % of the employees changed classes from the first to the last job class.	Complete
Problems/Issues with Job Class Assignment	Purpose: To identify limitations of the assignment of job classes based on these methods. Problems/Issues: The job history electronic file had "XXXXX"'s (mere 0.5% of the entire file) for job title. A call was made to ORISE to follow-up on this problem, they identified that these occurrences were added by ORISE to hold places for blank job titles.	Complete
Assessment of Exposures for Different Job Class Sent to I.H. at Site	Purpose: Gathered feedback and an estimate of correctness of the job exposure matrix from the facility on the combined background and generated exposures with all related job titles that were thought to be in the respective job class listed. Response: Respondent suggested minor changes among few job titles that he thought were included in the wrong job class. His feedback was incorporated.	Returned Complete
Analyses of Job Exposure Matrix	Approach: In SAS, a proportional hazard model (Cox Regression) was used for all twelve facilities combined, broken down by job classes generating exposures. The facility combined job classes analyzed for generated exposures were the chemists/biologists, kitchen, medical/doctors/nurses, physicist/nuclear/x-ray technicians/engineers, and sanitation/laundry job classes in proportional-hazards modeling, due to a lack of sample size and statistical power.	Complete

PANTEX: Job Exposure Matrix Development

Task	Scope	Status
Chemical Questionnaire Sent to I.H. at Site	Purpose: The questionnaire identified chemical processes, buildings or areas of chemical process, and time frame of the respective process. Response: Respondent listed all processes by a building number and chemicals used for all time frames. The reported noted that for 1940-1945 no chemical information. Also, attached was a current building code and list of the building names which indicated the type of process occurring within the area.	Returned Complete
Chemical Summary	Purpose: From the chemical questionnaire, a summary provided a list of chemicals for the facility which were grouped into chemical categories used across all facilities. Response: Response: A summary was developed by the Industrial Hygienist for the development of chemical classes. The chemical classes (background exposures) for this facility were identified as (1) acidic gases, (2) heavy/radioactive metals, (3) solvents/paints, (4) other emissions (TNT), (5) fumes/dust, (6) PAHs—greases/oils, (7) electricity, (8) heat, (9) gasoline/diesel/emissions, and (10) germicides.	Complete
Electronic Job History Data Requested	Purpose: Identified all job titles and their respective job dates for individual employees during the entire operation of the facility. Procedure: Job class data was manually entered in this file for all entries of job titles.	Received Complete
Job Class Assignment	Purpose: In managing the large amounts of job data, job titles were grouped into similar areas of work (job class) for the ease of comparisons across all facilities. All facilities available at this stage (Linde, Fernald, Mound, Hanford, X10, K25, Y12, SRS, LANL, Zia) were lumped into one file by unique job titles for assignment of job class by the Industrial Hygienist. This master job file served as a representative sample of job titles and their respective job classes for all facilities. Procedure: The job classes were manually entered into the electronic file for each employee's job title entry and or change during their employment. The job data was first sorted by job titles and job classes assigned based solely on the title. Next, job data was sorted by the employee's job history which ambiguous job titles was assigned a job class based on the most frequent job class or previous job class. The latter changes were flagged in the data. Also, data were reviewed for first and last job classes to identify the percent of employees that changed job classes. Stats: : The breakdown of the generated/not generated exposures based on the assigned first and last job class categories were as follows: First Job Class (No Gen. Exp. 47.6%; Generated Exp. 5.6%; Quest. Exp. 46.9%) and Last Job Class (No Gen. Exp. 47.7%; Generated Exp. 5.3%; Quest. Exp. 47.0%). It was found that only 1.7 % of the employees changed classes from the first to the last job class.	Complete
Problems/Issues with Job Class Assignment	Purpose: To identify limitations of the assignment of job classes based on these methods. Problems/Issues: The electronic file was developed by us from hard copy job cards and the facility roster. The job cards that were available and copied did not amount to all female employees listed in the roster file. Therefore, there were a large percentage (N=551, 46%) of employees that did not have a job history.	Complete
Assessment of Exposures for Different Job Class Sent to I.H. at Site	Purpose: Gathered feedback and an estimate of correctness of the job exposure matrix from the facility on the combined background and generated exposures with all related job titles that were thought to be in the respective job class listed. Response: No response.	Not Returned Complete
Analyses of Job Exposure Matrix	Approach: In SAS, a proportional hazard model (Cox Regression) was used for all twelve facilities combined, broken down by job classes generating exposures. The facility combined job classes analyzed for generated exposures were the chemists/biologists, kitchen, medical/doctors/nurses, physicist/nuclear/x-ray technicians/engineers, and sanitation/laundry job classes in proportional-hazards modeling, due to a lack of sample size and statistical power.	Complete

OAK RIDGE X-10: Job Exposure Matrix Development

Task	Scope	Status
Chemical Questionnaire Sent to I.H. at Site	Purpose: The questionnaire identified chemical processes, buildings or areas of chemical process, and time frame of the respective process. Response: Respondent listed detailed knowledge for all time periods for processes, building , and chemicals used. It was noted that monitoring prior to 1976 is not computerized therefore due to the laborious task they did not include that information.	Not Returned Complete
Chemical Summary	Purpose: From the chemical questionnaire, a summary provided a list of chemicals for the facility which were grouped into chemical categories used across all facilities. Response: Response: A summary was developed by the Industrial Hygienist for the development of chemical classes. The chemical classes (background exposures) for this facility were identified as (1) fibers, (2) acidic gases, (3) heavy/radioactive metals (Hg,Cd, U), (4) Beryllium, (5) solvents/paints, (6) noise, (7) PAHs, (8) wood dust, (9) metal dust/fumes, (10) other irritating gases, (11) electricity, (12) heat, (13) gasoline/diesel/emissions, and (14) germicides.	Complete
Electronic Job History Data Requested	Purpose: Identified all job titles and their respective job dates for individual employees during the entire operation of the facility. Procedure: Job class data was manually entered in this file for all entries of job titles.	Received Complete
Job Class Assignment	Purpose: In managing the large amounts of job data, job titles were grouped into similar areas of work (job class) for the ease of comparisons across all facilities. All facilities available at this stage (Linde, Fernald, Mound, Hanford, X10, K25, Y12, SRS, LANL, Zia) were lumped into one file by unique job titles for assignment of job class by the Industrial Hygienist. This master job file served as a representative sample of job titles and their respective job classes for all facilities. Procedure: The job classes were manually entered into the electronic file for each employee's job title entry and or change during their employment. The job data was first sorted by job titles and job classes assigned based solely on the title. Next, job data was sorted by the employee's job history which ambiguous job titles was assigned a job class based on the most frequent job class or previous job class. The latter changes were flagged in the data. Also, data were reviewed for first and last job classes to identify the percent of employees that changed job classes. Stats: The breakdown of the generated/not generated exposures based on the assigned first and last job class categories were as follows: First Job Class (No Gen. Exp. 65.5%; Generated Exp. 29.6%; Quest. Exp. 4.9%) and Last Job Class (No Gen. Exp. 63.4%; Generated Exp. 31.1%; Quest. Exp. 5.5%). It was found that only 17.5 % of the employees changed classes from the first to the last job class.	Complete
Problems/Issues with Job Class Assignment	Purpose: To identify limitations of the assignment of job classes based on these methods. Problems/Issues: The job history electronic file had "XXXXX"'s (0.9% of the entire file) for job title. A call was made to ORISE to follow-up on this problem, they identified that these occurrences were added by ORISE to hold places for blank job titles. This facility had the most changes between first and last job classes which may be due to the differing processes of TEC and Y12.	Complete
Assessment of Exposures for Different Job Class Sent to I.H. at Site	Purpose: Gathered feedback and an estimate of correctness of the job exposure matrix from the facility on the combined background and generated exposures with all related job titles that were thought to be in the respective job class listed. Response: No response.	Not Returned Complete
Analyses of Job Exposure Matrix	Approach: In SAS, a proportional hazard model (Cox Regression) was used for all twelve facilities combined, broken down by job classes generating exposures. The facility combined job classes analyzed for generated exposures were the chemists/biologists, kitchen, medical/doctors/nurses, physicist/nuclear/x-ray technicians/engineers, and sanitation/laundry job classes in proportional-hazards modeling, due to a lack of sample size and statistical power.	Complete

OAK RIDGE Y-12: Job Exposure Matrix Development

Task	Scope	Status
Chemical Questionnaire Sent to I.H. at Site	Purpose: The questionnaire identified chemical processes, buildings or areas of chemical process, and time frame of the respective process. Response: Respondent listed detailed knowledge for all time periods for processes, building , and chemicals used. It was noted that monitoring prior to 1976 is not computerized therefore due to the laborious task they did not include that information.	Not Returned Complete
Chemical Summary	Purpose: From the chemical questionnaire, a summary provided a list of chemicals for the facility which were grouped into chemical categories used across all facilities. Response: Response: A summary was developed by the Industrial Hygienist for the development of chemical classes. The chemical classes (background exposures) for this facility were identified as (1) fibers, (2) acidic gases, (3) heavy/radioactive metals (Hg, Cd, U), (4) Beryllium, (5) solvents/paints, (6) noise, (7) PAHs, (8) wood dust, (9) metal dust/fumes (10) other irritating gases, (11) electricity, (12) heat, (13) gasoline/diesel/emissions, and (14) germicides.	Complete
Electronic Job History Data Requested	Purpose: Identified all job titles and their respective job dates for individual employees during the entire operation of the facility. Procedure: Job class data was manually entered in this file for all entries of job titles. A 10% random sample of hard copy job cards were pulled from ORISE and copied for a quality control check with the electronic data.	Received Complete
Job Class Assignment	Purpose: In managing the large amounts of job data, job titles were grouped into similar areas of work (job class) for the ease of comparisons across all facilities. All facilities available at this stage (Linde, Fernald, Mound, Hanford, X10, K25, Y12, SRS, LANL, Zia) were lumped into one file by unique job titles for assignment of job class by the Industrial Hygienist. This master job file served as a representative sample of job titles and their respective job classes for all facilities. Procedure: The job classes were manually entered into the electronic file for each employee's job title entry and or change during their employment. The job data was first sorted by job titles and job classes assigned based solely on the title. Next, job data was sorted by the employee's job history which ambiguous job titles was assigned a job class based on the most frequent job class or previous job class. The latter changes were flagged in the data. Also, data were reviewed for first and last job classes to identify the percent of employees that changed job classes. Stats: The breakdown of the generated/not generated exposures based on the assigned first and last job class categories were as follows: First Job Class (No Gen. Exp. 31.5%; Generated Exp. 64.1%; Quest. Exp. 4.4%) and Last Job Class (No Gen. Exp. 33.2%; Generated Exp. 59.7%; Quest. Exp. 7.1%). It was found that a large percentage (43.1%) of the employees changed classes from the first to the last job class.	Complete
Problems/Issues with Job Class Assignment	Purpose: To identify limitations of the assignment of job classes based on these methods. Problems/Issues: A large number of employees changed classes between first and last job. This may be due to the change in chemical processes of TEC and Y12.	Complete
Assessment of Exposures for Different Job Class Sent to I.H. at Site	Purpose: Gathered feedback and an estimate of correctness of the job exposure matrix from the facility on the combined background and generated exposures with all related job titles that were thought to be in the respective job class listed. Response: Respondent suggested minor changes among few job titles that he thought were included in the wrong job class. His feedback was incorporated.	Returned Complete
Analyses of Job Exposure Matrix	Approach: In SAS, a proportional hazard model (Cox Regression) was used for all twelve facilities combined, broken down by job classes generating exposures. The facility combined job classes analyzed for generated exposures were the chemists/biologists, kitchen, medical/doctors/nurses, physicist/nuclear/x-ray technicians/engineers, and sanitation/laundry job classes in proportional-hazards modeling, due to a lack of sample size and statistical power.	Complete

HANFORD: Job Exposure Matrix Development

Task	Scope	Status
Chemical Questionnaire Sent to I.H. at Site	Purpose: The questionnaire identified chemical processes, buildings or areas of chemical process, and time frame of the respective process. Response: No response on chemical questionnaire, but documented resources was used for the assessment of chemicals usage.	Not Returned Complete
Chemical Summary	Purpose: From meetings and documentation, a summary provided a list of chemicals for the facility which were grouped into chemical categories used across all facilities. Response: Response: A summary was developed by the Industrial Hygienist for the development of chemical classes. The chemical classes (background exposures) for this facility were identified as (1) fibers, (2) acidic gases, (3) heavy/radioactive metals, (4) solvents/paints, (5) noise, (6) other emissions (RDX, TNT), (7) fumes/dust, (8) PAHs—greases/oils, (9) other irritating gases, (10) electricity, (11) heat, (12) gasoline/diesel/emissions, and (13) germicides.	Complete
Electronic Job History Data Requested	Purpose: Identified all job titles and their respective job dates for individual employees during the entire operation of the facility. Procedure: Job class data was manually entered in this file for all entries of job titles.	Received Complete
Job Class Assignment	Purpose: In managing the large amounts of job data, job titles were grouped into similar areas of work (job class) for the ease of comparisons across all facilities. All facilities available at this stage (Linde, Fernald, Mound, Hanford, X10, K25, Y12, SRS, LANL, Zia) were lumped into one file by unique job titles for assignment of job class by the Industrial Hygienist. This master job file served as a representative sample of job titles and their respective job classes for all facilities. Procedure: The job classes were manually entered into the electronic file for each employee's job title entry and or change during their employment. The job data was first sorted by job titles and job classes assigned based solely on the title. Next, job data was sorted by the employee's job history which ambiguous job titles was assigned a job class based on the most frequent job class or previous job class. The latter changes were flagged in the data. Also, data were reviewed for first and last job classes to identify the percent of employees that changed job classes. Stats: The breakdown of the generated/not generated exposures based on the assigned first and last job class categories were as follows: First Job Class (No Gen. Exp. 66.7%; Generated Exp. 28.5%; Quest. Exp. 4.8%) and Last Job Class (No Gen. Exp. 55.8%; Generated Exp. 28.5%; Quest. Exp. 4.5%). It was found that a large percentage (16.2%) of the employees changed classes from the first to the last job class.	Complete
Problems/Issues with Job Class Assignment	Purpose: To identify limitations of the assignment of job classes based on these methods. Problems/Issues: None.	Complete
Assessment of Exposures for Different Job Class Sent to I.H. at Site	Purpose: Gathered feedback and an estimate of correctness of the job exposure matrix from the facility on the combined background and generated exposures with all related job titles that were thought to be in the respective job class listed. Response: No response.	Not Returned Complete
Analyses of Job Exposure Matrix	Approach: In SAS, a proportional hazard model (Cox Regression) was used for all twelve facilities combined, broken down by job classes generating exposures. The facility combined job classes analyzed for generated exposures were the chemists/biologists, kitchen, medical/doctors/nurses, physicist/nuclear/x-ray technicians/engineers, and sanitation/laundry job classes in proportional-hazards modeling, due to a lack of sample size and statistical power.	Complete

LINDE: Job Exposure Matrix Development

Task	Scope	Status
Chemical Questionnaire Sent to I.H. at Site	Purpose: The questionnaire identified chemical processes, buildings or areas of chemical process, and time frame of the respective process. Response: Not Applicable for this site, documented resources was used for the assessment of chemical usage.	Not Applicable Complete
Chemical Summary	Purpose: From documentation, a summary provided a list of chemicals for the facility which were grouped into chemical categories used across all facilities. R Response: Response: A summary was developed by the Industrial Hygienist for the development of chemical classes. The chemical classes (background exposures) for this facility were identified as (1) fibers, (2) acidic gases, (3) heavy/radioactive metals (Thorium & Plutonium), (4) solvents (TBP, xylenes, & CCl_4/paints, (5) noise, (6) PCBs, (7) fumes/dust, (8) PAHs, (9) wood dust, (10) metal dust/fumes, (11) other irritating gases, (12) electricity, (13) heat, (14) gasoline/diesel/emissions, and (15) germicides.	Complete
Electronic Job History Data Requested	Purpose: Identified all job titles and their respective job dates for individual employees during the entire operation of the facility. Procedure: Job class data was manually entered in this file for all entries of job titles.	Received Complete
Job Class Assignment	Purpose: In managing the large amounts of job data, job titles were grouped into similar areas of work (job class) for the ease of comparisons across all facilities. All facilities available at this stage (Linde, Fernald, Mound, Hanford, X10, K25, Y12, SRS, LANL, Zia) were lumped into one file by unique job titles for assignment of job class by the Industrial Hygienist. This master job file served as a representative sample of job titles and their respective job classes for all facilities. Procedure: The job classes were manually entered into the electronic file for each employee's job title entry and or change during their employment. The job data was first sorted by job titles and job classes assigned based solely on the title. Next, job data was sorted by the employee's job history which ambiguous job titles was assigned a job class based on the most frequent job class or previous job class. The latter changes were flagged in the data. Also, data were reviewed for first and last job classes to identify the percent of employees that changed job classes. Stats: The breakdown of the generated/not generated exposures based on the assigned first and last job class categories were as follows: First Job Class (No Gen. Exp. 54.2%; Generated Exp. 38.2%; Quest. Exp. 7.5%) and Last Job Class (No Gen. Exp. 55.6%; Generated Exp. 36.9%; Quest. Exp. 7.5%). A small number of employees (N=12, 3.9%) that did not remain in the same class from first to last job class.	Complete
Problems/Issues with Job Class Assignment	Purpose: To identify limitations of the assignment of job classes based on these methods. Problems/Issues: In the job history file, the entire subset of women at this facility was small in number (N=306) and in comparison with the other facilities.. Therefore the job classes assigned were only 7 of the 16 (chemists/biologists, clerical, medical/doctors/nurses, sanitation/laundry, technical operators/maintenance/technicians, transportation, unknown).	Complete
Assessment of Exposures for Different Job Class Sent to I.H. at Site	Purpose: Gathered feedback and an estimate of correctness of the job exposure matrix from the facility on the combined background and generated exposures with all related job titles that were thought to be in the respective job class listed. Response: Not applicable for this facility, since this site is closed. An assessment was still complete for this site.	Not Applicable Complete
Analyses of Job Exposure Matrix	Approach: In SAS, a proportional hazard model (Cox Regression) was used for all twelve facilities combined, broken down by job classes generating exposures. The facility combined job classes analyzed for generated exposures were the chemists/biologists, kitchen, medical/doctors/nurses, physicist/nuclear/x-ray technicians/engineers, and sanitation/laundry job classes in proportional-hazards modeling, due to a lack of sample size and statistical power.	Complete

ROCKY FLATS: Job Exposure Matrix Development

Task	Scope	Status
Chemical Questionnaire Sent to I.H. at Site	Purpose: The questionnaire identified chemical processes, buildings or areas of chemical process, and time frame of the respective process. Response: No response on chemical questionnaire, but site visit meetings among industrial hygienists were used along with documented resources for the assessment of chemicals used.	Not Returned Complete
Chemical Summary	Purpose: From doumentation, a summary provided a list of chemicals for the facility which were grouped into chemical categories used across all facilities. Response: Response: A summary was developed by the Industrial Hygienist for the development of chemical classes. The chemical classes (background exposures) for this facility were identified as (1) fibers, (2) acidic gases, (3) heavy/radioactive metals, (4) solvents/paints, (5) noise, (6) fumes/dust, (7) PAHs—greases/oils, (8) other irritating gases, (9) electricity, (10) heat, (11) gasoline/diesel/emissions, and (12) germicides.	Complete
Electronic Job History Data Requested	Purpose: Identified all job titles and their respective job dates for individual employees during the entire operation of the facility. Procedure: Job class data was manually entered in this file for all entries of job titles.	Received Complete
Job Class Assignment	Purpose: In managing the large amounts of job data, job titles were grouped into similar areas of work (job class) for the ease of comparisons across all facilities. All facilities available at this stage (Linde, Fernald, Mound, Hanford, X10, K25, Y12, SRS, LANL, Zia) were lumped into one file by unique job titles for assignment of job class by the Industrial Hygienist. This master job file served as a representative sample of job titles and their respective job classes for all facilities. Procedure: The job classes were manually entered into the electronic file for each employee's job title entry and or change during their employment. The job data was first sorted by job titles and job classes assigned based solely on the title. Next, job data was sorted by the employee's job history which ambiguous job titles was assigned a job class based on the most frequent job class or previous job class. The latter changes were flagged in the data. Also, data were reviewed for first and last job classes to identify the percent of employees that changed job classes. Stats: The breakdown of the generated/not generated exposures based on the assigned first and last job class categories were as follows: First Job Class (No Gen. Exp. 67.9%; Generated Exp. 31.0%; Quest. Exp. 1.1%) and Last Job Class (No Gen. Exp. 62.2%; Generated Exp. 33.8%; Quest. Exp. 4.0%). A large number (26.3%) of employees did not remain in the same class from first to last job class.	Complete
Problems/Issues with Job Class Assignment	Purpose: To identify limitations of the assignment of job classes based on these methods. Problems/Issues: None	Complete
Assessment of Exposures for Different Job Class Sent to I.H. at Site	Purpose: Gathered feedback and an estimate of correctness of the job exposure matrix from the facility on the combined background and generated exposures with all related job titles that were thought to be in the respective job class listed. Response: No reponse.	Not Returned Complete
Analyses of Job Exposure Matrix	Approach: In SAS, a proportional hazard model (Cox Regression) was used for all twelve facilities combined, broken down by job classes generating exposures. The facility combined job classes analyzed for generated exposures were the chemists/biologists, kitchen, medical/doctors/nurses, physicist/nuclear/x-ray technicians/engineers, and sanitation/laundry job classes in proportional-hazards modeling, due to a lack of sample size and statistical power.	Complete

APPENDIX III TABLE 1: SMRS FOR FERNALD FEMALE WORKERS

PC LIFE TABLE ANALYSIS SYSTEM

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=================================================================================
                        G L O B A L   P A R A M E T E R S
STUDY PARAMETER FILE NAME: c:\ltas\FER1.LTP
LAST COMPLETE STEP: Stratify
STUDY DESCRIPTION: fer1
STUDY BEGIN DATE: 01/01/1940
STUDY END DATE: 01/01/1994
RATES IN USE: Standard U.S. Deaths 92 Minors 1940 - 99
AGE CATEGORIES: 15\20\25\30\35\40\45\50\55\60\65\70\75\80\85\
CALENDAR CATEGORIES: 1940\1945\1950\1955\1960\1965\1970\1975\1980\1985\1990\1995\
SINGLE CAUSE OF DEATH
=================================================================================
                        V E R I F Y   P A R A M E T E R S
INPUT DEMOGRAPHICS FILE: c:\ltas\fer\dem
INPUT WORK HISTORY FILE: c:\ltas\fer\wh
OUTPUT DEMOGRAPHICS FILE: c:\ltas\demout.txt
OUTPUT WORK HISTORY FILE: c:\ltas\whout.txt
BEGIN PERSON TIME AT LATER OF In-rec / Rate begin
STOP SURVIVORS PERSON TIME AT: END OF STUDY
GENDER/RACE SUBSETTING: KEEP ALL
EXPOSURE LEVEL: All exposed equally (no data)

SUMMARY REPORT FILE: .\summary.rpt
EXCEPTIONS REPORT FILE: .\except.rpt
EXPOSURE REPORT FILE: .\experr.rpt
=================================================================================
                      S T R A T I F Y   P A R A M E T E R S
ANALYSIS TYPE: SMR
```

DURATION	TIME SINCE FIRST EXPOSURE
MINIMUM->000Y	000Y
005Y	005Y
010Y	010Y
015Y	015Y
020Y	020Y
025Y	025Y
030Y	030Y

PERSON YEARS FILE: C:\LTAS\FER1PY
OBSERVED DEATHS FILE: C:\LTAS\FER1OB

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: FER1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	3648.80	0.00	0.00	0.00	0.00	0.00	0.00	3648.80
005Y - 010Y	2523.81	1116.39	0.00	0.00	0.00	0.00	0.00	3640.21
010Y - 015Y	2514.14	464.51	641.70	0.00	0.00	0.00	0.00	3620.36
015Y - 020Y	2382.53	449.59	154.90	437.36	0.00	0.00	0.00	3424.38
020Y - 025Y	2183.73	436.37	143.11	109.98	290.37	0.00	0.00	3163.57
025Y - 030Y	1954.09	424.30	137.29	104.06	39.99	237.34	0.00	2897.07
030Y & Over	2935.52	703.53	192.02	172.52	42.92	82.76	307.13	4436.41
Total	18142.62	3594.70	1269.01	823.93	373.29	320.09	307.13	24830.78

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: FER1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	0.00	0.00	55.00	100.35	27.26	15.53	42.95	55.53	1.21	0.00	0.00
20-24	0.00	0.00	225.60	623.20	388.81	149.80	103.96	156.70	106.51	1.20	0.00
25-29	0.00	0.00	111.67	621.53	730.03	455.32	190.23	140.86	173.31	106.41	1.20
30-34	0.00	0.00	78.82	311.41	682.00	761.66	458.51	200.60	160.81	173.31	99.83
35-39	0.00	0.00	47.28	226.64	366.40	708.07	769.95	465.30	209.25	160.64	136.60
40-44	0.00	0.00	27.83	132.06	264.21	395.77	719.28	787.26	471.73	209.07	124.37
45-49	0.00	0.00	25.95	89.12	143.84	276.33	388.27	723.22	788.88	469.68	181.90
50-54	0.00	0.00	2.46	48.71	96.91	145.18	279.66	388.68	713.43	780.80	399.50
55-59	0.00	0.00	0.00	4.38	49.34	93.96	148.53	272.69	380.16	700.38	643.99
60-64	0.00	0.00	0.00	0.00	4.39	44.60	84.71	145.96	261.84	373.54	517.05
65-69	0.00	0.00	0.00	0.00	0.00	4.39	41.39	77.89	138.97	242.33	271.48
70-74	0.00	0.00	0.00	0.00	0.00	0.00	4.39	39.39	71.95	116.15	154.80
75-79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.38	37.94	64.50	81.34
80-84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.39	25.78	36.83
85+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.65
TOTAL	0.00	0.00	574.60	2157.41	2753.18	3050.60	3231.83	3458.45	3520.37	3423.78	2660.55

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: FER1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1995+	TOTAL
15-19	0.00	297.84
20-24	0.00	1755.78
25-29	0.00	2530.57
30-34	0.00	2926.95
35-39	0.00	3090.13
40-44	0.00	3131.57
45-49	0.00	3087.19
50-54	0.00	2855.33
55-59	0.00	2293.42
60-64	0.00	1432.08
65-69	0.00	776.44
70-74	0.00	386.67
75-79	0.00	188.15
80-84	0.00	67.00
85+	0.00	11.65
TOTAL	0.00	24830.78

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: FER1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
1	TUBERCULOSIS	1	0.2369	4.22	0.1068	23.4521
1	RESPIRATORY TUBERCULOSIS	1	0.1983	5.04	0.1275	28.0110
2	OTHER TUBERCULOSIS	0	0.0386	0.00	0.0000	95.7096
2	MN OF BUCCAL CAVITY AND PHARYNX	0	0.4704	0.00	0.0000	7.8447
3	MN OF LIP	0	0.0018	0.00	0.0000	2070.5537
4	MN OF TONGUE	0	0.1098	0.00	0.0000	33.6149
5	MN OF OTHER PARTS OF BUCCAL CAVITY	0	0.1418	0.00	0.0000	26.0259
6	MN OF PHARYNX	0	0.2170	0.00	0.0000	17.0010
3	MN OF DIGESTIVE ORGANS AND PERITONEUM	11	7.2314	1.52	0.7583	2.7220
7	MN OF ESOPHAGUS	0	0.3092	0.00	0.0000	11.9331
8	MN OF STOMACH	0	0.7499	0.00	0.0000	4.9205
9	MN OF INTESTINE EXCEPT RECTUM	6	3.1856	1.88	0.6878	4.0996
10	MN OF RECTUM	3	0.5733	5.23*	1.0790	15.3009
11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	1	0.5645	1.77	0.0448	9.8423
12	MN OF LIVER NOT SPECIFIED	0	0.1781	0.00	0.0000	20.7181
13	MN OF PANCREAS	1	1.5289	0.65	0.0165	3.6337
14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	0	0.1418	0.00	0.0000	26.0160
4	MN OF RESPIRATORY SYSTEM	5	7.6424	0.65	0.2117	1.5286
15	MN OF LARYNX	0	0.1311	0.00	0.0000	28.1446
16	MN OF TRACHEA, BRONCHUS, AND LUNG	5	7.4252	0.67	0.2179	1.5733
17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	0	0.0861	0.00	0.0000	42.8546
5	MN OF BREAST	6	8.6987	0.69	0.2519	1.5014
18	MN OF BREAST	6	8.6987	0.69	0.2519	1.5014

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: FER1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
6	MN OF FEMALE GENITAL ORGANS	3	5.0301	0.60	0.1230	1.7439
19	MN OF CERVIX UTERI	0	1.3856	0.00	0.0000	2.6631
20	MN OF OTHER AND UNSPECIFIED PARTS OF UTERUS	0	0.9347	0.00	0.0000	3.9480
21	MN OF OVARY, FALLOPIAN TUBE, AND BROAD LIGAMENT	3	2.5852	1.16	0.2393	3.3932
22	MN OF OTHER FEMALE GENITAL ORGANS	0	0.1247	0.00	0.0000	29.6005
7	MN OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	1059609.6250
23	MN OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
24	MN OF OTHER MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	1059609.6250
8	MN OF URINARY ORGANS	2	0.8761	2.28	0.2764	8.2417
25	MN OF KIDNEY	1	0.5683	1.76	0.0445	9.7753
26	MN OF BLADDER AND OTHER URINARY ORGANS	1	0.3077	3.25	0.0822	18.0533
9	MN OF OTHER AND UNSPECIFIED SITES	1	4.4736	0.22	0.0057	1.2419
27	MN OF SKIN	0	0.6123	0.00	0.0000	6.0269
28	MN OF EYE	0	0.0237	0.00	0.0000	155.4448
29	MN OF BRAIN AND OTHER PARTS OF NERVOUS SYSTEM	1	1.0818	0.92	0.0234	5.1356
30	MN OF THYROID GLAND	0	0.0913	0.00	0.0000	40.4137
31	MN OF BONE	0	0.0940	0.00	0.0000	39.2507
32	MN OF CONNECTIVE TISSUE AND SOFT TISSUE	0	0.2395	0.00	0.0000	15.4074
33	MN OF OTHER AND UNSPECIFIED SITES (MINOR)	0	2.3310	0.00	0.0000	1.5830
10	NEOPLASMS OF LYMPHATIC AND HEMATOPOIETIC TISSUE	1	3.0927	0.32	0.0082	1.7963
34	LYMPHOSARCOMA AND RETICULOSARCOMA	0	0.3834	0.00	0.0000	9.6242
35	HODGKIN'S DISEASE	0	0.2659	0.00	0.0000	13.8750
36	LEUKEMIA AND ALEUKEMIA	1	1.1647	0.86	0.0217	4.7701
37	OTHER NEOPLASMS OF LYMPHATIC HEMATOPOIETIC TISSUE	0	1.2787	0.00	0.0000	2.8857

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: FER1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
11	BENIGN AND UNSPECIFIED NEOPLASMS	0	0.5649	0.00	0.0000	6.5322
38	BENIGN NEOPLASMS OF THE EYE, BRAIN, AND OTHER PARTS OF NERVOUS SYS	0	0.1138	0.00	0.0000	32.4148
39	NEOPLASMS OF EYE, BRAIN, & OTHER PARTS OF NERV SYSTEM UNSPECIF. NA	0	0.2336	0.00	0.0000	15.7943
40	OTHER BENIGN AND UNSPECIFIED NATURE NEOPLASMS	0	0.2174	0.00	0.0000	16.9708
12	DIABETES MELLITUS	3	2.6826	1.12	0.2306	3.2700
41	DIABETES MELLITUS	3	2.6826	1.12	0.2306	3.2700
13	DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS	0	0.4421	0.00	0.0000	8.3456
42	PERNICIOUS ANEMIAS	0	0.0077	0.00	0.0000	476.6640
43	ANEMIAS OF OTHER AND UNSPECIFIED TYPE	0	0.1762	0.00	0.0000	20.9438
44	COAGULATION DEFECTS, PURPURA, AND OTHER HEMORRHAGIC CONDITIONS	0	0.1316	0.00	0.0000	28.0461
45	ALL OTHER DISEASES OF BLOOD FORMING ORGANS	0	0.1267	0.00	0.0000	29.1347
14	MENTAL, PSYCHONEUROTIC, AND PERSONALITY DISORDERS	0	0.7185	0.00	0.0000	5.1355
46	ALCOHOLISM	0	0.2954	0.00	0.0000	12.4919
47	OTHER MENTAL DISORDERS	0	0.4231	0.00	0.0000	8.7207
15	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	0	1.8663	0.00	0.0000	1.9772
48	MULTIPLE SCLEROSIS	0	0.3443	0.00	0.0000	10.7176
49	OTHER DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	0	1.5220	0.00	0.0000	2.4245
16	DISEASES OF THE HEART	14	26.5283	0.53*	0.2883	0.8855
50	RHEUMATIC HEART DISEASE, INCLUDING FEVER	1	1.3135	0.76	0.0193	4.2297
51	ISCHEMIC HEART DISEASE	11	18.4913	0.59	0.2966	1.0645
52	CHRONIC DISEASE OF ENDOCARDIUM	0	0.3700	0.00	0.0000	9.9743
53	OTHER MYOCARDIAL DEGENERATION	0	0.1678	0.00	0.0000	21.9906
54	HYPERTENSION WITH HEART DISEASE	0	1.0229	0.00	0.0000	3.6075
55	OTHER DISEASES OF THE HEART	2	5.1628	0.39	0.0469	1.3985

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: FER1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
17	OTHER DISEASES OF CIRCULATORY SYSTEM	6	9.4498	0.63	0.2319	1.3820
56	HYPERTENSION WITHOUT HEART DISEASE	0	0.3670	0.00	0.0000	10.0548
57	CEREBROVASCULAR DISEASE	2	6.6548	0.30	0.0364	1.0850
58	DISEASES OF THE ARTERIES, VEINS, AND PULMONARY CIRCULATION	4	2.4280	1.65	0.4489	4.2134
18	DISEASES OF THE RESPIRATORY SYSTEM	7	6.6535	1.05	0.4215	2.1678
59	ACUTE RESPIRATORY INFECTIONS EXCEPT INFLUENZA AND PNEUMONIA	0	0.0502	0.00	0.0000	73.5005
60	INFLUENZA	0	0.1007	0.00	0.0000	36.6365
61	PNEUMONIA (EXCEPT NEWBORN)	1	2.0617	0.49	0.0123	2.6947
62	CHRONIC AND UNSPECIFIED BRONCHITIS	0	0.1972	0.00	0.0000	18.7077
63	EMPHYSEMA	0	0.7767	0.00	0.0000	4.7511
64	ASTHMA	0	0.3985	0.00	0.0000	9.2601
65	PNEUMOCONIOSES AND OTHER RESPIRATORY DISEASES	6	3.0685	1.96	0.7140	4.2561
19	DISEASES OF THE DIGESTIVE SYSTEM	7	5.4584	1.28	0.5138	2.6424
66	DISEASES OF THE STOMACH AND DUODENUM	2	0.3996	5.00	0.6059	18.0664
67	HERNIA AND INTESTINAL OBSTRUCTION	0	0.3042	0.00	0.0000	12.1295
68	CIRRHOSIS OF THE LIVER	3	2.7445	1.09	0.2254	3.1962
69	OTHER DISEASES OF DIGESTIVE SYSTEM	2	2.0100	1.00	0.1205	3.5921
20	DISEASES OF THE GENITO-URINARY SYSTEM	1	1.6711	0.60	0.0151	3.3244
70	ACUTE GLOMERULONEPHRITIS, NEPHROTIC SYNDROME, & ACUTE RENAL FAILUR	0	0.1408	0.00	0.0000	26.2126
71	CHRONIC & UNSPEC. NEPHRITIS, RENAL FAILURE, & OTHER RENAL SCLEROSI	0	0.7548	0.00	0.0000	4.8886
72	INFECTION OF KIDNEY	0	0.2097	0.00	0.0000	17.5928
73	CALCULI OF URINARY SYSTEM	0	0.0389	0.00	0.0000	94.8556
74	HYPERPLASIA OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
75	OTHER DISEASES OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	0.0000
76	DISEASES OF THE BREAST	0	0.0040	0.00	0.0000	915.0793

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: FER1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	0	0.0999	0.00	0.0000	36.9218
78	OTHER GENITO-URINARY SYSTEM DISEASES	1	0.4229	2.36	0.0598	13.1359
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	0	0.1665	0.00	0.0000	22.1579
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	0	0.0391	0.00	0.0000	94.4678
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	0	0.1275	0.00	0.0000	28.9478
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE	0	0.6162	0.00	0.0000	5.9879
81	ARTHRITIS AND SPONDYLITIS	0	0.1835	0.00	0.0000	20.1123
82	OSTEOMYELITIS AND PERIOSTITIS	0	0.0157	0.00	0.0000	235.3921
83	OTHER DISEASES OF MS SYSTEM	0	0.4171	0.00	0.0000	8.8468
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	1	1.1643	0.86	0.0217	4.7716
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	1	1.1643	0.86	0.0217	4.7716
24	ACCIDENTS	4	4.8789	0.82	0.2234	2.0968
85	TRANSPORTATION ACCIDENTS	4	2.8857	1.39	0.3777	3.5451
86	ACCIDENTAL POISONING	0	0.3831	0.00	0.0000	9.6327
87	ACCIDENTAL FALLS	0	0.4455	0.00	0.0000	8.2832
88	OTHER ACCIDENTS	0	0.9534	0.00	0.0000	3.8705
89	MEDICAL COMPLICATIONS AND MISADVENTURE	0	0.2113	0.00	0.0000	17.4643
25	VIOLENCE	1	2.9654	0.34	0.0085	1.8735
90	SUICIDE	1	2.1442	0.47	0.0118	2.5910
91	HOMICIDE	0	0.8212	0.00	0.0000	4.4933
26	OTHER CAUSES	1	2.9604	0.34	0.0085	1.8766
92	OTHER CAUSES	1	2.9604	0.34	0.0085	1.8766

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Summary of Observed and Expected Deaths
Study File: FER1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
	All Cancers	29	37.5153	0.77	0.5176	1.1102
	All Deaths	75	106.5394	0.70**	0.5537	0.8824

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

APPENDIX III TABLE 2: SMRs FOR HANFORD FEMALE WORKERS

PC LIFE TABLE ANALYSIS SYSTEM Page: 1

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==============================================================================
                        G L O B A L   P A R A M E T E R S
STUDY PARAMETER FILE NAME: c:\ltas\han1.ltp
LAST COMPLETE STEP: Stratify
STUDY DESCRIPTION: han1
STUDY BEGIN DATE: 01/01/1940
STUDY END DATE: 01/01/1994
RATES IN USE: Standard U.S. Deaths 92 Minors 1940 - 99
AGE CATEGORIES: 15\20\25\30\35\40\45\50\55\60\65\70\75\80\85\
CALENDAR CATEGORIES: 1940\1945\1950\1955\1960\1965\1970\1975\1980\1985\1990\1995\
SINGLE CAUSE OF DEATH
==============================================================================
                        V E R I F Y   P A R A M E T E R S
INPUT DEMOGRAPHICS FILE: c:\ltas\han\dem
INPUT WORK HISTORY FILE: c:\ltas\han\wh
OUTPUT DEMOGRAPHICS FILE: c:\ltas\dem.out
OUTPUT WORK HISTORY FILE: c:\ltas\wh.out
BEGIN PERSON TIME AT LATER OF In-rec / Rate begin
STOP SURVIVORS PERSON TIME AT: END OF STUDY
GENDER/RACE SUBSETTING: KEEP ALL
EXPOSURE LEVEL: All exposed equally (no data)

SUMMARY REPORT FILE: .\summary.rpt
EXCEPTIONS REPORT FILE: .\except.rpt
EXPOSURE REPORT FILE: .\experr.rpt
==============================================================================
                      S T R A T I F Y   P A R A M E T E R S
ANALYSIS TYPE: SMR
```

DURATION	TIME SINCE FIRST EXPOSURE
MINIMUM->000Y	000Y
005Y	005Y
010Y	010Y
015Y	015Y
020Y	020Y
025Y	025Y
030Y	030Y

PERSON YEARS FILE: C:\LTAS\HAN1PY
OBSERVED DEATHS FILE: C:\LTAS\HAN1OB

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: HAN1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	62777.20	0.00	0.00	0.00	0.00	0.00	0.00	62777.20
005Y - 010Y	40371.35	22108.94	0.00	0.00	0.00	0.00	0.00	62480.29
010Y - 015Y	40079.63	9785.16	12219.08	0.00	0.00	0.00	0.00	62083.87
015Y - 020Y	35100.59	6271.39	4085.71	7703.52	0.00	0.00	0.00	53161.20
020Y - 025Y	29525.36	4041.38	1958.25	2423.14	5087.14	0.00	0.00	43035.26
025Y - 030Y	26302.34	3459.80	1492.72	1528.11	1709.86	3216.82	0.00	37709.65
030Y & Over	62684.15	7668.89	2979.30	2483.25	2968.04	2522.92	5150.77	86457.32
Total	296840.62	53335.56	22735.06	14138.02	9765.04	5739.73	5150.77	407704.79

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: HAN1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	40.58	606.33	965.53	646.04	243.70	377.43	411.50	1041.30	113.66	0.00	0.00
20-24	135.19	3264.60	5200.19	4189.33	2017.64	2094.88	2201.77	4469.10	2789.35	113.24	0.00
25-29	91.37	2937.69	6385.45	6623.02	4513.15	2677.28	3018.58	4801.07	6010.16	2781.57	113.10
30-34	63.35	1850.04	4762.26	7170.49	6761.45	4792.22	3062.10	4344.37	5621.07	6001.64	2570.81
35-39	54.35	1527.85	3332.09	5451.98	7292.67	6899.67	5018.75	3842.42	4823.61	5604.71	4927.79
40-44	29.74	1189.14	2636.10	3919.06	5569.00	7471.50	7063.93	5500.79	4150.88	4790.88	4396.19
45-49	17.69	731.64	1788.85	2937.24	3954.25	5671.76	7599.04	7374.54	5693.54	4116.53	3730.15
50-54	19.86	556.22	1049.73	1858.33	2930.70	3990.94	5636.41	7747.65	7442.98	5637.07	3297.07
55-59	4.69	290.81	642.80	1036.45	1824.20	2892.47	3954.58	5602.05	7688.23	7317.94	4631.98
60-64	1.68	78.05	303.52	636.57	991.91	1755.07	2794.70	3812.72	5440.96	7485.71	5839.35
65-69	0.00	21.80	76.90	280.77	607.18	942.08	1642.23	2617.14	3583.59	5155.99	5673.94
70-74	0.00	2.05	21.92	72.18	240.91	561.84	865.92	1491.44	2346.58	3289.32	3654.26
75-79	0.00	0.00	2.04	19.68	60.98	198.93	487.07	726.68	1283.30	2028.88	2269.74
80-84	0.00	0.00	0.00	2.04	15.11	51.07	134.17	366.11	578.01	1031.04	1260.09
85+	0.00	0.00	0.00	0.00	2.05	15.75	47.89	106.20	338.52	591.73	764.30
TOTAL	458.52	13056.24	27167.38	34843.20	37024.89	40392.88	43938.64	53843.58	57904.44	55946.25	43128.78

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: HAN1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1995+	TOTAL
15-19	0.00	4446.07
20-24	0.00	26475.29
25-29	0.00	39952.45
30-34	0.00	46999.81
35-39	0.00	48775.89
40-44	0.00	46717.22
45-49	0.00	43615.23
50-54	0.00	40166.96
55-59	0.00	35886.21
60-64	0.00	29140.25
65-69	0.00	20601.62
70-74	0.00	12546.41
75-79	0.00	7077.31
80-84	0.00	3437.66
85+	0.00	1866.43
TOTAL	0.00	407704.79

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: HAN1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
1	TUBERCULOSIS	0	9.2216	0.00**	0.0000	0.4001
1	RESPIRATORY TUBERCULOSIS	0	8.2084	0.00**	0.0000	0.4495
2	OTHER TUBERCULOSIS	0	1.0132	0.00	0.0000	3.6419
2	MN OF BUCCAL CAVITY AND PHARYNX	7	9.9163	0.71	0.2828	1.4545
3	MN OF LIP	0	0.0572	0.00	0.0000	64.4942
4	MN OF TONGUE	1	2.3313	0.43	0.0109	2.3831
5	MN OF OTHER PARTS OF BUCCAL CAVITY	2	3.2069	0.62	0.0755	2.2515
6	MN OF PHARYNX	4	4.3209	0.93	0.2522	2.3676
3	MN OF DIGESTIVE ORGANS AND PERITONEUM	126	176.5390	0.71**	0.5945	0.8498
7	MN OF ESOPHAGUS	4	6.9042	0.58	0.1579	1.4817
8	MN OF STOMACH	12	19.3602	0.62	0.3199	1.0828
9	MN OF INTESTINE EXCEPT RECTUM	57	77.7059	0.73*	0.5555	0.9504
10	MN OF RECTUM	11	14.7490	0.75	0.3718	1.3346
11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	11	13.9676	0.79	0.3926	1.4092
12	MN OF LIVER NOT SPECIFIED	2	4.5683	0.44	0.0530	1.5805
13	MN OF PANCREAS	27	35.6758	0.76	0.4986	1.1012
14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	2	3.6080	0.55	0.0671	2.0012
4	MN OF RESPIRATORY SYSTEM	121	139.4438	0.87	0.7200	1.0368
15	MN OF LARYNX	2	2.5343	0.79	0.0955	2.8490
16	MN OF TRACHEA, BRONCHUS, AND LUNG	118	135.1474	0.87	0.7227	1.0456
17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	1	1.7621	0.57	0.0144	3.1527
5	MN OF BREAST	142	166.6459	0.85	0.7177	1.0044
18	MN OF BREAST	142	166.6459	0.85	0.7177	1.0044

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: HAN1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
6	MN OF FEMALE GENITAL ORGANS	73	106.8097	0.68**	0.5357	0.8594
19	MN OF CERVIX UTERI	16	27.2369	0.59*	0.3356	0.9540
20	MN OF OTHER AND UNSPECIFIED PARTS OF UTERUS	11	24.0371	0.46**	0.2281	0.8189
21	MN OF OVARY, FALLOPIAN TUBE, AND BROAD LIGAMENT	45	52.3908	0.86	0.6264	1.1493
22	MN OF OTHER FEMALE GENITAL ORGANS	1	3.1449	0.32	0.0080	1.7665
7	MN OF MALE GENITAL ORGANS	0	0.0001	0.00	0.0000	29580.8926
23	MN OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
24	MN OF OTHER MALE GENITAL ORGANS	0	0.0001	0.00	0.0000	29580.8926
8	MN OF URINARY ORGANS	12	20.8452	0.58	0.2971	1.0057
25	MN OF KIDNEY	8	12.1318	0.66	0.2839	1.2994
26	MN OF BLADDER AND OTHER URINARY ORGANS	4	8.7134	0.46	0.1251	1.1741
9	MN OF OTHER AND UNSPECIFIED SITES	70	91.7473	0.76*	0.5947	0.9640
27	MN OF SKIN	8	11.2559	0.71	0.3060	1.4005
28	MN OF EYE	0	0.5719	0.00	0.0000	6.4525
29	MN OF BRAIN AND OTHER PARTS OF NERVOUS SYSTEM	16	20.2383	0.79	0.4516	1.2839
30	MN OF THYROID GLAND	2	2.2569	0.89	0.1073	3.1992
31	MN OF BONE	2	2.0696	0.97	0.1170	3.4888
32	MN OF CONNECTIVE TISSUE AND SOFT TISSUE	6	4.4176	1.36	0.4960	2.9563
33	MN OF OTHER AND UNSPECIFIED SITES (MINOR)	36	50.9372	0.71*	0.4949	0.9785
10	NEOPLASMS OF LYMPHATIC AND HEMATOPOIETIC TISSUE	57	66.4389	0.86	0.6497	1.1116
34	LYMPHOSARCOMA AND RETICULOSARCOMA	9	9.0429	1.00	0.4541	1.8894
35	HODGKIN'S DISEASE	6	4.8164	1.25	0.4549	2.7115
36	LEUKEMIA AND ALEUKEMIA	20	25.2015	0.79	0.4845	1.2257
37	OTHER NEOPLASMS OF LYMPHATIC HEMATOPOIETIC TISSUE	22	27.3781	0.80	0.5034	1.2167

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: HAN1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
11	BENIGN AND UNSPECIFIED NEOPLASMS	5	13.0067	0.38*	0.1244	0.8982
38	BENIGN NEOPLASMS OF THE EYE, BRAIN, AND OTHER PARTS OF NERVOUS SYS	1	2.5329	0.39	0.0100	2.1934
39	NEOPLASMS OF EYE, BRAIN, & OTHER PARTS OF NERV SYSTEM UNSPECIF. NA	2	4.8991	0.41	0.0494	1.4738
40	OTHER BENIGN AND UNSPECIFIED NATURE NEOPLASMS	2	5.5747	0.36	0.0434	1.2952
12	DIABETES MELLITUS	31	67.0519	0.46**	0.3141	0.6563
41	DIABETES MELLITUS	31	67.0519	0.46**	0.3141	0.6563
13	DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS	7	10.6563	0.66	0.2632	1.3535
42	PERNICIOUS ANEMIAS	0	0.3731	0.00	0.0000	9.8889
43	ANEMIAS OF OTHER AND UNSPECIFIED TYPE	4	4.4973	0.89	0.2423	2.2747
44	COAGULATION DEFECTS, PURPURA, AND OTHER HEMORRHAGIC CONDITIONS	0	2.7175	0.00	0.0000	1.3579
45	ALL OTHER DISEASES OF BLOOD FORMING ORGANS	3	3.0683	0.98	0.2016	2.8588
14	MENTAL, PSYCHONEUROTIC, AND PERSONALITY DISORDERS	27	19.5139	1.38	0.9116	2.0132
46	ALCOHOLISM	4	4.6880	0.85	0.2325	2.1822
47	OTHER MENTAL DISORDERS	23	14.8259	1.55	0.9831	2.3279
15	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	30	42.5391	0.71	0.4757	1.0068
48	MULTIPLE SCLEROSIS	2	6.0303	0.33	0.0402	1.1973
49	OTHER DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	28	36.5088	0.77	0.5095	1.1085
16	DISEASES OF THE HEART	511	835.0543	0.61**	0.5600	0.6674
50	RHEUMATIC HEART DISEASE, INCLUDING FEVER	18	32.2441	0.56*	0.3307	0.8823
51	ISCHEMIC HEART DISEASE	406	604.3952	0.67**	0.6080	0.7404
52	CHRONIC DISEASE OF ENDOCARDIUM	5	11.0396	0.45	0.1466	1.0582
53	OTHER MYOCARDIAL DEGENERATION	2	7.8464	0.25*	0.0309	0.9202
54	HYPERTENSION WITH HEART DISEASE	15	34.3483	0.44**	0.2442	0.7203
55	OTHER DISEASES OF THE HEART	65	145.1807	0.45**	0.3455	0.5707

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: HAN1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
17	OTHER DISEASES OF CIRCULATORY SYSTEM	237	301.6054	0.79**	0.6889	0.8925
56	HYPERTENSION WITHOUT HEART DISEASE	8	10.7408	0.74	0.3207	1.4677
57	CEREBROVASCULAR DISEASE	179	219.0759	0.82**	0.7017	0.9459
58	DISEASES OF THE ARTERIES, VEINS, AND PULMONARY CIRCULATION	50	71.7887	0.70**	0.5169	0.9183
18	DISEASES OF THE RESPIRATORY SYSTEM	156	172.5925	0.90	0.7676	1.0574
59	ACUTE RESPIRATORY INFECTIONS EXCEPT INFLUENZA AND PNEUMONIA	1	1.2145	0.82	0.0208	4.5743
60	INFLUENZA	4	3.3195	1.21	0.3283	3.0819
61	PNEUMONIA (EXCEPT NEWBORN)	52	66.0739	0.79	0.5877	1.0321
62	CHRONIC AND UNSPECIFIED BRONCHITIS	3	4.9678	0.60	0.1245	1.7657
63	EMPHYSEMA	20	17.6711	1.13	0.6910	1.7481
64	ASTHMA	8	8.0190	1.00	0.4296	1.9659
65	PNEUMOCONIOSES AND OTHER RESPIRATORY DISEASES	68	71.3267	0.95	0.7403	1.2086
19	DISEASES OF THE DIGESTIVE SYSTEM	108	121.7867	0.89	0.7274	1.0707
66	DISEASES OF THE STOMACH AND DUODENUM	10	10.9005	0.92	0.4392	1.6872
67	HERNIA AND INTESTINAL OBSTRUCTION	9	9.8177	0.92	0.4183	1.7403
68	CIRRHOSIS OF THE LIVER	54	50.2129	1.08	0.8078	1.4032
69	OTHER DISEASES OF DIGESTIVE SYSTEM	35	50.8556	0.69*	0.4793	0.9572
20	DISEASES OF THE GENITO-URINARY SYSTEM	20	45.8913	0.44**	0.2661	0.6731
70	ACUTE GLOMERULONEPHRITIS, NEPHROTIC SYNDROME, & ACUTE RENAL FAILUR	1	3.8201	0.26	0.0066	1.4543
71	CHRONIC & UNSPEC. NEPHRITIS, RENAL FAILURE, & OTHER RENAL SCLEROSI	0	19.5919	0.00**	0.0000	0.1883
72	INFECTION OF KIDNEY	2	6.1093	0.33	0.0396	1.1818
73	CALCULI OF URINARY SYSTEM	1	1.1435	0.87	0.0221	4.8584
74	HYPERPLASIA OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
75	OTHER DISEASES OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	0.0000
76	DISEASES OF THE BREAST	0	0.0919	0.00	0.0000	40.1536

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: HAN1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	2	2.1183	0.94	0.1143	3.4086
78	OTHER GENITO-URINARY SYSTEM DISEASES	14	13.0164	1.08	0.5875	1.8047
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	3	4.3881	0.68	0.1410	1.9990
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	2	0.9666	2.07	0.2505	7.4698
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	1	3.4215	0.29	0.0074	1.6237
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE	14	13.2310	1.06	0.5780	1.7755
81	ARTHRITIS AND SPONDYLITIS	4	4.9517	0.81	0.2201	2.0660
82	OSTEOMYELITIS AND PERIOSTITIS	0	0.4177	0.00	0.0000	8.8344
83	OTHER DISEASES OF MS SYSTEM	10	7.8617	1.27	0.6090	2.3394
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	12	24.7730	0.48**	0.2500	0.8462
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	12	24.7730	0.48**	0.2500	0.8462
24	ACCIDENTS	100	94.4172	1.06	0.8617	1.2882
85	TRANSPORTATION ACCIDENTS	54	49.8960	1.08	0.8130	1.4121
86	ACCIDENTAL POISONING	9	6.4751	1.39	0.6343	2.6387
87	ACCIDENTAL FALLS	5	14.7954	0.34**	0.1094	0.7896
88	OTHER ACCIDENTS	29	18.7455	1.55*	1.0359	2.2219
89	MEDICAL COMPLICATIONS AND MISADVENTURE	3	4.5052	0.67	0.1373	1.9471
25	VIOLENCE	46	47.2463	0.97	0.7127	1.2987
90	SUICIDE	40	34.9247	1.15	0.8181	1.5597
91	HOMICIDE	6	12.3216	0.49	0.1778	1.0599
26	OTHER CAUSES	89	64.4534	1.38**	1.1089	1.6993
92	OTHER CAUSES	89	64.4534	1.38**	1.1089	1.6993

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: HAN1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
	All Cancers	608	778.3863	0.78**	0.7202	0.8457
	All Deaths	2004	2665.8147	0.75**	0.7192	0.7854

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

APPENDIX III TABLE 3: SMRs FOR K-25 FEMALE WORKERS

PC LIFE TABLE ANALYSIS SYSTEM

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================================================================================
                        G L O B A L   P A R A M E T E R S
STUDY PARAMETER FILE NAME: c:\ltas\k251.ltp
LAST COMPLETE STEP: Stratify
STUDY DESCRIPTION: k25
STUDY BEGIN DATE: 01/01/1940
STUDY END DATE: 01/01/1994
RATES IN USE: Standard U.S. Deaths 92 Minors 1940 - 99
AGE CATEGORIES: 15\20\25\30\35\40\45\50\55\60\65\70\75\80\85\
CALENDAR CATEGORIES: 1940\1945\1950\1955\1960\1965\1970\1975\1980\1985\1990\1995\
SINGLE CAUSE OF DEATH
================================================================================
                        V E R I F Y   P A R A M E T E R S
INPUT DEMOGRAPHICS FILE: c:\ltas\k25\dem
INPUT WORK HISTORY FILE: c:\ltas\k25\wh
OUTPUT DEMOGRAPHICS FILE: c:\ltas\dem.out
OUTPUT WORK HISTORY FILE: c:\ltas\wh.out
BEGIN PERSON TIME AT LATER OF In-rec / Rate begin
STOP SURVIVORS PERSON TIME AT: END OF STUDY
GENDER/RACE SUBSETTING: KEEP ALL
EXPOSURE LEVEL: All exposed equally (no data)

SUMMARY REPORT FILE: .\summary.rpt
EXCEPTIONS REPORT FILE: .\except.rpt
EXPOSURE REPORT FILE: .\experr.rpt
================================================================================
                      S T R A T I F Y   P A R A M E T E R S
ANALYSIS TYPE: SMR
```

DURATION	TIME SINCE FIRST EXPOSURE
MINIMUM->000Y	000Y
005Y	005Y
010Y	010Y
015Y	015Y
020Y	020Y
025Y	025Y
030Y	030Y

PERSON YEARS FILE: C:\LTAS\K251PY
OBSERVED DEATHS FILE: C:\LTAS\K251OB

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: K251.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	52754.16	0.00	0.00	0.00	0.00	0.00	0.00	52754.16
005Y - 010Y	39088.19	13435.73	0.00	0.00	0.00	0.00	0.00	52523.92
010Y - 015Y	38782.89	2811.83	10476.81	0.00	0.00	0.00	0.00	52071.53
015Y - 020Y	37432.69	2429.43	1223.73	6839.37	0.00	0.00	0.00	47925.21
020Y - 025Y	36004.25	2085.17	900.40	634.57	4061.41	0.00	0.00	43685.80
025Y - 030Y	34354.51	1859.58	797.08	527.76	327.10	2929.60	0.00	40795.62
030Y & Over	109731.52	5137.83	2101.34	1392.02	711.35	1121.08	6080.45	126275.58
Total	348148.22	27759.56	15499.35	9393.71	5099.86	4050.68	6080.45	416031.83

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Distribution of Person Years
Study File: K251.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	239.56	1997.19	170.44	96.84	49.71	104.06	81.41	155.14	17.57	0.00	0.00
20-24	378.43	13842.11	3665.51	1146.69	609.63	596.91	1002.30	1403.06	840.14	17.49	0.00
25-29	166.59	8403.81	15033.55	4291.18	1375.40	785.95	1055.10	2074.14	2350.55	838.48	17.49
30-34	111.08	4561.23	9016.29	15253.16	4358.04	1411.04	923.53	1639.79	2503.77	2348.92	796.51
35-39	72.52	2912.85	4898.75	9124.25	15238.64	4390.31	1534.10	1367.49	1919.15	2496.05	1946.97
40-44	45.88	1845.06	3125.40	4912.22	9077.18	15134.58	4449.04	1805.29	1506.22	1913.17	1997.01
45-49	20.29	1020.10	1935.85	3136.27	4882.20	8931.56	14926.96	4602.93	1893.84	1500.47	1443.31
50-54	10.31	440.40	1076.76	1913.35	3104.00	4801.61	8755.94	14781.66	4594.09	1880.54	1170.79
55-59	3.54	185.42	451.32	1038.30	1868.23	3022.54	4624.81	8573.28	14447.61	4513.37	1554.91
60-64	0.88	71.20	189.27	418.98	994.49	1797.37	2878.41	4389.02	8250.70	13980.91	3938.93
65-69	0.00	16.53	70.11	169.29	395.58	938.17	1649.82	2697.13	4093.14	7786.34	11062.23
70-74	0.00	1.02	16.69	62.89	143.33	339.30	811.53	1461.95	2408.13	3718.11	5154.80
75-79	0.00	3.86	1.14	15.77	47.58	126.93	272.20	668.26	1246.13	2007.51	2478.72
80-84	0.00	0.00	3.86	1.14	14.44	32.54	84.82	207.53	511.26	974.83	1227.57
85+	0.00	0.00	0.00	3.86	5.00	19.16	43.14	86.09	202.24	488.01	803.53
TOTAL	1049.10	35300.78	39654.93	41584.18	42163.45	42432.03	43093.11	45912.74	46784.55	44464.19	33592.77

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: K251.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1995+	TOTAL
15-19	0.00	2911.92
20-24	0.00	23502.26
25-29	0.00	36392.24
30-34	0.00	42923.38
35-39	0.00	45901.08
40-44	0.00	45811.04
45-49	0.00	44293.77
50-54	0.00	42529.45
55-59	0.00	40283.34
60-64	0.00	36910.17
65-69	0.00	28878.33
70-74	0.00	14117.75
75-79	0.00	6868.09
80-84	0.00	3057.99
85+	0.00	1651.03
TOTAL	0.00	416031.83

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: K251.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number		Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
1		TUBERCULOSIS	7	19.8619	0.35**	0.1412	0.7262
	1	RESPIRATORY TUBERCULOSIS	5	18.0261	0.28**	0.0898	0.6481
	2	OTHER TUBERCULOSIS	2	1.8358	1.09	0.1319	3.9331
2		MN OF BUCCAL CAVITY AND PHARYNX	16	11.8504	1.35	0.7712	2.1927
	3	MN OF LIP	0	0.0613	0.00	0.0000	60.2207
	4	MN OF TONGUE	7	2.7712	2.53*	1.0120	5.2047
	5	MN OF OTHER PARTS OF BUCCAL CAVITY	5	3.7506	1.33	0.4314	3.1148
	6	MN OF PHARYNX	4	5.2673	0.76	0.2069	1.9422
3		MN OF DIGESTIVE ORGANS AND PERITONEUM	148	202.5223	0.73**	0.6178	0.8585
	7	MN OF ESOPHAGUS	10	8.7865	1.14	0.5449	2.0932
	8	MN OF STOMACH	18	22.3150	0.81	0.4778	1.2749
	9	MN OF INTESTINE EXCEPT RECTUM	69	88.1056	0.78*	0.6093	0.9911
	10	MN OF RECTUM	12	16.7375	0.72	0.3700	1.2525
	11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	6	15.7085	0.38*	0.1395	0.8314
	12	MN OF LIVER NOT SPECIFIED	3	5.2212	0.57	0.1185	1.6800
	13	MN OF PANCREAS	29	41.5497	0.70	0.4673	1.0024
	14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	1	4.0981	0.24	0.0062	1.3556
4		MN OF RESPIRATORY SYSTEM	133	165.6352	0.80*	0.6723	0.9516
	15	MN OF LARYNX	3	3.1421	0.95	0.1969	2.7917
	16	MN OF TRACHEA, BRONCHUS, AND LUNG	129	160.4973	0.80*	0.6710	0.9550
	17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	1	1.9958	0.50	0.0127	2.7837
5		MN OF BREAST	135	190.1756	0.71**	0.5952	0.8402
	18	MN OF BREAST	135	190.1756	0.71**	0.5952	0.8402

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: K251.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
6	MN OF FEMALE GENITAL ORGANS	100	127.2461	0.79*	0.6394	0.9559
19	MN OF CERVIX UTERI	25	33.2687	0.75	0.4862	1.1094
20	MN OF OTHER AND UNSPECIFIED PARTS OF UTERUS	22	29.4899	0.75	0.4674	1.1295
21	MN OF OVARY, FALLOPIAN TUBE, AND BROAD LIGAMENT	46	60.8911	0.76	0.5530	1.0077
22	MN OF OTHER FEMALE GENITAL ORGANS	7	3.5964	1.95	0.7798	4.0105
7	MN OF MALE GENITAL ORGANS	0	0.0001	0.00	0.0000	30588.5410
23	MN OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
24	MN OF OTHER MALE GENITAL ORGANS	0	0.0001	0.00	0.0000	30588.5410
8	MN OF URINARY ORGANS	20	23.6715	0.84	0.5159	1.3049
25	MN OF KIDNEY	15	13.8281	1.08	0.6067	1.7892
26	MN OF BLADDER AND OTHER URINARY ORGANS	5	9.8434	0.51	0.1644	1.1868
9	MN OF OTHER AND UNSPECIFIED SITES	90	104.3448	0.86	0.6935	1.0602
27	MN OF SKIN	14	11.8935	1.18	0.6430	1.9751
28	MN OF EYE	0	0.6309	0.00	0.0000	5.8492
29	MN OF BRAIN AND OTHER PARTS OF NERVOUS SYSTEM	22	22.8345	0.96	0.6036	1.4588
30	MN OF THYROID GLAND	3	2.5404	1.18	0.2435	3.4529
31	MN OF BONE	2	2.2481	0.89	0.1077	3.2117
32	MN OF CONNECTIVE TISSUE AND SOFT TISSUE	3	4.8699	0.62	0.1270	1.8012
33	MN OF OTHER AND UNSPECIFIED SITES (MINOR)	46	59.3275	0.78	0.5676	1.0342
10	NEOPLASMS OF LYMPHATIC AND HEMATOPOIETIC TISSUE	52	74.6807	0.70**	0.5200	0.9131
34	LYMPHOSARCOMA AND RETICULOSARCOMA	8	10.2038	0.78	0.3376	1.5449
35	HODGKIN'S DISEASE	4	5.1003	0.78	0.2137	2.0058
36	LEUKEMIA AND ALEUKEMIA	14	27.7388	0.50**	0.2757	0.8469
37	OTHER NEOPLASMS OF LYMPHATIC HEMATOPOIETIC TISSUE	26	31.6378	0.82	0.5367	1.2042

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: K251.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
11	BENIGN AND UNSPECIFIED NEOPLASMS	12	15.7998	0.76	0.3920	1.3268
38	BENIGN NEOPLASMS OF THE EYE, BRAIN, AND OTHER PARTS OF NERVOUS SYS	0	3.0519	0.00	0.0000	1.2091
39	NEOPLASMS OF EYE, BRAIN, & OTHER PARTS OF NERV SYSTEM UNSPECIF. NA	5	5.6715	0.88	0.2853	2.0598
40	OTHER BENIGN AND UNSPECIFIED NATURE NEOPLASMS	7	7.0764	0.99	0.3963	2.0382
12	DIABETES MELLITUS	62	78.8158	0.79	0.6031	1.0085
41	DIABETES MELLITUS	62	78.8158	0.79	0.6031	1.0085
13	DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS	8	12.0836	0.66	0.2851	1.3046
42	PERNICIOUS ANEMIAS	0	0.4151	0.00	0.0000	8.8900
43	ANEMIAS OF OTHER AND UNSPECIFIED TYPE	3	5.0597	0.59	0.1223	1.7337
44	COAGULATION DEFECTS, PURPURA, AND OTHER HEMORRHAGIC CONDITIONS	3	3.1459	0.95	0.1966	2.7884
45	ALL OTHER DISEASES OF BLOOD FORMING ORGANS	2	3.4630	0.58	0.0699	2.0850
14	MENTAL, PSYCHONEUROTIC, AND PERSONALITY DISORDERS	25	20.8144	1.20	0.7771	1.7731
46	ALCOHOLISM	9	5.7165	1.57	0.7184	2.9889
47	OTHER MENTAL DISORDERS	16	15.0979	1.06	0.6053	1.7211
15	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	21	47.6466	0.44**	0.2727	0.6738
48	MULTIPLE SCLEROSIS	3	6.9479	0.43	0.0890	1.2625
49	OTHER DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	18	40.6987	0.44**	0.2620	0.6990
16	DISEASES OF THE HEART	699	915.4562	0.76**	0.7080	0.8223
50	RHEUMATIC HEART DISEASE, INCLUDING FEVER	28	39.1866	0.71	0.4747	1.0327
51	ISCHEMIC HEART DISEASE	557	649.9267	0.86**	0.7873	0.9312
52	CHRONIC DISEASE OF ENDOCARDIUM	3	12.2325	0.25**	0.0506	0.7171
53	OTHER MYOCARDIAL DEGENERATION	4	8.6196	0.46	0.1264	1.1869
54	HYPERTENSION WITH HEART DISEASE	16	42.7706	0.37**	0.2137	0.6075
55	OTHER DISEASES OF THE HEART	91	162.7202	0.56**	0.4503	0.6866

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: K251.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
17	OTHER DISEASES OF CIRCULATORY SYSTEM	268	327.5009	0.82**	0.7233	0.9224
56	HYPERTENSION WITHOUT HEART DISEASE	8	13.6067	0.59	0.2532	1.1586
57	CEREBROVASCULAR DISEASE	193	236.7686	0.82**	0.7042	0.9386
58	DISEASES OF THE ARTERIES, VEINS, AND PULMONARY CIRCULATION	67	77.1256	0.87	0.6732	1.1033
18	DISEASES OF THE RESPIRATORY SYSTEM	165	194.4047	0.85*	0.7242	0.9886
59	ACUTE RESPIRATORY INFECTIONS EXCEPT INFLUENZA AND PNEUMONIA	1	1.3691	0.73	0.0185	4.0579
60	INFLUENZA	1	3.7705	0.27	0.0067	1.4734
61	PNEUMONIA (EXCEPT NEWBORN)	66	71.0458	0.93	0.7184	1.1819
62	CHRONIC AND UNSPECIFIED BRONCHITIS	5	5.6320	0.89	0.2873	2.0742
63	EMPHYSEMA	22	20.5929	1.07	0.6693	1.6175
64	ASTHMA	5	9.4976	0.53	0.1704	1.2300
65	PNEUMOCONIOSES AND OTHER RESPIRATORY DISEASES	65	82.4967	0.79	0.6081	1.0043
19	DISEASES OF THE DIGESTIVE SYSTEM	102	141.5399	0.72**	0.5876	0.8748
66	DISEASES OF THE STOMACH AND DUODENUM	12	12.1766	0.99	0.5086	1.7216
67	HERNIA AND INTESTINAL OBSTRUCTION	10	11.2034	0.89	0.4273	1.6416
68	CIRRHOSIS OF THE LIVER	40	60.4660	0.66**	0.4725	0.9008
69	OTHER DISEASES OF DIGESTIVE SYSTEM	40	57.6939	0.69*	0.4953	0.9441
20	DISEASES OF THE GENITO-URINARY SYSTEM	36	55.9421	0.64**	0.4506	0.8909
70	ACUTE GLOMERULONEPHRITIS, NEPHROTIC SYNDROME, & ACUTE RENAL FAILUR	1	4.7353	0.21	0.0053	1.1732
71	CHRONIC & UNSPEC. NEPHRITIS, RENAL FAILURE, & OTHER RENAL SCLEROSI	7	24.8282	0.28**	0.1130	0.5809
72	INFECTION OF KIDNEY	10	7.3452	1.36	0.6518	2.5039
73	CALCULI OF URINARY SYSTEM	1	1.3373	0.75	0.0189	4.1542
74	HYPERPLASIA OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
75	OTHER DISEASES OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	0.0000
76	DISEASES OF THE BREAST	0	0.1056	0.00	0.0000	34.9290

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: K251.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	4	3.0907	1.29	0.3526	3.3100
78	OTHER GENITO-URINARY SYSTEM DISEASES	13	14.4997	0.90	0.4769	1.5333
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	4	5.3241	0.75	0.2047	1.9215
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	1	1.1161	0.90	0.0227	4.9778
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	3	4.2080	0.71	0.1470	2.0846
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE	15	14.7435	1.02	0.5690	1.6781
81	ARTHRITIS AND SPONDYLITIS	6	5.5853	1.07	0.3923	2.3383
82	OSTEOMYELITIS AND PERIOSTITIS	0	0.4990	0.00	0.0000	7.3943
83	OTHER DISEASES OF MS SYSTEM	9	8.6592	1.04	0.4743	1.9731
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	57	29.4254	1.94**	1.4670	2.5098
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	57	29.4254	1.94**	1.4670	2.5098
24	ACCIDENTS	94	99.1479	0.95	0.7661	1.1602
85	TRANSPORTATION ACCIDENTS	55	50.2675	1.09	0.8242	1.4242
86	ACCIDENTAL POISONING	1	6.6421	0.15*	0.0038	0.8364
87	ACCIDENTAL FALLS	15	15.2776	0.98	0.5491	1.6195
88	OTHER ACCIDENTS	21	21.8125	0.96	0.5957	1.4717
89	MEDICAL COMPLICATIONS AND MISADVENTURE	2	5.1481	0.39	0.0470	1.4025
25	VIOLENCE	50	48.6581	1.03	0.7626	1.3548
90	SUICIDE	31	35.5024	0.87	0.5932	1.2395
91	HOMICIDE	19	13.1556	1.44	0.8691	2.2555
26	OTHER CAUSES	125	76.8894	1.63**	1.3532	1.9370
92	OTHER CAUSES	125	76.8894	1.63**	1.3532	1.9370

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Summary of Observed and Expected Deaths
Study File: K251.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
	All Cancers	694	900.1268	0.77**	0.7147	0.8306
	All Deaths	2444	3004.1807	0.81**	0.7816	0.8464

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

APPENDIX III TABLE 4: SMRs FOR LOS ALAMOS FEMALE WORKERS

PC LIFE TABLE ANALYSIS SYSTEM

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==============================================================================
                        G L O B A L   P A R A M E T E R S
STUDY PARAMETER FILE NAME: c:\ltas\lan1.ltp
LAST COMPLETE STEP: Analyze
STUDY DESCRIPTION: lan1
STUDY BEGIN DATE: 01/01/1940
STUDY END DATE: 01/01/1994
RATES IN USE: Standard U.S. Deaths 92 Minors 1940 - 99
AGE CATEGORIES: 15\20\25\30\35\40\45\50\55\60\65\70\75\80\85\
CALENDAR CATEGORIES: 1940\1945\1950\1955\1960\1965\1970\1975\1980\1985\1990\1995\
SINGLE CAUSE OF DEATH
==============================================================================
                        V E R I F Y   P A R A M E T E R S
INPUT DEMOGRAPHICS FILE: c:\ltas\lan\dem
INPUT WORK HISTORY FILE: c:\ltas\lan\wh
OUTPUT DEMOGRAPHICS FILE: c:\ltas\dem.out
OUTPUT WORK HISTORY FILE: c:\ltas\wh.out
BEGIN PERSON TIME AT LATER OF In-rec / Rate begin
STOP SURVIVORS PERSON TIME AT: END OF STUDY
GENDER/RACE SUBSETTING: KEEP ALL
EXPOSURE LEVEL: All exposed equally (no data)

SUMMARY REPORT FILE: .\summary.rpt
EXCEPTIONS REPORT FILE: .\except.rpt
EXPOSURE REPORT FILE: .\experr.rpt
==============================================================================
                      S T R A T I F Y   P A R A M E T E R S
ANALYSIS TYPE: SMR
```

DURATION	TIME SINCE FIRST EXPOSURE
MINIMUM->000Y	000Y
005Y	005Y
010Y	010Y
015Y	015Y
020Y	020Y
025Y	025Y
030Y	030Y

PERSON YEARS FILE: C:\LTAS\LAN1PY
OBSERVED DEATHS FILE: C:\LTAS\LAN1OB

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: LAN1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	33586.02	0.00	0.00	0.00	0.00	0.00	0.00	33586.02
005Y - 010Y	21250.61	12187.05	0.00	0.00	0.00	0.00	0.00	33437.66
010Y - 015Y	21127.62	2368.20	9746.71	0.00	0.00	0.00	0.00	33242.54
015Y - 020Y	19798.68	2319.19	1003.52	7274.25	0.00	0.00	0.00	30395.64
020Y - 025Y	17592.49	2138.60	988.84	724.00	4027.00	0.00	0.00	25470.93
025Y - 030Y	15749.18	1861.82	911.15	691.11	503.50	2544.88	0.00	22261.65
030Y & Over	39156.68	3966.33	1587.90	1330.52	1121.66	616.74	3753.17	51533.00
Total	168261.28	24841.19	14238.12	10019.88	5652.16	3161.63	3753.17	229927.44

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: LAN1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	69.01	427.60	196.10	109.93	193.02	220.36	257.03	271.38	6.47	0.00	0.00
20-24	192.97	2602.86	2033.24	1176.58	883.56	1151.78	1363.89	1876.65	781.73	6.44	0.00
25-29	157.58	2616.98	4424.90	2926.58	1627.67	1266.39	1577.42	2246.62	2264.94	780.75	6.44
30-34	96.69	1386.14	3674.61	5147.68	3277.89	1863.35	1560.10	2308.05	2495.79	2264.94	755.70
35-39	58.53	871.23	1998.70	4190.03	5472.96	3509.41	2049.23	2082.19	2475.17	2486.73	1867.12
40-44	28.82	431.04	1261.76	2410.40	4458.24	5653.34	3654.22	2430.14	2209.42	2464.44	1991.86
45-49	14.69	226.28	643.88	1527.90	2560.11	4601.67	5785.66	3827.15	2514.84	2194.89	1951.10
50-54	6.35	93.88	357.08	766.56	1616.39	2582.11	4637.95	5858.91	3795.64	2487.25	1735.65
55-59	3.40	55.64	125.14	399.84	780.18	1611.36	2508.46	4612.74	5738.09	3708.26	2005.37
60-64	0.39	16.62	61.39	138.63	390.56	774.55	1564.31	2433.40	4481.24	5586.24	3048.26
65-69	0.00	6.00	22.10	64.88	131.18	367.12	727.44	1488.52	2316.71	4228.05	4415.89
70-74	0.00	0.00	6.24	22.11	63.69	116.85	330.57	652.60	1360.65	2164.27	2980.11
75-79	0.00	0.00	0.00	4.33	21.16	56.76	94.26	266.10	584.57	1191.62	1466.28
80-84	0.00	0.00	0.00	0.00	2.18	21.15	50.92	76.93	218.08	480.87	724.05
85+	0.00	0.00	0.00	0.00	0.00	2.18	18.93	56.42	96.94	227.30	368.61
TOTAL	628.42	8734.27	14805.14	18885.45	21478.79	23798.40	26180.38	30487.81	31340.30	30272.05	23316.43

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: LAN1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1995+	TOTAL
15-19	0.00	1750.89
20-24	0.00	12069.69
25-29	0.00	19896.27
30-34	0.00	24830.94
35-39	0.00	27061.30
40-44	0.00	26993.69
45-49	0.00	25848.17
50-54	0.00	23937.77
55-59	0.00	21548.50
60-64	0.00	18495.59
65-69	0.00	13767.89
70-74	0.00	7697.07
75-79	0.00	3685.08
80-84	0.00	1574.19
85+	0.00	770.38
TOTAL	0.00	229927.44

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: LAN1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number		Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
1		TUBERCULOSIS	0	5.4777	0.00**	0.0000	0.6736
	1	RESPIRATORY TUBERCULOSIS	0	4.9178	0.00*	0.0000	0.7503
	2	OTHER TUBERCULOSIS	0	0.5599	0.00	0.0000	6.5906
2		MN OF BUCCAL CAVITY AND PHARYNX	5	6.0473	0.83	0.2676	1.9318
	3	MN OF LIP	0	0.0299	0.00	0.0000	123.5600
	4	MN OF TONGUE	2	1.4175	1.41	0.1708	5.0936
	5	MN OF OTHER PARTS OF BUCCAL CAVITY	0	1.9149	0.00	0.0000	1.9270
	6	MN OF PHARYNX	3	2.6850	1.12	0.2304	3.2670
3		MN OF DIGESTIVE ORGANS AND PERITONEUM	55	101.5998	0.54**	0.4078	0.7046
	7	MN OF ESOPHAGUS	5	4.0821	1.22	0.3964	2.8619
	8	MN OF STOMACH	3	10.6105	0.28*	0.0583	0.8267
	9	MN OF INTESTINE EXCEPT RECTUM	26	44.9019	0.58**	0.3781	0.8485
	10	MN OF RECTUM	4	8.3169	0.48	0.1310	1.2300
	11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	5	7.9363	0.63	0.2039	1.4720
	12	MN OF LIVER NOT SPECIFIED	2	2.5579	0.78	0.0947	2.8228
	13	MN OF PANCREAS	10	21.1373	0.47*	0.2265	0.8701
	14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	0	2.0570	0.00	0.0000	1.7939
4		MN OF RESPIRATORY SYSTEM	64	88.9966	0.72**	0.5538	0.9183
	15	MN OF LARYNX	0	1.5919	0.00	0.0000	2.3179
	16	MN OF TRACHEA, BRONCHUS, AND LUNG	63	86.3616	0.73*	0.5605	0.9334
	17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	1	1.0431	0.96	0.0243	5.3260
5		MN OF BREAST	81	100.6570	0.80	0.6390	1.0002
	18	MN OF BREAST	81	100.6570	0.80	0.6390	1.0002

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: LAN1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
6	MN OF FEMALE GENITAL ORGANS	41	63.0865	0.65**	0.4663	0.8817
19	MN OF CERVIX UTERI	6	15.6764	0.38*	0.1398	0.8331
20	MN OF OTHER AND UNSPECIFIED PARTS OF UTERUS	12	13.7057	0.88	0.4519	1.5295
21	MN OF OVARY, FALLOPIAN TUBE, AND BROAD LIGAMENT	22	31.9341	0.69	0.4316	1.0431
22	MN OF OTHER FEMALE GENITAL ORGANS	1	1.7703	0.56	0.0143	3.1382
7	MN OF MALE GENITAL ORGANS	0	0.0001	0.00	0.0000	51645.1562
23	MN OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
24	MN OF OTHER MALE GENITAL ORGANS	0	0.0001	0.00	0.0000	51645.1562
8	MN OF URINARY ORGANS	6	12.1355	0.49	0.1805	1.0762
25	MN OF KIDNEY	5	7.2933	0.69	0.2219	1.6018
26	MN OF BLADDER AND OTHER URINARY ORGANS	1	4.8422	0.21	0.0052	1.1473
9	MN OF OTHER AND UNSPECIFIED SITES	45	54.7299	0.82	0.5997	1.1002
27	MN OF SKIN	7	6.7145	1.04	0.4177	2.1481
28	MN OF EYE	0	0.3325	0.00	0.0000	11.0985
29	MN OF BRAIN AND OTHER PARTS OF NERVOUS SYSTEM	9	12.4582	0.72	0.3296	1.3715
30	MN OF THYROID GLAND	0	1.2728	0.00	0.0000	2.8991
31	MN OF BONE	0	1.1483	0.00	0.0000	3.2135
32	MN OF CONNECTIVE TISSUE AND SOFT TISSUE	4	2.6376	1.52	0.4132	3.8786
33	MN OF OTHER AND UNSPECIFIED SITES (MINOR)	25	30.1660	0.83	0.5362	1.2235
10	NEOPLASMS OF LYMPHATIC AND HEMATOPOIETIC TISSUE	28	39.3303	0.71	0.4730	1.0290
34	LYMPHOSARCOMA AND RETICULOSARCOMA	4	5.2456	0.76	0.2078	1.9502
35	HODGKIN'S DISEASE	1	2.7524	0.36	0.0092	2.0184
36	LEUKEMIA AND ALEUKEMIA	6	14.6036	0.41*	0.1500	0.8943
37	OTHER NEOPLASMS OF LYMPHATIC HEMATOPOIETIC TISSUE	17	16.7286	1.02	0.5916	1.6272

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: LAN1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
11	BENIGN AND UNSPECIFIED NEOPLASMS	5	7.5020	0.67	0.2157	1.5572
38	BENIGN NEOPLASMS OF THE EYE, BRAIN, AND OTHER PARTS OF NERVOUS SYS	1	1.4838	0.67	0.0170	3.7440
39	NEOPLASMS OF EYE, BRAIN, & OTHER PARTS OF NERV SYSTEM UNSPECIF. NA	2	2.9020	0.69	0.0834	2.4880
40	OTHER BENIGN AND UNSPECIFIED NATURE NEOPLASMS	2	3.1162	0.64	0.0777	2.3170
12	DIABETES MELLITUS	14	37.1052	0.38**	0.2061	0.6331
41	DIABETES MELLITUS	14	37.1052	0.38**	0.2061	0.6331
13	DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS	0	5.8943	0.00**	0.0000	0.6260
42	PERNICIOUS ANEMIAS	0	0.1707	0.00	0.0000	21.6151
43	ANEMIAS OF OTHER AND UNSPECIFIED TYPE	0	2.3576	0.00	0.0000	1.5651
44	COAGULATION DEFECTS, PURPURA, AND OTHER HEMORRHAGIC CONDITIONS	0	1.5734	0.00	0.0000	2.3453
45	ALL OTHER DISEASES OF BLOOD FORMING ORGANS	0	1.7926	0.00	0.0000	2.0584
14	MENTAL, PSYCHONEUROTIC, AND PERSONALITY DISORDERS	19	10.3875	1.83*	1.1007	2.8566
46	ALCOHOLISM	7	2.7399	2.55*	1.0236	5.2643
47	OTHER MENTAL DISORDERS	12	7.6476	1.57	0.8099	2.7411
15	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	10	24.8264	0.40**	0.1928	0.7408
48	MULTIPLE SCLEROSIS	6	3.6918	1.63	0.5935	3.5376
49	OTHER DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	4	21.1347	0.19**	0.0516	0.4840
16	DISEASES OF THE HEART	215	445.0454	0.48**	0.4207	0.5522
50	RHEUMATIC HEART DISEASE, INCLUDING FEVER	8	18.6536	0.43*	0.1847	0.8451
51	ISCHEMIC HEART DISEASE	181	320.2714	0.57**	0.4858	0.6537
52	CHRONIC DISEASE OF ENDOCARDIUM	1	6.1597	0.16*	0.0041	0.9019
53	OTHER MYOCARDIAL DEGENERATION	1	3.2470	0.31	0.0078	1.7110
54	HYPERTENSION WITH HEART DISEASE	6	16.5391	0.36**	0.1325	0.7896
55	OTHER DISEASES OF THE HEART	18	80.1746	0.22**	0.1330	0.3548

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: LAN1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
17	OTHER DISEASES OF CIRCULATORY SYSTEM	113	155.0429	0.73**	0.6006	0.8763
56	HYPERTENSION WITHOUT HEART DISEASE	6	5.5807	1.08	0.3926	2.3402
57	CEREBROVASCULAR DISEASE	74	111.3583	0.66**	0.5218	0.8343
58	DISEASES OF THE ARTERIES, VEINS, AND PULMONARY CIRCULATION	33	38.1039	0.87	0.5960	1.2163
18	DISEASES OF THE RESPIRATORY SYSTEM	84	99.6929	0.84	0.6721	1.0432
59	ACUTE RESPIRATORY INFECTIONS EXCEPT INFLUENZA AND PNEUMONIA	0	0.6687	0.00	0.0000	5.5179
60	INFLUENZA	5	1.6819	2.97	0.9621	6.9458
61	PNEUMONIA (EXCEPT NEWBORN)	25	34.6150	0.72	0.4673	1.0662
62	CHRONIC AND UNSPECIFIED BRONCHITIS	4	2.9405	1.36	0.3707	3.4791
63	EMPHYSEMA	9	11.0927	0.81	0.3702	1.5403
64	ASTHMA	5	4.6243	1.08	0.3499	2.5263
65	PNEUMOCONIOSES AND OTHER RESPIRATORY DISEASES	36	44.0698	0.82	0.5721	1.1310
19	DISEASES OF THE DIGESTIVE SYSTEM	55	70.2292	0.78	0.5899	1.0194
66	DISEASES OF THE STOMACH AND DUODENUM	4	6.0430	0.66	0.1804	1.6929
67	HERNIA AND INTESTINAL OBSTRUCTION	0	5.1463	0.00*	0.0000	0.7170
68	CIRRHOSIS OF THE LIVER	31	30.5645	1.01	0.6890	1.4397
69	OTHER DISEASES OF DIGESTIVE SYSTEM	20	28.4755	0.70	0.4288	1.0848
20	DISEASES OF THE GENITO-URINARY SYSTEM	11	24.7578	0.44**	0.2215	0.7950
70	ACUTE GLOMERULONEPHRITIS, NEPHROTIC SYNDROME, & ACUTE RENAL FAILUR	1	2.1323	0.47	0.0119	2.6055
71	CHRONIC & UNSPEC. NEPHRITIS, RENAL FAILURE, & OTHER RENAL SCLEROSI	1	10.7247	0.09**	0.0024	0.5180
72	INFECTION OF KIDNEY	2	3.1211	0.64	0.0776	2.3134
73	CALCULI OF URINARY SYSTEM	1	0.6035	1.66	0.0419	9.2049
74	HYPERPLASIA OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
75	OTHER DISEASES OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	0.0000
76	DISEASES OF THE BREAST	0	0.0517	0.00	0.0000	71.3268

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Summary of Observed and Expected Deaths
Study File: LAN1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	0	1.1895	0.00	0.0000	3.1020
78	OTHER GENITO-URINARY SYSTEM DISEASES	6	6.9350	0.87	0.3159	1.8832
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	4	2.3292	1.72	0.4679	4.3922
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	2	0.5336	3.75	0.4538	13.5323
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	2	1.7956	1.11	0.1348	4.0210
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE	10	7.5896	1.32	0.6308	2.4233
81	ARTHRITIS AND SPONDYLITIS	2	2.8566	0.70	0.0848	2.5276
82	OSTEOMYELITIS AND PERIOSTITIS	1	0.2323	4.31	0.1089	23.9203
83	OTHER DISEASES OF MS SYSTEM	7	4.5008	1.56	0.6231	3.2047
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	9	13.5584	0.66	0.3029	1.2602
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	9	13.5584	0.66	0.3029	1.2602
24	ACCIDENTS	50	52.2018	0.96	0.7109	1.2628
85	TRANSPORTATION ACCIDENTS	24	27.9098	0.86	0.5508	1.2795
86	ACCIDENTAL POISONING	4	3.5886	1.11	0.3037	2.8508
87	ACCIDENTAL FALLS	7	7.5576	0.93	0.3711	1.9085
88	OTHER ACCIDENTS	13	10.5590	1.23	0.6549	2.1055
89	MEDICAL COMPLICATIONS AND MISADVENTURE	2	2.5868	0.77	0.0936	2.7912
25	VIOLENCE	34	26.4158	1.29	0.8912	1.7987
90	SUICIDE	29	20.4748	1.42	0.9484	2.0342
91	HOMICIDE	5	5.9410	0.84	0.2724	1.9664
26	OTHER CAUSES	45	35.9045	1.25	0.9141	1.6771
92	OTHER CAUSES	45	35.9045	1.25	0.9141	1.6771

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Summary of Observed and Expected Deaths
Study File: LAN1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
	All Cancers	325	466.5831	0.70**	0.6229	0.7766
	All Deaths	1003	1490.5437	0.67**	0.6319	0.7159

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

APPENDIX III TABLE 5: SMRs FOR LINDE FEMALE WORKERS


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==============================================================================
                        G L O B A L   P A R A M E T E R S
STUDY PARAMETER FILE NAME: c:\ltas\lin1.ltp
LAST COMPLETE STEP: Stratify
STUDY DESCRIPTION: lin1
STUDY BEGIN DATE: 01/01/1940
STUDY END DATE: 01/01/1994
RATES IN USE: Standard U.S. Deaths 92 Minors 1940 - 99
AGE CATEGORIES: 15\20\25\30\35\40\45\50\55\60\65\70\75\80\85\
CALENDAR CATEGORIES: 1940\1945\1950\1955\1960\1965\1970\1975\1980\1985\1990\1995\
SINGLE CAUSE OF DEATH
==============================================================================
                        V E R I F Y   P A R A M E T E R S
INPUT DEMOGRAPHICS FILE: c:\ltas\lin\dem
INPUT WORK HISTORY FILE: c:\ltas\lin\wh
OUTPUT DEMOGRAPHICS FILE: c:\ltas\dem.out
OUTPUT WORK HISTORY FILE: c:\ltas\wh.out
BEGIN PERSON TIME AT LATER OF In-rec / Rate begin
STOP SURVIVORS PERSON TIME AT: END OF STUDY
GENDER/RACE SUBSETTING: KEEP ALL
EXPOSURE LEVEL: All exposed equally (no data)

SUMMARY REPORT FILE: .\summary.rpt
EXCEPTIONS REPORT FILE: .\except.rpt
EXPOSURE REPORT FILE: .\experr.rpt
==============================================================================
                      S T R A T I F Y   P A R A M E T E R S
ANALYSIS TYPE: SMR
```

DURATION	TIME SINCE FIRST EXPOSURE
MINIMUM->000Y	000Y
005Y	005Y
010Y	010Y
015Y	015Y
020Y	020Y
025Y	025Y
030Y	030Y

PERSON YEARS FILE: C:\LTAS\LIN1PY
OBSERVED DEATHS FILE: C:\LTAS\LIN1OB

Distribution of Person Years
Study File: LIN1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	1504.79	0.00	0.00	0.00	0.00	0.00	0.00	1504.79
005Y - 010Y	1433.93	64.99	0.00	0.00	0.00	0.00	0.00	1498.92
010Y - 015Y	1418.68	54.99	10.00	0.00	0.00	0.00	0.00	1483.67
015Y - 020Y	1386.67	51.34	0.00	10.00	0.00	0.00	0.00	1448.02
020Y - 025Y	1362.99	44.99	0.00	0.00	10.00	0.00	0.00	1417.98
025Y - 030Y	1311.50	39.51	0.00	0.00	5.00	5.00	0.00	1361.01
030Y & Over	4144.65	90.86	0.00	0.00	19.99	0.00	20.20	4275.70
Total	12563.21	346.70	10.00	10.00	34.99	5.00	20.20	12990.10

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: LIN1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	21.90	50.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20-24	66.51	349.34	67.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25-29	37.92	358.91	363.83	67.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30-34	20.52	177.21	380.48	362.35	66.65	0.00	0.00	0.00	0.00	0.00	0.00
35-39	14.54	133.13	180.53	379.47	358.67	66.53	0.00	0.00	0.00	0.00	0.00
40-44	24.56	139.48	138.81	179.01	379.70	358.44	66.53	0.00	0.00	0.00	0.00
45-49	16.30	108.90	145.87	138.64	176.77	373.11	354.42	64.97	0.00	0.00	0.00
50-54	8.79	75.89	115.51	141.37	132.03	175.46	361.37	354.07	63.75	0.00	0.00
55-59	2.50	23.54	77.00	113.62	136.66	130.66	171.50	359.26	349.75	60.47	0.00
60-64	0.00	5.40	23.54	68.94	104.01	132.18	121.60	162.67	352.32	339.38	55.23
65-69	0.00	0.00	5.40	23.54	60.50	98.57	129.11	113.02	150.12	322.25	276.53
70-74	0.00	0.00	0.00	5.40	22.73	49.20	95.29	114.97	88.98	135.71	215.78
75-79	0.00	0.00	0.00	0.00	5.40	20.49	33.03	71.24	90.32	69.22	75.78
80-84	0.00	0.00	0.00	0.00	0.00	5.40	15.04	22.41	57.23	67.89	40.14
85+	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	14.50	42.41	45.05
TOTAL	213.55	1422.13	1498.20	1479.61	1443.13	1410.05	1348.01	1262.60	1166.98	1037.32	708.52

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: LIN1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1995+	TOTAL
15-19	0.00	72.24
20-24	0.00	483.10
25-29	0.00	827.92
30-34	0.00	1007.22
35-39	0.00	1132.87
40-44	0.00	1286.52
45-49	0.00	1378.99
50-54	0.00	1428.23
55-59	0.00	1424.97
60-64	0.00	1365.28
65-69	0.00	1179.05
70-74	0.00	728.06
75-79	0.00	365.47
80-84	0.00	208.10
85+	0.00	102.10
TOTAL	0.00	12990.10

----- Value too large   * Two-Sided $P < 0.05$ ** Two-Sided $P < 0.01$

Summary of Observed and Expected Deaths
Study File: LIN1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
1	TUBERCULOSIS	1	0.9056	1.10	0.0279	6.1346
1	RESPIRATORY TUBERCULOSIS	0	0.8209	0.00	0.0000	4.4951
2	OTHER TUBERCULOSIS	1	0.0847	11.81	0.2986	65.5854
2	MN OF BUCCAL CAVITY AND PHARYNX	1	0.4612	2.17	0.0549	12.0462
3	MN OF LIP	0	0.0034	0.00	0.0000	1091.4089
4	MN OF TONGUE	0	0.1078	0.00	0.0000	34.2448
5	MN OF OTHER PARTS OF BUCCAL CAVITY	1	0.1541	6.49	0.1642	36.0496
6	MN OF PHARYNX	0	0.1959	0.00	0.0000	18.8320
3	MN OF DIGESTIVE ORGANS AND PERITONEUM	8	9.1856	0.87	0.3750	1.7162
7	MN OF ESOPHAGUS	0	0.3665	0.00	0.0000	10.0684
8	MN OF STOMACH	2	1.1129	1.80	0.2176	6.4880
9	MN OF INTESTINE EXCEPT RECTUM	6	3.9451	1.52	0.5554	3.3104
10	MN OF RECTUM	0	0.7963	0.00	0.0000	4.6341
11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	0	0.7311	0.00	0.0000	5.0472
12	MN OF LIVER NOT SPECIFIED	0	0.2510	0.00	0.0000	14.7041
13	MN OF PANCREAS	0	1.7929	0.00	0.0000	2.0581
14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	0	0.1899	0.00	0.0000	19.4274
4	MN OF RESPIRATORY SYSTEM	6	5.6296	1.07	0.3892	2.3199
15	MN OF LARYNX	0	0.1134	0.00	0.0000	32.5305
16	MN OF TRACHEA, BRONCHUS, AND LUNG	6	5.4369	1.10	0.4030	2.4021
17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	0	0.0792	0.00	0.0000	46.5651
5	MN OF BREAST	7	7.1460	0.98	0.3924	2.0184
18	MN OF BREAST	7	7.1460	0.98	0.3924	2.0184

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: LIN1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
6	MN OF FEMALE GENITAL ORGANS	2	5.3781	0.37	0.0450	1.3425
19	MN OF CERVIX UTERI	0	1.3752	0.00	0.0000	2.6832
20	MN OF OTHER AND UNSPECIFIED PARTS OF UTERUS	0	1.4573	0.00	0.0000	2.5321
21	MN OF OVARY, FALLOPIAN TUBE, AND BROAD LIGAMENT	1	2.3782	0.42	0.0106	2.3361
22	MN OF OTHER FEMALE GENITAL ORGANS	1	0.1674	5.97	0.1511	33.1843
7	MN OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	806508.5000
23	MN OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
24	MN OF OTHER MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	806508.5000
8	MN OF URINARY ORGANS	2	1.0391	1.92	0.2330	6.9484
25	MN OF KIDNEY	1	0.5539	1.81	0.0457	10.0298
26	MN OF BLADDER AND OTHER URINARY ORGANS	1	0.4852	2.06	0.0521	11.4496
9	MN OF OTHER AND UNSPECIFIED SITES	3	4.1138	0.73	0.1504	2.1323
27	MN OF SKIN	0	0.4256	0.00	0.0000	8.6710
28	MN OF EYE	0	0.0271	0.00	0.0000	136.1670
29	MN OF BRAIN AND OTHER PARTS OF NERVOUS SYSTEM	1	0.8076	1.24	0.0313	6.8790
30	MN OF THYROID GLAND	0	0.1187	0.00	0.0000	31.0909
31	MN OF BONE	0	0.0983	0.00	0.0000	37.5453
32	MN OF CONNECTIVE TISSUE AND SOFT TISSUE	1	0.1727	5.79	0.1465	32.1639
33	MN OF OTHER AND UNSPECIFIED SITES (MINOR)	1	2.4639	0.41	0.0103	2.2548
10	NEOPLASMS OF LYMPHATIC AND HEMATOPOIETIC TISSUE	4	2.9960	1.34	0.3638	3.4146
34	LYMPHOSARCOMA AND RETICULOSARCOMA	0	0.4529	0.00	0.0000	8.1468
35	HODGKIN'S DISEASE	1	0.1853	5.40	0.1365	29.9749
36	LEUKEMIA AND ALEUKEMIA	0	1.1335	0.00	0.0000	3.2554
37	OTHER NEOPLASMS OF LYMPHATIC HEMATOPOIETIC TISSUE	3	1.2242	2.45	0.5053	7.1653

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: LIN1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
11	BENIGN AND UNSPECIFIED NEOPLASMS	1	0.6931	1.44	0.0365	8.0157
38	BENIGN NEOPLASMS OF THE EYE, BRAIN, AND OTHER PARTS OF NERVOUS SYS	1	0.1288	7.76	0.1964	43.1235
39	NEOPLASMS OF EYE, BRAIN, & OTHER PARTS OF NERV SYSTEM UNSPECIF. NA	0	0.2262	0.00	0.0000	16.3099
40	OTHER BENIGN AND UNSPECIFIED NATURE NEOPLASMS	0	0.3380	0.00	0.0000	10.9166
12	DIABETES MELLITUS	1	3.8203	0.26	0.0066	1.4542
41	DIABETES MELLITUS	1	3.8203	0.26	0.0066	1.4542
13	DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS	1	0.5319	1.88	0.0476	10.4454
42	PERNICIOUS ANEMIAS	0	0.0265	0.00	0.0000	138.9837
43	ANEMIAS OF OTHER AND UNSPECIFIED TYPE	1	0.2357	4.24	0.1073	23.5657
44	COAGULATION DEFECTS, PURPURA, AND OTHER HEMORRHAGIC CONDITIONS	0	0.1220	0.00	0.0000	30.2531
45	ALL OTHER DISEASES OF BLOOD FORMING ORGANS	0	0.1476	0.00	0.0000	25.0003
14	MENTAL, PSYCHONEUROTIC, AND PERSONALITY DISORDERS	0	0.9265	0.00	0.0000	3.9828
46	ALCOHOLISM	0	0.1846	0.00	0.0000	19.9943
47	OTHER MENTAL DISORDERS	0	0.7419	0.00	0.0000	4.9735
15	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	0	1.9218	0.00	0.0000	1.9201
48	MULTIPLE SCLEROSIS	0	0.2372	0.00	0.0000	15.5572
49	OTHER DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	0	1.6846	0.00	0.0000	2.1905
16	DISEASES OF THE HEART	43	47.4343	0.91	0.6560	1.2211
50	RHEUMATIC HEART DISEASE, INCLUDING FEVER	1	1.7222	0.58	0.0147	3.2259
51	ISCHEMIC HEART DISEASE	39	34.2541	1.14	0.8095	1.5565
52	CHRONIC DISEASE OF ENDOCARDIUM	0	0.5778	0.00	0.0000	6.3867
53	OTHER MYOCARDIAL DEGENERATION	0	0.6324	0.00	0.0000	5.8349
54	HYPERTENSION WITH HEART DISEASE	1	2.6695	0.37	0.0095	2.0811
55	OTHER DISEASES OF THE HEART	2	7.5783	0.26*	0.0320	0.9528

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: LIN1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
17	OTHER DISEASES OF CIRCULATORY SYSTEM	16	17.6798	0.90	0.5169	1.4697
56	HYPERTENSION WITHOUT HEART DISEASE	0	0.7198	0.00	0.0000	5.1264
57	CEREBROVASCULAR DISEASE	13	13.1425	0.99	0.5262	1.6916
58	DISEASES OF THE ARTERIES, VEINS, AND PULMONARY CIRCULATION	3	3.8174	0.79	0.1620	2.2979
18	DISEASES OF THE RESPIRATORY SYSTEM	10	8.4021	1.19	0.5698	2.1889
59	ACUTE RESPIRATORY INFECTIONS EXCEPT INFLUENZA AND PNEUMONIA	0	0.0615	0.00	0.0000	60.0095
60	INFLUENZA	0	0.2075	0.00	0.0000	17.7805
61	PNEUMONIA (EXCEPT NEWBORN)	4	3.5707	1.12	0.3052	2.8650
62	CHRONIC AND UNSPECIFIED BRONCHITIS	1	0.2411	4.15	0.1049	23.0461
63	EMPHYSEMA	3	0.7937	3.78	0.7793	11.0517
64	ASTHMA	1	0.3731	2.68	0.0678	14.8883
65	PNEUMOCONIOSES AND OTHER RESPIRATORY DISEASES	1	3.1544	0.32	0.0080	1.7612
19	DISEASES OF THE DIGESTIVE SYSTEM	4	5.9584	0.67	0.1829	1.7169
66	DISEASES OF THE STOMACH AND DUODENUM	0	0.5807	0.00	0.0000	6.3548
67	HERNIA AND INTESTINAL OBSTRUCTION	0	0.5980	0.00	0.0000	6.1709
68	CIRRHOSIS OF THE LIVER	4	2.1592	1.85	0.5048	4.7379
69	OTHER DISEASES OF DIGESTIVE SYSTEM	0	2.6206	0.00	0.0000	1.4081
20	DISEASES OF THE GENITO-URINARY SYSTEM	3	2.7743	1.08	0.2230	3.1618
70	ACUTE GLOMERULONEPHRITIS, NEPHROTIC SYNDROME, & ACUTE RENAL FAILUR	0	0.2231	0.00	0.0000	16.5402
71	CHRONIC & UNSPEC. NEPHRITIS, RENAL FAILURE, & OTHER RENAL SCLEROSI	0	1.2060	0.00	0.0000	3.0597
72	INFECTION OF KIDNEY	0	0.4113	0.00	0.0000	8.9712
73	CALCULI OF URINARY SYSTEM	1	0.0719	13.91	0.3520	77.2922
74	HYPERPLASIA OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
75	OTHER DISEASES OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	0.0000
76	DISEASES OF THE BREAST	0	0.0046	0.00	0.0000	805.7591

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Date: 12/16/1999
Time: 17:08

PC LIFE TABLE ANALYSIS SYSTEM

Summary of Observed and Expected Deaths
Study File: MOU1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
6	MN OF FEMALE GENITAL ORGANS	13	14.5026	0.90	0.4768	1.5330
19	MN OF CERVIX UTERI	1	3.7863	0.26	0.0067	1.4673
20	MN OF OTHER AND UNSPECIFIED PARTS OF UTERUS	4	3.0523	1.31	0.3571	3.3517
21	MN OF OVARY, FALLOPIAN TUBE, AND BROAD LIGAMENT	8	7.2750	1.10	0.4735	2.1669
22	MN OF OTHER FEMALE GENITAL ORGANS	0	0.3891	0.00	0.0000	9.4839
7	MN OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	301923.5938
23	MN OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
24	MN OF OTHER MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	301923.5938
8	MN OF URINARY ORGANS	3	2.6760	1.12	0.2312	3.2780
25	MN OF KIDNEY	2	1.6404	1.22	0.1476	4.4016
26	MN OF BLADDER AND OTHER URINARY ORGANS	1	1.0356	0.97	0.0244	5.3645
9	MN OF OTHER AND UNSPECIFIED SITES	8	12.4934	0.64	0.2757	1.2618
27	MN OF SKIN	1	1.5478	0.65	0.0163	3.5892
28	MN OF EYE	0	0.0713	0.00	0.0000	51.7775
29	MN OF BRAIN AND OTHER PARTS OF NERVOUS SYSTEM	2	2.8635	0.70	0.0846	2.5215
30	MN OF THYROID GLAND	0	0.2793	0.00	0.0000	13.2106
31	MN OF BONE	1	0.2563	3.90	0.0987	21.6770
32	MN OF CONNECTIVE TISSUE AND SOFT TISSUE	0	0.6263	0.00	0.0000	5.8918
33	MN OF OTHER AND UNSPECIFIED SITES (MINOR)	4	6.8489	0.58	0.1591	1.4937
10	NEOPLASMS OF LYMPHATIC AND HEMATOPOIETIC TISSUE	5	8.8053	0.57	0.1838	1.3267
34	LYMPHOSARCOMA AND RETICULOSARCOMA	1	1.1403	0.88	0.0222	4.8718
35	HODGKIN'S DISEASE	0	0.6352	0.00	0.0000	5.8092
36	LEUKEMIA AND ALEUKEMIA	2	3.2590	0.61	0.0743	2.2155
37	OTHER NEOPLASMS OF LYMPHATIC HEMATOPOIETIC TISSUE	2	3.7707	0.53	0.0642	1.9148

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: MOU1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
11	BENIGN AND UNSPECIFIED NEOPLASMS	0	1.6696	0.00	0.0000	2.2101
38	BENIGN NEOPLASMS OF THE EYE, BRAIN, AND OTHER PARTS OF NERVOUS SYS	0	0.3300	0.00	0.0000	11.1824
39	NEOPLASMS OF EYE, BRAIN, & OTHER PARTS OF NERV SYSTEM UNSPECIF. NA	0	0.6529	0.00	0.0000	5.6520
40	OTHER BENIGN AND UNSPECIFIED NATURE NEOPLASMS	0	0.6867	0.00	0.0000	5.3733
12	DIABETES MELLITUS	13	8.4771	1.53	0.8157	2.6226
41	DIABETES MELLITUS	13	8.4771	1.53	0.8157	2.6226
13	DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS	0	1.3139	0.00	0.0000	2.8084
42	PERNICIOUS ANEMIAS	0	0.0335	0.00	0.0000	110.1495
43	ANEMIAS OF OTHER AND UNSPECIFIED TYPE	0	0.5289	0.00	0.0000	6.9774
44	COAGULATION DEFECTS, PURPURA, AND OTHER HEMORRHAGIC CONDITIONS	0	0.3651	0.00	0.0000	10.1080
45	ALL OTHER DISEASES OF BLOOD FORMING ORGANS	0	0.3865	0.00	0.0000	9.5473
14	MENTAL, PSYCHONEUROTIC, AND PERSONALITY DISORDERS	2	2.1948	0.91	0.1103	3.2897
46	ALCOHOLISM	0	0.7255	0.00	0.0000	5.0862
47	OTHER MENTAL DISORDERS	2	1.4693	1.36	0.1648	4.9140
15	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	2	5.4209	0.37	0.0447	1.3319
48	MULTIPLE SCLEROSIS	1	0.8794	1.14	0.0288	6.3175
49	OTHER DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	1	4.5415	0.22	0.0056	1.2233
16	DISEASES OF THE HEART	60	92.3456	0.65**	0.4958	0.8364
50	RHEUMATIC HEART DISEASE, INCLUDING FEVER	0	3.9853	0.00*	0.0000	0.9259
51	ISCHEMIC HEART DISEASE	47	65.4274	0.72*	0.5278	0.9553
52	CHRONIC DISEASE OF ENDOCARDIUM	0	1.2561	0.00	0.0000	2.9376
53	OTHER MYOCARDIAL DEGENERATION	0	0.7249	0.00	0.0000	5.0905
54	HYPERTENSION WITH HEART DISEASE	0	3.9188	0.00*	0.0000	0.9416
55	OTHER DISEASES OF THE HEART	13	17.0330	0.76	0.4060	1.3052

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: MOU1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
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Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
17	OTHER DISEASES OF CIRCULATORY SYSTEM	16	32.6785	0.49**	0.2797	0.7952
56	HYPERTENSION WITHOUT HEART DISEASE	0	1.2839	0.00	0.0000	2.8739
57	CEREBROVASCULAR DISEASE	12	23.3705	0.51*	0.2650	0.8970
58	DISEASES OF THE ARTERIES, VEINS, AND PULMONARY CIRCULATION	4	8.0240	0.50	0.1358	1.2749
18	DISEASES OF THE RESPIRATORY SYSTEM	10	21.1803	0.47*	0.2260	0.8683
59	ACUTE RESPIRATORY INFECTIONS EXCEPT INFLUENZA AND PNEUMONIA	0	0.1453	0.00	0.0000	25.3961
60	INFLUENZA	0	0.3459	0.00	0.0000	10.6693
61	PNEUMONIA (EXCEPT NEWBORN)	2	7.0043	0.29	0.0346	1.0308
62	CHRONIC AND UNSPECIFIED BRONCHITIS	0	0.6246	0.00	0.0000	5.9073
63	EMPHYSEMA	2	2.4124	0.83	0.1004	2.9930
64	ASTHMA	0	1.0985	0.00	0.0000	3.3590
65	PNEUMOCONIOSES AND OTHER RESPIRATORY DISEASES	6	9.5493	0.63	0.2294	1.3676
19	DISEASES OF THE DIGESTIVE SYSTEM	7	15.9137	0.44*	0.1762	0.9064
66	DISEASES OF THE STOMACH AND DUODENUM	0	1.2796	0.00	0.0000	2.8836
67	HERNIA AND INTESTINAL OBSTRUCTION	1	1.0670	0.94	0.0237	5.2065
68	CIRRHOSIS OF THE LIVER	2	7.3632	0.27*	0.0329	0.9806
69	OTHER DISEASES OF DIGESTIVE SYSTEM	4	6.2038	0.64	0.1757	1.6490
20	DISEASES OF THE GENITO-URINARY SYSTEM	4	5.4639	0.73	0.1995	1.8723
70	ACUTE GLOMERULONEPHRITIS, NEPHROTIC SYNDROME, & ACUTE RENAL FAILUR	0	0.4631	0.00	0.0000	7.9682
71	CHRONIC & UNSPEC. NEPHRITIS, RENAL FAILURE, & OTHER RENAL SCLEROSI	0	2.4392	0.00	0.0000	1.5128
72	INFECTION OF KIDNEY	1	0.6899	1.45	0.0367	8.0529
73	CALCULI OF URINARY SYSTEM	1	0.1275	7.85	0.1985	43.5897
74	HYPERPLASIA OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
75	OTHER DISEASES OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	0.0000
76	DISEASES OF THE BREAST	0	0.0118	0.00	0.0000	313.5019

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: LIN1.LTP
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Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	0	0.1346	0.00	0.0000	27.4238
78	OTHER GENITO-URINARY SYSTEM DISEASES	2	0.7229	2.77	0.3349	9.9872
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	1	0.2687	3.72	0.0941	20.6747
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	0	0.0506	0.00	0.0000	72.8556
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	1	0.2181	4.59	0.1160	25.4766
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE	1	0.5891	1.70	0.0429	9.4311
81	ARTHRITIS AND SPONDYLITIS	1	0.2559	3.91	0.0989	21.7129
82	OSTEOMYELITIS AND PERIOSTITIS	0	0.0238	0.00	0.0000	155.1094
83	OTHER DISEASES OF MS SYSTEM	0	0.3094	0.00	0.0000	11.9258
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	2	1.3328	1.50	0.1817	5.4172
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	2	1.3328	1.50	0.1817	5.4172
24	ACCIDENTS	7	3.7393	1.87	0.7500	3.8572
85	TRANSPORTATION ACCIDENTS	5	1.6602	3.01	0.9746	7.0366
86	ACCIDENTAL POISONING	2	0.2103	9.51*	1.1512	34.3285
87	ACCIDENTAL FALLS	0	0.7897	0.00	0.0000	4.6727
88	OTHER ACCIDENTS	0	0.8665	0.00	0.0000	4.2583
89	MEDICAL COMPLICATIONS AND MISADVENTURE	0	0.2125	0.00	0.0000	17.3624
25	VIOLENCE	1	1.4969	0.67	0.0169	3.7113
90	SUICIDE	0	1.1101	0.00	0.0000	3.3241
91	HOMICIDE	1	0.3869	2.58	0.0654	14.3600
26	OTHER CAUSES	8	3.1316	2.55*	1.1000	5.0339
92	OTHER CAUSES	8	3.1316	2.55*	1.1000	5.0339

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Summary of Observed and Expected Deaths
Study File: LIN1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
	All Cancers	33	35.9495	0.92	0.6318	1.2892
	All Deaths	133	137.5559	0.97	0.8095	1.1459

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

APPENDIX III TABLE 6: SMRs FOR MOUND FEMALE WORKERS


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===========================================================================
                        G L O B A L   P A R A M E T E R S
STUDY PARAMETER FILE NAME: c:\ltas\mou1.ltp
LAST COMPLETE STEP: Stratify
STUDY DESCRIPTION: Mou1
STUDY BEGIN DATE: 01/01/1940
STUDY END DATE: 01/01/1994
RATES IN USE: Standard U.S. Deaths 92 Minors 1940 - 99
AGE CATEGORIES: 15\20\25\30\35\40\45\50\55\60\65\70\75\80\85\
CALENDAR CATEGORIES: 1940\1945\1950\1955\1960\1965\1970\1975\1980\1985\1990\1995\
SINGLE CAUSE OF DEATH
===========================================================================
                        V E R I F Y   P A R A M E T E R S
INPUT DEMOGRAPHICS FILE: c:\ltas\mou\dem
INPUT WORK HISTORY FILE: c:\ltas\mou\wh
OUTPUT DEMOGRAPHICS FILE: c:\ltas\dem.out
OUTPUT WORK HISTORY FILE: c:\ltas\wh.out
BEGIN PERSON TIME AT LATER OF In-rec / Rate begin
STOP SURVIVORS PERSON TIME AT: END OF STUDY
GENDER/RACE SUBSETTING: KEEP ALL
EXPOSURE LEVEL: All exposed equally (no data)

SUMMARY REPORT FILE: .\summary.rpt
EXCEPTIONS REPORT FILE: .\except.rpt
EXPOSURE REPORT FILE: .\experr.rpt
===========================================================================
                      S T R A T I F Y   P A R A M E T E R S
ANALYSIS TYPE: SMR
```

DURATION	TIME SINCE FIRST EXPOSURE
MINIMUM->000Y	000Y
005Y	005Y
010Y	010Y
015Y	015Y
020Y	020Y
025Y	025Y
030Y	030Y

PERSON YEARS FILE: C:\LTAS\MOU1PY
OBSERVED DEATHS FILE: C:\LTAS\MOU1OB

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: MOU1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	8345.86	0.00	0.00	0.00	0.00	0.00	0.00	8345.86
005Y - 010Y	4118.85	4200.27	0.00	0.00	0.00	0.00	0.00	8319.12
010Y - 015Y	4100.99	731.01	3428.90	0.00	0.00	0.00	0.00	8260.89
015Y - 020Y	3945.29	718.24	301.47	2571.36	0.00	0.00	0.00	7536.37
020Y - 025Y	3667.19	676.57	295.10	257.17	1956.60	0.00	0.00	6852.63
025Y - 030Y	3234.49	576.72	276.92	241.54	94.96	1424.78	0.00	5849.40
030Y & Over	7198.86	921.61	260.14	302.63	151.52	120.50	1533.04	10488.30
Total	34611.52	7824.43	4562.53	3372.70	2203.08	1545.28	1533.04	55652.58

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: MOU1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	7.41	77.94	49.19	49.76	40.72	53.03	26.64	8.96	1.80	0.00	0.00
20-24	20.58	625.34	378.87	265.98	407.50	393.79	351.63	169.83	81.12	1.80	0.00
25-29	9.91	505.99	987.07	554.18	496.08	672.54	585.60	502.59	303.62	81.03	1.80
30-34	6.60	191.40	690.56	1155.52	800.27	632.59	767.04	697.92	625.02	303.62	76.20
35-39	4.42	111.86	291.27	820.21	1394.78	924.75	701.21	839.84	772.55	624.05	264.38
40-44	1.46	85.91	171.51	391.87	1025.26	1515.57	955.61	749.71	892.08	770.68	531.59
45-49	0.34	19.66	125.61	233.46	523.16	1096.15	1548.53	986.16	776.07	881.24	615.51
50-54	0.47	21.68	25.94	144.51	281.07	539.27	1094.34	1544.24	993.06	767.10	704.21
55-59	0.42	25.93	32.70	32.49	149.71	287.43	538.47	1064.56	1514.61	967.33	602.60
60-64	0.00	0.87	30.94	32.70	32.56	146.73	283.33	521.91	1016.28	1457.37	779.20
65-69	0.00	0.00	0.87	30.94	32.71	29.95	142.64	267.62	493.51	950.07	1139.06
70-74	0.00	0.00	0.00	0.87	26.04	30.74	28.17	128.34	241.93	453.68	647.19
75-79	0.00	0.00	0.00	0.00	0.77	20.28	25.89	23.61	104.04	216.87	314.08
80-84	0.00	0.00	0.00	0.00	0.00	0.77	10.60	14.23	17.45	83.48	129.15
85+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.51	17.86	26.75	54.42
TOTAL	51.62	1666.56	2784.52	3712.48	5210.62	6343.59	7059.71	7528.02	7851.00	7585.07	5859.38

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: MOU1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1995+	TOTAL
15-19	0.00	315.47
20-24	0.00	2696.44
25-29	0.00	4700.40
30-34	0.00	5946.74
35-39	0.00	6749.32
40-44	0.00	7091.24
45-49	0.00	6805.88
50-54	0.00	6115.90
55-59	0.00	5216.24
60-64	0.00	4301.87
65-69	0.00	3087.38
70-74	0.00	1556.96
75-79	0.00	705.53
80-84	0.00	255.68
85+	0.00	107.54
TOTAL	0.00	55652.58

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: MOU1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number		Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
1		TUBERCULOSIS	1	1.1792	0.85	0.0215	4.7112
	1	RESPIRATORY TUBERCULOSIS	1	1.0425	0.96	0.0243	5.3288
	2	OTHER TUBERCULOSIS	0	0.1367	0.00	0.0000	26.9981
2		MN OF BUCCAL CAVITY AND PHARYNX	1	1.3863	0.72	0.0182	4.0076
	3	MN OF LIP	0	0.0061	0.00	0.0000	606.9948
	4	MN OF TONGUE	0	0.3244	0.00	0.0000	11.3761
	5	MN OF OTHER PARTS OF BUCCAL CAVITY	0	0.4287	0.00	0.0000	8.6083
	6	MN OF PHARYNX	1	0.6272	1.59	0.0403	8.8583
3		MN OF DIGESTIVE ORGANS AND PERITONEUM	19	22.4224	0.85	0.5099	1.3233
	7	MN OF ESOPHAGUS	1	0.9611	1.04	0.0263	5.7802
	8	MN OF STOMACH	0	2.3768	0.00	0.0000	1.5525
	9	MN OF INTESTINE EXCEPT RECTUM	10	9.8150	1.02	0.4878	1.8738
	10	MN OF RECTUM	1	1.8087	0.55	0.0140	3.0715
	11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	2	1.7447	1.15	0.1388	4.1385
	12	MN OF LIVER NOT SPECIFIED	0	0.5647	0.00	0.0000	6.5341
	13	MN OF PANCREAS	5	4.7056	1.06	0.3439	2.4826
	14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	0	0.4458	0.00	0.0000	8.2775
4		MN OF RESPIRATORY SYSTEM	16	20.9222	0.76	0.4368	1.2420
	15	MN OF LARYNX	0	0.3766	0.00	0.0000	9.7990
	16	MN OF TRACHEA, BRONCHUS, AND LUNG	16	20.3059	0.79	0.4501	1.2797
	17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	0	0.2397	0.00	0.0000	15.3959
5		MN OF BREAST	30	23.5216	1.28	0.8603	1.8208
	18	MN OF BREAST	30	23.5216	1.28	0.8603	1.8208

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: MOU1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	1	0.2810	3.56	0.0900	19.7691
78	OTHER GENITO-URINARY SYSTEM DISEASES	1	1.4515	0.69	0.0174	3.8274
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	0	0.5272	0.00	0.0000	6.9989
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	0	0.1199	0.00	0.0000	30.7841
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	0	0.4074	0.00	0.0000	9.0584
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE	0	1.7518	0.00	0.0000	2.1064
81	ARTHRITIS AND SPONDYLITIS	0	0.6035	0.00	0.0000	6.1140
82	OSTEOMYELITIS AND PERIOSTITIS	0	0.0513	0.00	0.0000	71.9163
83	OTHER DISEASES OF MS SYSTEM	0	1.0969	0.00	0.0000	3.3639
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	2	3.2852	0.61	0.0737	2.1978
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	2	3.2852	0.61	0.0737	2.1978
24	ACCIDENTS	9	12.1177	0.74	0.3389	1.4100
85	TRANSPORTATION ACCIDENTS	4	6.6174	0.60	0.1647	1.5459
86	ACCIDENTAL POISONING	2	0.8886	2.25	0.2725	8.1250
87	ACCIDENTAL FALLS	2	1.5152	1.32	0.1598	4.7653
88	OTHER ACCIDENTS	1	2.5000	0.40	0.0101	2.2222
89	MEDICAL COMPLICATIONS AND MISADVENTURE	0	0.5964	0.00	0.0000	6.1868
25	VIOLENCE	9	6.6188	1.36	0.6205	2.5814
90	SUICIDE	8	4.9160	1.63	0.7007	3.2067
91	HOMICIDE	1	1.7028	0.59	0.0149	3.2626
26	OTHER CAUSES	8	8.2769	0.97	0.4162	1.9046
92	OTHER CAUSES	8	8.2769	0.97	0.4162	1.9046

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: MOU1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
	All Cancers	95	106.7298	0.89	0.7201	1.0881
	All Deaths	238	327.1449	0.73**	0.6380	0.8260

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

APPENDIX TABLE 7: SMRs FOR PANTEX FEMALE WORKERS

```
PC LIFE TABLE ANALYSIS SYSTEM                                        Page: 1
==============================================================================
                        G L O B A L   P A R A M E T E R S
STUDY PARAMETER FILE NAME: c:\ltas\pan1.ltp
LAST COMPLETE STEP: Analyze
STUDY DESCRIPTION: Pan1
STUDY BEGIN DATE: 01/01/1940
STUDY END DATE: 01/01/1994
RATES IN USE: Standard U.S. Deaths 92 Minors 1940 - 99
AGE CATEGORIES: 15\20\25\30\35\40\45\50\55\60\65\70\75\80\85\
CALENDAR CATEGORIES: 1940\1945\1950\1955\1960\1965\1970\1975\1980\1985\1990\1995\
SINGLE CAUSE OF DEATH
==============================================================================
                        V E R I F Y   P A R A M E T E R S
INPUT DEMOGRAPHICS FILE: c:\ltas\pan\dem
INPUT WORK HISTORY FILE: c:\ltas\pan\wh
OUTPUT DEMOGRAPHICS FILE: c:\ltas\dem.out
OUTPUT WORK HISTORY FILE: c:\ltas\wh.out
BEGIN PERSON TIME AT LATER OF In-rec / Rate begin
STOP SURVIVORS PERSON TIME AT: END OF STUDY
GENDER/RACE SUBSETTING: KEEP ALL
EXPOSURE LEVEL: All exposed equally (no data)

SUMMARY REPORT FILE: .\summary.rpt
EXCEPTIONS REPORT FILE: .\except.rpt
EXPOSURE REPORT FILE: .\experr.rpt
==============================================================================
                      S T R A T I F Y   P A R A M E T E R S
ANALYSIS TYPE: SMR

    DURATION       TIME SINCE FIRST EXPOSURE
 ----------------  -------------------------

MINIMUM->000Y              000Y

         005Y              005Y

         010Y              010Y

         015Y              015Y

         020Y              020Y

         025Y              025Y

         030Y              030Y


PERSON YEARS FILE: C:\LTAS\PAN1PY
OBSERVED DEATHS FILE: C:\LTAS\PAN1OB
```

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: PAN1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	5222.42	0.00	0.00	0.00	0.00	0.00	0.00	5222.42
005Y - 010Y	2526.02	2684.21	0.00	0.00	0.00	0.00	0.00	5210.23
010Y - 015Y	2498.88	531.24	2109.29	0.00	0.00	0.00	0.00	5139.41
015Y - 020Y	2170.54	522.51	120.05	1283.03	0.00	0.00	0.00	4096.12
020Y - 025Y	1582.70	429.59	116.05	84.99	599.72	0.00	0.00	2813.05
025Y - 030Y	1010.62	246.08	84.39	74.01	20.00	262.57	0.00	1697.67
030Y & Over	1305.27	264.17	86.12	74.64	45.97	66.88	202.19	2045.23
Total	16316.45	4677.80	2515.90	1516.66	665.68	329.45	202.19	26224.14

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Distribution of Person Years
Study File: PAN1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	0.00	0.00	5.31	7.94	8.71	20.96	45.13	19.76	0.72	0.00	0.00
20-24	0.00	0.00	103.11	105.66	111.11	305.48	471.07	425.45	164.91	0.71	0.00
25-29	0.00	0.00	94.25	284.17	223.16	267.84	619.55	816.08	648.25	164.72	0.71
30-34	0.00	0.00	47.43	197.41	349.37	313.53	371.20	777.54	1004.94	648.25	159.75
35-39	0.00	0.00	44.03	114.34	244.85	393.95	400.79	512.63	842.13	996.57	560.76
40-44	0.00	0.00	39.81	96.73	143.72	285.10	466.71	464.96	581.22	841.32	804.97
45-49	0.00	0.00	14.82	65.43	105.64	168.67	322.06	541.15	486.65	576.77	646.36
50-54	0.00	0.00	14.50	27.13	70.79	111.93	192.87	379.69	569.22	483.18	441.76
55-59	0.00	0.00	9.12	23.67	27.13	66.79	118.01	206.31	396.07	556.38	376.33
60-64	0.00	0.00	0.00	13.57	23.68	27.12	66.45	120.74	214.40	385.69	438.64
65-69	0.00	0.00	0.00	0.00	11.91	20.60	22.05	63.38	115.46	196.66	283.63
70-74	0.00	0.00	0.00	0.00	0.00	9.98	11.85	21.26	63.46	108.83	131.06
75-79	0.00	0.00	0.00	0.00	0.00	0.00	6.43	7.42	17.13	60.82	78.11
80-84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.96	5.15	16.18	41.35
85+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.96	4.93	10.99
TOTAL	0.00	0.00	372.38	936.07	1320.07	1991.96	3114.19	4360.33	5113.68	5041.03	3974.43

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: PAN1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1995+	TOTAL
15-19	0.00	108.54
20-24	0.00	1687.52
25-29	0.00	3118.74
30-34	0.00	3869.42
35-39	0.00	4110.05
40-44	0.00	3724.53
45-49	0.00	2927.55
50-54	0.00	2291.08
55-59	0.00	1779.81
60-64	0.00	1290.31
65-69	0.00	713.69
70-74	0.00	346.45
75-79	0.00	169.91
80-84	0.00	66.64
85+	0.00	19.89
TOTAL	0.00	26224.14

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: PAN1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
1	TUBERCULOSIS	0	0.1714	0.00	0.0000	21.5323
1	RESPIRATORY TUBERCULOSIS	0	0.1391	0.00	0.0000	26.5243
2	OTHER TUBERCULOSIS	0	0.0323	0.00	0.0000	114.4083
2	MN OF BUCCAL CAVITY AND PHARYNX	0	0.4156	0.00	0.0000	8.8785
3	MN OF LIP	0	0.0016	0.00	0.0000	2307.8101
4	MN OF TONGUE	0	0.0984	0.00	0.0000	37.5117
5	MN OF OTHER PARTS OF BUCCAL CAVITY	0	0.1261	0.00	0.0000	29.2614
6	MN OF PHARYNX	0	0.1895	0.00	0.0000	19.4684
3	MN OF DIGESTIVE ORGANS AND PERITONEUM	3	6.4619	0.46	0.0957	1.3575
7	MN OF ESOPHAGUS	0	0.2717	0.00	0.0000	13.5822
8	MN OF STOMACH	1	0.6747	1.48	0.0375	8.2345
9	MN OF INTESTINE EXCEPT RECTUM	1	2.8441	0.35	0.0089	1.9534
10	MN OF RECTUM	0	0.5121	0.00	0.0000	7.2052
11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	0	0.5149	0.00	0.0000	7.1658
12	MN OF LIVER NOT SPECIFIED	0	0.1602	0.00	0.0000	23.0333
13	MN OF PANCREAS	1	1.3573	0.74	0.0186	4.0930
14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	0	0.1268	0.00	0.0000	29.0994
4	MN OF RESPIRATORY SYSTEM	8	6.7449	1.19	0.5107	2.3372
15	MN OF LARYNX	0	0.1141	0.00	0.0000	32.3351
16	MN OF TRACHEA, BRONCHUS, AND LUNG	7	6.5516	1.07	0.4280	2.2015
17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	1	0.0792	12.63	0.3195	70.1574
5	MN OF BREAST	2	7.9733	0.25*	0.0304	0.9056
18	MN OF BREAST	2	7.9733	0.25*	0.0304	0.9056

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: PAN1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
11	BENIGN AND UNSPECIFIED NEOPLASMS	0	0.4928	0.00	0.0000	7.4877
38	BENIGN NEOPLASMS OF THE EYE, BRAIN, AND OTHER PARTS OF NERVOUS SYS	0	0.0936	0.00	0.0000	39.4274
39	NEOPLASMS OF EYE, BRAIN, & OTHER PARTS OF NERV SYSTEM UNSPECIF. NA	0	0.2110	0.00	0.0000	17.4908
40	OTHER BENIGN AND UNSPECIFIED NATURE NEOPLASMS	0	0.1883	0.00	0.0000	19.6014
12	DIABETES MELLITUS	0	2.4600	0.00	0.0000	1.5000
41	DIABETES MELLITUS	0	2.4600	0.00	0.0000	1.5000
13	DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS	0	0.4126	0.00	0.0000	8.9423
42	PERNICIOUS ANEMIAS	0	0.0072	0.00	0.0000	515.4965
43	ANEMIAS OF OTHER AND UNSPECIFIED TYPE	0	0.1676	0.00	0.0000	22.0157
44	COAGULATION DEFECTS, PURPURA, AND OTHER HEMORRHAGIC CONDITIONS	0	0.1228	0.00	0.0000	30.0562
45	ALL OTHER DISEASES OF BLOOD FORMING ORGANS	0	0.1151	0.00	0.0000	32.0562
14	MENTAL, PSYCHONEUROTIC, AND PERSONALITY DISORDERS	2	0.7357	2.72	0.3291	9.8145
46	ALCOHOLISM	1	0.2809	3.56	0.0901	19.7788
47	OTHER MENTAL DISORDERS	1	0.4548	2.20	0.0556	12.2157
15	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	1	1.7460	0.57	0.0145	3.1818
48	MULTIPLE SCLEROSIS	0	0.3183	0.00	0.0000	11.5937
49	OTHER DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	1	1.4278	0.70	0.0177	3.8911
16	DISEASES OF THE HEART	7	24.3415	0.29**	0.1152	0.5925
50	RHEUMATIC HEART DISEASE, INCLUDING FEVER	0	1.0532	0.00	0.0000	3.5036
51	ISCHEMIC HEART DISEASE	6	16.9636	0.35**	0.1292	0.7699
52	CHRONIC DISEASE OF ENDOCARDIUM	0	0.3508	0.00	0.0000	10.5194
53	OTHER MYOCARDIAL DEGENERATION	0	0.1642	0.00	0.0000	22.4701
54	HYPERTENSION WITH HEART DISEASE	0	0.9394	0.00	0.0000	3.9282
55	OTHER DISEASES OF THE HEART	1	4.8703	0.21	0.0052	1.1407

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: PAN1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	0	0.0789	0.00	0.0000	46.7754
78	OTHER GENITO-URINARY SYSTEM DISEASES	0	0.4002	0.00	0.0000	9.2214
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	0	0.1423	0.00	0.0000	25.9386
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	0	0.0364	0.00	0.0000	101.3163
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	0	0.1058	0.00	0.0000	34.8644
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE	0	0.6000	0.00	0.0000	6.1500
81	ARTHRITIS AND SPONDYLITIS	0	0.1643	0.00	0.0000	22.4609
82	OSTEOMYELITIS AND PERIOSTITIS	0	0.0145	0.00	0.0000	254.2288
83	OTHER DISEASES OF MS SYSTEM	0	0.4212	0.00	0.0000	8.7607
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	5	1.1314	4.42*	1.4301	10.3250
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	5	1.1314	4.42*	1.4301	10.3250
24	ACCIDENTS	2	5.0205	0.40	0.0482	1.4382
85	TRANSPORTATION ACCIDENTS	2	3.0591	0.65	0.0791	2.3602
86	ACCIDENTAL POISONING	0	0.4288	0.00	0.0000	8.6057
87	ACCIDENTAL FALLS	0	0.4253	0.00	0.0000	8.6770
88	OTHER ACCIDENTS	0	0.9119	0.00	0.0000	4.0467
89	MEDICAL COMPLICATIONS AND MISADVENTURE	0	0.1954	0.00	0.0000	18.8808
25	VIOLENCE	2	3.1914	0.63	0.0759	2.2624
90	SUICIDE	2	2.2068	0.91	0.1097	3.2718
91	HOMICIDE	0	0.9846	0.00	0.0000	3.7476
26	OTHER CAUSES	8	2.8952	2.76*	1.1898	5.4450
92	OTHER CAUSES	8	2.8952	2.76*	1.1898	5.4450

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Summary of Observed and Expected Deaths
Study File: PAN1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
	All Cancers	20	33.8020	0.59*	0.3613	0.9139
	All Deaths	64	98.3767	0.65**	0.5010	0.8308

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

APPENDIX III TABLE 8: SMRs FOR ROCKY FLATS FEMALE WORKERS

PC LIFE TABLE ANALYSIS SYSTEM

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==============================================================================
                        G L O B A L   P A R A M E T E R S
STUDY PARAMETER FILE NAME: c:\ltas\rf1.ltp
LAST COMPLETE STEP: Stratify
STUDY DESCRIPTION: rf1
STUDY BEGIN DATE: 01/01/1940
STUDY END DATE: 01/01/1994
RATES IN USE: Standard U.S. Deaths 92 Minors 1940 - 99
AGE CATEGORIES: 15\20\25\30\35\40\45\50\55\60\65\70\75\80\85\
CALENDAR CATEGORIES: 1940\1945\1950\1955\1960\1965\1970\1975\1980\1985\1990\1995\
SINGLE CAUSE OF DEATH
==============================================================================
                        V E R I F Y   P A R A M E T E R S
INPUT DEMOGRAPHICS FILE: c:\ltas\rf\dem
INPUT WORK HISTORY FILE: c:\ltas\rf\wh
OUTPUT DEMOGRAPHICS FILE: c:\ltas\demout.txt
OUTPUT WORK HISTORY FILE: c:\ltas\whout.txt
BEGIN PERSON TIME AT LATER OF In-rec / Rate begin
STOP SURVIVORS PERSON TIME AT: END OF STUDY
GENDER/RACE SUBSETTING: KEEP ALL
EXPOSURE LEVEL: All exposed equally (no data)

SUMMARY REPORT FILE: .\summary.rpt
EXCEPTIONS REPORT FILE: .\except.rpt
EXPOSURE REPORT FILE: .\experr.rpt
==============================================================================
                      S T R A T I F Y   P A R A M E T E R S
ANALYSIS TYPE: SMR
```

DURATION	TIME SINCE FIRST EXPOSURE
MINIMUM->000Y	000Y
005Y	005Y
010Y	010Y
015Y	015Y
020Y	020Y
025Y	025Y
030Y	030Y

PERSON YEARS FILE: C:\LTAS\RF1PY
OBSERVED DEATHS FILE: C:\LTAS\RF1OB

Summary of Observed and Expected Deaths
Study File: Y12.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	6	9.1277	0.66	0.2400	1.4308
78	OTHER GENITO-URINARY SYSTEM DISEASES	65	41.6782	1.56**	1.2036	1.9878
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	9	16.0799	0.56	0.2554	1.0626
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	0	3.1032	0.00	0.0000	1.1891
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	9	12.9767	0.69	0.3165	1.3167
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE	43	38.3828	1.12	0.8107	1.5091
81	ARTHRITIS AND SPONDYLITIS	15	14.9082	1.01	0.5627	1.6596
82	OSTEOMYELITIS AND PERIOSTITIS	0	1.4675	0.00	0.0000	2.5144
83	OTHER DISEASES OF MS SYSTEM	28	22.0071	1.27	0.8453	1.8389
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	175	85.0516	2.06**	1.7640	2.3860
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	175	85.0516	2.06**	1.7640	2.3860
24	ACCIDENTS	217	247.2639	0.88	0.7647	1.0025
85	TRANSPORTATION ACCIDENTS	118	119.8625	0.98	0.8148	1.1790
86	ACCIDENTAL POISONING	11	15.8198	0.70	0.3466	1.2442
87	ACCIDENTAL FALLS	33	39.2014	0.84	0.5794	1.1823
88	OTHER ACCIDENTS	49	58.5422	0.84	0.6192	1.1066
89	MEDICAL COMPLICATIONS AND MISADVENTURE	6	13.8380	0.43*	0.1583	0.9438
25	VIOLENCE	88	116.0130	0.76**	0.6083	0.9346
90	SUICIDE	51	82.5250	0.62**	0.4601	0.8126
91	HOMICIDE	37	33.4879	1.10	0.7778	1.5230
26	OTHER CAUSES	251	209.7436	1.20**	1.0532	1.3543
92	OTHER CAUSES	251	209.7436	1.20**	1.0532	1.3543

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

APPENDIX III TABLE 12: SMRs FOR ZIA WORKERS

PC LIFE TABLE ANALYSIS SYSTEM

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==============================================================================
                        G L O B A L   P A R A M E T E R S
STUDY PARAMETER FILE NAME: c:\ltas\zia.ltp
LAST COMPLETE STEP: Stratify
STUDY DESCRIPTION: zia
STUDY BEGIN DATE: 01/01/1940
STUDY END DATE: 01/01/1994
RATES IN USE: Standard U.S. Deaths 92 Minors 1940 - 99
AGE CATEGORIES: 15\20\25\30\35\40\45\50\55\60\65\70\75\80\85\
CALENDAR CATEGORIES: 1940\1945\1950\1955\1960\1965\1970\1975\1980\1985\1990\1995\
SINGLE CAUSE OF DEATH
==============================================================================
                        V E R I F Y   P A R A M E T E R S
INPUT DEMOGRAPHICS FILE: c:\ltas\zia\dem
INPUT WORK HISTORY FILE: c:\ltas\zia\wh
OUTPUT DEMOGRAPHICS FILE: c:\ltas\dem.out
OUTPUT WORK HISTORY FILE: c:\ltas\wh.out
BEGIN PERSON TIME AT LATER OF In-rec / Rate begin
STOP SURVIVORS PERSON TIME AT: END OF STUDY
GENDER/RACE SUBSETTING: KEEP ALL
EXPOSURE LEVEL: All exposed equally (no data)

SUMMARY REPORT FILE: .\summary.rpt
EXCEPTIONS REPORT FILE: .\except.rpt
EXPOSURE REPORT FILE: .\experr.rpt
==============================================================================
                      S T R A T I F Y   P A R A M E T E R S
ANALYSIS TYPE: SMR
```

DURATION	TIME SINCE FIRST EXPOSURE
MINIMUM->000Y	000Y
005Y	005Y
010Y	010Y
015Y	015Y
020Y	020Y
025Y	025Y
030Y	030Y

PERSON YEARS FILE: C:\LTAS\ZIAPY
OBSERVED DEATHS FILE: C:\LTAS\ZIAOB

Distribution of Person Years
Study File: ZIA.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	13590.68	0.00	0.00	0.00	0.00	0.00	0.00	13590.68
005Y - 010Y	11466.70	2036.59	0.00	0.00	0.00	0.00	0.00	13503.30
010Y - 015Y	11388.14	975.78	1033.03	0.00	0.00	0.00	0.00	13396.95
015Y - 020Y	10914.03	641.60	298.29	532.70	0.00	0.00	0.00	12386.62
020Y - 025Y	10241.36	519.12	212.40	128.63	348.81	0.00	0.00	11450.32
025Y - 030Y	9666.86	449.66	191.85	112.38	92.20	232.08	0.00	10745.04
030Y & Over	24784.41	1051.85	418.72	254.60	188.57	131.76	430.37	27260.28
Total	92052.18	5674.61	2154.29	1028.31	629.57	363.84	430.37	102333.18

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: ZIA.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	0.00	366.27	159.01	30.46	26.17	29.88	15.10	42.39	1.59	0.00	0.00
20-24	0.00	1298.50	1624.39	457.59	188.11	247.28	128.41	259.79	159.70	1.58	0.00
25-29	0.00	890.12	2640.90	1779.32	588.61	266.34	288.48	317.52	385.91	159.51	1.58
30-34	0.00	584.54	1733.18	2749.89	1845.54	660.07	296.39	411.23	438.37	385.86	154.20
35-39	0.00	471.01	1182.89	1829.86	2809.55	1889.53	674.53	370.60	475.44	436.34	312.64
40-44	0.00	387.97	914.59	1230.77	1856.67	2842.39	1894.82	746.26	452.37	472.63	358.12
45-49	0.00	241.39	707.77	950.66	1241.68	1866.42	2808.06	1920.64	798.98	443.03	371.97
50-54	0.00	156.55	420.19	725.88	953.23	1238.99	1836.67	2784.10	1904.01	781.23	360.16
55-59	0.00	113.53	237.78	428.16	742.80	933.17	1200.93	1802.99	2721.45	1844.55	656.29
60-64	0.00	49.51	172.89	234.97	431.87	720.79	902.80	1149.60	1727.25	2611.43	1563.81
65-69	0.00	24.30	69.49	164.47	220.75	419.87	684.72	842.06	1084.90	1613.16	1972.52
70-74	0.00	0.00	22.93	68.55	143.92	194.21	376.00	625.90	781.93	997.40	1129.44
75-79	0.00	0.00	0.00	22.91	61.84	123.95	155.47	304.23	542.38	669.84	667.72
80-84	0.00	0.00	0.00	0.00	20.43	50.75	96.83	112.89	244.40	433.74	421.87
85+	0.00	0.00	0.00	0.00	0.00	19.11	47.37	101.51	150.38	281.85	386.23
TOTAL	0.00	4583.68	9886.03	10673.50	11131.15	11502.76	11406.59	11791.71	11869.05	11132.15	8356.57

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Distribution of Person Years
Study File: ZIA.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1995+	TOTAL
15-19	0.00	670.87
20-24	0.00	4365.36
25-29	0.00	7318.28
30-34	0.00	9259.28
35-39	0.00	10452.39
40-44	0.00	11156.60
45-49	0.00	11350.60
50-54	0.00	11161.00
55-59	0.00	10681.65
60-64	0.00	9564.92
65-69	0.00	7096.23
70-74	0.00	4340.28
75-79	0.00	2548.34
80-84	0.00	1380.93
85+	0.00	986.46
TOTAL	0.00	102333.18

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ZIA.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
1	TUBERCULOSIS	1	3.0974	0.32	0.0082	1.7936
1	RESPIRATORY TUBERCULOSIS	0	2.7774	0.00	0.0000	1.3286
2	OTHER TUBERCULOSIS	1	0.3200	3.13	0.0791	17.3623
2	MN OF BUCCAL CAVITY AND PHARYNX	4	3.2112	1.25	0.3394	3.1858
3	MN OF LIP	0	0.0219	0.00	0.0000	168.8720
4	MN OF TONGUE	1	0.7546	1.33	0.0335	7.3625
5	MN OF OTHER PARTS OF BUCCAL CAVITY	1	1.0715	0.93	0.0236	5.1847
6	MN OF PHARYNX	2	1.3632	1.47	0.1776	5.2963
3	MN OF DIGESTIVE ORGANS AND PERITONEUM	38	60.3976	0.63**	0.4452	0.8636
7	MN OF ESOPHAGUS	1	2.2535	0.44	0.0112	2.4653
8	MN OF STOMACH	4	6.7534	0.59	0.1614	1.5148
9	MN OF INTESTINE EXCEPT RECTUM	13	26.6339	0.49**	0.2596	0.8347
10	MN OF RECTUM	3	5.1434	0.58	0.1203	1.7055
11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	3	4.7759	0.63	0.1295	1.8367
12	MN OF LIVER NOT SPECIFIED	2	1.5938	1.25	0.1519	4.5302
13	MN OF PANCREAS	12	11.9933	1.00	0.5164	1.7479
14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	0	1.2503	0.00	0.0000	2.9512
4	MN OF RESPIRATORY SYSTEM	40	42.9042	0.93	0.6660	1.2696
15	MN OF LARYNX	0	0.7922	0.00	0.0000	4.6579
16	MN OF TRACHEA, BRONCHUS, AND LUNG	39	41.5502	0.94	0.6674	1.2832
17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	1	0.5618	1.78	0.0450	9.8882
5	MN OF BREAST	36	51.6996	0.70*	0.4876	0.9640
18	MN OF BREAST	36	51.6996	0.70*	0.4876	0.9640

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ZIA.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
11	BENIGN AND UNSPECIFIED NEOPLASMS	0	4.2519	0.00*	0.0000	0.8678
38	BENIGN NEOPLASMS OF THE EYE, BRAIN, AND OTHER PARTS OF NERVOUS SYS	0	0.8267	0.00	0.0000	4.4638
39	NEOPLASMS OF EYE, BRAIN, & OTHER PARTS OF NERV SYSTEM UNSPECIF. NA	0	1.5439	0.00	0.0000	2.3901
40	OTHER BENIGN AND UNSPECIFIED NATURE NEOPLASMS	0	1.8814	0.00	0.0000	1.9613
12	DIABETES MELLITUS	9	22.9597	0.39**	0.1789	0.7442
41	DIABETES MELLITUS	9	22.9597	0.39**	0.1789	0.7442
13	DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS	1	3.5952	0.28	0.0070	1.5453
42	PERNICIOUS ANEMIAS	0	0.1585	0.00	0.0000	23.2783
43	ANEMIAS OF OTHER AND UNSPECIFIED TYPE	0	1.5486	0.00	0.0000	2.3828
44	COAGULATION DEFECTS, PURPURA, AND OTHER HEMORRHAGIC CONDITIONS	0	0.8522	0.00	0.0000	4.3301
45	ALL OTHER DISEASES OF BLOOD FORMING ORGANS	1	1.0359	0.97	0.0244	5.3628
14	MENTAL, PSYCHONEUROTIC, AND PERSONALITY DISORDERS	13	6.9291	1.88*	0.9980	3.2085
46	ALCOHOLISM	1	1.2674	0.79	0.0200	4.3835
47	OTHER MENTAL DISORDERS	12	5.6618	2.12*	1.0939	3.7026
15	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	5	14.0008	0.36*	0.1156	0.8344
48	MULTIPLE SCLEROSIS	1	1.7642	0.57	0.0143	3.1491
49	OTHER DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	4	12.2366	0.33*	0.0891	0.8360
16	DISEASES OF THE HEART	187	314.6628	0.59**	0.5122	0.6858
50	RHEUMATIC HEART DISEASE, INCLUDING FEVER	7	10.8895	0.64	0.2575	1.3245
51	ISCHEMIC HEART DISEASE	142	230.8101	0.62**	0.5182	0.7251
52	CHRONIC DISEASE OF ENDOCARDIUM	0	4.0224	0.00*	0.0000	0.9174
53	OTHER MYOCARDIAL DEGENERATION	2	3.5308	0.57	0.0686	2.0449
54	HYPERTENSION WITH HEART DISEASE	1	13.0946	0.08**	0.0019	0.4243
55	OTHER DISEASES OF THE HEART	35	52.3153	0.67*	0.4659	0.9305

----- Value too large * Two-Sided $P < 0.05$ ** Two-Sided $P < 0.01$

Summary of Observed and Expected Deaths
Study File: ZIA.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	0	0.6665	0.00	0.0000	5.5365
78	OTHER GENITO-URINARY SYSTEM DISEASES	7	4.8246	1.45	0.5813	2.9895
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	4	1.5530	2.58	0.7018	6.5873
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	1	0.3329	3.00	0.0760	16.6878
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	3	1.2201	2.46	0.5070	7.1894
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE	7	4.2274	1.66	0.6634	3.4119
81	ARTHRITIS AND SPONDYLITIS	3	1.7560	1.71	0.3522	4.9954
82	OSTEOMYELITIS AND PERIOSTITIS	0	0.1466	0.00	0.0000	25.1776
83	OTHER DISEASES OF MS SYSTEM	4	2.3248	1.72	0.4688	4.4004
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	16	7.7996	2.05*	1.1718	3.3315
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	16	7.7996	2.05*	1.1718	3.3315
24	ACCIDENTS	33	27.3323	1.21	0.8310	1.6957
85	TRANSPORTATION ACCIDENTS	17	12.8124	1.33	0.7725	2.1245
86	ACCIDENTAL POISONING	2	1.6203	1.23	0.1494	4.4560
87	ACCIDENTAL FALLS	6	5.8659	1.02	0.3735	2.2264
88	OTHER ACCIDENTS	6	5.5880	1.07	0.3921	2.3371
89	MEDICAL COMPLICATIONS AND MISADVENTURE	2	1.4456	1.38	0.1675	4.9947
25	VIOLENCE	8	11.6778	0.69	0.2950	1.3499
90	SUICIDE	6	9.1863	0.65	0.2385	1.4217
91	HOMICIDE	2	2.4915	0.80	0.0972	2.8979
26	OTHER CAUSES	47	20.1276	2.34**	1.7156	3.1053
92	OTHER CAUSES	47	20.1276	2.34**	1.7156	3.1053

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Time: 17:26

Summary of Observed and Expected Deaths
Study File: ZIA.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
	All Cancers	177	250.1388	0.71**	0.6072	0.8199
	All Deaths	686	925.5252	0.74**	0.6868	0.7988

----- Value too large   * Two-Sided $P < 0.05$ ** Two-Sided $P < 0.01$

Distribution of Person Years
Study File: RF1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	7791.96	0.00	0.00	0.00	0.00	0.00	0.00	7791.96
005Y - 010Y	4843.46	2922.78	0.00	0.00	0.00	0.00	0.00	7766.24
010Y - 015Y	4825.46	615.52	2289.85	0.00	0.00	0.00	0.00	7730.83
015Y - 020Y	4425.94	615.25	184.27	1426.61	0.00	0.00	0.00	6652.07
020Y - 025Y	3787.12	581.71	178.55	89.99	869.34	0.00	0.00	5506.71
025Y - 030Y	2757.29	368.97	143.35	89.86	44.99	450.51	0.00	3854.97
030Y & Over	2767.88	321.73	138.77	132.31	88.93	2.00	355.27	3806.89
Total	31199.11	5425.96	2934.80	1738.77	1003.26	452.51	355.27	43109.68

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: RF1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	0.00	0.00	35.98	44.16	114.23	114.60	49.60	42.80	1.94	0.00	0.00
20-24	0.00	0.00	152.20	434.74	458.50	843.79	653.78	495.89	187.10	1.93	0.00
25-29	0.00	0.00	101.48	448.12	663.45	752.98	1163.79	898.44	726.60	186.84	1.93
30-34	0.00	0.00	59.49	310.84	536.70	782.09	925.29	1294.54	1038.57	726.60	181.27
35-39	0.00	0.00	48.55	179.45	413.23	698.78	904.40	1045.83	1350.17	1026.79	610.66
40-44	0.00	0.00	21.84	131.33	229.18	564.40	817.85	968.29	1101.33	1332.16	851.80
45-49	0.00	0.00	16.33	55.19	160.84	297.52	658.24	870.38	1010.39	1091.03	1081.93
50-54	0.00	0.00	4.90	39.56	57.58	171.11	359.49	694.33	876.23	1000.57	829.31
55-59	0.00	0.00	0.00	4.11	37.22	66.89	201.11	367.25	704.93	861.14	798.29
60-64	0.00	0.00	0.00	0.00	4.12	40.27	71.53	200.18	362.23	684.00	645.36
65-69	0.00	0.00	0.00	0.00	0.00	4.12	41.27	69.81	198.08	338.48	526.00
70-74	0.00	0.00	0.00	0.00	0.00	0.00	4.12	41.27	69.89	190.97	230.62
75-79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.11	40.38	65.94	129.94
80-84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.12	36.18	40.86
85+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.12	19.60
TOTAL	0.00	0.00	440.77	1647.51	2675.04	4336.55	5850.45	6993.13	7671.95	7546.74	5947.55

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: RF1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1995+	TOTAL
15-19	0.00	403.32
20-24	0.00	3227.93
25-29	0.00	4943.63
30-34	0.00	5855.39
35-39	0.00	6277.86
40-44	0.00	6018.18
45-49	0.00	5241.85
50-54	0.00	4033.07
55-59	0.00	3040.94
60-64	0.00	2007.68
65-69	0.00	1177.74
70-74	0.00	536.87
75-79	0.00	240.37
80-84	0.00	81.15
85+	0.00	23.72
TOTAL	0.00	43109.68

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: RF1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number		Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
1		TUBERCULOSIS	0	0.2553	0.00	0.0000	14.4509
	1	RESPIRATORY TUBERCULOSIS	0	0.2048	0.00	0.0000	18.0195
	2	OTHER TUBERCULOSIS	0	0.0506	0.00	0.0000	72.9701
2		MN OF BUCCAL CAVITY AND PHARYNX	0	0.6818	0.00	0.0000	5.4122
	3	MN OF LIP	0	0.0025	0.00	0.0000	1500.9933
	4	MN OF TONGUE	0	0.1605	0.00	0.0000	22.9845
	5	MN OF OTHER PARTS OF BUCCAL CAVITY	0	0.2047	0.00	0.0000	18.0255
	6	MN OF PHARYNX	0	0.3141	0.00	0.0000	11.7485
3		MN OF DIGESTIVE ORGANS AND PERITONEUM	4	10.2794	0.39*	0.1060	0.9952
	7	MN OF ESOPHAGUS	0	0.4386	0.00	0.0000	8.4124
	8	MN OF STOMACH	0	1.0488	0.00	0.0000	3.5184
	9	MN OF INTESTINE EXCEPT RECTUM	1	4.5371	0.22	0.0056	1.2245
	10	MN OF RECTUM	0	0.8016	0.00	0.0000	4.6033
	11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	1	0.8152	1.23	0.0310	6.8152
	12	MN OF LIVER NOT SPECIFIED	0	0.2490	0.00	0.0000	14.8200
	13	MN OF PANCREAS	2	2.1878	0.91	0.1107	3.3002
	14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	0	0.2013	0.00	0.0000	18.3320
4		MN OF RESPIRATORY SYSTEM	8	11.4062	0.70	0.3020	1.3821
	15	MN OF LARYNX	1	0.1905	5.25	0.1328	29.1652
	16	MN OF TRACHEA, BRONCHUS, AND LUNG	6	11.0862	0.54	0.1976	1.1780
	17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	1	0.1296	7.72	0.1952	42.8719
5		MN OF BREAST	9	13.1673	0.68	0.3119	1.2976
	18	MN OF BREAST	9	13.1673	0.68	0.3119	1.2976

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: RF1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
6	MN OF FEMALE GENITAL ORGANS	5	7.2383	0.69	0.2236	1.6139
19	MN OF CERVIX UTERI	2	2.0155	0.99	0.1201	3.5823
20	MN OF OTHER AND UNSPECIFIED PARTS OF UTERUS	2	1.2987	1.54	0.1864	5.5595
21	MN OF OVARY, FALLOPIAN TUBE, AND BROAD LIGAMENT	1	3.7453	0.27	0.0068	1.4834
22	MN OF OTHER FEMALE GENITAL ORGANS	0	0.1788	0.00	0.0000	20.6391
7	MN OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	1101250.8750
23	MN OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
24	MN OF OTHER MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	1101250.8750
8	MN OF URINARY ORGANS	1	1.2675	0.79	0.0200	4.3832
25	MN OF KIDNEY	1	0.8367	1.20	0.0302	6.6400
26	MN OF BLADDER AND OTHER URINARY ORGANS	0	0.4308	0.00	0.0000	8.5657
9	MN OF OTHER AND UNSPECIFIED SITES	5	6.7415	0.74	0.2400	1.7329
27	MN OF SKIN	0	0.9751	0.00	0.0000	3.7842
28	MN OF EYE	0	0.0337	0.00	0.0000	109.4051
29	MN OF BRAIN AND OTHER PARTS OF NERVOUS SYSTEM	1	1.6537	0.60	0.0153	3.3594
30	MN OF THYROID GLAND	0	0.1282	0.00	0.0000	28.7737
31	MN OF BONE	0	0.1380	0.00	0.0000	26.7424
32	MN OF CONNECTIVE TISSUE AND SOFT TISSUE	0	0.3881	0.00	0.0000	9.5086
33	MN OF OTHER AND UNSPECIFIED SITES (MINOR)	4	3.4247	1.17	0.3183	2.9872
10	NEOPLASMS OF LYMPHATIC AND HEMATOPOIETIC TISSUE	1	4.6398	0.22	0.0055	1.1974
34	LYMPHOSARCOMA AND RETICULOSARCOMA	0	0.5248	0.00	0.0000	7.0312
35	HODGKIN'S DISEASE	0	0.4036	0.00	0.0000	9.1424
36	LEUKEMIA AND ALEUKEMIA	0	1.7789	0.00	0.0000	2.0744
37	OTHER NEOPLASMS OF LYMPHATIC HEMATOPOIETIC TISSUE	1	1.9325	0.52	0.0131	2.8748

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: RF1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
11	BENIGN AND UNSPECIFIED NEOPLASMS	3	0.7993	3.75	0.7738	10.9739
38	BENIGN NEOPLASMS OF THE EYE, BRAIN, AND OTHER PARTS OF NERVOUS SYS	1	0.1535	6.51	0.1647	36.1808
39	NEOPLASMS OF EYE, BRAIN, & OTHER PARTS OF NERV SYSTEM UNSPECIF. NA	0	0.3460	0.00	0.0000	10.6642
40	OTHER BENIGN AND UNSPECIFIED NATURE NEOPLASMS	2	0.2998	6.67	0.8077	24.0854
12	DIABETES MELLITUS	0	3.8624	0.00*	0.0000	0.9554
41	DIABETES MELLITUS	0	3.8624	0.00*	0.0000	0.9554
13	DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS	0	0.6539	0.00	0.0000	5.6428
42	PERNICIOUS ANEMIAS	0	0.0096	0.00	0.0000	383.6532
43	ANEMIAS OF OTHER AND UNSPECIFIED TYPE	0	0.2580	0.00	0.0000	14.3007
44	COAGULATION DEFECTS, PURPURA, AND OTHER HEMORRHAGIC CONDITIONS	0	0.2010	0.00	0.0000	18.3613
45	ALL OTHER DISEASES OF BLOOD FORMING ORGANS	0	0.1853	0.00	0.0000	19.9116
14	MENTAL, PSYCHONEUROTIC, AND PERSONALITY DISORDERS	2	1.1373	1.76	0.2129	6.3486
46	ALCOHOLISM	0	0.4625	0.00	0.0000	7.9775
47	OTHER MENTAL DISORDERS	2	0.6747	2.96	0.3588	10.7006
15	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	0	2.8306	0.00	0.0000	1.3036
48	MULTIPLE SCLEROSIS	0	0.5333	0.00	0.0000	6.9186
49	OTHER DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	0	2.2972	0.00	0.0000	1.6063
16	DISEASES OF THE HEART	12	36.9380	0.32**	0.1677	0.5675
50	RHEUMATIC HEART DISEASE, INCLUDING FEVER	0	1.6728	0.00	0.0000	2.2059
51	ISCHEMIC HEART DISEASE	9	25.5198	0.35**	0.1609	0.6695
52	CHRONIC DISEASE OF ENDOCARDIUM	0	0.5466	0.00	0.0000	6.7512
53	OTHER MYOCARDIAL DEGENERATION	0	0.2052	0.00	0.0000	17.9811
54	HYPERTENSION WITH HEART DISEASE	0	1.3408	0.00	0.0000	2.7521
55	OTHER DISEASES OF THE HEART	3	7.6529	0.39	0.0808	1.1462

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: RF1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
17	OTHER DISEASES OF CIRCULATORY SYSTEM	6	13.2703	0.45	0.1651	0.9841
56	HYPERTENSION WITHOUT HEART DISEASE	0	0.4897	0.00	0.0000	7.5353
57	CEREBROVASCULAR DISEASE	4	9.2520	0.43	0.1178	1.1057
58	DISEASES OF THE ARTERIES, VEINS, AND PULMONARY CIRCULATION	2	3.5287	0.57	0.0686	2.0461
18	DISEASES OF THE RESPIRATORY SYSTEM	7	9.7350	0.72	0.2881	1.4816
59	ACUTE RESPIRATORY INFECTIONS EXCEPT INFLUENZA AND PNEUMONIA	0	0.0711	0.00	0.0000	51.9044
60	INFLUENZA	0	0.1317	0.00	0.0000	28.0235
61	PNEUMONIA (EXCEPT NEWBORN)	2	2.9844	0.67	0.0811	2.4193
62	CHRONIC AND UNSPECIFIED BRONCHITIS	0	0.2804	0.00	0.0000	13.1597
63	EMPHYSEMA	1	1.1123	0.90	0.0227	4.9945
64	ASTHMA	0	0.6023	0.00	0.0000	6.1270
65	PNEUMOCONIOSES AND OTHER RESPIRATORY DISEASES	4	4.5529	0.88	0.2394	2.2470
19	DISEASES OF THE DIGESTIVE SYSTEM	4	7.9344	0.50	0.1374	1.2894
66	DISEASES OF THE STOMACH AND DUODENUM	0	0.5597	0.00	0.0000	6.5929
67	HERNIA AND INTESTINAL OBSTRUCTION	0	0.4087	0.00	0.0000	9.0288
68	CIRRHOSIS OF THE LIVER	3	4.0388	0.74	0.1532	2.1719
69	OTHER DISEASES OF DIGESTIVE SYSTEM	1	2.9272	0.34	0.0086	1.8979
20	DISEASES OF THE GENITO-URINARY SYSTEM	1	2.2723	0.44	0.0111	2.4449
70	ACUTE GLOMERULONEPHRITIS, NEPHROTIC SYNDROME, & ACUTE RENAL FAILUR	0	0.1918	0.00	0.0000	19.2342
71	CHRONIC & UNSPEC. NEPHRITIS, RENAL FAILURE, & OTHER RENAL SCLEROSI	0	1.0305	0.00	0.0000	3.5807
72	INFECTION OF KIDNEY	0	0.2493	0.00	0.0000	14.8010
73	CALCULI OF URINARY SYSTEM	0	0.0478	0.00	0.0000	77.1815
74	HYPERPLASIA OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
75	OTHER DISEASES OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	0.0000
76	DISEASES OF THE BREAST	0	0.0058	0.00	0.0000	631.6779

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: RF1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	0	0.1308	0.00	0.0000	28.2167
78	OTHER GENITO-URINARY SYSTEM DISEASES	1	0.6162	1.62	0.0411	9.0157
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	0	0.2228	0.00	0.0000	16.5655
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	0	0.0577	0.00	0.0000	64.0059
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	0	0.1651	0.00	0.0000	22.3499
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE	1	0.9649	1.04	0.0262	5.7575
81	ARTHRITIS AND SPONDYLITIS	0	0.2587	0.00	0.0000	14.2635
82	OSTEOMYELITIS AND PERIOSTITIS	0	0.0226	0.00	0.0000	163.4753
83	OTHER DISEASES OF MS SYSTEM	1	0.6837	1.46	0.0370	8.1263
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	0	1.7980	0.00	0.0000	2.0523
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	0	1.7980	0.00	0.0000	2.0523
24	ACCIDENTS	5	8.1739	0.61	0.1980	1.4292
85	TRANSPORTATION ACCIDENTS	5	5.0487	0.99	0.3205	2.3139
86	ACCIDENTAL POISONING	0	0.6793	0.00	0.0000	5.4320
87	ACCIDENTAL FALLS	0	0.6424	0.00	0.0000	5.7444
88	OTHER ACCIDENTS	0	1.4866	0.00	0.0000	2.4822
89	MEDICAL COMPLICATIONS AND MISADVENTURE	0	0.3170	0.00	0.0000	11.6410
25	VIOLENCE	4	5.1857	0.77	0.2102	1.9728
90	SUICIDE	3	3.6576	0.82	0.1691	2.3983
91	HOMICIDE	1	1.5281	0.65	0.0166	3.6356
26	OTHER CAUSES	7	4.6351	1.51	0.6050	3.1118
92	OTHER CAUSES	7	4.6351	1.51	0.6050	3.1118

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Summary of Observed and Expected Deaths
Study File: RF1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
	All Cancers	33	55.4218	0.60**	0.4098	0.8362
	All Deaths	85	156.0912	0.54**	0.4350	0.6734

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

APPENDIX III TABLE 9: SMRs FOR SAVANNAH RIVER PLANT FEMALE WORKERS

PC LIFE TABLE ANALYSIS SYSTEM

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==============================================================================
                        G L O B A L   P A R A M E T E R S
STUDY PARAMETER FILE NAME: c:\ltas\sr1.ltp
LAST COMPLETE STEP: Stratify
STUDY DESCRIPTION: sr1
STUDY BEGIN DATE: 01/01/1940
STUDY END DATE: 01/01/1994
RATES IN USE: Standard U.S. Deaths 92 Minors 1940 - 99
AGE CATEGORIES: 15\20\25\30\35\40\45\50\55\60\65\70\75\80\85\
CALENDAR CATEGORIES: 1940\1945\1950\1955\1960\1965\1970\1975\1980\1985\1990\1995\
SINGLE CAUSE OF DEATH
==============================================================================
                        V E R I F Y   P A R A M E T E R S
INPUT DEMOGRAPHICS FILE: c:\ltas\sr1\dem
INPUT WORK HISTORY FILE: c:\ltas\sr1\wh
OUTPUT DEMOGRAPHICS FILE: c:\ltas\demout.txt
OUTPUT WORK HISTORY FILE: c:\ltas\whout.txt
BEGIN PERSON TIME AT LATER OF In-rec / Rate begin
STOP SURVIVORS PERSON TIME AT: END OF STUDY
GENDER/RACE SUBSETTING: KEEP ALL
EXPOSURE LEVEL: All exposed equally (no data)

SUMMARY REPORT FILE: .\summary.rpt
EXCEPTIONS REPORT FILE: .\except.rpt
EXPOSURE REPORT FILE: .\experr.rpt
==============================================================================
                       S T R A T I F Y   P A R A M E T E R S
ANALYSIS TYPE: SMR
```

DURATION	TIME SINCE FIRST EXPOSURE
MINIMUM->000Y	000Y
005Y	005Y
010Y	010Y
015Y	015Y
020Y	020Y
025Y	025Y
030Y	030Y

PERSON YEARS FILE: C:\LTAS\SR1PY
OBSERVED DEATHS FILE: C:\LTAS\SR1OB

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: SR1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	12696.94	0.00	0.00	0.00	0.00	0.00	0.00	12696.94
005Y - 010Y	6066.77	6595.92	0.00	0.00	0.00	0.00	0.00	12662.69
010Y - 015Y	6027.84	1343.88	5182.60	0.00	0.00	0.00	0.00	12554.32
015Y - 020Y	5424.76	1264.46	396.12	3456.18	0.00	0.00	0.00	10541.52
020Y - 025Y	4861.98	1179.45	354.95	251.92	2130.49	0.00	0.00	8778.79
025Y - 030Y	4364.92	1137.98	327.72	223.28	214.28	1595.15	0.00	7863.34
030Y & Over	7333.94	2118.12	602.47	392.64	359.01	617.05	2174.18	13597.40
Total	46777.14	13639.82	6863.85	4324.02	2703.78	2212.20	2174.18	78695.00

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: SR1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	0.00	0.00	268.56	134.29	100.04	41.45	48.86	78.23	22.59	0.00	0.00
20-24	0.00	0.00	952.35	2020.30	671.66	469.16	522.95	882.70	545.69	22.54	0.00
25-29	0.00	0.00	500.48	2228.70	2235.33	814.86	654.69	1159.12	1389.06	543.97	22.01
30-34	0.00	0.00	289.07	1069.59	2325.29	2272.74	863.86	882.63	1407.41	1379.76	504.62
35-39	0.00	0.00	121.26	553.36	1132.90	2345.59	2320.96	980.01	976.29	1401.50	1112.14
40-44	0.56	0.31	97.75	255.17	602.18	1136.94	2369.71	2434.11	1032.92	971.81	1111.50
45-49	0.00	4.68	25.67	171.81	268.95	626.05	1144.19	2422.59	2456.69	1030.75	755.97
50-54	0.00	0.00	12.93	38.95	182.78	265.43	621.96	1145.04	2416.54	2429.28	820.64
55-59	0.00	0.00	3.90	20.19	38.95	180.63	260.24	618.85	1119.79	2352.73	2072.28
60-64	0.00	0.00	0.00	7.20	20.20	37.93	169.14	251.16	604.40	1094.55	1683.87
65-69	0.00	0.00	0.00	0.00	7.21	19.30	37.93	160.48	238.00	583.84	760.35
70-74	0.00	0.00	0.00	0.00	0.00	6.26	16.15	36.01	137.31	213.80	391.80
75-79	0.00	0.00	0.00	0.00	0.00	0.00	6.25	11.46	30.19	116.68	123.44
80-84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.25	9.77	23.61	70.28
85+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.26	10.79	13.13
TOTAL	0.56	5.00	2271.97	6499.57	7585.50	8216.34	9036.89	11068.64	12392.90	12175.59	9442.03

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: SR1.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1995+	TOTAL
15-19	0.00	694.02
20-24	0.00	6087.35
25-29	0.00	9548.22
30-34	0.00	10994.98
35-39	0.00	10944.02
40-44	0.00	10012.97
45-49	0.00	8907.36
50-54	0.00	7933.55
55-59	0.00	6667.56
60-64	0.00	3868.45
65-69	0.00	1807.10
70-74	0.00	801.32
75-79	0.00	288.02
80-84	0.00	109.91
85+	0.00	30.17
TOTAL	0.00	78695.00

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: SR1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number		Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
1		TUBERCULOSIS	0	0.6521	0.00	0.0000	5.6584
	1	RESPIRATORY TUBERCULOSIS	0	0.5446	0.00	0.0000	6.7759
	2	OTHER TUBERCULOSIS	0	0.1075	0.00	0.0000	34.3115
2		MN OF BUCCAL CAVITY AND PHARYNX	2	1.2472	1.60	0.1941	5.7893
	3	MN OF LIP	0	0.0042	0.00	0.0000	868.2660
	4	MN OF TONGUE	1	0.2911	3.44	0.0869	19.0861
	5	MN OF OTHER PARTS OF BUCCAL CAVITY	0	0.3682	0.00	0.0000	10.0206
	6	MN OF PHARYNX	1	0.5836	1.71	0.0433	9.5196
3		MN OF DIGESTIVE ORGANS AND PERITONEUM	12	18.3891	0.65	0.3368	1.1400
	7	MN OF ESOPHAGUS	0	0.7818	0.00	0.0000	4.7198
	8	MN OF STOMACH	2	1.9168	1.04	0.1263	3.7668
	9	MN OF INTESTINE EXCEPT RECTUM	8	8.1080	0.99	0.4248	1.9443
	10	MN OF RECTUM	1	1.4583	0.69	0.0173	3.8096
	11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	0	1.4486	0.00	0.0000	2.5473
	12	MN OF LIVER NOT SPECIFIED	0	0.4503	0.00	0.0000	8.1954
	13	MN OF PANCREAS	1	3.8660	0.26	0.0065	1.4370
	14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	0	0.3594	0.00	0.0000	10.2683
4		MN OF RESPIRATORY SYSTEM	11	20.9011	0.53*	0.2624	0.9417
	15	MN OF LARYNX	0	0.3525	0.00	0.0000	10.4686
	16	MN OF TRACHEA, BRONCHUS, AND LUNG	11	20.3139	0.54*	0.2699	0.9690
	17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	0	0.2347	0.00	0.0000	15.7206
5		MN OF BREAST	12	24.1443	0.50*	0.2565	0.8682
	18	MN OF BREAST	12	24.1443	0.50*	0.2565	0.8682

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: SR1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
6	MN OF FEMALE GENITAL ORGANS	13	13.4980	0.96	0.5123	1.6470
19	MN OF CERVIX UTERI	1	3.8890	0.26	0.0065	1.4285
20	MN OF OTHER AND UNSPECIFIED PARTS OF UTERUS	1	2.3538	0.42	0.0107	2.3602
21	MN OF OVARY, FALLOPIAN TUBE, AND BROAD LIGAMENT	11	6.9379	1.59	0.7904	2.8371
22	MN OF OTHER FEMALE GENITAL ORGANS	0	0.3174	0.00	0.0000	11.6265
7	MN OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	491899.2188
23	MN OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
24	MN OF OTHER MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	491899.2188
8	MN OF URINARY ORGANS	3	2.2471	1.34	0.2753	3.9037
25	MN OF KIDNEY	3	1.5077	1.99	0.4103	5.8182
26	MN OF BLADDER AND OTHER URINARY ORGANS	0	0.7394	0.00	0.0000	4.9904
9	MN OF OTHER AND UNSPECIFIED SITES	13	12.1712	1.07	0.5682	1.8266
27	MN OF SKIN	7	1.7461	4.01**	1.6060	8.2602
28	MN OF EYE	0	0.0621	0.00	0.0000	59.4170
29	MN OF BRAIN AND OTHER PARTS OF NERVOUS SYSTEM	2	3.0268	0.66	0.0800	2.3854
30	MN OF THYROID GLAND	0	0.2324	0.00	0.0000	15.8788
31	MN OF BONE	0	0.2610	0.00	0.0000	14.1395
32	MN OF CONNECTIVE TISSUE AND SOFT TISSUE	0	0.6868	0.00	0.0000	5.3727
33	MN OF OTHER AND UNSPECIFIED SITES (MINOR)	4	6.1560	0.65	0.1770	1.6618
10	NEOPLASMS OF LYMPHATIC AND HEMATOPOIETIC TISSUE	8	8.3279	0.96	0.4136	1.8929
34	LYMPHOSARCOMA AND RETICULOSARCOMA	0	0.9941	0.00	0.0000	3.7117
35	HODGKIN'S DISEASE	1	0.7815	1.28	0.0324	7.1091
36	LEUKEMIA AND ALEUKEMIA	4	3.2004	1.25	0.3406	3.1965
37	OTHER NEOPLASMS OF LYMPHATIC HEMATOPOIETIC TISSUE	3	3.3519	0.90	0.1845	2.6170

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: SR1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
11	BENIGN AND UNSPECIFIED NEOPLASMS	0	1.4996	0.00	0.0000	2.4606
38	BENIGN NEOPLASMS OF THE EYE, BRAIN, AND OTHER PARTS OF NERVOUS SYS	0	0.2976	0.00	0.0000	12.3979
39	NEOPLASMS OF EYE, BRAIN, & OTHER PARTS OF NERV SYSTEM UNSPECIF. NA	0	0.6355	0.00	0.0000	5.8061
40	OTHER BENIGN AND UNSPECIFIED NATURE NEOPLASMS	0	0.5664	0.00	0.0000	6.5143
12	DIABETES MELLITUS	4	6.8192	0.59	0.1598	1.5002
41	DIABETES MELLITUS	4	6.8192	0.59	0.1598	1.5002
13	DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS	2	1.2111	1.65	0.1999	5.9619
42	PERNICIOUS ANEMIAS	0	0.0186	0.00	0.0000	198.6802
43	ANEMIAS OF OTHER AND UNSPECIFIED TYPE	0	0.4954	0.00	0.0000	7.4490
44	COAGULATION DEFECTS, PURPURA, AND OTHER HEMORRHAGIC CONDITIONS	1	0.3698	2.70	0.0684	15.0239
45	ALL OTHER DISEASES OF BLOOD FORMING ORGANS	1	0.3273	3.05	0.0773	16.9716
14	MENTAL, PSYCHONEUROTIC, AND PERSONALITY DISORDERS	2	2.0008	1.00	0.1210	3.6087
46	ALCOHOLISM	1	0.9064	1.10	0.0279	6.1291
47	OTHER MENTAL DISORDERS	1	1.0944	0.91	0.0231	5.0764
15	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	1	4.9949	0.20	0.0051	1.1122
48	MULTIPLE SCLEROSIS	0	0.9978	0.00	0.0000	3.6983
49	OTHER DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	1	3.9972	0.25	0.0063	1.3899
16	DISEASES OF THE HEART	42	63.4607	0.66**	0.4769	0.8946
50	RHEUMATIC HEART DISEASE, INCLUDING FEVER	0	3.4375	0.00	0.0000	1.0735
51	ISCHEMIC HEART DISEASE	36	43.4590	0.83	0.5801	1.1468
52	CHRONIC DISEASE OF ENDOCARDIUM	0	0.8952	0.00	0.0000	4.1218
53	OTHER MYOCARDIAL DEGENERATION	0	0.4230	0.00	0.0000	8.7228
54	HYPERTENSION WITH HEART DISEASE	0	2.3945	0.00	0.0000	1.5410
55	OTHER DISEASES OF THE HEART	6	12.8514	0.47	0.1705	1.0162

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: SR1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
17	OTHER DISEASES OF CIRCULATORY SYSTEM	11	23.1612	0.47*	0.2368	0.8498
56	HYPERTENSION WITHOUT HEART DISEASE	2	0.8683	2.30	0.2789	8.3158
57	CEREBROVASCULAR DISEASE	6	16.1010	0.37*	0.1361	0.8111
58	DISEASES OF THE ARTERIES, VEINS, AND PULMONARY CIRCULATION	3	6.1919	0.48	0.0999	1.4167
18	DISEASES OF THE RESPIRATORY SYSTEM	15	16.9589	0.88	0.4947	1.4589
59	ACUTE RESPIRATORY INFECTIONS EXCEPT INFLUENZA AND PNEUMONIA	0	0.1350	0.00	0.0000	27.3239
60	INFLUENZA	0	0.2572	0.00	0.0000	14.3475
61	PNEUMONIA (EXCEPT NEWBORN)	8	5.1537	1.55	0.6684	3.0588
62	CHRONIC AND UNSPECIFIED BRONCHITIS	0	0.4959	0.00	0.0000	7.4404
63	EMPHYSEMA	1	1.9673	0.51	0.0129	2.8239
64	ASTHMA	1	1.1325	0.88	0.0223	4.9056
65	PNEUMOCONIOSES AND OTHER RESPIRATORY DISEASES	5	7.8172	0.64	0.2070	1.4944
19	DISEASES OF THE DIGESTIVE SYSTEM	9	14.7938	0.61	0.2776	1.1549
66	DISEASES OF THE STOMACH AND DUODENUM	0	1.0003	0.00	0.0000	3.6887
67	HERNIA AND INTESTINAL OBSTRUCTION	0	0.7431	0.00	0.0000	4.9655
68	CIRRHOSIS OF THE LIVER	5	7.7833	0.64	0.2079	1.5009
69	OTHER DISEASES OF DIGESTIVE SYSTEM	4	5.2671	0.76	0.2069	1.9423
20	DISEASES OF THE GENITO-URINARY SYSTEM	2	4.1777	0.48	0.0580	1.7283
70	ACUTE GLOMERULONEPHRITIS, NEPHROTIC SYNDROME, & ACUTE RENAL FAILUR	0	0.3489	0.00	0.0000	10.5765
71	CHRONIC & UNSPEC. NEPHRITIS, RENAL FAILURE, & OTHER RENAL SCLEROSI	0	1.9149	0.00	0.0000	1.9270
72	INFECTION OF KIDNEY	0	0.5144	0.00	0.0000	7.1732
73	CALCULI OF URINARY SYSTEM	1	0.0961	10.41	0.2633	57.8343
74	HYPERPLASIA OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
75	OTHER DISEASES OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	0.0000
76	DISEASES OF THE BREAST	0	0.0108	0.00	0.0000	341.9267

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: SR1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	0	0.2827	0.00	0.0000	13.0507
78	OTHER GENITO-URINARY SYSTEM DISEASES	1	1.0098	0.99	0.0251	5.5014
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	0	0.4245	0.00	0.0000	8.6933
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	0	0.1038	0.00	0.0000	35.5400
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	0	0.3206	0.00	0.0000	11.5084
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE	1	1.7385	0.58	0.0146	3.1956
81	ARTHRITIS AND SPONDYLITIS	1	0.4473	2.24	0.0566	12.4191
82	OSTEOMYELITIS AND PERIOSTITIS	0	0.0396	0.00	0.0000	93.1920
83	OTHER DISEASES OF MS SYSTEM	0	1.2516	0.00	0.0000	2.9483
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	0	3.2842	0.00	0.0000	1.1236
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	0	3.2842	0.00	0.0000	1.1236
24	ACCIDENTS	10	14.7505	0.68	0.3246	1.2468
85	TRANSPORTATION ACCIDENTS	7	8.9906	0.78	0.3119	1.6043
86	ACCIDENTAL POISONING	0	1.2670	0.00	0.0000	2.9124
87	ACCIDENTAL FALLS	0	1.1341	0.00	0.0000	3.2536
88	OTHER ACCIDENTS	2	2.7812	0.72	0.0871	2.5960
89	MEDICAL COMPLICATIONS AND MISADVENTURE	1	0.5776	1.73	0.0438	9.6185
25	VIOLENCE	9	9.5409	0.94	0.4304	1.7908
90	SUICIDE	5	6.5741	0.76	0.2461	1.7770
91	HOMICIDE	4	2.9667	1.35	0.3674	3.4483
26	OTHER CAUSES	39	8.8216	4.42**	3.1433	6.0438
92	OTHER CAUSES	39	8.8216	4.42**	3.1433	6.0438

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Summary of Observed and Expected Deaths
Study File: SR1.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
	All Cancers	74	100.9260	0.73**	0.5757	0.9205
	All Deaths	221	279.2161	0.79**	0.6906	0.9030

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

APPENDIX III TABLE 10: SMRs FOR X-10 FEMALE WORKERS

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PC LIFE TABLE ANALYSIS SYSTEM                                         Page: 1
=============================================================================
                       G L O B A L   P A R A M E T E R S
STUDY PARAMETER FILE NAME: c:\ltas\x10.ltp
LAST COMPLETE STEP: Stratify
STUDY DESCRIPTION: x10
STUDY BEGIN DATE: 01/01/1940
STUDY END DATE: 01/01/1994
RATES IN USE: Standard U.S. Deaths 92 Minors 1940 - 99
AGE CATEGORIES: 15\20\25\30\35\40\45\50\55\60\65\70\75\80\85\
CALENDAR CATEGORIES: 1940\1945\1950\1955\1960\1965\1970\1975\1980\1985\1990\1995\
SINGLE CAUSE OF DEATH
=============================================================================
                       V E R I F Y   P A R A M E T E R S
INPUT DEMOGRAPHICS FILE: c:\ltas\x10\dem
INPUT WORK HISTORY FILE: c:\ltas\x10\wh
OUTPUT DEMOGRAPHICS FILE: c:\ltas\dem.out
OUTPUT WORK HISTORY FILE: c:\ltas\wh.out
BEGIN PERSON TIME AT LATER OF In-rec / Rate begin
STOP SURVIVORS PERSON TIME AT: END OF STUDY
GENDER/RACE SUBSETTING: KEEP ALL
EXPOSURE LEVEL: All exposed equally (no data)

SUMMARY REPORT FILE: .\summary.rpt
EXCEPTIONS REPORT FILE: .\except.rpt
EXPOSURE REPORT FILE: .\experr.rpt
=============================================================================
                     S T R A T I F Y   P A R A M E T E R S
ANALYSIS TYPE: SMR
```

DURATION	TIME SINCE FIRST EXPOSURE
MINIMUM->000Y	000Y
005Y	005Y
010Y	010Y
015Y	015Y
020Y	020Y
025Y	025Y
030Y	030Y

PERSON YEARS FILE: C:\LTAS\X10PY
OBSERVED DEATHS FILE: C:\LTAS\X10OB

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: X10.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	26153.26	0.00	0.00	0.00	0.00	0.00	0.00	26153.26
005Y - 010Y	14592.90	11429.99	0.00	0.00	0.00	0.00	0.00	26022.90
010Y - 015Y	14522.33	2628.42	8691.35	0.00	0.00	0.00	0.00	25842.09
015Y - 020Y	12930.19	2332.27	984.64	5808.51	0.00	0.00	0.00	22055.61
020Y - 025Y	11210.06	1965.79	796.52	583.04	3551.67	0.00	0.00	18107.08
025Y - 030Y	9305.12	1703.95	681.25	472.98	426.01	2409.89	0.00	14999.21
030Y & Over	19520.95	3791.69	1474.30	1101.38	746.95	1052.14	3868.78	31556.18
Total	108234.82	23852.10	12628.06	7965.91	4724.63	3462.03	3868.78	164736.33

----- Value too large * Two-Sided $P < 0.05$ ** Two-Sided $P < 0.01$

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: X10.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	100.11	253.60	57.75	93.25	111.06	130.59	110.38	143.95	11.30	0.00	0.00
20-24	227.47	2258.28	1105.45	880.96	1104.54	1635.61	1366.20	1723.19	863.04	11.25	0.00
25-29	116.68	1715.73	3194.11	1695.03	1491.24	1834.54	2427.10	2533.21	2554.16	860.76	11.25
30-34	56.90	844.67	2140.80	3498.67	1921.52	1739.06	2070.97	3029.20	2977.40	2551.28	818.40
35-39	23.84	431.79	1105.37	2347.98	3629.47	2087.24	1882.15	2405.52	3288.33	2969.22	2125.64
40-44	10.50	169.53	576.67	1204.04	2437.03	3758.11	2193.66	2113.94	2563.01	3267.95	2415.47
45-49	9.30	105.49	228.84	632.82	1255.01	2480.83	3772.31	2327.39	2203.92	2546.52	2571.60
50-54	2.36	48.50	138.69	238.33	651.56	1279.14	2512.86	3803.60	2374.34	2189.00	1977.87
55-59	0.01	12.22	54.48	151.94	243.99	643.01	1253.98	2480.26	3746.03	2330.90	1713.17
60-64	0.00	2.26	17.01	55.52	153.22	240.43	628.73	1226.02	2413.10	3630.24	1876.88
65-69	0.00	0.00	2.26	17.01	55.34	149.52	232.15	595.27	1171.35	2295.37	2793.23
70-74	0.00	0.00	0.00	2.26	15.53	51.02	142.12	206.91	535.00	1077.49	1556.69
75-79	0.00	0.00	0.00	0.00	0.00	11.99	42.74	128.01	177.94	458.64	698.32
80-84	0.00	0.00	0.00	0.00	0.00	0.00	11.99	37.84	104.33	135.09	261.69
85+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.82	24.24	101.40	133.92
TOTAL	547.17	5842.09	8621.42	10817.82	13069.51	16041.10	18647.35	22763.14	25007.50	24425.12	18954.11

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Distribution of Person Years
Study File: X10.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1995+	TOTAL
15-19	0.00	1012.00
20-24	0.00	11176.00
25-29	0.00	18433.82
30-34	0.00	21648.86
35-39	0.00	22296.56
40-44	0.00	20709.90
45-49	0.00	18134.03
50-54	0.00	15216.27
55-59	0.00	12630.00
60-64	0.00	10243.41
65-69	0.00	7311.49
70-74	0.00	3587.03
75-79	0.00	1517.65
80-84	0.00	550.95
85+	0.00	268.38
TOTAL	0.00	164736.33

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: X10.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
1	TUBERCULOSIS	3	4.2545	0.71	0.1454	2.0618
1	RESPIRATORY TUBERCULOSIS	2	3.8042	0.53	0.0636	1.8980
2	OTHER TUBERCULOSIS	1	0.4504	2.22	0.0562	12.3358
2	MN OF BUCCAL CAVITY AND PHARYNX	5	3.3886	1.48	0.4775	3.4475
3	MN OF LIP	0	0.0145	0.00	0.0000	253.8317
4	MN OF TONGUE	2	0.7924	2.52	0.3056	9.1115
5	MN OF OTHER PARTS OF BUCCAL CAVITY	1	1.0415	0.96	0.0243	5.3340
6	MN OF PHARYNX	2	1.5401	1.30	0.1572	4.6881
3	MN OF DIGESTIVE ORGANS AND PERITONEUM	37	54.3269	0.68*	0.4795	0.9388
7	MN OF ESOPHAGUS	5	2.4139	2.07	0.6703	4.8395
8	MN OF STOMACH	4	5.8723	0.68	0.1856	1.7421
9	MN OF INTESTINE EXCEPT RECTUM	15	23.6480	0.63	0.3548	1.0463
10	MN OF RECTUM	4	4.3601	0.92	0.2500	2.3463
11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	5	4.2123	1.19	0.3841	2.7734
12	MN OF LIVER NOT SPECIFIED	0	1.3746	0.00	0.0000	2.6845
13	MN OF PANCREAS	4	11.3623	0.35*	0.0959	0.9004
14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	0	1.0834	0.00	0.0000	3.4061
4	MN OF RESPIRATORY SYSTEM	41	51.1159	0.80	0.5755	1.0882
15	MN OF LARYNX	0	0.9240	0.00	0.0000	3.9933
16	MN OF TRACHEA, BRONCHUS, AND LUNG	41	49.5919	0.83	0.5932	1.1216
17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	0	0.6000	0.00	0.0000	6.1502
5	MN OF BREAST	48	58.8001	0.82	0.6018	1.0824
18	MN OF BREAST	48	58.8001	0.82	0.6018	1.0824

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: X10.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
6	MN OF FEMALE GENITAL ORGANS	24	36.4476	0.66*	0.4218	0.9798
19	MN OF CERVIX UTERI	4	10.1106	0.40	0.1078	1.0118
20	MN OF OTHER AND UNSPECIFIED PARTS OF UTERUS	7	7.6201	0.92	0.3680	1.8928
21	MN OF OVARY, FALLOPIAN TUBE, AND BROAD LIGAMENT	13	17.7589	0.73	0.3894	1.2519
22	MN OF OTHER FEMALE GENITAL ORGANS	0	0.9579	0.00	0.0000	3.8521
7	MN OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	143402.2656
23	MN OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
24	MN OF OTHER MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	143402.2656
8	MN OF URINARY ORGANS	8	6.4666	1.24	0.5327	2.4378
25	MN OF KIDNEY	6	3.9802	1.51	0.5505	3.2812
26	MN OF BLADDER AND OTHER URINARY ORGANS	2	2.4864	0.80	0.0974	2.9039
9	MN OF OTHER AND UNSPECIFIED SITES	19	31.2656	0.61*	0.3657	0.9490
27	MN OF SKIN	5	3.9759	1.26	0.4070	2.9382
28	MN OF EYE	0	0.1698	0.00	0.0000	21.7369
29	MN OF BRAIN AND OTHER PARTS OF NERVOUS SYSTEM	1	7.2281	0.14*	0.0035	0.7686
30	MN OF THYROID GLAND	0	0.6774	0.00	0.0000	5.4475
31	MN OF BONE	0	0.6608	0.00	0.0000	5.5838
32	MN OF CONNECTIVE TISSUE AND SOFT TISSUE	0	1.6331	0.00	0.0000	2.2595
33	MN OF OTHER AND UNSPECIFIED SITES (MINOR)	13	16.9205	0.77	0.4087	1.3139
10	NEOPLASMS OF LYMPHATIC AND HEMATOPOIETIC TISSUE	15	21.9490	0.68	0.3822	1.1272
34	LYMPHOSARCOMA AND RETICULOSARCOMA	2	2.7463	0.73	0.0882	2.6291
35	HODGKIN'S DISEASE	0	1.7151	0.00	0.0000	2.1514
36	LEUKEMIA AND ALEUKEMIA	10	8.2590	1.21	0.5797	2.2269
37	OTHER NEOPLASMS OF LYMPHATIC HEMATOPOIETIC TISSUE	3	9.2286	0.33*	0.0670	0.9505

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: X10.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
11	BENIGN AND UNSPECIFIED NEOPLASMS	3	4.3486	0.69	0.1422	2.0172
38	BENIGN NEOPLASMS OF THE EYE, BRAIN, AND OTHER PARTS OF NERVOUS SYS	1	0.8339	1.20	0.0303	6.6620
39	NEOPLASMS OF EYE, BRAIN, & OTHER PARTS OF NERV SYSTEM UNSPECIF. NA	1	1.6688	0.60	0.0152	3.3291
40	OTHER BENIGN AND UNSPECIFIED NATURE NEOPLASMS	1	1.8458	0.54	0.0137	3.0098
12	DIABETES MELLITUS	8	21.3191	0.38**	0.1616	0.7394
41	DIABETES MELLITUS	8	21.3191	0.38**	0.1616	0.7394
13	DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS	1	3.3799	0.30	0.0075	1.6437
42	PERNICIOUS ANEMIAS	0	0.0832	0.00	0.0000	44.3566
43	ANEMIAS OF OTHER AND UNSPECIFIED TYPE	1	1.3988	0.71	0.0181	3.9716
44	COAGULATION DEFECTS, PURPURA, AND OTHER HEMORRHAGIC CONDITIONS	0	0.9533	0.00	0.0000	3.8708
45	ALL OTHER DISEASES OF BLOOD FORMING ORGANS	0	0.9446	0.00	0.0000	3.9065
14	MENTAL, PSYCHONEUROTIC, AND PERSONALITY DISORDERS	6	5.7226	1.05	0.3829	2.2822
46	ALCOHOLISM	0	1.9921	0.00	0.0000	1.8523
47	OTHER MENTAL DISORDERS	6	3.7305	1.61	0.5873	3.5008
15	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	7	13.6557	0.51	0.2054	1.0562
48	MULTIPLE SCLEROSIS	1	2.2856	0.44	0.0111	2.4307
49	OTHER DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	6	11.3701	0.53	0.1927	1.1486
16	DISEASES OF THE HEART	116	221.9069	0.52**	0.4319	0.6270
50	RHEUMATIC HEART DISEASE, INCLUDING FEVER	4	9.9875	0.40	0.1091	1.0243
51	ISCHEMIC HEART DISEASE	93	154.4157	0.60**	0.4861	0.7378
52	CHRONIC DISEASE OF ENDOCARDIUM	0	3.0535	0.00	0.0000	1.2085
53	OTHER MYOCARDIAL DEGENERATION	0	1.7497	0.00	0.0000	2.1089
54	HYPERTENSION WITH HEART DISEASE	0	10.2707	0.00**	0.0000	0.3593
55	OTHER DISEASES OF THE HEART	19	42.4297	0.45**	0.2695	0.6993

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: X10.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
17	OTHER DISEASES OF CIRCULATORY SYSTEM	63	80.0695	0.79	0.6046	1.0067
56	HYPERTENSION WITHOUT HEART DISEASE	3	3.3983	0.88	0.1820	2.5813
57	CEREBROVASCULAR DISEASE	43	57.0575	0.75	0.5453	1.0152
58	DISEASES OF THE ARTERIES, VEINS, AND PULMONARY CIRCULATION	17	19.6137	0.87	0.5046	1.3878
18	DISEASES OF THE RESPIRATORY SYSTEM	43	51.4893	0.84	0.6043	1.1249
59	ACUTE RESPIRATORY INFECTIONS EXCEPT INFLUENZA AND PNEUMONIA	0	0.3722	0.00	0.0000	9.9145
60	INFLUENZA	1	0.8927	1.12	0.0283	6.2234
61	PNEUMONIA (EXCEPT NEWBORN)	14	17.3783	0.81	0.4401	1.3518
62	CHRONIC AND UNSPECIFIED BRONCHITIS	1	1.4816	0.67	0.0171	3.7497
63	EMPHYSEMA	5	5.6369	0.89	0.2871	2.0724
64	ASTHMA	1	2.8925	0.35	0.0087	1.9207
65	PNEUMOCONIOSES AND OTHER RESPIRATORY DISEASES	21	22.8351	0.92	0.5690	1.4058
19	DISEASES OF THE DIGESTIVE SYSTEM	15	39.9975	0.38**	0.2097	0.6186
66	DISEASES OF THE STOMACH AND DUODENUM	0	3.1167	0.00	0.0000	1.1840
67	HERNIA AND INTESTINAL OBSTRUCTION	2	2.6554	0.75	0.0912	2.7190
68	CIRRHOSIS OF THE LIVER	6	18.7239	0.32**	0.1170	0.6975
69	OTHER DISEASES OF DIGESTIVE SYSTEM	7	15.5015	0.45*	0.1809	0.9305
20	DISEASES OF THE GENITO-URINARY SYSTEM	10	14.3185	0.70	0.3343	1.2845
70	ACUTE GLOMERULONEPHRITIS, NEPHROTIC SYNDROME, & ACUTE RENAL FAILUR	1	1.2114	0.83	0.0209	4.5861
71	CHRONIC & UNSPEC. NEPHRITIS, RENAL FAILURE, & OTHER RENAL SCLEROSI	3	6.4943	0.46	0.0952	1.3507
72	INFECTION OF KIDNEY	1	1.7742	0.56	0.0143	3.1312
73	CALCULI OF URINARY SYSTEM	0	0.3182	0.00	0.0000	11.5948
74	HYPERPLASIA OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
75	OTHER DISEASES OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	0.0000
76	DISEASES OF THE BREAST	0	0.0300	0.00	0.0000	122.9027

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: X10.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	1	0.8394	1.19	0.0301	6.6183
78	OTHER GENITO-URINARY SYSTEM DISEASES	4	3.6508	1.10	0.2985	2.8022
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	2	1.4061	1.42	0.1722	5.1351
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	0	0.3078	0.00	0.0000	11.9900
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	2	1.0983	1.82	0.2205	6.5740
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE	4	4.4744	0.89	0.2436	2.2864
81	ARTHRITIS AND SPONDYLITIS	2	1.4269	1.40	0.1697	5.0600
82	OSTEOMYELITIS AND PERIOSTITIS	0	0.1324	0.00	0.0000	27.8661
83	OTHER DISEASES OF MS SYSTEM	2	2.9150	0.69	0.0831	2.4769
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	17	9.0293	1.88*	1.0961	3.0147
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	17	9.0293	1.88*	1.0961	3.0147
24	ACCIDENTS	33	34.1789	0.97	0.6645	1.3560
85	TRANSPORTATION ACCIDENTS	16	19.4146	0.82	0.4707	1.3384
86	ACCIDENTAL POISONING	0	2.6442	0.00	0.0000	1.3955
87	ACCIDENTAL FALLS	4	3.6358	1.10	0.2998	2.8137
88	OTHER ACCIDENTS	11	6.9504	1.58	0.7890	2.8320
89	MEDICAL COMPLICATIONS AND MISADVENTURE	2	1.5338	1.30	0.1579	4.7073
25	VIOLENCE	20	19.6995	1.02	0.6199	1.5681
90	SUICIDE	14	13.7443	1.02	0.5564	1.7092
91	HOMICIDE	6	5.9553	1.01	0.3679	2.1930
26	OTHER CAUSES	32	23.2633	1.38	0.9407	1.9420
92	OTHER CAUSES	32	23.2633	1.38	0.9407	1.9420

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: X10.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
	All Cancers	197	263.7603	0.75**	0.6462	0.8588
	All Deaths	580	816.2739	0.71**	0.6539	0.7708

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

APPENDIX III TABLE 11: SMRs FOR Y-12 FEMALE WORKERS


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==============================================================================
                        G L O B A L   P A R A M E T E R S
STUDY PARAMETER FILE NAME: c:\ltas\y12.ltp
LAST COMPLETE STEP: Stratify
STUDY DESCRIPTION: y12
STUDY BEGIN DATE: 01/01/1940
STUDY END DATE: 01/01/1994
RATES IN USE: Standard U.S. Deaths 92 Minors 1940 - 99
AGE CATEGORIES: 15\20\25\30\35\40\45\50\55\60\65\70\75\80\85\
CALENDAR CATEGORIES: 1940\1945\1950\1955\1960\1965\1970\1975\1980\1985\1990\1995\
SINGLE CAUSE OF DEATH
==============================================================================
                        V E R I F Y   P A R A M E T E R S
INPUT DEMOGRAPHICS FILE: c:\ltas\y12\dem
INPUT WORK HISTORY FILE: c:\ltas\y12\wh
OUTPUT DEMOGRAPHICS FILE: c:\ltas\dem.out
OUTPUT WORK HISTORY FILE: c:\ltas\wh.out
BEGIN PERSON TIME AT LATER OF In-rec / Rate begin
STOP SURVIVORS PERSON TIME AT: END OF STUDY
GENDER/RACE SUBSETTING: KEEP ALL
EXPOSURE LEVEL: All exposed equally (no data)

SUMMARY REPORT FILE: .\summary.rpt
EXCEPTIONS REPORT FILE: .\except.rpt
EXPOSURE REPORT FILE: .\experr.rpt
==============================================================================
                      S T R A T I F Y   P A R A M E T E R S
ANALYSIS TYPE: SMR
```

DURATION	TIME SINCE FIRST EXPOSURE
MINIMUM->000Y	000Y
005Y	005Y
010Y	010Y
015Y	015Y
020Y	020Y
025Y	025Y
030Y	030Y

PERSON YEARS FILE: C:\LTAS\Y12PY
OBSERVED DEATHS FILE: C:\LTAS\Y12OB

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: Y12.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	112260.26	0.00	0.00	0.00	0.00	0.00	0.00	112260.26
005Y - 010Y	102525.20	9333.90	0.00	0.00	0.00	0.00	0.00	111859.11
010Y - 015Y	101994.46	2321.03	6864.52	0.00	0.00	0.00	0.00	111180.01
015Y - 020Y	100684.57	2122.16	995.66	4468.83	0.00	0.00	0.00	108271.22
020Y - 025Y	98488.81	1909.63	796.17	471.12	3111.62	0.00	0.00	104777.36
025Y - 030Y	95302.72	1712.91	680.68	376.26	322.11	2299.31	0.00	100694.00
030Y & Over	319245.41	4685.77	1699.32	970.32	582.76	1252.62	4719.53	333155.72
Total	930501.43	22085.39	11036.36	6286.54	4016.49	3551.93	4719.53	982197.67

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: Y12.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	1533.20	4023.17	77.18	37.09	40.73	43.45	79.30	50.35	4.99	0.00	0.00
20-24	2775.06	36839.91	5762.92	561.87	377.30	363.89	817.11	783.07	342.66	4.96	0.00
25-29	1495.43	24555.19	38832.36	6265.85	821.00	530.49	749.05	1343.20	1341.82	342.23	4.96
30-34	1048.08	13507.53	25458.55	39136.15	6387.75	887.38	677.36	981.98	1621.95	1336.34	321.43
35-39	729.83	9128.71	13965.40	25522.01	39047.85	6409.43	983.79	822.41	1145.29	1611.40	1136.08
40-44	386.50	5275.04	9361.75	13957.92	25451.07	38833.46	6470.24	1159.76	919.40	1142.81	1296.80
45-49	181.00	2483.37	5362.47	9359.21	13871.62	25202.90	38535.07	6560.71	1233.64	913.59	836.02
50-54	78.35	1024.22	2507.59	5317.58	9251.53	13658.25	24801.59	38063.79	6537.35	1217.71	714.65
55-59	33.84	301.39	1026.84	2447.17	5231.69	9040.41	13295.65	24293.54	37164.53	6387.75	995.11
60-64	11.90	94.14	297.05	1003.99	2353.18	5022.49	8705.66	12693.81	23376.05	35928.70	5872.65
65-69	6.74	42.26	89.02	281.83	956.00	2197.70	4642.40	8126.33	11760.32	22077.60	29059.78
70-74	0.00	11.88	40.82	84.04	269.03	876.54	1957.86	4174.33	7290.84	10653.56	14798.69
75-79	0.00	0.00	11.87	31.91	80.57	235.12	747.52	1661.31	3591.60	6221.53	7091.95
80-84	0.00	0.00	0.00	9.80	29.70	58.31	168.10	587.09	1295.88	2863.46	3810.32
85+	0.00	0.00	0.00	0.00	6.12	28.13	54.43	149.29	481.74	1206.46	2166.86
TOTAL	8279.94	97286.81	102793.82	104016.45	104175.14	103387.96	102685.12	101450.97	98108.06	91908.09	68105.31

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: Y12.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1995+	TOTAL
15-19	0.00	5889.46
20-24	0.00	48628.74
25-29	0.00	76281.59
30-34	0.00	91364.49
35-39	0.00	100502.20
40-44	0.00	104254.75
45-49	0.00	104539.61
50-54	0.00	103172.63
55-59	0.00	100217.93
60-64	0.00	95359.62
65-69	0.00	79240.01
70-74	0.00	40157.58
75-79	0.00	19673.38
80-84	0.00	8822.65
85+	0.00	4093.03
TOTAL	0.00	982197.67

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: Y12.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
1	TUBERCULOSIS	17	64.5104	0.26**	0.1534	0.4220
1	RESPIRATORY TUBERCULOSIS	12	58.5545	0.20**	0.1058	0.3580
2	OTHER TUBERCULOSIS	5	5.9559	0.84	0.2717	1.9615
2	MN OF BUCCAL CAVITY AND PHARYNX	26	31.3656	0.83	0.5413	1.2146
3	MN OF LIP	0	0.1649	0.00	0.0000	22.3726
4	MN OF TONGUE	5	7.3069	0.68	0.2215	1.5988
5	MN OF OTHER PARTS OF BUCCAL CAVITY	9	9.9460	0.90	0.4129	1.7179
6	MN OF PHARYNX	12	13.9477	0.86	0.4440	1.5030
3	MN OF DIGESTIVE ORGANS AND PERITONEUM	360	545.9252	0.66**	0.5931	0.7312
7	MN OF ESOPHAGUS	17	24.9578	0.68	0.3966	1.0907
8	MN OF STOMACH	36	61.9097	0.58**	0.4072	0.8051
9	MN OF INTESTINE EXCEPT RECTUM	153	234.8714	0.65**	0.5523	0.7632
10	MN OF RECTUM	22	44.6162	0.49**	0.3089	0.7466
11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	31	41.6919	0.74	0.5051	1.0555
12	MN OF LIVER NOT SPECIFIED	15	14.2878	1.05	0.5872	1.7317
13	MN OF PANCREAS	83	112.5684	0.74**	0.5873	0.9140
14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	3	11.0218	0.27**	0.0561	0.7959
4	MN OF RESPIRATORY SYSTEM	405	427.4666	0.95	0.8574	1.0444
15	MN OF LARYNX	9	8.3587	1.08	0.4913	2.0441
16	MN OF TRACHEA, BRONCHUS, AND LUNG	394	413.9120	0.95	0.8602	1.0507
17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	2	5.1959	0.38	0.0466	1.3896
5	MN OF BREAST	354	485.9717	0.73**	0.6545	0.8084
18	MN OF BREAST	354	485.9717	0.73**	0.6545	0.8084

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Category Number		Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
1		TUBERCULOSIS	17	64.5104	0.26**	0.1534	0.4220
	1	RESPIRATORY TUBERCULOSIS	12	58.5545	0.20**	0.1058	0.3580
	2	OTHER TUBERCULOSIS	5	5.9559	0.84	0.2717	1.9615
2		MN OF BUCCAL CAVITY AND PHARYNX	26	31.3656	0.83	0.5413	1.2146
	3	MN OF LIP	0	0.1649	0.00	0.0000	22.3726
	4	MN OF TONGUE	5	7.3069	0.68	0.2215	1.5988
	5	MN OF OTHER PARTS OF BUCCAL CAVITY	9	9.9460	0.90	0.4129	1.7179
	6	MN OF PHARYNX	12	13.9477	0.86	0.4440	1.5030
3		MN OF DIGESTIVE ORGANS AND PERITONEUM	360	545.9252	0.66**	0.5931	0.7312
	7	MN OF ESOPHAGUS	17	24.9578	0.68	0.3966	1.0907
	8	MN OF STOMACH	36	61.9097	0.58**	0.4072	0.8051
	9	MN OF INTESTINE EXCEPT RECTUM	153	234.8714	0.65**	0.5523	0.7632
	10	MN OF RECTUM	22	44.6162	0.49**	0.3089	0.7466
	11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	31	41.6919	0.74	0.5051	1.0555
	12	MN OF LIVER NOT SPECIFIED	15	14.2878	1.05	0.5872	1.7317
	13	MN OF PANCREAS	83	112.5684	0.74**	0.5873	0.9140
	14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	3	11.0218	0.27**	0.0561	0.7959
4		MN OF RESPIRATORY SYSTEM	405	427.4666	0.95	0.8574	1.0444
	15	MN OF LARYNX	9	8.3587	1.08	0.4913	2.0441
	16	MN OF TRACHEA, BRONCHUS, AND LUNG	394	413.9120	0.95	0.8602	1.0507
	17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	2	5.1959	0.38	0.0466	1.3896
5		MN OF BREAST	354	485.9717	0.73**	0.6545	0.8084
	18	MN OF BREAST	354	485.9717	0.73**	0.6545	0.8084

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: Y12.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
17	OTHER DISEASES OF CIRCULATORY SYSTEM	699	910.7659	0.77**	0.7116	0.8266
56	HYPERTENSION WITHOUT HEART DISEASE	25	41.9845	0.60**	0.3852	0.8791
57	CEREBROVASCULAR DISEASE	515	661.7702	0.78**	0.7124	0.8484
58	DISEASES OF THE ARTERIES, VEINS, AND PULMONARY CIRCULATION	159	207.0111	0.77**	0.6533	0.8972
18	DISEASES OF THE RESPIRATORY SYSTEM	436	518.7040	0.84**	0.7635	0.9233
59	ACUTE RESPIRATORY INFECTIONS EXCEPT INFLUENZA AND PNEUMONIA	5	3.6164	1.38	0.4474	3.2303
60	INFLUENZA	2	10.6006	0.19**	0.0228	0.6811
61	PNEUMONIA (EXCEPT NEWBORN)	157	192.3127	0.82*	0.6937	0.9545
62	CHRONIC AND UNSPECIFIED BRONCHITIS	22	14.7221	1.49	0.9362	2.2626
63	EMPHYSEMA	40	53.6388	0.75	0.5327	1.0155
64	ASTHMA	10	25.3216	0.39**	0.1891	0.7263
65	PNEUMOCONIOSES AND OTHER RESPIRATORY DISEASES	200	218.4917	0.92	0.7929	1.0514
19	DISEASES OF THE DIGESTIVE SYSTEM	263	375.3914	0.70**	0.6185	0.7906
66	DISEASES OF THE STOMACH AND DUODENUM	25	32.7475	0.76	0.4939	1.1270
67	HERNIA AND INTESTINAL OBSTRUCTION	20	31.0959	0.64	0.3927	0.9934
68	CIRRHOSIS OF THE LIVER	111	156.6996	0.71**	0.5827	0.8531
69	OTHER DISEASES OF DIGESTIVE SYSTEM	107	154.8484	0.69**	0.5663	0.8350
20	DISEASES OF THE GENITO-URINARY SYSTEM	138	163.8047	0.84*	0.7078	0.9953
70	ACUTE GLOMERULONEPHRITIS, NEPHROTIC SYNDROME, & ACUTE RENAL FAILUR	11	13.8058	0.80	0.3972	1.4257
71	CHRONIC & UNSPEC. NEPHRITIS, RENAL FAILURE, & OTHER RENAL SCLEROSI	40	73.8515	0.54**	0.3869	0.7376
72	INFECTION OF KIDNEY	16	21.3793	0.75	0.4275	1.2154
73	CALCULI OF URINARY SYSTEM	0	3.6736	0.00	0.0000	1.0045
74	HYPERPLASIA OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
75	OTHER DISEASES OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	0.0000
76	DISEASES OF THE BREAST	0	0.2887	0.00	0.0000	12.7822

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	340332.37	0.00	0.00	0.00	0.00	0.00	0.00	340332.37
005Y - 010Y	250807.81	88116.78	0.00	0.00	0.00	0.00	0.00	338924.59
010Y - 015Y	249281.07	24631.58	62693.83	0.00	0.00	0.00	0.00	336606.48
015Y - 020Y	236596.47	19737.42	9748.35	41811.73	0.00	0.00	0.00	307893.97
020Y - 025Y	220508.04	16008.39	6740.33	5758.54	26044.16	0.00	0.00	275059.47
025Y - 030Y	205313.63	13841.29	5724.42	4441.35	3800.01	17607.94	0.00	250728.63
030Y & Over	600809.23	30722.37	11540.40	8606.83	7027.66	7586.44	28595.07	694888.00
Total	2103648.61	193057.83	96447.33	60618.46	36871.82	25194.38	28595.07	2544433.51

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Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	2011.78	7802.43	2040.06	1350.12	955.33	1151.35	1167.91	1909.80	183.84	0.00	0.00
20-24	3796.20	61080.93	21271.08	11862.92	7218.37	8252.39	8983.06	12645.42	6861.96	183.14	0.00
25-29	2075.49	41984.42	72670.03	27784.94	14765.13	10324.54	12329.59	16832.84	18148.38	6846.27	182.48
30-34	1403.22	23102.77	48331.55	76363.18	29312.46	16115.73	11976.33	16567.85	19895.10	18120.52	6438.72
35-39	958.04	15588.43	27216.12	50739.59	77401.96	30323.26	17239.87	14734.23	18277.38	19814.01	15000.77
40-44	528.03	9523.49	18373.81	28820.57	51493.44	77949.60	31121.60	19160.49	15880.59	18176.91	15879.67
45-49	259.62	4941.51	11021.90	19297.75	29144.08	51592.97	77842.81	32221.83	19857.43	15764.50	14185.82
50-54	126.51	2417.35	5726.26	11260.27	19328.56	28959.42	51091.13	77545.76	32280.65	19653.73	12451.62
55-59	48.41	1008.49	2661.07	5700.31	11130.11	18969.34	28276.27	50253.79	75971.26	31601.20	16050.32
60-64	14.84	318.05	1095.61	2611.09	5504.17	10739.53	18271.38	27107.19	48500.76	73557.77	26259.23
65-69	6.74	110.89	336.15	1032.73	2478.36	5191.39	9993.15	17118.64	25344.15	45790.14	58234.64
70-74	0.00	14.94	108.60	318.30	925.17	2235.92	4643.97	8994.37	15396.65	23119.27	31045.25
75-79	0.00	3.86	15.05	94.60	278.30	794.45	1870.86	3876.81	7745.94	13172.04	15475.41
80-84	0.00	0.00	3.86	12.99	81.87	220.00	572.47	1435.24	3050.06	6172.14	8064.21
85+	0.00	0.00	0.00	3.86	13.17	84.34	211.89	516.84	1336.64	2985.76	4778.29
TOTAL	11228.88	167897.56	210871.15	237253.23	250030.48	262904.23	275592.28	300921.11	308730.78	294957.39	224046.42

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1995+	TOTAL			
15-19	0.00	18572.64			
20-24	0.00	142155.47			
25-29	0.00	223944.12			
30-34	0.00	267627.44			
35-39	0.00	287293.65			
40-44	0.00	286908.20			
45-49	0.00	276130.21			
50-54	0.00	260841.25			
55-59	0.00	241670.56			
60-64	0.00	213979.63			
65-69	0.00	165636.98			
70-74	0.00	86802.44			
75-79	0.00	43327.31			
80-84	0.00	19612.84			
85+	0.00	9930.78	2544433.51	2	0.00

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Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number		Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
1		TUBERCULOSIS	31	109.8240	0.28**	0.1918	0.4007
	1	RESPIRATORY TUBERCULOSIS	21	99.2387	0.21**	0.1309	0.3235
	2	OTHER TUBERCULOSIS	10	10.5854	0.94	0.4523	1.7375
2		MN OF BUCCAL CAVITY AND PHARYNX	67	70.4417	0.95	0.7371	1.2079
	3	MN OF LIP	0	0.3692	0.00	0.0000	9.9939
	4	MN OF TONGUE	19	16.4658	1.15	0.6944	1.8021
	5	MN OF OTHER PARTS OF BUCCAL CAVITY	19	22.3550	0.85	0.5115	1.3273
	6	MN OF PHARYNX	29	31.2517	0.93	0.6213	1.3327
3		MN OF DIGESTIVE ORGANS AND PERITONEUM	821	1215.2810	0.68**	0.6301	0.7234
	7	MN OF ESOPHAGUS	43	52.5269	0.82	0.5924	1.1027
	8	MN OF STOMACH	82	134.7012	0.61**	0.4841	0.7556
	9	MN OF INTESTINE EXCEPT RECTUM	365	528.3023	0.69**	0.6218	0.7655
	10	MN OF RECTUM	61	99.8735	0.61**	0.4672	0.7846
	11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	65	94.1114	0.69**	0.5330	0.8803
	12	MN OF LIVER NOT SPECIFIED	24	31.4568	0.76	0.4887	1.1353
	13	MN OF PANCREAS	175	249.7253	0.70**	0.6008	0.8126
	14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	6	24.5836	0.24**	0.0891	0.5312
4		MN OF RESPIRATORY SYSTEM	858	988.8085	0.87**	0.8106	0.9278
	15	MN OF LARYNX	15	18.6215	0.81	0.4505	1.3287
	16	MN OF TRACHEA, BRONCHUS, AND LUNG	835	958.1797	0.87**	0.8133	0.9326
	17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	8	12.0072	0.67	0.2869	1.3129
5		MN OF BREAST	862	1138.6039	0.76**	0.7074	0.8093
	18	MN OF BREAST	862	1138.6039	0.76**	0.7074	0.8093

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
6	MN OF FEMALE GENITAL ORGANS	524	758.9800	0.69**	0.6325	0.7521
19	MN OF CERVIX UTERI	154	199.3546	0.77**	0.6553	0.9046
20	MN OF OTHER AND UNSPECIFIED PARTS OF UTERUS	93	175.7397	0.53**	0.4271	0.6483
21	MN OF OVARY, FALLOPIAN TUBE, AND BROAD LIGAMENT	267	362.2640	0.74**	0.6513	0.8310
22	MN OF OTHER FEMALE GENITAL ORGANS	10	21.6216	0.46*	0.2214	0.8506
7	MN OF MALE GENITAL ORGANS	0	0.0008	0.00	0.0000	4841.5532
23	MN OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
24	MN OF OTHER MALE GENITAL ORGANS	0	0.0008	0.00	0.0000	4841.5532
8	MN OF URINARY ORGANS	116	142.2581	0.82*	0.6738	0.9780
25	MN OF KIDNEY	73	82.7137	0.88	0.6918	1.1097
26	MN OF BLADDER AND OTHER URINARY ORGANS	43	59.5444	0.72*	0.5226	0.9728
9	MN OF OTHER AND UNSPECIFIED SITES	481	626.9910	0.77**	0.7001	0.8389
27	MN OF SKIN	76	72.1675	1.05	0.8297	1.3181
28	MN OF EYE	4	3.7337	1.07	0.2919	2.7400
29	MN OF BRAIN AND OTHER PARTS OF NERVOUS SYSTEM	101	136.4779	0.74**	0.6028	0.8992
30	MN OF THYROID GLAND	11	15.2616	0.72	0.3593	1.2897
31	MN OF BONE	10	13.5461	0.74	0.3534	1.3577
32	MN OF CONNECTIVE TISSUE AND SOFT TISSUE	20	29.6298	0.67	0.4121	1.0425
33	MN OF OTHER AND UNSPECIFIED SITES (MINOR)	259	356.1746	0.73**	0.6413	0.8213
10	NEOPLASMS OF LYMPHATIC AND HEMATOPOIETIC TISSUE	346	448.5641	0.77**	0.6922	0.8571
34	LYMPHOSARCOMA AND RETICULOSARCOMA	54	60.4162	0.89	0.6714	1.1662
35	HODGKIN'S DISEASE	22	30.7336	0.72	0.4484	1.0838
36	LEUKEMIA AND ALEUKEMIA	118	166.7837	0.71**	0.5856	0.8473
37	OTHER NEOPLASMS OF LYMPHATIC HEMATOPOIETIC TISSUE	152	190.6308	0.80**	0.6756	0.9347

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
11	BENIGN AND UNSPECIFIED NEOPLASMS	54	94.1027	0.57**	0.4311	0.7488
38	BENIGN NEOPLASMS OF THE EYE, BRAIN, AND OTHER PARTS OF NERVOUS SYS	12	18.0706	0.66	0.3427	1.1601
39	NEOPLASMS OF EYE, BRAIN, & OTHER PARTS OF NERV SYSTEM UNSPECIF. NA	19	33.8391	0.56*	0.3379	0.8769
40	OTHER BENIGN AND UNSPECIFIED NATURE NEOPLASMS	23	42.1929	0.55**	0.3454	0.8180
12	DIABETES MELLITUS	274	479.0948	0.57**	0.5062	0.6438
41	DIABETES MELLITUS	274	479.0948	0.57**	0.5062	0.6438
13	DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS	48	72.5985	0.66**	0.4875	0.8766
42	PERNICIOUS ANEMIAS	1	2.4474	0.41	0.0103	2.2700
43	ANEMIAS OF OTHER AND UNSPECIFIED TYPE	20	30.5863	0.65	0.3992	1.0099
44	COAGULATION DEFECTS, PURPURA, AND OTHER HEMORRHAGIC CONDITIONS	13	18.8644	0.69	0.3666	1.1785
45	ALL OTHER DISEASES OF BLOOD FORMING ORGANS	14	20.7005	0.68	0.3694	1.1348
14	MENTAL, PSYCHONEUROTIC, AND PERSONALITY DISORDERS	166	126.1405	1.32**	1.1234	1.5321
46	ALCOHOLISM	31	34.1892	0.91	0.6160	1.2871
47	OTHER MENTAL DISORDERS	135	91.9513	1.47**	1.2309	1.7378
15	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	120	286.0149	0.42**	0.3478	0.5017
48	MULTIPLE SCLEROSIS	18	41.2058	0.44**	0.2588	0.6904
49	OTHER DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	102	244.8091	0.42**	0.3397	0.5058
16	DISEASES OF THE HEART	3625	5536.9487	0.65**	0.6336	0.6764
50	RHEUMATIC HEART DISEASE, INCLUDING FEVER	135	227.6601	0.59**	0.4972	0.7019
51	ISCHEMIC HEART DISEASE	2922	3926.3833	0.74**	0.7175	0.7717
52	CHRONIC DISEASE OF ENDOCARDIUM	15	73.8576	0.20**	0.1136	0.3350
53	OTHER MYOCARDIAL DEGENERATION	20	51.8448	0.39**	0.2355	0.5958
54	HYPERTENSION WITH HEART DISEASE	75	265.0293	0.28**	0.2226	0.3547
55	OTHER DISEASES OF THE HEART	458	992.1736	0.46**	0.4203	0.5059

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
17	OTHER DISEASES OF CIRCULATORY SYSTEM	1513	1995.4377	0.76**	0.7205	0.7974
56	HYPERTENSION WITHOUT HEART DISEASE	53	83.3051	0.64**	0.4765	0.8322
57	CEREBROVASCULAR DISEASE	1098	1445.1847	0.76**	0.7155	0.8061
58	DISEASES OF THE ARTERIES, VEINS, AND PULMONARY CIRCULATION	362	466.9481	0.78**	0.6974	0.8594
18	DISEASES OF THE RESPIRATORY SYSTEM	990	1166.8857	0.85**	0.7964	0.9030
59	ACUTE RESPIRATORY INFECTIONS EXCEPT INFLUENZA AND PNEUMONIA	8	8.1723	0.98	0.4215	1.9290
60	INFLUENZA	14	22.6857	0.62	0.3371	1.0355
61	PNEUMONIA (EXCEPT NEWBORN)	348	429.4564	0.81**	0.7274	0.9001
62	CHRONIC AND UNSPECIFIED BRONCHITIS	38	33.4869	1.13	0.8029	1.5576
63	EMPHYSEMA	110	122.2687	0.90	0.7394	1.0843
64	ASTHMA	31	56.8005	0.55**	0.3708	0.7747
65	PNEUMOCONIOSES AND OTHER RESPIRATORY DISEASES	441	494.0154	0.89*	0.8113	0.9800
19	DISEASES OF THE DIGESTIVE SYSTEM	619	844.3708	0.73**	0.6765	0.7932
66	DISEASES OF THE STOMACH AND DUODENUM	59	73.0657	0.81	0.6147	1.0416
67	HERNIA AND INTESTINAL OBSTRUCTION	44	67.0051	0.66**	0.4771	0.8816
68	CIRRHOSIS OF THE LIVER	277	358.3887	0.77**	0.6846	0.8695
69	OTHER DISEASES OF DIGESTIVE SYSTEM	239	345.9113	0.69**	0.6061	0.7843
20	DISEASES OF THE GENITO-URINARY SYSTEM	241	338.8235	0.71**	0.6243	0.8070
70	ACUTE GLOMERULONEPHRITIS, NEPHROTIC SYNDROME, & ACUTE RENAL FAILUR	15	28.5301	0.53*	0.2940	0.8672
71	CHRONIC & UNSPEC. NEPHRITIS, RENAL FAILURE, & OTHER RENAL SCLEROSI	57	150.2433	0.38**	0.2873	0.4915
72	INFECTION OF KIDNEY	34	44.2394	0.77	0.5322	1.0740
73	CALCULI OF URINARY SYSTEM	6	7.9034	0.76	0.2772	1.6524
74	HYPERPLASIA OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
75	OTHER DISEASES OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	0.0000
76	DISEASES OF THE BREAST	0	0.6391	0.00	0.0000	5.7738

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	14	18.0400	0.78	0.4239	1.3022
78	OTHER GENITO-URINARY SYSTEM DISEASES	115	89.2282	1.29**	1.0640	1.5471
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	27	32.8323	0.82	0.5418	1.1965
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	6	6.7676	0.89	0.3237	1.9298
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	21	26.0648	0.81	0.4985	1.2316
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE	96	88.9092	1.08	0.8746	1.3186
81	ARTHRITIS AND SPONDYLITIS	34	33.3977	1.02	0.7049	1.4227
82	OSTEOMYELITIS AND PERIOSTITIS	1	3.0629	0.33	0.0083	1.8138
83	OTHER DISEASES OF MS SYSTEM	61	52.4486	1.16	0.8896	1.4940
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	296	181.6325	1.63**	1.4493	1.8263
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	296	181.6325	1.63**	1.4493	1.8263
24	ACCIDENTS	564	603.2235	0.93	0.8594	1.0154
85	TRANSPORTATION ACCIDENTS	311	308.4251	1.01	0.8994	1.1269
86	ACCIDENTAL POISONING	31	40.6473	0.76	0.5181	1.0826
87	ACCIDENTAL FALLS	72	91.2860	0.79*	0.6171	0.9933
88	OTHER ACCIDENTS	132	131.6973	1.00	0.8386	1.1886
89	MEDICAL COMPLICATIONS AND MISADVENTURE	18	31.1678	0.58*	0.3421	0.9128
25	VIOLENCE	272	298.7096	0.91	0.8056	1.0255
90	SUICIDE	190	216.9663	0.88	0.7556	1.0095
91	HOMICIDE	82	81.7433	1.00	0.7978	1.2452
26	OTHER CAUSES	660	461.1025	1.43**	1.3242	1.5448
92	OTHER CAUSES	660	461.1025	1.43**	1.3242	1.5448

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
	All Cancers	4075	5389.9302	0.76**	0.7330	0.7796
	All Deaths	13671	18106.5801	0.76**	0.7424	0.7678

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

APPENDIX III TABLE 14: POOLED SMRS FOR THOSE EMPLOYED LESS THAN 12 MONTHS


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==============================================================================
                       G L O B A L   P A R A M E T E R S
STUDY PARAMETER FILE NAME: c:\ltas\alllt12.ltp
LAST COMPLETE STEP: Stratify
STUDY DESCRIPTION: less than 12
STUDY BEGIN DATE: 01/01/1940
STUDY END DATE: 01/01/1994
RATES IN USE: Standard U.S. Deaths 92 Minors 1940 - 99
AGE CATEGORIES: 15\20\25\30\35\40\45\50\55\60\65\70\75\80\85\
CALENDAR CATEGORIES: 1940\1945\1950\1955\1960\1965\1970\1975\1980\1985\1990\1995\
SINGLE CAUSE OF DEATH
==============================================================================
                       V E R I F Y   P A R A M E T E R S
INPUT DEMOGRAPHICS FILE: c:\ltas\all\demlt12
INPUT WORK HISTORY FILE: c:\ltas\all\whlt12
OUTPUT DEMOGRAPHICS FILE: c:\ltas\all\odemlt12
OUTPUT WORK HISTORY FILE: c:\ltas\all\owhlt12
BEGIN PERSON TIME AT LATER OF In-rec / Rate begin
STOP SURVIVORS PERSON TIME AT: END OF STUDY
GENDER/RACE SUBSETTING: KEEP ALL
EXPOSURE LEVEL: All exposed equally (no data)

SUMMARY REPORT FILE: .\summary.rpt
EXCEPTIONS REPORT FILE: .\except.rpt
EXPOSURE REPORT FILE: .\experr.rpt
==============================================================================
                     S T R A T I F Y   P A R A M E T E R S
ANALYSIS TYPE: SMR
```

DURATION	TIME SINCE FIRST EXPOSURE
MINIMUM->000Y	000Y
005Y	005Y
010Y	010Y
015Y	015Y
020Y	020Y
025Y	025Y
030Y	030Y

PERSON YEARS FILE: C:\LTAS\ALLLT1PY
OBSERVED DEATHS FILE: C:\LTAS\ALLLT1OB

Distribution of Person Years
Study File: ALLLT12.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	140315.99	0.00	0.00	0.00	0.00	0.00	0.00	140315.99
005Y - 010Y	139751.93	0.00	0.00	0.00	0.00	0.00	0.00	139751.93
010Y - 015Y	138920.47	0.00	0.00	0.00	0.00	0.00	0.00	138920.47
015Y - 020Y	133147.58	0.00	0.00	0.00	0.00	0.00	0.00	133147.58
020Y - 025Y	125767.09	0.00	0.00	0.00	0.00	0.00	0.00	125767.09
025Y - 030Y	118270.77	0.00	0.00	0.00	0.00	0.00	0.00	118270.77
030Y & Over	363336.79	0.00	0.00	0.00	0.00	0.00	0.00	363336.79
Total	1159510.62	0.00	0.00	0.00	0.00	0.00	0.00	1159510.62

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: ALLLT12.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	901.69	4707.32	529.62	243.11	168.24	284.48	380.86	532.88	55.24	0.00	0.00
20-24	1749.27	36734.51	9807.32	2894.01	1435.89	1943.09	2710.31	3184.23	1843.64	55.01	0.00
25-29	986.87	24857.89	41563.81	11584.58	3537.03	2120.52	2857.95	4071.52	4140.51	1840.48	54.87
30-34	662.88	13125.89	27322.35	42347.41	11854.67	3741.62	2351.62	3407.09	4504.00	4135.15	1718.73
35-39	431.86	8593.44	14503.32	27693.83	42354.02	11945.82	3866.04	2619.61	3596.51	4486.03	3378.34
40-44	241.07	5048.32	9446.19	14711.78	27691.23	42186.56	11970.02	4017.00	2729.63	3574.14	3573.34
45-49	132.03	2523.79	5569.84	9577.91	14694.65	27415.04	41686.56	11934.02	4082.10	2709.74	2739.16
50-54	65.23	1195.32	2798.83	5597.74	9525.47	14515.44	26938.86	41079.67	11779.93	4031.20	2136.30
55-59	26.46	477.74	1281.37	2768.95	5537.19	9312.35	14041.10	26339.91	40006.49	11493.94	3367.58
60-64	13.81	166.89	523.22	1248.55	2684.46	5306.16	8938.48	13372.47	25337.74	38665.85	10049.53
65-69	6.74	77.47	174.20	491.46	1186.49	2503.54	4918.32	8392.88	12400.67	23819.88	30834.30
70-74	0.00	12.90	76.19	167.09	453.83	1085.80	2215.54	4389.44	7542.81	11306.50	16069.18
75-79	0.00	3.86	13.01	66.33	145.99	390.37	922.47	1857.10	3808.46	6470.84	7544.13
80-84	0.00	0.00	3.86	10.95	62.05	120.92	289.88	708.08	1466.22	3035.41	3969.53
85+	0.00	0.00	0.00	3.86	11.12	65.20	126.55	287.00	689.00	1532.73	2485.14
TOTAL	5217.92	97525.34	113613.11	119407.56	121342.34	122936.90	124214.55	126192.90	123982.95	117156.90	87920.15

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: ALLLT12.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1995+	TOTAL			
15-19	0.00	7803.43			
20-24	0.00	62357.27			
25-29	0.00	97616.05			
30-34	0.00	115171.41			
35-39	0.00	123468.83			
40-44	0.00	125189.27			
45-49	0.00	123064.84			
50-54	0.00	119663.99			
55-59	0.00	114653.06			
60-64	0.00	106307.16			
65-69	0.00	84805.97			
70-74	0.00	43319.29			
75-79	0.00	21222.55			
80-84	0.00	9666.90			
85+	0.00	5200.61	1159510.62	1	0.00

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLLT12.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
1	TUBERCULOSIS	22	64.1026	0.34**	0.2150	0.5196
1	RESPIRATORY TUBERCULOSIS	16	58.1011	0.28**	0.1573	0.4472
2	OTHER TUBERCULOSIS	6	6.0015	1.00	0.3651	2.1761
2	MN OF BUCCAL CAVITY AND PHARYNX	26	34.7867	0.75	0.4881	1.0952
3	MN OF LIP	0	0.1845	0.00	0.0000	20.0040
4	MN OF TONGUE	11	8.1166	1.36	0.6756	2.4251
5	MN OF OTHER PARTS OF BUCCAL CAVITY	7	11.0486	0.63	0.2538	1.3055
6	MN OF PHARYNX	8	15.4371	0.52	0.2231	1.0212
3	MN OF DIGESTIVE ORGANS AND PERITONEUM	405	602.8378	0.67**	0.6080	0.7406
7	MN OF ESOPHAGUS	26	26.9675	0.96	0.6296	1.4127
8	MN OF STOMACH	40	67.6391	0.59**	0.4224	0.8053
9	MN OF INTESTINE EXCEPT RECTUM	179	260.6933	0.69**	0.5897	0.7949
10	MN OF RECTUM	25	49.4794	0.51**	0.3269	0.7459
11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	30	46.3615	0.65*	0.4365	0.9238
12	MN OF LIVER NOT SPECIFIED	12	15.6957	0.76	0.3946	1.3356
13	MN OF PANCREAS	91	123.8221	0.73**	0.5917	0.9023
14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	2	12.1792	0.16**	0.0199	0.5928
4	MN OF RESPIRATORY SYSTEM	438	478.7667	0.91	0.8312	1.0047
15	MN OF LARYNX	5	9.2334	0.54	0.1752	1.2652
16	MN OF TRACHEA, BRONCHUS, AND LUNG	430	463.7085	0.93	0.8417	1.0192
17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	3	5.8248	0.52	0.1062	1.5060
5	MN OF BREAST	383	547.6940	0.70**	0.6310	0.7730
18	MN OF BREAST	383	547.6940	0.70**	0.6310	0.7730

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLLT12.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
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Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
6	MN OF FEMALE GENITAL ORGANS	249	375.2821	0.66**	0.5836	0.7512
19	MN OF CERVIX UTERI	82	99.5610	0.82	0.6550	1.0223
20	MN OF OTHER AND UNSPECIFIED PARTS OF UTERUS	45	88.8942	0.51**	0.3692	0.6774
21	MN OF OVARY, FALLOPIAN TUBE, AND BROAD LIGAMENT	116	176.0427	0.66**	0.5445	0.7903
22	MN OF OTHER FEMALE GENITAL ORGANS	6	10.7843	0.56	0.2032	1.2110
7	MN OF MALE GENITAL ORGANS	0	0.0004	0.00	0.0000	10025.8848
23	MN OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
24	MN OF OTHER MALE GENITAL ORGANS	0	0.0004	0.00	0.0000	10025.8848
8	MN OF URINARY ORGANS	48	70.0668	0.69**	0.5051	0.9083
25	MN OF KIDNEY	33	40.1941	0.82	0.5651	1.1531
26	MN OF BLADDER AND OTHER URINARY ORGANS	15	29.8727	0.50**	0.2808	0.8282
9	MN OF OTHER AND UNSPECIFIED SITES	246	304.1770	0.81**	0.7108	0.9164
27	MN OF SKIN	33	33.6704	0.98	0.6745	1.3765
28	MN OF EYE	2	1.8081	1.11	0.1339	3.9932
29	MN OF BRAIN AND OTHER PARTS OF NERVOUS SYSTEM	55	64.9392	0.85	0.6380	1.1024
30	MN OF THYROID GLAND	6	7.5515	0.79	0.2901	1.7294
31	MN OF BONE	5	6.5782	0.76	0.2460	1.7759
32	MN OF CONNECTIVE TISSUE AND SOFT TISSUE	5	14.0941	0.35*	0.1148	0.8289
33	MN OF OTHER AND UNSPECIFIED SITES (MINOR)	140	175.5356	0.80**	0.6709	0.9412
10	NEOPLASMS OF LYMPHATIC AND HEMATOPOIETIC TISSUE	155	217.7565	0.71**	0.6041	0.8331
34	LYMPHOSARCOMA AND RETICULOSARCOMA	27	29.5587	0.91	0.6018	1.3291
35	HODGKIN'S DISEASE	9	14.4921	0.62	0.2834	1.1790
36	LEUKEMIA AND ALEUKEMIA	54	80.5205	0.67**	0.5038	0.8751
37	OTHER NEOPLASMS OF LYMPHATIC HEMATOPOIETIC TISSUE	65	93.1853	0.70**	0.5383	0.8891

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLLT12.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
11	BENIGN AND UNSPECIFIED NEOPLASMS	29	47.2978	0.61**	0.4105	0.8806
38	BENIGN NEOPLASMS OF THE EYE, BRAIN, AND OTHER PARTS OF NERVOUS SYS	5	9.0305	0.55	0.1792	1.2936
39	NEOPLASMS OF EYE, BRAIN, & OTHER PARTS OF NERV SYSTEM UNSPECIF. NA	12	16.5309	0.73	0.3747	1.2681
40	OTHER BENIGN AND UNSPECIFIED NATURE NEOPLASMS	12	21.7364	0.55*	0.2849	0.9644
12	DIABETES MELLITUS	147	242.4218	0.61**	0.5123	0.7127
41	DIABETES MELLITUS	147	242.4218	0.61**	0.5123	0.7127
13	DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS	27	36.0581	0.75	0.4933	1.0895
42	PERNICIOUS ANEMIAS	1	1.2761	0.78	0.0198	4.3536
43	ANEMIAS OF OTHER AND UNSPECIFIED TYPE	10	15.3537	0.65	0.3118	1.1979
44	COAGULATION DEFECTS, PURPURA, AND OTHER HEMORRHAGIC CONDITIONS	9	9.2695	0.97	0.4430	1.8432
45	ALL OTHER DISEASES OF BLOOD FORMING ORGANS	7	10.1589	0.69	0.2761	1.4198
14	MENTAL, PSYCHONEUROTIC, AND PERSONALITY DISORDERS	69	62.2328	1.11	0.8626	1.4032
46	ALCOHOLISM	16	16.7252	0.96	0.5464	1.5536
47	OTHER MENTAL DISORDERS	53	45.5077	1.16	0.8723	1.5234
15	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	52	139.6387	0.37**	0.2781	0.4884
48	MULTIPLE SCLEROSIS	9	19.5892	0.46*	0.2096	0.8722
49	OTHER DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	43	120.0495	0.36**	0.2592	0.4825
16	DISEASES OF THE HEART	1908	2786.3564	0.68**	0.6544	0.7162
50	RHEUMATIC HEART DISEASE, INCLUDING FEVER	81	114.1096	0.71**	0.5637	0.8823
51	ISCHEMIC HEART DISEASE	1523	1967.5236	0.77**	0.7357	0.8139
52	CHRONIC DISEASE OF ENDOCARDIUM	8	36.8195	0.22**	0.0936	0.4281
53	OTHER MYOCARDIAL DEGENERATION	14	27.2956	0.51*	0.2802	0.8606
54	HYPERTENSION WITH HEART DISEASE	50	140.8535	0.35**	0.2635	0.4680
55	OTHER DISEASES OF THE HEART	232	499.7545	0.46**	0.4064	0.5280

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLLT12.LTP
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Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
17	OTHER DISEASES OF CIRCULATORY SYSTEM	762	1009.3473	0.75**	0.7023	0.8105
56	HYPERTENSION WITHOUT HEART DISEASE	30	44.2748	0.68*	0.4571	0.9673
57	CEREBROVASCULAR DISEASE	548	731.7671	0.75**	0.6875	0.8143
58	DISEASES OF THE ARTERIES, VEINS, AND PULMONARY CIRCULATION	184	233.3054	0.79**	0.6788	0.9112
18	DISEASES OF THE RESPIRATORY SYSTEM	499	578.7295	0.86**	0.7882	0.9413
59	ACUTE RESPIRATORY INFECTIONS EXCEPT INFLUENZA AND PNEUMONIA	5	4.0672	1.23	0.3978	2.8723
60	INFLUENZA	4	11.6682	0.34*	0.0934	0.8768
61	PNEUMONIA (EXCEPT NEWBORN)	165	216.0978	0.76**	0.6515	0.8894
62	CHRONIC AND UNSPECIFIED BRONCHITIS	17	16.4699	1.03	0.6009	1.6527
63	EMPHYSEMA	53	59.7519	0.89	0.6644	1.1602
64	ASTHMA	15	28.0670	0.53*	0.2989	0.8815
65	PNEUMOCONIOSES AND OTHER RESPIRATORY DISEASES	240	242.6074	0.99	0.8680	1.1227
19	DISEASES OF THE DIGESTIVE SYSTEM	319	417.9785	0.76**	0.6817	0.8517
66	DISEASES OF THE STOMACH AND DUODENUM	38	36.4114	1.04	0.7384	1.4325
67	HERNIA AND INTESTINAL OBSTRUCTION	17	34.1238	0.50**	0.2900	0.7977
68	CIRRHOSIS OF THE LIVER	147	175.3727	0.84*	0.7082	0.9852
69	OTHER DISEASES OF DIGESTIVE SYSTEM	117	172.0705	0.68**	0.5623	0.8149
20	DISEASES OF THE GENITO-URINARY SYSTEM	137	175.4370	0.78**	0.6556	0.9232
70	ACUTE GLOMERULONEPHRITIS, NEPHROTIC SYNDROME, & ACUTE RENAL FAILUR	12	14.7545	0.81	0.4198	1.4208
71	CHRONIC & UNSPEC. NEPHRITIS, RENAL FAILURE, & OTHER RENAL SCLEROSI	36	78.2807	0.46**	0.3220	0.6367
72	INFECTION OF KIDNEY	15	22.9843	0.65	0.3650	1.0765
73	CALCULI OF URINARY SYSTEM	3	4.0185	0.75	0.1539	2.1829
74	HYPERPLASIA OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
75	OTHER DISEASES OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	0.0000
76	DISEASES OF THE BREAST	0	0.3189	0.00	0.0000	11.5706

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLLT12.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	8	9.6316	0.83	0.3576	1.6367
78	OTHER GENITO-URINARY SYSTEM DISEASES	63	45.4485	1.39*	1.0651	1.7736
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	9	17.0596	0.53	0.2407	1.0015
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	2	3.4021	0.59	0.0712	2.1223
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	7	13.6576	0.51	0.2053	1.0561
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE	53	43.1511	1.23	0.9200	1.6066
81	ARTHRITIS AND SPONDYLITIS	13	16.5482	0.79	0.4179	1.3435
82	OSTEOMYELITIS AND PERIOSTITIS	0	1.5684	0.00	0.0000	2.3527
83	OTHER DISEASES OF MS SYSTEM	40	25.0345	1.60**	1.1413	2.1758
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	154	91.5278	1.68**	1.4273	1.9703
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	154	91.5278	1.68**	1.4273	1.9703
24	ACCIDENTS	274	285.6439	0.96	0.8490	1.0798
85	TRANSPORTATION ACCIDENTS	150	141.3690	1.06	0.8980	1.2451
86	ACCIDENTAL POISONING	22	18.5683	1.18	0.7423	1.7939
87	ACCIDENTAL FALLS	35	45.4442	0.77	0.5364	1.0712
88	OTHER ACCIDENTS	61	64.8876	0.94	0.7190	1.2076
89	MEDICAL COMPLICATIONS AND MISADVENTURE	6	15.3748	0.39*	0.1425	0.8494
25	VIOLENCE	129	136.7188	0.94	0.7877	1.1211
90	SUICIDE	77	98.0889	0.79*	0.6195	0.9811
91	HOMICIDE	52	38.6298	1.35*	1.0053	1.7653
26	OTHER CAUSES	345	230.3585	1.50**	1.3438	1.6643
92	OTHER CAUSES	345	230.3585	1.50**	1.3438	1.6643

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLLT12.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
	All Cancers	1950	2631.3682	0.74**	0.7085	0.7747
	All Deaths	6885	8995.4268	0.77**	0.7474	0.7837

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

APPENDIX III TABLE 15: POOLED SMRS FOR THOSE EMPLOYED LESS THAN 24 MONTHS

PC LIFE TABLE ANALYSIS SYSTEM Page: 1

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==============================================================================
                       G L O B A L   P A R A M E T E R S
STUDY PARAMETER FILE NAME: c:\ltas\alllt24.ltp
LAST COMPLETE STEP: Stratify
STUDY DESCRIPTION: less than 24
STUDY BEGIN DATE: 01/01/1940
STUDY END DATE: 01/01/1994
RATES IN USE: Standard U.S. Deaths 92 Minors 1940 - 99
AGE CATEGORIES: 15\20\25\30\35\40\45\50\55\60\65\70\75\80\85\
CALENDAR CATEGORIES: 1940\1945\1950\1955\1960\1965\1970\1975\1980\1985\1990\1995\
SINGLE CAUSE OF DEATH
==============================================================================
                       V E R I F Y   P A R A M E T E R S
INPUT DEMOGRAPHICS FILE: c:\ltas\all\demlt24
INPUT WORK HISTORY FILE: c:\ltas\all\whlt24
OUTPUT DEMOGRAPHICS FILE: c:\ltas\all\dlt24.out
OUTPUT WORK HISTORY FILE: c:\ltas\all\whlt24.out
BEGIN PERSON TIME AT LATER OF In-rec / Rate begin
STOP SURVIVORS PERSON TIME AT: END OF STUDY
GENDER/RACE SUBSETTING: KEEP ALL
EXPOSURE LEVEL: All exposed equally (no data)

SUMMARY REPORT FILE: .\summary.rpt
EXCEPTIONS REPORT FILE: .\except.rpt
EXPOSURE REPORT FILE: .\experr.rpt
==============================================================================
                     S T R A T I F Y   P A R A M E T E R S
ANALYSIS TYPE: SMR
```

DURATION	TIME SINCE FIRST EXPOSURE
MINIMUM->000Y	000Y
005Y	005Y
010Y	010Y
015Y	015Y
020Y	020Y
025Y	025Y
030Y	030Y

PERSON YEARS FILE: C:\LTAS\ALLLT2PY
OBSERVED DEATHS FILE: C:\LTAS\ALLLT2OB

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: ALLLT24.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	199423.76	0.00	0.00	0.00	0.00	0.00	0.00	199423.76
005Y - 010Y	198617.47	0.00	0.00	0.00	0.00	0.00	0.00	198617.47
010Y - 015Y	197456.56	0.00	0.00	0.00	0.00	0.00	0.00	197456.56
015Y - 020Y	188571.73	0.00	0.00	0.00	0.00	0.00	0.00	188571.73
020Y - 025Y	177412.37	0.00	0.00	0.00	0.00	0.00	0.00	177412.37
025Y - 030Y	166262.06	0.00	0.00	0.00	0.00	0.00	0.00	166262.06
030Y & Over	501354.72	0.00	0.00	0.00	0.00	0.00	0.00	501354.72
Total	1629098.66	0.00	0.00	0.00	0.00	0.00	0.00	1629098.66

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: ALLLT24.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	1474.56	6236.73	883.23	503.05	364.96	520.08	531.47	780.68	75.69	0.00	0.00
20-24	2784.09	49632.83	13711.14	5030.60	2853.14	3703.06	4092.63	4882.99	2784.31	75.39	0.00
25-29	1507.90	33657.09	56416.69	16712.32	6135.36	4150.01	5281.26	6332.58	6472.63	2778.82	75.25
30-34	1003.24	18002.92	37104.95	57726.04	17173.18	6571.19	4573.34	6176.05	7058.92	6464.49	2609.00
35-39	639.33	11736.47	19946.11	37710.40	57812.56	17347.23	6764.84	5012.22	6453.53	7017.26	5285.52
40-44	345.30	6800.52	12938.18	20302.48	37741.11	57609.32	17390.34	7012.30	5149.06	6413.48	5641.86
45-49	179.47	3389.75	7460.07	13125.44	20295.69	37398.85	57009.07	17360.48	7088.96	5104.04	4975.79
50-54	85.04	1642.23	3766.41	7503.74	13066.33	20041.39	36784.94	56222.75	17157.74	6995.30	4001.52
55-59	30.55	658.16	1775.41	3729.84	7414.25	12784.67	19433.73	36027.56	54860.29	16774.98	5812.69
60-64	14.40	234.60	721.36	1726.86	3605.92	7127.46	12310.92	18568.12	34693.58	53063.55	14483.38
65-69	6.74	91.45	243.85	672.48	1646.97	3375.61	6599.97	11531.00	17201.92	32672.87	42320.11
70-74	0.00	12.90	90.41	231.08	614.40	1503.76	3000.76	5933.16	10353.49	15624.21	21932.94
75-79	0.00	3.86	13.01	76.42	204.81	530.50	1268.16	2521.20	5110.80	8863.87	10424.16
80-84	0.00	0.00	3.86	10.95	69.98	168.13	399.34	982.00	1984.45	4064.36	5398.01
85+	0.00	0.00	0.00	3.86	11.12	72.69	169.32	369.84	935.69	2017.20	3280.43
TOTAL	8070.63	132099.50	155074.67	165065.55	169009.80	172903.95	175610.08	179712.93	177381.06	167929.80	126240.67

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: ALLLT24.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1995+	TOTAL			
15-19	0.00	11370.45			
20-24	0.00	89550.18			
25-29	0.00	139519.91			
30-34	0.00	164463.32			
35-39	0.00	175725.47			
40-44	0.00	177343.96			
45-49	0.00	173387.59			
50-54	0.00	167267.39			
55-59	0.00	159302.14			
60-64	0.00	146550.15			
65-69	0.00	116362.97			
70-74	0.00	59297.12			
75-79	0.00	29016.78			
80-84	0.00	13081.07			
85+	0.00	6860.15	1629098.66	1	0.00

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLLT24.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number		Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
1		TUBERCULOSIS	25	84.6944	0.30**	0.1910	0.4358
	1	RESPIRATORY TUBERCULOSIS	17	76.7785	0.22**	0.1289	0.3545
	2	OTHER TUBERCULOSIS	8	7.9159	1.01	0.4352	1.9915
2		MN OF BUCCAL CAVITY AND PHARYNX	45	47.8048	0.94	0.6865	1.2596
	3	MN OF LIP	0	0.2513	0.00	0.0000	14.6827
	4	MN OF TONGUE	14	11.1583	1.25	0.6854	2.1053
	5	MN OF OTHER PARTS OF BUCCAL CAVITY	14	15.1713	0.92	0.5041	1.5484
	6	MN OF PHARYNX	17	21.2238	0.80	0.4663	1.2825
3		MN OF DIGESTIVE ORGANS AND PERITONEUM	546	825.7278	0.66**	0.6069	0.7191
	7	MN OF ESOPHAGUS	29	36.4314	0.80	0.5330	1.1433
	8	MN OF STOMACH	57	92.1791	0.62**	0.4683	0.8012
	9	MN OF INTESTINE EXCEPT RECTUM	236	357.7677	0.66**	0.5782	0.7494
	10	MN OF RECTUM	36	67.8608	0.53**	0.3715	0.7345
	11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	41	63.6136	0.64**	0.4625	0.8744
	12	MN OF LIVER NOT SPECIFIED	19	21.4449	0.89	0.5332	1.3837
	13	MN OF PANCREAS	126	169.7311	0.74**	0.6184	0.8839
	14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	2	16.6991	0.12**	0.0145	0.4324
4		MN OF RESPIRATORY SYSTEM	604	663.0679	0.91*	0.8397	0.9866
	15	MN OF LARYNX	9	12.6747	0.71	0.3240	1.3480
	16	MN OF TRACHEA, BRONCHUS, AND LUNG	591	642.3540	0.92*	0.8474	0.9973
	17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	4	8.0392	0.50	0.1356	1.2725
5		MN OF BREAST	553	758.5393	0.73**	0.6695	0.7924
	18	MN OF BREAST	553	758.5393	0.73**	0.6695	0.7924

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLLT24.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
6	MN OF FEMALE GENITAL ORGANS	350	515.5988	0.68**	0.6096	0.7538
19	MN OF CERVIX UTERI	117	135.9978	0.86	0.7115	1.0311
20	MN OF OTHER AND UNSPECIFIED PARTS OF UTERUS	56	121.3340	0.46**	0.3486	0.5994
21	MN OF OVARY, FALLOPIAN TUBE, AND BROAD LIGAMENT	170	243.5417	0.70**	0.5970	0.8112
22	MN OF OTHER FEMALE GENITAL ORGANS	7	14.7253	0.48	0.1904	0.9795
7	MN OF MALE GENITAL ORGANS	0	0.0005	0.00	0.0000	7279.9424
23	MN OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
24	MN OF OTHER MALE GENITAL ORGANS	0	0.0005	0.00	0.0000	7279.9424
8	MN OF URINARY ORGANS	78	96.2182	0.81	0.6408	1.0118
25	MN OF KIDNEY	50	55.5079	0.90	0.6685	1.1876
26	MN OF BLADDER AND OTHER URINARY ORGANS	28	40.7103	0.69	0.4569	0.9941
9	MN OF OTHER AND UNSPECIFIED SITES	327	420.0338	0.78**	0.6964	0.8676
27	MN OF SKIN	46	47.0749	0.98	0.7153	1.3034
28	MN OF EYE	2	2.5034	0.80	0.0967	2.8842
29	MN OF BRAIN AND OTHER PARTS OF NERVOUS SYSTEM	75	90.4775	0.83	0.6520	1.0391
30	MN OF THYROID GLAND	7	10.3448	0.68	0.2711	1.3943
31	MN OF BONE	6	9.0689	0.66	0.2416	1.4401
32	MN OF CONNECTIVE TISSUE AND SOFT TISSUE	8	19.5121	0.41**	0.1765	0.8079
33	MN OF OTHER AND UNSPECIFIED SITES (MINOR)	183	241.0523	0.76**	0.6532	0.8775
10	NEOPLASMS OF LYMPHATIC AND HEMATOPOIETIC TISSUE	224	300.6244	0.75**	0.6507	0.8494
34	LYMPHOSARCOMA AND RETICULOSARCOMA	38	40.8227	0.93	0.6586	1.2777
35	HODGKIN'S DISEASE	14	20.2374	0.69	0.3779	1.1608
36	LEUKEMIA AND ALEUKEMIA	75	111.2834	0.67**	0.5301	0.8448
37	OTHER NEOPLASMS OF LYMPHATIC HEMATOPOIETIC TISSUE	97	128.2808	0.76**	0.6132	0.9225

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLLT24.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
11	BENIGN AND UNSPECIFIED NEOPLASMS	36	64.6480	0.56**	0.3900	0.7710
38	BENIGN NEOPLASMS OF THE EYE, BRAIN, AND OTHER PARTS OF NERVOUS SYS	7	12.3837	0.57	0.2265	1.1647
39	NEOPLASMS OF EYE, BRAIN, & OTHER PARTS OF NERV SYSTEM UNSPECIF. NA	13	22.8080	0.57*	0.3032	0.9747
40	OTHER BENIGN AND UNSPECIFIED NATURE NEOPLASMS	16	29.4563	0.54*	0.3103	0.8821
12	DIABETES MELLITUS	193	329.0301	0.59**	0.5067	0.6754
41	DIABETES MELLITUS	193	329.0301	0.59**	0.5067	0.6754
13	DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS	35	49.2052	0.71*	0.4954	0.9893
42	PERNICIOUS ANEMIAS	1	1.7171	0.58	0.0147	3.2355
43	ANEMIAS OF OTHER AND UNSPECIFIED TYPE	13	20.7994	0.63	0.3325	1.0689
44	COAGULATION DEFECTS, PURPURA, AND OTHER HEMORRHAGIC CONDITIONS	11	12.7157	0.87	0.4312	1.5480
45	ALL OTHER DISEASES OF BLOOD FORMING ORGANS	10	13.9730	0.72	0.3426	1.3162
14	MENTAL, PSYCHONEUROTIC, AND PERSONALITY DISORDERS	102	84.4805	1.21	0.9844	1.4657
46	ALCOHOLISM	19	22.8508	0.83	0.5004	1.2985
47	OTHER MENTAL DISORDERS	83	61.6297	1.35**	1.0726	1.6695
15	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	80	192.0575	0.42**	0.3303	0.5184
48	MULTIPLE SCLEROSIS	14	27.3192	0.51*	0.2799	0.8599
49	OTHER DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	66	164.7384	0.40**	0.3098	0.5097
16	DISEASES OF THE HEART	2583	3785.9675	0.68**	0.6562	0.7091
50	RHEUMATIC HEART DISEASE, INCLUDING FEVER	103	156.7920	0.66**	0.5362	0.7967
51	ISCHEMIC HEART DISEASE	2080	2677.5171	0.78**	0.7438	0.8110
52	CHRONIC DISEASE OF ENDOCARDIUM	10	50.1552	0.20**	0.0955	0.3667
53	OTHER MYOCARDIAL DEGENERATION	19	36.5380	0.52**	0.3129	0.8121
54	HYPERTENSION WITH HEART DISEASE	56	187.7202	0.30**	0.2253	0.3874
55	OTHER DISEASES OF THE HEART	315	677.2449	0.47**	0.4152	0.5194

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLLT24.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
17	OTHER DISEASES OF CIRCULATORY SYSTEM	1041	1367.3276	0.76**	0.7158	0.8090
56	HYPERTENSION WITHOUT HEART DISEASE	41	58.9757	0.70*	0.4988	0.9431
57	CEREBROVASCULAR DISEASE	760	990.8316	0.77**	0.7135	0.8236
58	DISEASES OF THE ARTERIES, VEINS, AND PULMONARY CIRCULATION	240	317.5203	0.76**	0.6632	0.8578
18	DISEASES OF THE RESPIRATORY SYSTEM	682	791.9279	0.86**	0.7978	0.9283
59	ACUTE RESPIRATORY INFECTIONS EXCEPT INFLUENZA AND PNEUMONIA	7	5.5618	1.26	0.5042	2.5933
60	INFLUENZA	6	15.8020	0.38*	0.1386	0.8265
61	PNEUMONIA (EXCEPT NEWBORN)	233	292.9581	0.80**	0.6965	0.9043
62	CHRONIC AND UNSPECIFIED BRONCHITIS	27	22.6739	1.19	0.7846	1.7326
63	EMPHYSEMA	72	82.6405	0.87	0.6817	1.0972
64	ASTHMA	22	38.3917	0.57**	0.3590	0.8676
65	PNEUMOCONIOSES AND OTHER RESPIRATORY DISEASES	315	333.8999	0.94	0.8421	1.0535
19	DISEASES OF THE DIGESTIVE SYSTEM	433	572.7211	0.76**	0.6865	0.8307
66	DISEASES OF THE STOMACH AND DUODENUM	45	49.7431	0.90	0.6598	1.2105
67	HERNIA AND INTESTINAL OBSTRUCTION	25	46.3051	0.54**	0.3493	0.7970
68	CIRRHOSIS OF THE LIVER	197	241.5037	0.82**	0.7058	0.9379
69	OTHER DISEASES OF DIGESTIVE SYSTEM	166	235.1693	0.71**	0.6026	0.8218
20	DISEASES OF THE GENITO-URINARY SYSTEM	181	236.4079	0.77**	0.6581	0.8857
70	ACUTE GLOMERULONEPHRITIS, NEPHROTIC SYNDROME, & ACUTE RENAL FAILUR	13	19.9242	0.65	0.3471	1.1158
71	CHRONIC & UNSPEC. NEPHRITIS, RENAL FAILURE, & OTHER RENAL SCLEROSI	49	105.3745	0.47**	0.3440	0.6148
72	INFECTION OF KIDNEY	23	31.0112	0.74	0.4700	1.1129
73	CALCULI OF URINARY SYSTEM	3	5.4708	0.55	0.1131	1.6034
74	HYPERPLASIA OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
75	OTHER DISEASES OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	0.0000
76	DISEASES OF THE BREAST	0	0.4341	0.00	0.0000	8.5003

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLLT24.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	12	12.9389	0.93	0.4787	1.6202
78	OTHER GENITO-URINARY SYSTEM DISEASES	81	61.2543	1.32*	1.0501	1.6436
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	16	22.9544	0.70	0.3982	1.1320
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	4	4.6213	0.87	0.2358	2.2137
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	12	18.3331	0.65	0.3378	1.1435
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE	65	59.2863	1.10	0.8461	1.3974
81	ARTHRITIS AND SPONDYLITIS	17	22.6901	0.75	0.4362	1.1997
82	OSTEOMYELITIS AND PERIOSTITIS	0	2.1192	0.00	0.0000	1.7413
83	OTHER DISEASES OF MS SYSTEM	48	34.4771	1.39*	1.0264	1.8459
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	205	124.0392	1.65**	1.4342	1.8951
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	205	124.0392	1.65**	1.4342	1.8951
24	ACCIDENTS	390	395.9888	0.98	0.8895	1.0876
85	TRANSPORTATION ACCIDENTS	214	198.1563	1.08	0.9401	1.2348
86	ACCIDENTAL POISONING	27	25.9397	1.04	0.6858	1.5145
87	ACCIDENTAL FALLS	50	61.8854	0.81	0.5996	1.0652
88	OTHER ACCIDENTS	92	88.9605	1.03	0.8337	1.2683
89	MEDICAL COMPLICATIONS AND MISADVENTURE	7	21.0469	0.33**	0.1332	0.6853
25	VIOLENCE	176	190.9678	0.92	0.7905	1.0683
90	SUICIDE	113	138.5106	0.82*	0.6723	0.9809
91	HOMICIDE	63	52.4572	1.20	0.9228	1.5366
26	OTHER CAUSES	471	314.2106	1.50**	1.3667	1.6407
92	OTHER CAUSES	471	314.2106	1.50**	1.3667	1.6407

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLLT24.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
	All Cancers	2727	3627.6150	0.75**	0.7238	0.7805
	All Deaths	9441	12293.5312	0.77**	0.7526	0.7836

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

APPENDIX III TABLE 16: POOLED SMRS FOR THOSE EMPLOYED GREATER THAN 12 MONTHS

```
PC LIFE TABLE ANALYSIS SYSTEM                                          Page: 1
================================================================================
                        G L O B A L   P A R A M E T E R S
STUDY PARAMETER FILE NAME: c:\ltas\allgt12.ltp
LAST COMPLETE STEP: Stratify
STUDY DESCRIPTION: greater than 12
STUDY BEGIN DATE: 01/01/1940
STUDY END DATE: 01/01/1994
RATES IN USE: Standard U.S. Deaths 92 Minors 1940 - 99
AGE CATEGORIES: 15\20\25\30\35\40\45\50\55\60\65\70\75\80\85\
CALENDAR CATEGORIES: 1940\1945\1950\1955\1960\1965\1970\1975\1980\1985\1990\1995\
SINGLE CAUSE OF DEATH
================================================================================
                        V E R I F Y   P A R A M E T E R S
INPUT DEMOGRAPHICS FILE: c:\ltas\all\demgt12
INPUT WORK HISTORY FILE: c:\ltas\all\whgt12
OUTPUT DEMOGRAPHICS FILE: c:\ltas\all\dgt12.out
OUTPUT WORK HISTORY FILE: c:\ltas\all\wgt12.out
BEGIN PERSON TIME AT LATER OF In-rec / Rate begin
STOP SURVIVORS PERSON TIME AT: END OF STUDY
GENDER/RACE SUBSETTING: KEEP ALL
EXPOSURE LEVEL: All exposed equally (no data)

SUMMARY REPORT FILE: .\summary.rpt
EXCEPTIONS REPORT FILE: .\except.rpt
EXPOSURE REPORT FILE: .\experr.rpt
================================================================================
                      S T R A T I F Y   P A R A M E T E R S
ANALYSIS TYPE: SMR

    DURATION       TIME SINCE FIRST EXPOSURE
_________________ _________________________

MINIMUM->000Y              000Y

         005Y              005Y

         010Y              010Y

         015Y              015Y

         020Y              020Y

         025Y              025Y

         030Y              030Y

PERSON YEARS FILE: C:\LTAS\ALLGT1PY
OBSERVED DEATHS FILE: C:\LTAS\ALLGT1OB
```

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: ALLGT12.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	200016.38	0.00	0.00	0.00	0.00	0.00	0.00	200016.38
005Y - 010Y	111055.87	88116.78	0.00	0.00	0.00	0.00	0.00	199172.65
010Y - 015Y	110360.60	24631.58	62693.83	0.00	0.00	0.00	0.00	197686.01
015Y - 020Y	103448.90	19737.42	9748.35	41811.73	0.00	0.00	0.00	174746.40
020Y - 025Y	94740.95	16008.39	6740.33	5758.54	26044.16	0.00	0.00	149292.38
025Y - 030Y	87042.86	13841.29	5724.42	4441.35	3800.01	17607.94	0.00	132457.86
030Y & Over	237472.44	30722.37	11540.40	8606.83	7027.66	7586.44	28595.07	331551.21
Total	944138.00	193057.83	96447.33	60618.46	36871.82	25194.38	28595.07	1384922.89

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Distribution of Person Years
Study File: ALLGT12.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	1110.09	3095.12	1510.44	1107.01	787.09	866.87	787.05	1376.93	128.61	0.00	0.00
20-24	2046.93	24346.42	11463.76	8968.91	5782.48	6309.31	6272.75	9461.19	5018.32	128.13	0.00
25-29	1088.62	17126.53	31106.23	16200.36	11228.09	8204.02	9471.64	12761.32	14007.86	5005.79	127.60
30-34	740.34	9976.88	21009.20	34015.77	17457.79	12374.11	9624.71	13160.76	15391.10	13985.37	4719.99
35-39	526.18	6994.99	12712.80	23045.75	35047.94	18377.44	13373.83	12114.62	14680.87	15327.98	11622.43
40-44	286.95	4475.16	8927.62	14108.80	23802.21	35763.04	19151.59	15143.49	13150.96	14602.77	12306.33
45-49	127.59	2417.72	5452.05	9719.84	14449.42	24177.94	36156.25	20287.81	15775.33	13054.76	11446.65
50-54	61.27	1222.02	2927.44	5662.53	9803.09	14443.98	24152.27	36466.09	20500.72	15622.53	10315.32
55-59	21.95	530.75	1379.71	2931.37	5592.92	9656.99	14235.17	23913.88	35964.77	20107.26	12682.74
60-64	1.04	151.16	572.39	1362.54	2819.71	5433.37	9332.91	13734.71	23163.02	34891.92	16209.70
65-69	0.00	33.42	161.95	541.27	1291.88	2687.84	5074.82	8725.75	12943.48	21970.25	27400.34
70-74	0.00	2.05	32.41	151.20	471.34	1150.12	2428.42	4604.93	7853.83	11812.77	14976.07
75-79	0.00	0.00	2.04	28.27	132.30	404.08	948.39	2019.72	3937.48	6701.20	7931.28
80-84	0.00	0.00	0.00	2.04	19.82	99.08	282.59	727.16	1583.84	3136.73	4094.67
85+	0.00	0.00	0.00	0.00	2.05	19.14	85.34	229.84	647.64	1453.03	2293.15
TOTAL	6010.95	70372.22	97258.05	117845.67	128688.14	139967.33	151377.73	174728.21	184747.83	177800.49	136126.27

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: ALLGT12.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1995+	TOTAL			
15-19	0.00	10769.21			
20-24	0.00	79798.19			
25-29	0.00	126328.07			
30-34	0.00	152456.03			
35-39	0.00	163824.82			
40-44	0.00	161718.93			
45-49	0.00	153065.37			
50-54	0.00	141177.26			
55-59	0.00	127017.50			
60-64	0.00	107672.48			
65-69	0.00	80831.01			
70-74	0.00	43483.15			
75-79	0.00	22104.76			
80-84	0.00	9945.94			
85+	0.00	4730.17	1384922.89	1	0.00

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLGT12.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number		Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
1		TUBERCULOSIS	9	45.7214	0.20**	0.0898	0.3737
	1	RESPIRATORY TUBERCULOSIS	5	41.1376	0.12**	0.0393	0.2840
	2	OTHER TUBERCULOSIS	4	4.5839	0.87	0.2378	2.2318
2		MN OF BUCCAL CAVITY AND PHARYNX	41	35.6550	1.15	0.8251	1.5600
	3	MN OF LIP	0	0.1848	0.00	0.0000	19.9717
	4	MN OF TONGUE	8	8.3492	0.96	0.4126	1.8881
	5	MN OF OTHER PARTS OF BUCCAL CAVITY	12	11.3065	1.06	0.5478	1.8541
	6	MN OF PHARYNX	21	15.8146	1.33	0.8217	2.0299
3		MN OF DIGESTIVE ORGANS AND PERITONEUM	416	612.4430	0.68**	0.6155	0.7478
	7	MN OF ESOPHAGUS	17	25.5595	0.67	0.3872	1.0650
	8	MN OF STOMACH	42	67.0620	0.63**	0.4513	0.8466
	9	MN OF INTESTINE EXCEPT RECTUM	186	267.6087	0.70**	0.5987	0.8024
	10	MN OF RECTUM	36	50.3941	0.71*	0.5003	0.9890
	11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	35	47.7500	0.73	0.5105	1.0194
	12	MN OF LIVER NOT SPECIFIED	12	15.7611	0.76	0.3930	1.3300
	13	MN OF PANCREAS	84	125.9031	0.67**	0.5321	0.8260
	14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	4	12.4044	0.32*	0.0879	0.8247
4		MN OF RESPIRATORY SYSTEM	420	510.0420	0.82**	0.7466	0.9061
	15	MN OF LARYNX	10	9.3881	1.07	0.5099	1.9590
	16	MN OF TRACHEA, BRONCHUS, AND LUNG	405	494.4715	0.82**	0.7412	0.9028
	17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	5	6.1824	0.81	0.2617	1.8896
5		MN OF BREAST	479	590.9055	0.81**	0.7396	0.8866
	18	MN OF BREAST	479	590.9055	0.81**	0.7396	0.8866

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLGT12.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
6	MN OF FEMALE GENITAL ORGANS	275	383.6986	0.72**	0.6345	0.8066
19	MN OF CERVIX UTERI	72	99.7938	0.72**	0.5645	0.9086
20	MN OF OTHER AND UNSPECIFIED PARTS OF UTERUS	48	86.8459	0.55**	0.4075	0.7328
21	MN OF OVARY, FALLOPIAN TUBE, AND BROAD LIGAMENT	151	186.2214	0.81**	0.6867	0.9510
22	MN OF OTHER FEMALE GENITAL ORGANS	4	10.8374	0.37*	0.1006	0.9440
7	MN OF MALE GENITAL ORGANS	0	0.0004	0.00	0.0000	9362.9922
23	MN OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
24	MN OF OTHER MALE GENITAL ORGANS	0	0.0004	0.00	0.0000	9362.9922
8	MN OF URINARY ORGANS	68	72.1914	0.94	0.7314	1.1942
25	MN OF KIDNEY	40	42.5196	0.94	0.6720	1.2811
26	MN OF BLADDER AND OTHER URINARY ORGANS	28	29.6717	0.94	0.6269	1.3639
9	MN OF OTHER AND UNSPECIFIED SITES	235	322.8138	0.73**	0.6379	0.8272
27	MN OF SKIN	43	38.4973	1.12	0.8083	1.5046
28	MN OF EYE	2	1.9255	1.04	0.1257	3.7497
29	MN OF BRAIN AND OTHER PARTS OF NERVOUS SYSTEM	46	71.5384	0.64**	0.4707	0.8577
30	MN OF THYROID GLAND	5	7.7100	0.65	0.2099	1.5152
31	MN OF BONE	5	6.9679	0.72	0.2322	1.6766
32	MN OF CONNECTIVE TISSUE AND SOFT TISSUE	15	15.5357	0.97	0.5400	1.5926
33	MN OF OTHER AND UNSPECIFIED SITES (MINOR)	119	180.6389	0.66**	0.5457	0.7883
10	NEOPLASMS OF LYMPHATIC AND HEMATOPOIETIC TISSUE	191	230.8076	0.83**	0.7143	0.9536
34	LYMPHOSARCOMA AND RETICULOSARCOMA	27	30.8575	0.87	0.5765	1.2731
35	HODGKIN'S DISEASE	13	16.2415	0.80	0.4258	1.3688
36	LEUKEMIA AND ALEUKEMIA	64	86.2629	0.74*	0.5713	0.9474
37	OTHER NEOPLASMS OF LYMPHATIC HEMATOPOIETIC TISSUE	87	97.4457	0.89	0.7151	1.1013

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLGT12.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
11	BENIGN AND UNSPECIFIED NEOPLASMS	25	46.8049	0.53**	0.3456	0.7885
38	BENIGN NEOPLASMS OF THE EYE, BRAIN, AND OTHER PARTS OF NERVOUS SYS	7	9.0401	0.77	0.3102	1.5955
39	NEOPLASMS OF EYE, BRAIN, & OTHER PARTS OF NERV SYSTEM UNSPECIF. NA	7	17.3082	0.40*	0.1620	0.8333
40	OTHER BENIGN AND UNSPECIFIED NATURE NEOPLASMS	11	20.4566	0.54*	0.2681	0.9622
12	DIABETES MELLITUS	127	236.6736	0.54**	0.4473	0.6385
41	DIABETES MELLITUS	127	236.6736	0.54**	0.4473	0.6385
13	DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS	21	36.5404	0.57**	0.3556	0.8785
42	PERNICIOUS ANEMIAS	0	1.1713	0.00	0.0000	3.1503
43	ANEMIAS OF OTHER AND UNSPECIFIED TYPE	10	15.2326	0.66	0.3143	1.2074
44	COAGULATION DEFECTS, PURPURA, AND OTHER HEMORRHAGIC CONDITIONS	4	9.5949	0.42	0.1136	1.0662
45	ALL OTHER DISEASES OF BLOOD FORMING ORGANS	7	10.5415	0.66	0.2660	1.3682
14	MENTAL, PSYCHONEUROTIC, AND PERSONALITY DISORDERS	97	63.9076	1.52**	1.2308	1.8516
46	ALCOHOLISM	15	17.4640	0.86	0.4804	1.4167
47	OTHER MENTAL DISORDERS	82	46.4436	1.77**	1.4042	2.1916
15	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	68	146.3760	0.46**	0.3607	0.5889
48	MULTIPLE SCLEROSIS	9	21.6165	0.42**	0.1900	0.7904
49	OTHER DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	59	124.7595	0.47**	0.3600	0.6100
16	DISEASES OF THE HEART	1717	2750.5972	0.62**	0.5950	0.6545
50	RHEUMATIC HEART DISEASE, INCLUDING FEVER	54	113.5506	0.48**	0.3572	0.6205
51	ISCHEMIC HEART DISEASE	1399	1958.8647	0.71**	0.6772	0.7526
52	CHRONIC DISEASE OF ENDOCARDIUM	7	37.0381	0.19**	0.0757	0.3894
53	OTHER MYOCARDIAL DEGENERATION	6	24.5492	0.24**	0.0892	0.5320
54	HYPERTENSION WITH HEART DISEASE	25	124.1760	0.20**	0.1303	0.2972
55	OTHER DISEASES OF THE HEART	226	492.4188	0.46**	0.4011	0.5229

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLGT12.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
17	OTHER DISEASES OF CIRCULATORY SYSTEM	751	986.0911	0.76**	0.7081	0.8181
56	HYPERTENSION WITHOUT HEART DISEASE	23	39.0302	0.59**	0.3734	0.8843
57	CEREBROVASCULAR DISEASE	550	713.4186	0.77**	0.7078	0.8381
58	DISEASES OF THE ARTERIES, VEINS, AND PULMONARY CIRCULATION	178	233.6423	0.76**	0.6540	0.8824
18	DISEASES OF THE RESPIRATORY SYSTEM	491	588.1569	0.83**	0.7626	0.9120
59	ACUTE RESPIRATORY INFECTIONS EXCEPT INFLUENZA AND PNEUMONIA	3	4.1051	0.73	0.1507	2.1368
60	INFLUENZA	10	11.0175	0.91	0.4345	1.6693
61	PNEUMONIA (EXCEPT NEWBORN)	183	213.3586	0.86*	0.7379	0.9914
62	CHRONIC AND UNSPECIFIED BRONCHITIS	21	17.0169	1.23	0.7636	1.8865
63	EMPHYSEMA	57	62.5169	0.91	0.6905	1.1813
64	ASTHMA	16	28.7334	0.56*	0.3181	0.9043
65	PNEUMOCONIOSES AND OTHER RESPIRATORY DISEASES	201	251.4084	0.80**	0.6928	0.9180
19	DISEASES OF THE DIGESTIVE SYSTEM	300	426.3922	0.70**	0.6262	0.7879
66	DISEASES OF THE STOMACH AND DUODENUM	21	36.6544	0.57**	0.3545	0.8758
67	HERNIA AND INTESTINAL OBSTRUCTION	27	32.8813	0.82	0.5410	1.1948
68	CIRRHOSIS OF THE LIVER	130	183.0160	0.71**	0.5935	0.8435
69	OTHER DISEASES OF DIGESTIVE SYSTEM	122	173.8405	0.70**	0.5828	0.8380
20	DISEASES OF THE GENITO-URINARY SYSTEM	104	163.3865	0.64**	0.5201	0.7713
70	ACUTE GLOMERULONEPHRITIS, NEPHROTIC SYNDROME, & ACUTE RENAL FAILUR	3	13.7757	0.22**	0.0449	0.6368
71	CHRONIC & UNSPEC. NEPHRITIS, RENAL FAILURE, & OTHER RENAL SCLEROSI	21	71.9625	0.29**	0.1806	0.4461
72	INFECTION OF KIDNEY	19	21.2551	0.89	0.5379	1.3960
73	CALCULI OF URINARY SYSTEM	3	3.8849	0.77	0.1592	2.2580
74	HYPERPLASIA OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
75	OTHER DISEASES OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	0.0000
76	DISEASES OF THE BREAST	0	0.3202	0.00	0.0000	11.5246

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLGT12.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	6	8.4084	0.71	0.2606	1.5532
78	OTHER GENITO-URINARY SYSTEM DISEASES	52	43.7798	1.19	0.8870	1.5576
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	18	15.7727	1.14	0.6760	1.8037
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	4	3.3655	1.19	0.3239	3.0397
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	14	12.4072	1.13	0.6164	1.8933
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE	43	45.7582	0.94	0.6800	1.2658
81	ARTHRITIS AND SPONDYLITIS	21	16.8496	1.25	0.7712	1.9052
82	OSTEOMYELITIS AND PERIOSTITIS	1	1.4945	0.67	0.0169	3.7173
83	OTHER DISEASES OF MS SYSTEM	21	27.4141	0.77	0.4740	1.1710
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	142	90.1053	1.58**	1.3274	1.8575
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	142	90.1053	1.58**	1.3274	1.8575
24	ACCIDENTS	290	317.5792	0.91	0.8111	1.0245
85	TRANSPORTATION ACCIDENTS	161	167.0559	0.96	0.8206	1.1247
86	ACCIDENTAL POISONING	9	22.0789	0.41**	0.1860	0.7739
87	ACCIDENTAL FALLS	37	45.8416	0.81	0.5682	1.1126
88	OTHER ACCIDENTS	71	66.8097	1.06	0.8300	1.3405
89	MEDICAL COMPLICATIONS AND MISADVENTURE	12	15.7930	0.76	0.3922	1.3274
25	VIOLENCE	143	161.9908	0.88	0.7440	1.0399
90	SUICIDE	113	118.8773	0.95	0.7834	1.1428
91	HOMICIDE	30	43.1135	0.70	0.4694	0.9934
26	OTHER CAUSES	315	230.7443	1.37**	1.2185	1.5245
92	OTHER CAUSES	315	230.7443	1.37**	1.2185	1.5245

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLGT12.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
	All Cancers	2125	2758.5566	0.77**	0.7379	0.8038
	All Deaths	6786	9111.1533	0.74**	0.7272	0.7627

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

APPENDIX III TABLE 17: SMRs FOR WORKERS EMPLOYED GREATER 24 MONTHS
PC LIFE TABLE ANALYSIS SYSTEM

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==============================================================================
                        G L O B A L   P A R A M E T E R S
STUDY PARAMETER FILE NAME: c:\ltas\allgt24.ltp
LAST COMPLETE STEP: Stratify
STUDY DESCRIPTION: greater than 24
STUDY BEGIN DATE: 01/01/1940
STUDY END DATE: 01/01/1994
RATES IN USE: Standard U.S. Deaths 92 Minors 1940 - 99
AGE CATEGORIES: 15\20\25\30\35\40\45\50\55\60\65\70\75\80\85\
CALENDAR CATEGORIES: 1940\1945\1950\1955\1960\1965\1970\1975\1980\1985\1990\1995\
SINGLE CAUSE OF DEATH
==============================================================================
                        V E R I F Y   P A R A M E T E R S
INPUT DEMOGRAPHICS FILE: c:\ltas\all\demgt24
INPUT WORK HISTORY FILE: c:\ltas\all\whgt24
OUTPUT DEMOGRAPHICS FILE: c:\ltas\all\dg24.out
OUTPUT WORK HISTORY FILE: c:\ltas\all\whg24.out
BEGIN PERSON TIME AT LATER OF In-rec / Rate begin
STOP SURVIVORS PERSON TIME AT: END OF STUDY
GENDER/RACE SUBSETTING: KEEP ALL
EXPOSURE LEVEL: All exposed equally (no data)

SUMMARY REPORT FILE: .\summary.rpt
EXCEPTIONS REPORT FILE: .\except.rpt
EXPOSURE REPORT FILE: .\experr.rpt
==============================================================================
                      S T R A T I F Y   P A R A M E T E R S
ANALYSIS TYPE: SMR
```

DURATION	TIME SINCE FIRST EXPOSURE
MINIMUM->000Y	000Y
005Y	005Y
010Y	010Y
015Y	015Y
020Y	020Y
025Y	025Y
030Y	030Y

PERSON YEARS FILE: C:\LTAS\ALLGT2PY
OBSERVED DEATHS FILE: C:\LTAS\ALLGT2OB

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: ALLGT24.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	140908.61	0.00	0.00	0.00	0.00	0.00	0.00	140908.61
005Y - 010Y	52190.34	88116.78	0.00	0.00	0.00	0.00	0.00	140307.12
010Y - 015Y	51824.51	24631.58	62693.83	0.00	0.00	0.00	0.00	139149.92
015Y - 020Y	48024.74	19737.42	9748.35	41811.73	0.00	0.00	0.00	119322.25
020Y - 025Y	43095.67	16008.39	6740.33	5758.54	26044.16	0.00	0.00	97647.10
025Y - 030Y	39051.57	13841.29	5724.42	4441.35	3800.01	17607.94	0.00	84466.57
030Y & Over	99454.52	30722.37	11540.40	8606.83	7027.66	7586.44	28595.07	193533.28
Total	474549.96	193057.83	96447.33	60618.46	36871.82	25194.38	28595.07	915334.85

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: ALLGT24.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	537.22	1565.71	1156.83	847.08	590.37	631.27	636.44	1129.13	108.15	0.00	0.00
20-24	1012.11	11448.10	7559.94	6832.32	4365.22	4549.34	4890.44	7762.43	4077.65	107.75	0.00
25-29	567.59	8327.33	16253.35	11072.62	8629.76	6174.54	7048.33	10500.27	11675.75	4067.45	107.23
30-34	399.98	5099.84	11226.59	18637.14	12139.28	9544.54	7403.00	10391.81	12836.18	11656.03	3829.72
35-39	318.70	3851.96	7270.02	13029.19	19589.40	12976.03	10475.03	9722.01	11823.85	12796.74	9715.24
40-44	182.72	2722.97	5435.63	8518.09	13752.33	20340.28	13731.26	12148.19	10731.53	11763.43	10237.81
45-49	80.15	1551.76	3561.83	6172.31	8848.39	14194.12	20833.74	14861.36	12768.47	10660.46	9210.03
50-54	41.46	775.12	1959.85	3756.53	6262.23	8918.03	14306.19	21323.00	15122.90	12658.43	8450.10
55-59	17.85	350.33	885.66	1970.48	3715.86	6184.67	8842.54	14226.23	21110.97	14826.22	10237.63
60-64	0.45	83.45	374.26	884.23	1898.25	3612.07	5960.47	8539.06	13807.18	20494.22	11775.85
65-69	0.00	19.44	92.30	360.25	831.40	1815.78	3393.17	5587.64	8142.23	13117.26	15914.53
70-74	0.00	2.05	18.19	87.22	310.77	732.16	1643.20	3061.21	5043.16	7495.06	9112.30
75-79	0.00	0.00	2.04	18.17	73.49	263.95	602.70	1355.61	2635.14	4308.17	5051.25
80-84	0.00	0.00	0.00	2.04	11.89	51.87	173.13	453.25	1065.61	2107.78	2666.20
85+	0.00	0.00	0.00	0.00	2.05	11.65	42.57	147.00	400.95	968.56	1497.85
TOTAL	3158.25	35798.05	55796.48	72187.68	81020.68	90000.28	99982.20	121208.18	131349.72	127027.59	97805.75

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: ALLGT24.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

AGES	1995+	TOTAL
15-19	0.00	7202.19
20-24	0.00	52605.29
25-29	0.00	84424.21
30-34	0.00	103164.13
35-39	0.00	111568.17
40-44	0.00	109564.24
45-49	0.00	102742.62
50-54	0.00	93573.86
55-59	0.00	82368.43
60-64	0.00	67429.48
65-69	0.00	49274.00
70-74	0.00	27505.32
75-79	0.00	14310.53
80-84	0.00	6531.77
85+	0.00	3070.63
TOTAL	0.00	915334.85

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLGT24.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number		Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
1		TUBERCULOSIS	6	25.1295	0.24**	0.0872	0.5197
	1	RESPIRATORY TUBERCULOSIS	4	22.4601	0.18**	0.0485	0.4555
	2	OTHER TUBERCULOSIS	2	2.6695	0.75	0.0907	2.7047
2		MN OF BUCCAL CAVITY AND PHARYNX	22	22.6370	0.97	0.6088	1.4715
	3	MN OF LIP	0	0.1179	0.00	0.0000	31.2956
	4	MN OF TONGUE	5	5.3075	0.94	0.3049	2.2011
	5	MN OF OTHER PARTS OF BUCCAL CAVITY	5	7.1837	0.70	0.2252	1.6262
	6	MN OF PHARYNX	12	10.0278	1.20	0.6176	2.0905
3		MN OF DIGESTIVE ORGANS AND PERITONEUM	275	389.5529	0.71**	0.6250	0.7945
	7	MN OF ESOPHAGUS	14	16.0955	0.87	0.4751	1.4595
	8	MN OF STOMACH	25	42.5222	0.59**	0.3804	0.8679
	9	MN OF INTESTINE EXCEPT RECTUM	129	170.5339	0.76**	0.6315	0.8988
	10	MN OF RECTUM	25	32.0128	0.78	0.5052	1.1529
	11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	24	30.4980	0.79	0.5041	1.1710
	12	MN OF LIVER NOT SPECIFIED	5	10.0119	0.50	0.1616	1.1668
	13	MN OF PANCREAS	49	79.9941	0.61**	0.4531	0.8098
	14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	4	7.8845	0.51	0.1382	1.2975
4		MN OF RESPIRATORY SYSTEM	254	325.7417	0.78**	0.6868	0.8818
	15	MN OF LARYNX	6	5.9467	1.01	0.3684	2.1962
	16	MN OF TRACHEA, BRONCHUS, AND LUNG	244	315.8269	0.77**	0.6787	0.8758
	17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	4	3.9681	1.01	0.2747	2.5781
5		MN OF BREAST	309	380.0623	0.81**	0.7249	0.9089
	18	MN OF BREAST	309	380.0623	0.81**	0.7249	0.9089

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLGT24.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
6	MN OF FEMALE GENITAL ORGANS	174	243.3819	0.71**	0.6126	0.8294
19	MN OF CERVIX UTERI	37	63.3570	0.58**	0.4111	0.8050
20	MN OF OTHER AND UNSPECIFIED PARTS OF UTERUS	37	54.4061	0.68*	0.4788	0.9374
21	MN OF OVARY, FALLOPIAN TUBE, AND BROAD LIGAMENT	97	118.7224	0.82*	0.6625	0.9967
22	MN OF OTHER FEMALE GENITAL ORGANS	3	6.8964	0.44	0.0897	1.2720
7	MN OF MALE GENITAL ORGANS	0	0.0003	0.00	0.0000	14454.7178
23	MN OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
24	MN OF OTHER MALE GENITAL ORGANS	0	0.0003	0.00	0.0000	14454.7178
8	MN OF URINARY ORGANS	38	46.0399	0.83	0.5840	1.1329
25	MN OF KIDNEY	23	27.2057	0.85	0.5357	1.2686
26	MN OF BLADDER AND OTHER URINARY ORGANS	15	18.8342	0.80	0.4454	1.3137
9	MN OF OTHER AND UNSPECIFIED SITES	154	206.9572	0.74**	0.6312	0.8714
27	MN OF SKIN	30	25.0929	1.20	0.8065	1.7068
28	MN OF EYE	2	1.2303	1.63	0.1968	5.8686
29	MN OF BRAIN AND OTHER PARTS OF NERVOUS SYSTEM	26	46.0001	0.57**	0.3691	0.8282
30	MN OF THYROID GLAND	4	4.9167	0.81	0.2217	2.0807
31	MN OF BONE	4	4.4771	0.89	0.2434	2.2850
32	MN OF CONNECTIVE TISSUE AND SOFT TISSUE	12	10.1177	1.19	0.6121	2.0719
33	MN OF OTHER AND UNSPECIFIED SITES (MINOR)	76	115.1223	0.66**	0.5201	0.8263
10	NEOPLASMS OF LYMPHATIC AND HEMATOPOIETIC TISSUE	122	147.9399	0.82*	0.6848	0.9847
34	LYMPHOSARCOMA AND RETICULOSARCOMA	16	19.5934	0.82	0.4665	1.3262
35	HODGKIN'S DISEASE	8	10.4961	0.76	0.3282	1.5019
36	LEUKEMIA AND ALEUKEMIA	43	55.5002	0.77	0.5606	1.0436
37	OTHER NEOPLASMS OF LYMPHATIC HEMATOPOIETIC TISSUE	55	62.3502	0.88	0.6645	1.1482

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Summary of Observed and Expected Deaths
Study File: ALLGT24.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
11	BENIGN AND UNSPECIFIED NEOPLASMS	18	29.4546	0.61*	0.3620	0.9659
38	BENIGN NEOPLASMS OF THE EYE, BRAIN, AND OTHER PARTS OF NERVOUS SYS	5	5.6869	0.88	0.2845	2.0542
39	NEOPLASMS OF EYE, BRAIN, & OTHER PARTS OF NERV SYSTEM UNSPECIF. NA	6	11.0311	0.54	0.1986	1.1839
40	OTHER BENIGN AND UNSPECIFIED NATURE NEOPLASMS	7	12.7366	0.55	0.2202	1.1324
12	DIABETES MELLITUS	81	150.0652	0.54**	0.4286	0.6709
41	DIABETES MELLITUS	81	150.0652	0.54**	0.4286	0.6709
13	DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS	13	23.3933	0.56*	0.2956	0.9504
42	PERNICIOUS ANEMIAS	0	0.7304	0.00	0.0000	5.0524
43	ANEMIAS OF OTHER AND UNSPECIFIED TYPE	7	9.7869	0.72	0.2865	1.4738
44	COAGULATION DEFECTS, PURPURA, AND OTHER HEMORRHAGIC CONDITIONS	2	6.1487	0.33	0.0394	1.1743
45	ALL OTHER DISEASES OF BLOOD FORMING ORGANS	4	6.7274	0.59	0.1620	1.5207
14	MENTAL, PSYCHONEUROTIC, AND PERSONALITY DISORDERS	64	41.6599	1.54**	1.1830	1.9618
46	ALCOHOLISM	12	11.3383	1.06	0.5462	1.8489
47	OTHER MENTAL DISORDERS	52	30.3216	1.71**	1.2807	2.2490
15	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	40	93.9573	0.43**	0.3041	0.5797
48	MULTIPLE SCLEROSIS	4	13.8865	0.29**	0.0785	0.7367
49	OTHER DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	36	80.0707	0.45**	0.3149	0.6225
16	DISEASES OF THE HEART	1042	1750.9839	0.60**	0.5595	0.6324
50	RHEUMATIC HEART DISEASE, INCLUDING FEVER	32	70.8683	0.45**	0.3088	0.6375
51	ISCHEMIC HEART DISEASE	842	1248.8687	0.67**	0.6294	0.7213
52	CHRONIC DISEASE OF ENDOCARDIUM	5	23.7024	0.21**	0.0683	0.4929
53	OTHER MYOCARDIAL DEGENERATION	1	15.3067	0.07**	0.0017	0.3629
54	HYPERTENSION WITH HEART DISEASE	19	77.3093	0.25**	0.1479	0.3838
55	OTHER DISEASES OF THE HEART	143	314.9287	0.45**	0.3827	0.5349

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLGT24.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
17	OTHER DISEASES OF CIRCULATORY SYSTEM	472	628.1112	0.75**	0.6852	0.8224
56	HYPERTENSION WITHOUT HEART DISEASE	12	24.3294	0.49*	0.2546	0.8616
57	CEREBROVASCULAR DISEASE	338	454.3543	0.74**	0.6667	0.8276
58	DISEASES OF THE ARTERIES, VEINS, AND PULMONARY CIRCULATION	122	149.4275	0.82*	0.6780	0.9749
18	DISEASES OF THE RESPIRATORY SYSTEM	308	374.9585	0.82**	0.7322	0.9185
59	ACUTE RESPIRATORY INFECTIONS EXCEPT INFLUENZA AND PNEUMONIA	1	2.6105	0.38	0.0097	2.1281
60	INFLUENZA	8	6.8838	1.16	0.5004	2.2900
61	PNEUMONIA (EXCEPT NEWBORN)	115	136.4983	0.84	0.6956	1.0113
62	CHRONIC AND UNSPECIFIED BRONCHITIS	11	10.8129	1.02	0.5071	1.8204
63	EMPHYSEMA	38	39.6283	0.96	0.6785	1.3162
64	ASTHMA	9	18.4088	0.49*	0.2231	0.9281
65	PNEUMOCONIOSES AND OTHER RESPIRATORY DISEASES	126	160.1159	0.79**	0.6555	0.9369
19	DISEASES OF THE DIGESTIVE SYSTEM	186	271.6498	0.68**	0.5898	0.7905
66	DISEASES OF THE STOMACH AND DUODENUM	14	23.3227	0.60	0.3279	1.0072
67	HERNIA AND INTESTINAL OBSTRUCTION	19	20.6999	0.92	0.5524	1.4335
68	CIRRHOSIS OF THE LIVER	80	116.8853	0.68**	0.5427	0.8518
69	OTHER DISEASES OF DIGESTIVE SYSTEM	73	110.7419	0.66**	0.5167	0.8288
20	DISEASES OF THE GENITO-URINARY SYSTEM	60	102.4156	0.59**	0.4470	0.7541
70	ACUTE GLOMERULONEPHRITIS, NEPHROTIC SYNDROME, & ACUTE RENAL FAILUR	2	8.6060	0.23*	0.0281	0.8390
71	CHRONIC & UNSPEC. NEPHRITIS, RENAL FAILURE, & OTHER RENAL SCLEROSI	8	44.8687	0.18**	0.0768	0.3513
72	INFECTION OF KIDNEY	11	13.2283	0.83	0.4145	1.4880
73	CALCULI OF URINARY SYSTEM	3	2.4326	1.23	0.2543	3.6060
74	HYPERPLASIA OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
75	OTHER DISEASES OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	0.0000
76	DISEASES OF THE BREAST	0	0.2050	0.00	0.0000	18.0008

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLGT24.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	2	5.1011	0.39	0.0475	1.4154
78	OTHER GENITO-URINARY SYSTEM DISEASES	34	27.9740	1.22	0.8416	1.6985
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	11	9.8780	1.11	0.5551	1.9927
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	2	2.1463	0.93	0.1128	3.3641
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	9	7.7317	1.16	0.5312	2.2099
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE	31	29.6231	1.05	0.7109	1.4855
81	ARTHRITIS AND SPONDYLITIS	17	10.7077	1.59	0.9243	2.5421
82	OSTEOMYELITIS AND PERIOSTITIS	1	0.9438	1.06	0.0268	5.8864
83	OTHER DISEASES OF MS SYSTEM	13	17.9715	0.72	0.3848	1.2371
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	91	57.5939	1.58**	1.2721	1.9400
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	91	57.5939	1.58**	1.2721	1.9400
24	ACCIDENTS	174	207.2342	0.84*	0.7195	0.9741
85	TRANSPORTATION ACCIDENTS	97	110.2686	0.88	0.7133	1.0731
86	ACCIDENTAL POISONING	4	14.7075	0.27**	0.0741	0.6956
87	ACCIDENTAL FALLS	22	29.4004	0.75	0.4688	1.1330
88	OTHER ACCIDENTS	40	42.7368	0.94	0.6686	1.2746
89	MEDICAL COMPLICATIONS AND MISADVENTURE	11	10.1209	1.09	0.5418	1.9448
25	VIOLENCE	96	107.7416	0.89	0.7217	1.0881
90	SUICIDE	77	78.4555	0.98	0.7745	1.2267
91	HOMICIDE	19	29.2861	0.65	0.3904	1.0132
26	OTHER CAUSES	189	146.8920	1.29**	1.1097	1.4838
92	OTHER CAUSES	189	146.8920	1.29**	1.1097	1.4838

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALLGT24.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Entire Exposed Study Group

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
	All Cancers	1348	1762.3129	0.76**	0.7246	0.8069
	All Deaths	4230	5813.0547	0.73**	0.7059	0.7499

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

APPENDIX III TABLE 18: POOLED SMRS, 2 YEARS INDUCTION TIME

PC LIFE TABLE ANALYSIS SYSTEM

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G L O B A L   P A R A M E T E R S

STUDY PARAMETER FILE NAME: c:\ltas\all.ltp
LAST COMPLETE STEP: Stratify
STUDY DESCRIPTION: all
STUDY BEGIN DATE: 01/01/1940
STUDY END DATE: 01/01/1994
RATES IN USE: Standard U.S. Deaths 92 Minors 1940 - 99
AGE CATEGORIES: 15\20\25\30\35\40\45\50\55\60\65\70\75\80\85\
CALENDAR CATEGORIES: 1940\1945\1950\1955\1960\1965\1970\1975\1980\1985\1990\1995\
SINGLE CAUSE OF DEATH

==

V E R I F Y   P A R A M E T E R S

INPUT DEMOGRAPHICS FILE: c:\ltas\all\dem
INPUT WORK HISTORY FILE: c:\ltas\all\wh
OUTPUT DEMOGRAPHICS FILE: c:\ltas\demout1.txt
OUTPUT WORK HISTORY FILE: c:\ltas\whout1.txt
BEGIN PERSON TIME AT LATER OF In-rec / Rate begin
STOP SURVIVORS PERSON TIME AT: END OF STUDY
GENDER/RACE SUBSETTING: KEEP ALL
EXPOSURE LEVEL: All exposed equally (no data)

SUMMARY REPORT FILE: .\summary.rpt
EXCEPTIONS REPORT FILE: .\except.rpt
EXPOSURE REPORT FILE: .\experr.rpt

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S T R A T I F Y   P A R A M E T E R S

ANALYSIS TYPE: SMR

DURATION	TIME SINCE FIRST EXPOSURE
MINIMUM->000Y	000Y
005Y	005Y
010Y	010Y
015Y	015Y
020Y	020Y
025Y	025Y
030Y	030Y

LAG PERIOD: 2 Years
PERSON YEARS FILE: C:\LTAS\ALLPY
OBSERVED DEATHS FILE: C:\LTAS\ALLOB

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	339806.78	0.00	0.00	0.00	0.00	0.00	0.00	339806.78
005Y - 010Y	250304.41	87932.25	0.00	0.00	0.00	0.00	0.00	338236.66
010Y - 015Y	246420.16	23589.52	60281.93	0.00	0.00	0.00	0.00	330291.62
015Y - 020Y	229170.59	17509.51	8429.40	36521.92	0.00	0.00	0.00	291631.42
020Y - 025Y	215029.22	15201.53	6301.49	5345.94	24150.08	0.00	0.00	266028.26
025Y - 030Y	198819.72	13010.06	5304.96	3980.80	3485.77	16405.27	0.00	241006.59
030Y & Over	523164.37	25745.22	9539.21	7097.98	5743.64	6239.43	23684.44	601214.29
Total	2002715.25	182988.08	89857.00	52946.63	33379.49	22644.70	23684.44	2408215.61

Zero exposed: 136217.89 Full Total: 2544433.51

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Zero Exposure Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	2011.78	7508.48	1932.71	1323.45	951.46	1136.03	1115.48	1744.55	116.60	0.00	0.00
20-24	3796.20	25563.41	5068.48	3128.31	2230.14	3335.67	3083.52	5814.00	757.80	0.00	0.00
25-29	2075.36	12649.11	2923.63	1358.73	757.13	981.15	1140.69	3276.30	497.94	0.00	0.00
30-34	1403.22	7519.88	1786.67	984.49	469.14	540.67	606.97	1980.01	307.12	0.00	0.00
35-39	958.04	5135.38	1163.55	722.66	461.72	498.05	462.25	1295.47	169.91	0.00	0.00
40-44	528.03	2934.06	772.92	491.68	337.97	427.38	359.69	933.33	112.59	0.00	0.00
45-49	259.62	1563.31	378.32	276.76	159.78	287.39	275.11	624.42	68.24	0.00	0.00
50-54	126.17	713.03	156.15	90.26	60.62	102.68	123.26	380.83	44.70	0.00	0.00
55-59	48.41	291.28	35.28	33.26	32.23	26.95	47.36	158.58	18.20	0.00	0.00
60-64	14.84	77.76	11.47	4.85	1.79	6.81	5.55	27.31	4.71	0.00	0.00
65-69	6.74	28.73	0.14	0.00	0.00	0.00	0.00	2.06	0.00	0.00	0.00
70-74	0.00	1.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75-79	0.00	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80-84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
85+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	11228.41	63986.43	14229.32	8414.45	5461.98	7342.77	7219.88	16236.85	2097.80	0.00	0.00

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Zero Exposure Group

AGES	1995+	TOTAL
15-19	0.00	17840.54
20-24	0.00	52777.52
25-29	0.00	25660.04
30-34	0.00	15598.16
35-39	0.00	10867.02
40-44	0.00	6897.64
45-49	0.00	3892.94
50-54	0.00	1797.71
55-59	0.00	691.55
60-64	0.00	155.10
65-69	0.00	37.68
70-74	0.00	1.02
75-79	0.00	0.98
80-84	0.00	0.00
85+	0.00	0.00
TOTAL	0.00	136217.89

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Exposure Greater Than Zero

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	0.00	293.95	107.35	26.67	3.87	15.32	52.43	165.25	67.24	0.00	0.00
20-24	0.00	35517.52	16202.60	8734.61	4988.22	4916.73	5899.55	6831.42	6104.16	183.14	0.00
25-29	0.13	29335.31	69746.41	26426.21	14007.99	9343.39	11188.90	13556.55	17650.44	6846.27	182.48
30-34	0.00	15582.89	46544.88	75378.69	28843.32	15575.06	11369.37	14587.85	19587.98	18120.52	6438.72
35-39	0.00	10453.05	26052.57	50016.93	76940.24	29825.21	16777.62	13438.76	18107.47	19814.01	15000.77
40-44	0.00	6589.43	17600.89	28328.89	51155.47	77522.21	30761.92	18227.16	15768.00	18176.91	15879.67
45-49	0.00	3378.21	10643.58	19020.99	28984.30	51305.58	77567.70	31597.41	19789.19	15764.50	14185.82
50-54	0.34	1704.31	5570.11	11170.02	19267.94	28856.74	50967.86	77164.93	32235.95	19653.73	12451.62
55-59	0.00	717.21	2625.79	5667.05	11097.88	18942.38	28228.90	50095.21	75953.06	31601.20	16050.32
60-64	0.00	240.29	1084.14	2606.24	5502.38	10732.73	18265.83	27079.88	48496.05	73557.77	26259.23
65-69	0.00	82.16	336.01	1032.73	2478.36	5191.39	9993.15	17116.57	25344.15	45790.14	58234.64
70-74	0.00	13.93	108.60	318.30	925.17	2235.92	4643.97	8994.37	15396.65	23119.27	31045.25
75-79	0.00	2.87	15.05	94.60	278.30	794.45	1870.86	3876.81	7745.94	13172.04	15475.41
80-84	0.00	0.00	3.86	12.99	81.87	220.00	572.47	1435.24	3050.06	6172.14	8064.21
85+	0.00	0.00	0.00	3.86	13.17	84.34	211.89	516.84	1336.64	2985.76	4778.29
TOTAL	0.47	103911.13	196641.83	228838.78	244568.50	255561.46	268372.41	284684.26	306632.97	294957.39	224046.42

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Exposure Greater Than Zero

AGES	1995+	TOTAL			
15-19	0.00	732.10			
20-24	0.00	89377.94			
25-29	0.00	198284.08			
30-34	0.00	252029.28			
35-39	0.00	276426.63			
40-44	0.00	280010.56			
45-49	0.00	272237.27			
50-54	0.00	259043.54			
55-59	0.00	240979.01			
60-64	0.00	213824.53			
65-69	0.00	165599.30			
70-74	0.00	86801.42			
75-79	0.00	43326.33			
80-84	0.00	19612.84			
85+	0.00	9930.78	2408215.61	2	0.00

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
1	TUBERCULOSIS	28	86.4413	0.32**	0.2152	0.4682
1	RESPIRATORY TUBERCULOSIS	18	77.3521	0.23**	0.1378	0.3678
2	OTHER TUBERCULOSIS	10	9.0893	1.10	0.5267	2.0234
2	MN OF BUCCAL CAVITY AND PHARYNX	67	70.1117	0.96	0.7406	1.2136
3	MN OF LIP	0	0.3647	0.00	0.0000	10.1170
4	MN OF TONGUE	19	16.3896	1.16	0.6976	1.8105
5	MN OF OTHER PARTS OF BUCCAL CAVITY	19	22.2707	0.85	0.5134	1.3324
6	MN OF PHARYNX	29	31.0868	0.93	0.6246	1.3398
3	MN OF DIGESTIVE ORGANS AND PERITONEUM	818	1208.1887	0.68**	0.6314	0.7251
7	MN OF ESOPHAGUS	43	52.3792	0.82	0.5941	1.1058
8	MN OF STOMACH	82	133.3003	0.62**	0.4892	0.7636
9	MN OF INTESTINE EXCEPT RECTUM	363	525.6018	0.69**	0.6214	0.7655
10	MN OF RECTUM	61	98.9118	0.62**	0.4717	0.7922
11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	65	93.2553	0.70**	0.5379	0.8884
12	MN OF LIVER NOT SPECIFIED	24	31.3613	0.77	0.4902	1.1387
13	MN OF PANCREAS	174	249.0721	0.70**	0.5986	0.8105
14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	6	24.3068	0.25**	0.0901	0.5373
4	MN OF RESPIRATORY SYSTEM	855	986.8729	0.87**	0.8093	0.9264
15	MN OF LARYNX	15	18.5611	0.81	0.4520	1.3330
16	MN OF TRACHEA, BRONCHUS, AND LUNG	832	956.3575	0.87**	0.8118	0.9311
17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	8	11.9542	0.67	0.2882	1.3187
5	MN OF BREAST	862	1130.6497	0.76**	0.7123	0.8150
18	MN OF BREAST	862	1130.6497	0.76**	0.7123	0.8150

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
6	MN OF FEMALE GENITAL ORGANS	518	748.7637	0.69**	0.6335	0.7540
19	MN OF CERVIX UTERI	149	197.8330	0.75**	0.6371	0.8843
20	MN OF OTHER AND UNSPECIFIED PARTS OF UTERUS	93	169.9723	0.55**	0.4416	0.6703
21	MN OF OVARY, FALLOPIAN TUBE, AND BROAD LIGAMENT	266	359.5129	0.74**	0.6536	0.8344
22	MN OF OTHER FEMALE GENITAL ORGANS	10	21.4455	0.47*	0.2232	0.8576
7	MN OF MALE GENITAL ORGANS	0	0.0008	0.00	0.0000	4842.1841
23	MN OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
24	MN OF OTHER MALE GENITAL ORGANS	0	0.0008	0.00	0.0000	4842.1841
8	MN OF URINARY ORGANS	115	141.6184	0.81*	0.6704	0.9747
25	MN OF KIDNEY	72	82.3080	0.87	0.6844	1.1016
26	MN OF BLADDER AND OTHER URINARY ORGANS	43	59.3104	0.72*	0.5246	0.9766
9	MN OF OTHER AND UNSPECIFIED SITES	479	621.1893	0.77**	0.7036	0.8434
27	MN OF SKIN	76	71.4324	1.06	0.8382	1.3317
28	MN OF EYE	4	3.7153	1.08	0.2934	2.7535
29	MN OF BRAIN AND OTHER PARTS OF NERVOUS SYSTEM	99	134.7835	0.73**	0.5970	0.8943
30	MN OF THYROID GLAND	11	15.2142	0.72	0.3604	1.2938
31	MN OF BONE	10	13.3273	0.75	0.3592	1.3800
32	MN OF CONNECTIVE TISSUE AND SOFT TISSUE	20	29.4784	0.68	0.4142	1.0479
33	MN OF OTHER AND UNSPECIFIED SITES (MINOR)	259	353.2383	0.73**	0.6466	0.8282
10	NEOPLASMS OF LYMPHATIC AND HEMATOPOIETIC TISSUE	345	444.8278	0.78**	0.6959	0.8619
34	LYMPHOSARCOMA AND RETICULOSARCOMA	53	60.0281	0.88	0.6613	1.1549
35	HODGKIN'S DISEASE	22	30.1166	0.73	0.4576	1.1060
36	LEUKEMIA AND ALEUKEMIA	118	164.2832	0.72**	0.5945	0.8602
37	OTHER NEOPLASMS OF LYMPHATIC HEMATOPOIETIC TISSUE	152	190.3999	0.80**	0.6764	0.9358

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
11	BENIGN AND UNSPECIFIED NEOPLASMS	53	91.0726	0.58**	0.4359	0.7612
38	BENIGN NEOPLASMS OF THE EYE, BRAIN, AND OTHER PARTS OF NERVOUS SYS	12	17.6467	0.68	0.3510	1.1879
39	NEOPLASMS OF EYE, BRAIN, & OTHER PARTS OF NERV SYSTEM UNSPECIF. NA	19	33.1038	0.57*	0.3454	0.8963
40	OTHER BENIGN AND UNSPECIFIED NATURE NEOPLASMS	22	40.3220	0.55**	0.3418	0.8261
12	DIABETES MELLITUS	273	475.0215	0.57**	0.5085	0.6471
41	DIABETES MELLITUS	273	475.0215	0.57**	0.5085	0.6471
13	DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS	48	71.3364	0.67**	0.4961	0.8921
42	PERNICIOUS ANEMIAS	1	2.3105	0.43	0.0109	2.4045
43	ANEMIAS OF OTHER AND UNSPECIFIED TYPE	20	30.0950	0.66	0.4058	1.0264
44	COAGULATION DEFECTS, PURPURA, AND OTHER HEMORRHAGIC CONDITIONS	13	18.5019	0.70	0.3738	1.2016
45	ALL OTHER DISEASES OF BLOOD FORMING ORGANS	14	20.4290	0.69	0.3743	1.1499
14	MENTAL, PSYCHONEUROTIC, AND PERSONALITY DISORDERS	166	124.7807	1.33**	1.1356	1.5488
46	ALCOHOLISM	31	33.6780	0.92	0.6253	1.3066
47	OTHER MENTAL DISORDERS	135	91.1027	1.48**	1.2424	1.7540
15	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	120	281.2408	0.43**	0.3538	0.5102
48	MULTIPLE SCLEROSIS	18	40.1836	0.45**	0.2653	0.7080
49	OTHER DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	102	241.0571	0.42**	0.3450	0.5137
16	DISEASES OF THE HEART	3617	5506.0889	0.66**	0.6357	0.6787
50	RHEUMATIC HEART DISEASE, INCLUDING FEVER	135	219.8017	0.61**	0.5149	0.7270
51	ISCHEMIC HEART DISEASE	2919	3913.8596	0.75**	0.7190	0.7734
52	CHRONIC DISEASE OF ENDOCARDIUM	15	72.6219	0.21**	0.1155	0.3407
53	OTHER MYOCARDIAL DEGENERATION	18	50.5524	0.36**	0.2109	0.5628
54	HYPERTENSION WITH HEART DISEASE	75	260.8983	0.29**	0.2261	0.3604
55	OTHER DISEASES OF THE HEART	455	988.3550	0.46**	0.4190	0.5047

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
17	OTHER DISEASES OF CIRCULATORY SYSTEM	1511	1983.4702	0.76**	0.7239	0.8012
56	HYPERTENSION WITHOUT HEART DISEASE	53	82.7171	0.64**	0.4799	0.8381
57	CEREBROVASCULAR DISEASE	1097	1436.0022	0.76**	0.7194	0.8105
58	DISEASES OF THE ARTERIES, VEINS, AND PULMONARY CIRCULATION	361	464.7509	0.78**	0.6987	0.8612
18	DISEASES OF THE RESPIRATORY SYSTEM	988	1156.7917	0.85**	0.8017	0.9090
59	ACUTE RESPIRATORY INFECTIONS EXCEPT INFLUENZA AND PNEUMONIA	8	7.9494	1.01	0.4333	1.9831
60	INFLUENZA	14	21.5064	0.65	0.3556	1.0923
61	PNEUMONIA (EXCEPT NEWBORN)	346	423.5958	0.82**	0.7330	0.9076
62	CHRONIC AND UNSPECIFIED BRONCHITIS	38	33.1811	1.15	0.8103	1.5720
63	EMPHYSEMA	110	122.1308	0.90	0.7402	1.0856
64	ASTHMA	31	55.8977	0.55**	0.3767	0.7872
65	PNEUMOCONIOSES AND OTHER RESPIRATORY DISEASES	441	492.5304	0.90*	0.8137	0.9830
19	DISEASES OF THE DIGESTIVE SYSTEM	617	831.8956	0.74**	0.6843	0.8026
66	DISEASES OF THE STOMACH AND DUODENUM	58	72.2439	0.80	0.6096	1.0379
67	HERNIA AND INTESTINAL OBSTRUCTION	44	65.0951	0.68**	0.4911	0.9074
68	CIRRHOSIS OF THE LIVER	276	354.9223	0.78**	0.6886	0.8750
69	OTHER DISEASES OF DIGESTIVE SYSTEM	239	339.6342	0.70**	0.6173	0.7988
20	DISEASES OF THE GENITO-URINARY SYSTEM	237	331.0974	0.72**	0.6276	0.8130
70	ACUTE GLOMERULONEPHRITIS, NEPHROTIC SYNDROME, & ACUTE RENAL FAILUR	15	27.7275	0.54*	0.3026	0.8923
71	CHRONIC & UNSPEC. NEPHRITIS, RENAL FAILURE, & OTHER RENAL SCLEROSI	54	146.2693	0.37**	0.2773	0.4817
72	INFECTION OF KIDNEY	34	43.3890	0.78	0.5426	1.0951
73	CALCULI OF URINARY SYSTEM	6	7.6773	0.78	0.2854	1.7011
74	HYPERPLASIA OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
75	OTHER DISEASES OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	0.0000
76	DISEASES OF THE BREAST	0	0.6350	0.00	0.0000	5.8108

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	13	16.4290	0.79	0.4209	1.3532
78	OTHER GENITO-URINARY SYSTEM DISEASES	115	88.9703	1.29**	1.0671	1.5515
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	26	32.2843	0.81	0.5259	1.1801
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	5	6.6866	0.75	0.2420	1.7471
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	21	25.5978	0.82	0.5076	1.2541
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE	96	88.1939	1.09	0.8817	1.3293
81	ARTHRITIS AND SPONDYLITIS	34	33.2168	1.02	0.7087	1.4304
82	OSTEOMYELITIS AND PERIOSTITIS	1	3.0099	0.33	0.0084	1.8457
83	OTHER DISEASES OF MS SYSTEM	61	51.9672	1.17	0.8978	1.5078
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	292	178.5757	1.64**	1.4530	1.8339
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	292	178.5757	1.64**	1.4530	1.8339
24	ACCIDENTS	530	578.1272	0.92*	0.8404	0.9982
85	TRANSPORTATION ACCIDENTS	288	291.6227	0.99	0.8768	1.1085
86	ACCIDENTAL POISONING	29	38.9082	0.75	0.4991	1.0705
87	ACCIDENTAL FALLS	71	90.2742	0.79*	0.6142	0.9921
88	OTHER ACCIDENTS	124	126.3945	0.98	0.8160	1.1697
89	MEDICAL COMPLICATIONS AND MISADVENTURE	18	30.9276	0.58*	0.3448	0.9199
25	VIOLENCE	264	286.5384	0.92	0.8135	1.0395
90	SUICIDE	186	209.5906	0.89	0.7645	1.0246
91	HOMICIDE	78	76.9478	1.01	0.8012	1.2651
26	OTHER CAUSES	652	438.3138	1.49**	1.3755	1.6062
92	OTHER CAUSES	652	438.3138	1.49**	1.3755	1.6062

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
	All Cancers	4059	5352.2241	0.76**	0.7352	0.7821
	All Deaths	13577	17893.4922	0.76**	0.7461	0.7716

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

APPENDIX III TABLE 19: POOLED SMRS, 5 YEARS INDUCTION TIME

PC LIFE TABLE ANALYSIS SYSTEM Page: 1

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===========================================================================
                       G L O B A L   P A R A M E T E R S
STUDY PARAMETER FILE NAME: c:\ltas\all.ltp
LAST COMPLETE STEP: Stratify
STUDY DESCRIPTION: all
STUDY BEGIN DATE: 01/01/1940
STUDY END DATE: 01/01/1994
RATES IN USE: Standard U.S. Deaths 92 Minors 1940 - 99
AGE CATEGORIES: 15\20\25\30\35\40\45\50\55\60\65\70\75\80\85\
CALENDAR CATEGORIES: 1940\1945\1950\1955\1960\1965\1970\1975\1980\1985\1990\1995\
SINGLE CAUSE OF DEATH
===========================================================================
                       V E R I F Y   P A R A M E T E R S
INPUT DEMOGRAPHICS FILE: c:\ltas\all\dem
INPUT WORK HISTORY FILE: c:\ltas\all\wh
OUTPUT DEMOGRAPHICS FILE: c:\ltas\demout1.txt
OUTPUT WORK HISTORY FILE: c:\ltas\whout1.txt
BEGIN PERSON TIME AT LATER OF In-rec / Rate begin
STOP SURVIVORS PERSON TIME AT: END OF STUDY
GENDER/RACE SUBSETTING: KEEP ALL
EXPOSURE LEVEL: All exposed equally (no data)

SUMMARY REPORT FILE: .\summary.rpt
EXCEPTIONS REPORT FILE: .\except.rpt
EXPOSURE REPORT FILE: .\experr.rpt
===========================================================================
                     S T R A T I F Y   P A R A M E T E R S
ANALYSIS TYPE: SMR
```

DURATION	TIME SINCE FIRST EXPOSURE
MINIMUM->000Y	000Y
005Y	005Y
010Y	010Y
015Y	015Y
020Y	020Y
025Y	025Y
030Y	030Y

LAG PERIOD: 5 Years

PERSON YEARS FILE: C:\LTAS\ALLPY

OBSERVED DEATHS FILE: C:\LTAS\ALLOB

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	338924.59	0.00	0.00	0.00	0.00	0.00	0.00	338924.59
005Y - 010Y	249281.07	87325.41	0.00	0.00	0.00	0.00	0.00	336606.48
010Y - 015Y	236472.22	19728.15	51536.84	0.00	0.00	0.00	0.00	307737.21
015Y - 020Y	220632.29	16017.67	6744.59	31821.69	0.00	0.00	0.00	275216.24
020Y - 025Y	205313.63	13841.29	5724.42	4441.35	21407.95	0.00	0.00	250728.63
025Y - 030Y	189619.72	11905.68	4699.44	3573.82	3002.42	14860.21	0.00	227661.29
030Y & Over	411189.51	18816.69	6840.97	5033.01	4025.24	4330.77	16990.53	467226.71
Total	1851433.02	167634.88	75546.25	44869.87	28435.61	19190.98	16990.53	2204101.14

Zero exposed: 340332.37 Full Total: 2544433.51

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Zero Exposure Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995+
15-19	2011.78	7802.22	2037.52	1350.12	955.33	1151.35	1167.91	1909.80	183.84	0.00	0.00	0.00
20-24	3796.20	59072.96	13478.30	9826.49	5867.74	7297.56	7834.02	11481.06	4953.54	0.00	0.00	0.00
25-29	2075.49	38195.13	11690.36	6551.58	2926.14	3128.56	4097.39	7874.60	5525.28	0.00	0.00	0.00
30-34	1403.22	21035.93	6479.72	3854.39	1550.43	1386.34	1658.95	4270.53	3077.51	0.00	0.00	0.00
35-39	958.04	14193.60	4222.76	2635.55	1354.98	1177.61	1209.36	2809.14	1784.64	0.00	0.00	0.00
40-44	528.03	8574.15	2891.92	1790.83	1032.46	1098.15	972.47	2000.88	1220.88	0.00	0.00	0.00
45-49	259.62	4419.46	1592.74	1067.20	617.85	726.42	824.22	1429.39	850.54	0.00	0.00	0.00
50-54	126.51	2160.17	841.85	387.63	276.77	270.87	419.56	923.28	517.86	0.00	0.00	0.00
55-59	48.41	882.79	283.64	118.21	101.49	88.23	169.85	366.04	280.07	0.00	0.00	0.00
60-64	14.84	269.80	106.60	30.90	30.86	23.03	32.22	82.63	106.15	0.00	0.00	0.00
65-69	6.74	97.34	27.67	3.49	0.56	0.00	1.71	12.59	6.36	0.00	0.00	0.00
70-74	0.00	8.20	1.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75-79	0.00	3.86	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80-84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
85+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	11228.88	156715.59	43654.49	27616.38	14714.61	16348.13	18387.66	33159.94	18506.68	0.00	0.00	0.00

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Zero Exposure Group

AGES	TOTAL
15-19	18569.89
20-24	123607.88
25-29	82064.52
30-34	44717.01
35-39	30345.68
40-44	20109.78
45-49	11787.43
50-54	5924.49
55-59	2338.73
60-64	697.03
65-69	156.46
70-74	9.49
75-79	3.98
80-84	0.00
85+	0.00
TOTAL	340332.37

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Exposure Greater Than Zero

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995+
15-19	0.00	0.21	2.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20-24	0.00	2007.97	7792.78	2036.43	1350.62	954.83	1149.04	1164.36	1908.42	183.14	0.00	0.00
25-29	0.00	3789.30	60979.67	21233.36	11838.99	7195.98	8232.21	8958.25	12623.09	6846.27	182.48	0.00
30-34	0.00	2066.84	41851.83	72508.80	27762.03	14729.39	10317.39	12297.33	16817.59	18120.52	6438.72	0.00
35-39	0.00	1394.83	22993.36	48104.04	76046.98	29145.65	16030.51	11925.09	16492.73	19814.01	15000.77	0.00
40-44	0.00	949.34	15481.89	27029.74	50460.98	76851.44	30149.14	17159.61	14659.71	18176.91	15879.67	0.00
45-49	0.00	522.06	9429.16	18230.55	28526.23	50866.55	77018.58	30792.44	19006.89	15764.50	14185.82	0.00
50-54	0.00	257.17	4884.42	10872.64	19051.79	28688.55	50671.56	76622.48	31762.79	19653.73	12451.62	0.00
55-59	0.00	125.70	2377.43	5582.10	11028.62	18881.10	28106.41	49887.75	75691.19	31601.20	16050.32	0.00
60-64	0.00	48.25	989.02	2580.19	5473.31	10716.51	18239.16	27024.56	48394.61	73557.77	26259.23	0.00
65-69	0.00	13.56	308.48	1029.24	2477.80	5191.39	9991.44	17106.05	25337.79	45790.14	58234.64	0.00
70-74	0.00	6.74	107.31	318.30	925.17	2235.92	4643.97	8994.37	15396.65	23119.27	31045.25	0.00
75-79	0.00	0.00	14.92	94.60	278.30	794.45	1870.86	3876.81	7745.94	13172.04	15475.41	0.00
80-84	0.00	0.00	3.86	12.99	81.87	220.00	572.47	1435.24	3050.06	6172.14	8064.21	0.00
85+	0.00	0.00	0.00	3.86	13.17	84.34	211.89	516.84	1336.64	2985.76	4778.29	0.00
TOTAL	0.00	11181.96	167216.66	209636.85	235315.86	246556.11	257204.62	267761.17	290224.10	294957.39	224046.42	0.00

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Exposure Greater Than Zero

AGES	TOTAL		
15-19	2.75		
20-24	18547.59		
25-29	141879.60		
30-34	222910.43		
35-39	256947.96		
40-44	266798.42		
45-49	264342.78		
50-54	254916.76		
55-59	239331.83		
60-64	213282.61		
65-69	165480.52		
70-74	86792.95		
75-79	43323.33		
80-84	19612.84		
85+	9930.78	2204101.14	2930.78

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number		Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
1		TUBERCULOSIS	24	55.8653	0.43**	0.2752	0.6392
	1	RESPIRATORY TUBERCULOSIS	15	48.6982	0.31**	0.1723	0.5081
	2	OTHER TUBERCULOSIS	9	7.1671	1.26	0.5730	2.3839
2		MN OF BUCCAL CAVITY AND PHARYNX	65	69.4650	0.94	0.7221	1.1927
	3	MN OF LIP	0	0.3568	0.00	0.0000	10.3406
	4	MN OF TONGUE	17	16.2354	1.05	0.6096	1.6766
	5	MN OF OTHER PARTS OF BUCCAL CAVITY	19	22.0944	0.86	0.5175	1.3430
	6	MN OF PHARYNX	29	30.7783	0.94	0.6309	1.3532
3		MN OF DIGESTIVE ORGANS AND PERITONEUM	813	1194.3870	0.68**	0.6347	0.7291
	7	MN OF ESOPHAGUS	43	52.0649	0.83	0.5976	1.1125
	8	MN OF STOMACH	82	130.6277	0.63**	0.4992	0.7792
	9	MN OF INTESTINE EXCEPT RECTUM	360	520.2815	0.69**	0.6223	0.7672
	10	MN OF RECTUM	61	97.0745	0.63**	0.4806	0.8072
	11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	64	91.7278	0.70**	0.5373	0.8910
	12	MN OF LIVER NOT SPECIFIED	24	31.0975	0.77	0.4943	1.1484
	13	MN OF PANCREAS	173	247.6854	0.70**	0.5983	0.8107
	14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	6	23.8276	0.25**	0.0919	0.5481
4		MN OF RESPIRATORY SYSTEM	853	982.7675	0.87**	0.8107	0.9282
	15	MN OF LARYNX	15	18.4388	0.81	0.4550	1.3418
	16	MN OF TRACHEA, BRONCHUS, AND LUNG	830	952.4947	0.87**	0.8131	0.9328
	17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	8	11.8341	0.68	0.2911	1.3321
5		MN OF BREAST	857	1114.5739	0.77**	0.7183	0.8222
	18	MN OF BREAST	857	1114.5739	0.77**	0.7183	0.8222

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
6	MN OF FEMALE GENITAL ORGANS	504	729.7787	0.69**	0.6316	0.7536
19	MN OF CERVIX UTERI	139	194.0091	0.72**	0.6023	0.8460
20	MN OF OTHER AND UNSPECIFIED PARTS OF UTERUS	91	160.3603	0.57**	0.4569	0.6967
21	MN OF OVARY, FALLOPIAN TUBE, AND BROAD LIGAMENT	264	354.2911	0.75**	0.6580	0.8407
22	MN OF OTHER FEMALE GENITAL ORGANS	10	21.1182	0.47*	0.2267	0.8709
7	MN OF MALE GENITAL ORGANS	0	0.0008	0.00	0.0000	4845.3960
23	MN OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
24	MN OF OTHER MALE GENITAL ORGANS	0	0.0008	0.00	0.0000	4845.3960
8	MN OF URINARY ORGANS	113	140.3723	0.81*	0.6634	0.9678
25	MN OF KIDNEY	71	81.5310	0.87	0.6801	1.0985
26	MN OF BLADDER AND OTHER URINARY ORGANS	42	58.8413	0.71*	0.5144	0.9649
9	MN OF OTHER AND UNSPECIFIED SITES	471	610.9216	0.77**	0.7029	0.8438
27	MN OF SKIN	74	69.9923	1.06	0.8301	1.3273
28	MN OF EYE	4	3.6735	1.09	0.2967	2.7848
29	MN OF BRAIN AND OTHER PARTS OF NERVOUS SYSTEM	96	131.8383	0.73**	0.5898	0.8892
30	MN OF THYROID GLAND	11	15.0951	0.73	0.3633	1.3040
31	MN OF BONE	9	12.9723	0.69	0.3166	1.3171
32	MN OF CONNECTIVE TISSUE AND SOFT TISSUE	20	29.1583	0.69	0.4188	1.0594
33	MN OF OTHER AND UNSPECIFIED SITES (MINOR)	257	348.1917	0.74**	0.6506	0.8341
10	NEOPLASMS OF LYMPHATIC AND HEMATOPOIETIC TISSUE	344	438.1111	0.79**	0.7044	0.8727
34	LYMPHOSARCOMA AND RETICULOSARCOMA	52	59.1910	0.88	0.6561	1.1521
35	HODGKIN'S DISEASE	22	28.8604	0.76	0.4776	1.1542
36	LEUKEMIA AND ALEUKEMIA	118	160.2158	0.74**	0.6096	0.8820
37	OTHER NEOPLASMS OF LYMPHATIC HEMATOPOIETIC TISSUE	152	189.8439	0.80**	0.6784	0.9385

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
11	BENIGN AND UNSPECIFIED NEOPLASMS	50	86.2792	0.58**	0.4301	0.7640
38	BENIGN NEOPLASMS OF THE EYE, BRAIN, AND OTHER PARTS OF NERVOUS SYS	11	16.9411	0.65	0.3237	1.1619
39	NEOPLASMS OF EYE, BRAIN, & OTHER PARTS OF NERV SYSTEM UNSPECIF. NA	19	31.9527	0.59*	0.3578	0.9286
40	OTHER BENIGN AND UNSPECIFIED NATURE NEOPLASMS	20	37.3854	0.53**	0.3266	0.8263
12	DIABETES MELLITUS	272	468.1290	0.58**	0.5140	0.6544
41	DIABETES MELLITUS	272	468.1290	0.58**	0.5140	0.6544
13	DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS	47	69.3997	0.68**	0.4976	0.9006
42	PERNICIOUS ANEMIAS	1	2.1097	0.47	0.0120	2.6333
43	ANEMIAS OF OTHER AND UNSPECIFIED TYPE	19	29.3285	0.65	0.3899	1.0117
44	COAGULATION DEFECTS, PURPURA, AND OTHER HEMORRHAGIC CONDITIONS	13	17.9403	0.72	0.3855	1.2392
45	ALL OTHER DISEASES OF BLOOD FORMING ORGANS	14	20.0212	0.70	0.3820	1.1733
14	MENTAL, PSYCHONEUROTIC, AND PERSONALITY DISORDERS	162	122.4762	1.32**	1.1268	1.5428
46	ALCOHOLISM	27	32.7415	0.82	0.5433	1.1999
47	OTHER MENTAL DISORDERS	135	89.7347	1.50**	1.2613	1.7807
15	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	119	273.9235	0.43**	0.3599	0.5199
48	MULTIPLE SCLEROSIS	18	38.4893	0.47**	0.2770	0.7392
49	OTHER DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	101	235.4342	0.43**	0.3494	0.5213
16	DISEASES OF THE HEART	3605	5450.8955	0.66**	0.6399	0.6833
50	RHEUMATIC HEART DISEASE, INCLUDING FEVER	133	207.2202	0.64**	0.5374	0.7606
51	ISCHEMIC HEART DISEASE	2911	3889.3179	0.75**	0.7215	0.7762
52	CHRONIC DISEASE OF ENDOCARDIUM	15	70.8328	0.21**	0.1184	0.3493
53	OTHER MYOCARDIAL DEGENERATION	17	48.0900	0.35**	0.2058	0.5660
54	HYPERTENSION WITH HEART DISEASE	75	253.2873	0.30**	0.2329	0.3712
55	OTHER DISEASES OF THE HEART	454	982.1473	0.46**	0.4207	0.5068

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
17	OTHER DISEASES OF CIRCULATORY SYSTEM	1503	1960.5845	0.77**	0.7283	0.8064
56	HYPERTENSION WITHOUT HEART DISEASE	53	81.4606	0.65**	0.4873	0.8510
57	CEREBROVASCULAR DISEASE	1092	1418.4164	0.77**	0.7249	0.8169
58	DISEASES OF THE ARTERIES, VEINS, AND PULMONARY CIRCULATION	358	460.7076	0.78**	0.6986	0.8619
18	DISEASES OF THE RESPIRATORY SYSTEM	978	1141.8441	0.86**	0.8037	0.9119
59	ACUTE RESPIRATORY INFECTIONS EXCEPT INFLUENZA AND PNEUMONIA	8	7.6514	1.05	0.4502	2.0603
60	INFLUENZA	13	20.1076	0.65	0.3439	1.1056
61	PNEUMONIA (EXCEPT NEWBORN)	342	415.1683	0.82**	0.7388	0.9159
62	CHRONIC AND UNSPECIFIED BRONCHITIS	37	32.7337	1.13	0.7957	1.5581
63	EMPHYSEMA	110	121.8399	0.90	0.7420	1.0882
64	ASTHMA	29	54.3081	0.53**	0.3575	0.7669
65	PNEUMOCONIOSES AND OTHER RESPIRATORY DISEASES	439	490.0349	0.90*	0.8140	0.9837
19	DISEASES OF THE DIGESTIVE SYSTEM	611	811.8338	0.75**	0.6941	0.8147
66	DISEASES OF THE STOMACH AND DUODENUM	58	70.8789	0.82	0.6213	1.0579
67	HERNIA AND INTESTINAL OBSTRUCTION	43	62.1444	0.69*	0.5007	0.9321
68	CIRRHOSIS OF THE LIVER	274	348.2364	0.79**	0.6964	0.8857
69	OTHER DISEASES OF DIGESTIVE SYSTEM	236	330.5740	0.71**	0.6257	0.8110
20	DISEASES OF THE GENITO-URINARY SYSTEM	233	319.2910	0.73**	0.6390	0.8297
70	ACUTE GLOMERULONEPHRITIS, NEPHROTIC SYNDROME, & ACUTE RENAL FAILUR	14	26.5851	0.53*	0.2877	0.8836
71	CHRONIC & UNSPEC. NEPHRITIS, RENAL FAILURE, & OTHER RENAL SCLEROSI	54	140.0523	0.39**	0.2896	0.5031
72	INFECTION OF KIDNEY	33	42.0002	0.79	0.5408	1.1035
73	CALCULI OF URINARY SYSTEM	5	7.3040	0.68	0.2215	1.5994
74	HYPERPLASIA OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
75	OTHER DISEASES OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	0.0000
76	DISEASES OF THE BREAST	0	0.6269	0.00	0.0000	5.8866

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	12	14.2142	0.84	0.4357	1.4748
78	OTHER GENITO-URINARY SYSTEM DISEASES	115	88.5084	1.30**	1.0727	1.5596
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	24	31.4225	0.76	0.4892	1.1365
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	5	6.5738	0.76	0.2461	1.7771
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	19	24.8487	0.76	0.4601	1.1941
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE	96	86.9680	1.10	0.8941	1.3480
81	ARTHRITIS AND SPONDYLITIS	34	32.9013	1.03	0.7155	1.4441
82	OSTEOMYELITIS AND PERIOSTITIS	1	2.9442	0.34	0.0086	1.8870
83	OTHER DISEASES OF MS SYSTEM	61	51.1225	1.19	0.9127	1.5328
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	289	173.5979	1.66**	1.4783	1.8682
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	289	173.5979	1.66**	1.4783	1.8682
24	ACCIDENTS	499	542.2993	0.92	0.8412	1.0046
85	TRANSPORTATION ACCIDENTS	266	268.0722	0.99	0.8766	1.1190
86	ACCIDENTAL POISONING	28	36.2796	0.77	0.5127	1.1155
87	ACCIDENTAL FALLS	70	88.6035	0.79	0.6158	0.9982
88	OTHER ACCIDENTS	119	118.8690	1.00	0.8293	1.1980
89	MEDICAL COMPLICATIONS AND MISADVENTURE	16	30.4749	0.53**	0.2999	0.8527
25	VIOLENCE	248	266.6986	0.93	0.8177	1.0531
90	SUICIDE	176	197.4117	0.89	0.7647	1.0334
91	HOMICIDE	72	69.2869	1.04	0.8130	1.3087
26	OTHER CAUSES	639	407.2691	1.57**	1.4497	1.6955
92	OTHER CAUSES	639	407.2691	1.57**	1.4497	1.6955

----- Value too large * Two-Sided $P < 0.05$ ** Two-Sided $P < 0.01$

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
	All Cancers	4020	5280.3765	0.76**	0.7380	0.7852
	All Deaths	13419	17549.1543	0.76**	0.7518	0.7777

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

APPENDIX III TABLE 20: POOLED SMRS, 10 YEARS INDUCTION TIME


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==========================================================================
                   G L O B A L   P A R A M E T E R S
STUDY PARAMETER FILE NAME: c:\ltas\all.ltp
LAST COMPLETE STEP: Stratify
STUDY DESCRIPTION: all
STUDY BEGIN DATE: 01/01/1940
STUDY END DATE: 01/01/1994
RATES IN USE: Standard U.S. Deaths 92 Minors 1940 - 99
AGE CATEGORIES: 15\20\25\30\35\40\45\50\55\60\65\70\75\80\85\
CALENDAR CATEGORIES: 1940\1945\1950\1955\1960\1965\1970\1975\1980\1985\1990\1995\
SINGLE CAUSE OF DEATH
==========================================================================
                   V E R I F Y   P A R A M E T E R S
INPUT DEMOGRAPHICS FILE: c:\ltas\all\dem
INPUT WORK HISTORY FILE: c:\ltas\all\wh
OUTPUT DEMOGRAPHICS FILE: c:\ltas\demout1.txt
OUTPUT WORK HISTORY FILE: c:\ltas\whout1.txt
BEGIN PERSON TIME AT LATER OF In-rec / Rate begin
STOP SURVIVORS PERSON TIME AT: END OF STUDY
GENDER/RACE SUBSETTING: KEEP ALL
EXPOSURE LEVEL: All exposed equally (no data)

SUMMARY REPORT FILE: .\summary.rpt
EXCEPTIONS REPORT FILE: .\except.rpt
EXPOSURE REPORT FILE: .\experr.rpt
==========================================================================
                 S T R A T I F Y   P A R A M E T E R S
ANALYSIS TYPE: SMR
```

DURATION	TIME SINCE FIRST EXPOSURE
MINIMUM->000Y	000Y
005Y	005Y
010Y	010Y
015Y	015Y
020Y	020Y
025Y	025Y
030Y	030Y

LAG PERIOD: 10 Years
PERSON YEARS FILE: C:\LTAS\ALLPY
OBSERVED DEATHS FILE: C:\LTAS\ALLOB

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	336326.97	0.00	0.00	0.00	0.00	0.00	0.00	336326.97
005Y - 010Y	236751.73	71264.99	0.00	0.00	0.00	0.00	0.00	308016.71
010Y - 015Y	220515.26	16009.48	38547.03	0.00	0.00	0.00	0.00	275071.77
015Y - 020Y	205430.65	13849.48	5727.83	25865.13	0.00	0.00	0.00	250873.10
020Y - 025Y	189619.72	11905.68	4699.44	3573.82	17862.63	0.00	0.00	227661.29
025Y - 030Y	171981.55	9762.66	3631.73	2783.64	2302.10	11493.16	0.00	201954.84
030Y & Over	239207.96	9054.03	3209.23	2249.37	1723.14	1855.22	7972.93	265271.87
Total	1599833.85	131846.31	55815.26	34471.96	21887.87	13348.38	7972.93	1865176.55

Zero exposed: 679256.95 Full Total: 2544433.51

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Zero Exposure Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989
15-19	2011.78	7802.43	2040.06	1350.12	955.33	1151.35	1167.91	1909.80	183.84	0.00
20-24	3796.20	61080.93	21270.87	11860.38	7218.37	8252.39	8983.06	12645.42	6861.96	183.14
25-29	2075.49	41984.42	70666.15	20005.37	12732.96	8979.05	11378.40	15686.29	16984.61	4944.68
30-34	1403.22	23102.77	44550.86	15514.54	8093.02	4306.39	4786.72	8356.60	10935.84	5514.14
35-39	958.04	15588.43	25164.18	9083.83	5196.56	2711.66	2584.97	4465.35	6034.16	3060.84
40-44	528.03	9523.49	16990.10	5991.73	3656.00	2442.87	2141.13	3208.35	4026.28	1771.40
45-49	259.62	4941.51	10079.67	3932.01	2389.45	1751.04	1912.47	2394.37	2830.26	1215.25
50-54	126.51	2417.35	5211.29	1951.08	1332.28	883.36	1133.96	1741.46	1937.29	843.66
55-59	48.41	1008.49	2406.90	940.59	477.01	361.59	436.61	768.90	1194.11	513.39
60-64	14.84	318.05	970.99	301.54	144.85	120.70	114.30	243.89	454.11	277.12
65-69	6.74	110.89	290.44	104.35	29.07	28.54	17.06	42.48	89.06	103.56
70-74	0.00	14.94	95.56	27.68	3.49	0.56	0.00	1.63	12.60	6.35
75-79	0.00	3.86	8.31	1.27	0.00	0.00	0.00	0.00	0.00	0.00
80-84	0.00	0.00	3.86	0.13	0.00	0.00	0.00	0.00	0.00	0.00
85+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	11228.88	167897.56	199749.24	71064.61	42228.38	30989.51	34656.59	51464.55	51544.10	18433.53

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Zero Exposure Group

AGES	1990-1994	1995+	TOTAL
15-19	0.00	0.00	18572.64
20-24	0.00	0.00	142152.72
25-29	0.00	0.00	205437.44
30-34	0.00	0.00	126564.10
35-39	0.00	0.00	74848.01
40-44	0.00	0.00	50279.38
45-49	0.00	0.00	31705.63
50-54	0.00	0.00	17578.23
55-59	0.00	0.00	8155.98
60-64	0.00	0.00	2960.38
65-69	0.00	0.00	822.20
70-74	0.00	0.00	162.81
75-79	0.00	0.00	13.44
80-84	0.00	0.00	3.98
85+	0.00	0.00	0.00
TOTAL	0.00	0.00	679256.95

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Exposure Greater Than Zero

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989
15-19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20-24	0.00	0.00	0.21	2.54	0.00	0.00	0.00	0.00	0.00	0.00
25-29	0.00	0.00	2003.88	7779.57	2032.17	1345.49	951.19	1146.55	1163.76	1901.59
30-34	0.00	0.00	3780.68	60848.64	21219.44	11809.34	7189.61	8211.25	8959.27	12606.38
35-39	0.00	0.00	2051.94	41655.76	72205.40	27611.60	14654.90	10268.88	12243.21	16753.17
40-44	0.00	0.00	1383.71	22828.85	47837.44	75506.72	28980.47	15952.14	11854.31	16405.51
45-49	0.00	0.00	942.23	15365.74	26754.63	49841.93	75930.34	29827.46	17027.17	14549.25
50-54	0.00	0.00	514.97	9309.19	17996.28	28076.06	49957.17	75804.30	30343.36	18810.06
55-59	0.00	0.00	254.18	4759.73	10653.10	18607.75	27839.66	49484.89	74777.15	31087.81
60-64	0.00	0.00	124.62	2309.56	5359.32	10618.83	18157.08	26863.30	48046.66	73280.65
65-69	0.00	0.00	45.70	928.38	2449.30	5162.84	9976.09	17076.16	25255.09	45686.57
70-74	0.00	0.00	13.04	290.62	921.68	2235.36	4643.97	8992.74	15384.05	23112.92
75-79	0.00	0.00	6.74	93.33	278.30	794.45	1870.86	3876.81	7745.94	13172.04
80-84	0.00	0.00	0.00	12.86	81.87	220.00	572.47	1435.24	3050.06	6172.14
85+	0.00	0.00	0.00	3.86	13.17	84.34	211.89	516.84	1336.64	2985.76
TOTAL	0.00	0.00	11121.91	166188.62	207802.09	231914.72	240935.70	249456.56	257186.67	276523.85

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Exposure Greater Than Zero

AGES	1990-1994	1995+	TOTAL			
15-19	0.00	0.00	0.00			
20-24	0.00	0.00	2.75			
25-29	182.48	0.00	18506.68			
30-34	6438.72	0.00	141063.34			
35-39	15000.77	0.00	212445.63			
40-44	15879.67	0.00	236628.82			
45-49	14185.82	0.00	244424.57			
50-54	12451.62	0.00	243263.02			
55-59	16050.32	0.00	233514.58			
60-64	26259.23	0.00	211019.25			
65-69	58234.64	0.00	164814.78			
70-74	31045.25	0.00	86639.62			
75-79	15475.41	0.00	43313.87			
80-84	8064.21	0.00	19608.85			
85+	4778.29	0.00	9930.78	1865176.55	1046.42	0.00

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number		Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
1		TUBERCULOSIS	21	33.0763	0.63*	0.3929	0.9706
	1	RESPIRATORY TUBERCULOSIS	13	27.5607	0.47**	0.2509	0.8067
	2	OTHER TUBERCULOSIS	8	5.5156	1.45	0.6245	2.8581
2		MN OF BUCCAL CAVITY AND PHARYNX	65	67.7733	0.96	0.7402	1.2224
	3	MN OF LIP	0	0.3424	0.00	0.0000	10.7784
	4	MN OF TONGUE	17	15.8521	1.07	0.6244	1.7171
	5	MN OF OTHER PARTS OF BUCCAL CAVITY	19	21.5466	0.88	0.5307	1.3771
	6	MN OF PHARYNX	29	30.0324	0.97	0.6466	1.3869
3		MN OF DIGESTIVE ORGANS AND PERITONEUM	798	1161.5245	0.69**	0.6402	0.7364
	7	MN OF ESOPHAGUS	43	51.1782	0.84	0.6080	1.1318
	8	MN OF STOMACH	82	124.6462	0.66**	0.5232	0.8166
	9	MN OF INTESTINE EXCEPT RECTUM	350	507.0782	0.69**	0.6198	0.7665
	10	MN OF RECTUM	60	92.9591	0.65**	0.4925	0.8308
	11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	62	89.2964	0.69**	0.5323	0.8901
	12	MN OF LIVER NOT SPECIFIED	23	29.6203	0.78	0.4921	1.1652
	13	MN OF PANCREAS	172	243.7391	0.71**	0.6041	0.8194
	14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE	6	23.0071	0.26**	0.0952	0.5676
4		MN OF RESPIRATORY SYSTEM	853	971.0358	0.88**	0.8205	0.9394
	15	MN OF LARYNX	15	18.1263	0.83	0.4628	1.3650
	16	MN OF TRACHEA, BRONCHUS, AND LUNG	830	941.5430	0.88**	0.8226	0.9436
	17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	8	11.3665	0.70	0.3031	1.3869
5		MN OF BREAST	828	1072.4458	0.77**	0.7204	0.8265
	18	MN OF BREAST	828	1072.4458	0.77**	0.7204	0.8265

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
6	MN OF FEMALE GENITAL ORGANS	478	688.2724	0.69**	0.6336	0.7596
19	MN OF CERVIX UTERI	130	174.9686	0.74**	0.6208	0.8822
20	MN OF OTHER AND UNSPECIFIED PARTS OF UTERUS	88	151.2360	0.58**	0.4667	0.7169
21	MN OF OVARY, FALLOPIAN TUBE, AND BROAD LIGAMENT	250	341.6647	0.73**	0.6438	0.8283
22	MN OF OTHER FEMALE GENITAL ORGANS	10	20.4032	0.49*	0.2346	0.9014
7	MN OF MALE GENITAL ORGANS	0	0.0008	0.00	0.0000	4854.5430
23	MN OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
24	MN OF OTHER MALE GENITAL ORGANS	0	0.0008	0.00	0.0000	4854.5430
8	MN OF URINARY ORGANS	112	137.2835	0.82*	0.6717	0.9817
25	MN OF KIDNEY	70	79.6366	0.88	0.6852	1.1106
26	MN OF BLADDER AND OTHER URINARY ORGANS	42	57.6470	0.73*	0.5250	0.9848
9	MN OF OTHER AND UNSPECIFIED SITES	460	588.1116	0.78**	0.7123	0.8570
27	MN OF SKIN	70	66.2531	1.06	0.8236	1.3349
28	MN OF EYE	4	3.4919	1.15	0.3121	2.9297
29	MN OF BRAIN AND OTHER PARTS OF NERVOUS SYSTEM	94	125.1328	0.75**	0.6070	0.9193
30	MN OF THYROID GLAND	11	14.5308	0.76	0.3774	1.3546
31	MN OF BONE	9	11.7564	0.77	0.3493	1.4533
32	MN OF CONNECTIVE TISSUE AND SOFT TISSUE	20	28.1271	0.71	0.4341	1.0982
33	MN OF OTHER AND UNSPECIFIED SITES (MINOR)	252	338.8195	0.74**	0.6548	0.8415
10	NEOPLASMS OF LYMPHATIC AND HEMATOPOIETIC TISSUE	336	420.1059	0.80**	0.7166	0.8901
34	LYMPHOSARCOMA AND RETICULOSARCOMA	49	55.9761	0.88	0.6476	1.1573
35	HODGKIN'S DISEASE	21	24.6925	0.85	0.5262	1.3001
36	LEUKEMIA AND ALEUKEMIA	116	151.8475	0.76**	0.6312	0.9163
37	OTHER NEOPLASMS OF LYMPHATIC HEMATOPOIETIC TISSUE	150	187.5898	0.80**	0.6768	0.9383

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
11	BENIGN AND UNSPECIFIED NEOPLASMS	48	78.5487	0.61**	0.4505	0.8102
38	BENIGN NEOPLASMS OF THE EYE, BRAIN, AND OTHER PARTS OF	10	15.5890	0.64	0.3071	1.1798
39	NEOPLASMS OF EYE, BRAIN, & OTHER PARTS OF NERV SYSTEM U	19	29.8188	0.64	0.3834	0.9951
40	OTHER BENIGN AND UNSPECIFIED NATURE NEOPLASMS	19	33.1409	0.57*	0.3450	0.8953
12	DIABETES MELLITUS	268	454.8097	0.59**	0.5208	0.6642
41	DIABETES MELLITUS	268	454.8097	0.59**	0.5208	0.6642
13	DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS	47	65.8960	0.71*	0.5240	0.9485
42	PERNICIOUS ANEMIAS	1	1.8196	0.55	0.0139	3.0532
43	ANEMIAS OF OTHER AND UNSPECIFIED TYPE	19	27.7615	0.68	0.4119	1.0688
44	COAGULATION DEFECTS, PURPURA, AND OTHER HEMORRHAGIC CON	13	16.9536	0.77	0.4079	1.3113
45	ALL OTHER DISEASES OF BLOOD FORMING ORGANS	14	19.3613	0.72	0.3950	1.2133
14	MENTAL, PSYCHONEUROTIC, AND PERSONALITY DISORDERS	162	118.2826	1.37**	1.1668	1.5975
46	ALCOHOLISM	27	30.6304	0.88	0.5808	1.2826
47	OTHER MENTAL DISORDERS	135	87.6522	1.54**	1.2913	1.8230
15	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	114	261.4144	0.44**	0.3597	0.5239
48	MULTIPLE SCLEROSIS	18	35.5415	0.51**	0.3000	0.8005
49	OTHER DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	96	225.8729	0.43**	0.3443	0.5190
16	DISEASES OF THE HEART	3568	5328.7427	0.67**	0.6478	0.6919
50	RHEUMATIC HEART DISEASE, INCLUDING FEVER	129	183.1942	0.70**	0.5879	0.8367
51	ISCHEMIC HEART DISEASE	2890	3831.3442	0.75**	0.7271	0.7823
52	CHRONIC DISEASE OF ENDOCARDIUM	14	68.6597	0.20**	0.1114	0.3421
53	OTHER MYOCARDIAL DEGENERATION	15	41.1566	0.36**	0.2038	0.6012
54	HYPERTENSION WITH HEART DISEASE	72	234.1486	0.31**	0.2406	0.3872
55	OTHER DISEASES OF THE HEART	448	970.2391	0.46**	0.4200	0.5065

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
17	OTHER DISEASES OF CIRCULATORY SYSTEM	1487	1902.9523	0.78**	0.7422	0.8222
56	HYPERTENSION WITHOUT HEART DISEASE	51	76.8135	0.66**	0.4943	0.8730
57	CEREBROVASCULAR DISEASE	1081	1375.1538	0.79**	0.7399	0.8344
58	DISEASES OF THE ARTERIES, VEINS, AND PULMONARY CIRCULAT	355	450.9850	0.79**	0.7074	0.8735
18	DISEASES OF THE RESPIRATORY SYSTEM	969	1116.7955	0.87**	0.8139	0.9241
59	ACUTE RESPIRATORY INFECTIONS EXCEPT INFLUENZA AND PNEUM	8	7.1576	1.12	0.4813	2.2024
60	INFLUENZA	13	18.3359	0.71	0.3771	1.2125
61	PNEUMONIA (EXCEPT NEWBORN)	340	402.5481	0.84**	0.7572	0.9393
62	CHRONIC AND UNSPECIFIED BRONCHITIS	35	32.1778	1.09	0.7575	1.5128
63	EMPHYSEMA	110	120.9023	0.91	0.7477	1.0966
64	ASTHMA	28	50.6636	0.55**	0.3672	0.7988
65	PNEUMOCONIOSES AND OTHER RESPIRATORY DISEASES	435	485.0103	0.90*	0.8146	0.9853
19	DISEASES OF THE DIGESTIVE SYSTEM	589	774.9519	0.76**	0.6999	0.8240
66	DISEASES OF THE STOMACH AND DUODENUM	54	68.2745	0.79	0.5941	1.0320
67	HERNIA AND INTESTINAL OBSTRUCTION	42	58.2543	0.72*	0.5196	0.9746
68	CIRRHOSIS OF THE LIVER	267	331.7663	0.80**	0.7111	0.9073
69	OTHER DISEASES OF DIGESTIVE SYSTEM	226	316.6568	0.71**	0.6237	0.8131
20	DISEASES OF THE GENITO-URINARY SYSTEM	224	298.7249	0.75**	0.6549	0.8548
70	ACUTE GLOMERULONEPHRITIS, NEPHROTIC SYNDROME, & ACUTE R	11	24.4993	0.45**	0.2238	0.8034
71	CHRONIC & UNSPEC. NEPHRITIS, RENAL FAILURE, & OTHER REN	51	128.8750	0.40**	0.2946	0.5203
72	INFECTION OF KIDNEY	32	39.0858	0.82	0.5599	1.1558
73	CALCULI OF URINARY SYSTEM	5	6.6176	0.76	0.2445	1.7653
74	HYPERPLASIA OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
75	OTHER DISEASES OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	0.0000
76	DISEASES OF THE BREAST	0	0.5939	0.00	0.0000	6.2137

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	10	11.5634	0.86	0.4140	1.5905
78	OTHER GENITO-URINARY SYSTEM DISEASES	115	87.4900	1.31**	1.0852	1.5778
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	23	29.7376	0.77	0.4901	1.1606
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	5	6.3275	0.79	0.2557	1.8463
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	18	23.4101	0.77	0.4555	1.2153
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TI	91	84.2908	1.08	0.8692	1.3255
81	ARTHRITIS AND SPONDYLITIS	33	32.2017	1.02	0.7053	1.4392
82	OSTEOMYELITIS AND PERIOSTITIS	1	2.8391	0.35	0.0089	1.9568
83	OTHER DISEASES OF MS SYSTEM	57	49.2500	1.16	0.8765	1.4995
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	285	164.1875	1.74**	1.5401	1.9495
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	285	164.1875	1.74**	1.5401	1.9495
24	ACCIDENTS	441	484.7073	0.91*	0.8269	0.9988
85	TRANSPORTATION ACCIDENTS	223	230.5848	0.97	0.8443	1.1027
86	ACCIDENTAL POISONING	24	32.2512	0.74	0.4767	1.1073
87	ACCIDENTAL FALLS	69	85.2497	0.81	0.6297	1.0244
88	OTHER ACCIDENTS	110	107.4675	1.02	0.8412	1.2337
89	MEDICAL COMPLICATIONS AND MISADVENTURE	15	29.1541	0.51**	0.2878	0.8487
25	VIOLENCE	221	232.1709	0.95	0.8305	1.0860
90	SUICIDE	157	175.3460	0.90	0.7608	1.0469
91	HOMICIDE	64	56.8249	1.13	0.8673	1.4382
26	OTHER CAUSES	619	370.1821	1.67**	1.5430	1.8092
92	OTHER CAUSES	619	370.1821	1.67**	1.5430	1.8092

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
	All Cancers	3930	5106.5527	0.77**	0.7457	0.7940
	All Deaths	13107	16906.0254	0.78**	0.7621	0.7887

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

APPENDIX III TABLE 21: POOLED SMRS, 20 YEARS INDUCTION TIME

PC LIFE TABLE ANALYSIS SYSTEM

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==============================================================================
                       G L O B A L   P A R A M E T E R S
STUDY PARAMETER FILE NAME: c:\ltas\all.ltp
LAST COMPLETE STEP: Stratify
STUDY DESCRIPTION: all
STUDY BEGIN DATE: 01/01/1940
STUDY END DATE: 01/01/1994
RATES IN USE: Standard U.S. Deaths 92 Minors 1940 - 99
AGE CATEGORIES: 15\20\25\30\35\40\45\50\55\60\65\70\75\80\85\
CALENDAR CATEGORIES: 1940\1945\1950\1955\1960\1965\1970\1975\1980\1985\1990\1995\
SINGLE CAUSE OF DEATH
==============================================================================
                       V E R I F Y   P A R A M E T E R S
INPUT DEMOGRAPHICS FILE: c:\ltas\all\dem
INPUT WORK HISTORY FILE: c:\ltas\all\wh
OUTPUT DEMOGRAPHICS FILE: c:\ltas\demout1.txt
OUTPUT WORK HISTORY FILE: c:\ltas\whout1.txt
BEGIN PERSON TIME AT LATER OF In-rec / Rate begin
STOP SURVIVORS PERSON TIME AT: END OF STUDY
GENDER/RACE SUBSETTING: KEEP ALL
EXPOSURE LEVEL: All exposed equally (no data)

SUMMARY REPORT FILE: .\summary.rpt
EXCEPTIONS REPORT FILE: .\except.rpt
EXPOSURE REPORT FILE: .\experr.rpt
==============================================================================
                      S T R A T I F Y   P A R A M E T E R S
ANALYSIS TYPE: SMR
```

DURATION	TIME SINCE FIRST EXPOSURE
MINIMUM->000Y	000Y
005Y	005Y
010Y	010Y
015Y	015Y
020Y	020Y
025Y	025Y
030Y	030Y

LAG PERIOD: 20 Years
PERSON YEARS FILE: C:\LTAS\ALLPY
OBSERVED DEATHS FILE: C:\LTAS\ALLOB

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	274674.43	0.00	0.00	0.00	0.00	0.00	0.00	274674.43
005Y - 010Y	205698.67	45415.01	0.00	0.00	0.00	0.00	0.00	251113.68
010Y - 015Y	189619.72	11905.68	26135.88	0.00	0.00	0.00	0.00	227661.29
015Y - 020Y	172069.44	9767.20	3633.40	16586.35	0.00	0.00	0.00	202056.39
020Y - 025Y	144423.03	6284.03	2227.66	1598.53	8236.38	0.00	0.00	162769.62
025Y - 030Y	94097.26	2747.11	973.90	644.12	403.06	2880.42	0.00	101745.87
030Y & Over	599.79	18.35	6.00	5.46	1.48	1.73	22.03	654.84
Total	1081182.33	76137.37	32976.85	18834.47	8640.91	2882.15	22.03	1220676.10

Zero exposed: 1323757.40 Full Total: 2544433.51

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Zero Exposure Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	2011.78	7802.43	2040.06	1350.12	955.33	1151.35	1167.91	1909.80	183.84	0.00	0.00
20-24	3796.20	61080.93	21271.08	11862.92	7218.37	8252.39	8983.06	12645.42	6861.96	183.14	0.00
25-29	2075.49	41984.42	72670.03	27784.94	14765.13	10324.54	12329.59	16832.84	18148.38	6846.27	182.48
30-34	1403.22	23102.77	48331.55	76363.18	29312.25	16113.20	11976.33	16567.85	19895.10	18120.52	6438.72
35-39	958.04	15588.43	27216.12	50739.59	75411.58	22595.52	15231.20	13399.06	17334.46	18674.89	14169.02
40-44	528.03	9523.49	18373.81	28820.57	47754.07	17827.97	10156.42	7482.59	8769.93	10061.23	8723.78
45-49	259.62	4941.51	11021.90	19297.75	27125.95	10687.53	7000.71	5060.74	5397.39	5647.38	4747.16
50-54	126.51	2417.35	5726.26	11260.27	17978.91	6725.60	4708.06	4131.37	4033.44	4009.03	3257.19
55-59	48.41	1008.49	2661.07	5700.31	10217.40	4160.35	2751.76	2468.08	3054.78	2843.47	2263.09
60-64	14.84	318.05	1095.61	2611.09	5035.37	1977.06	1388.76	1090.77	1530.79	1974.94	1516.47
65-69	6.74	110.89	336.15	1032.73	2244.27	893.29	450.25	375.37	484.70	827.30	917.76
70-74	0.00	14.94	108.60	318.30	820.62	262.32	129.12	104.22	118.26	237.83	306.89
75-79	0.00	3.86	15.05	94.60	235.76	74.97	22.38	23.84	16.95	42.14	61.43
80-84	0.00	0.00	3.86	12.99	71.95	22.40	1.50	0.00	0.00	1.63	7.52
85+	0.00	0.00	0.00	3.86	9.79	1.04	0.00	0.00	0.00	0.00	0.00
TOTAL	11228.88	167897.56	210871.15	237253.23	239156.75	101069.54	76297.04	82091.97	85830.00	69469.77	42591.52

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Zero Exposure Group

AGES	1995+	TOTAL			
15-19	0.00	18572.64			
20-24	0.00	142155.47			
25-29	0.00	223944.12			
30-34	0.00	267624.70			
35-39	0.00	271317.91			
40-44	0.00	168021.89			
45-49	0.00	101187.63			
50-54	0.00	64373.99			
55-59	0.00	37177.22			
60-64	0.00	18553.75			
65-69	0.00	7679.46			
70-74	0.00	2421.11			
75-79	0.00	590.98			
80-84	0.00	121.85			
85+	0.00	14.69	1323757.40	1	0.00

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Exposure Greater Than Zero

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20-24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25-29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30-34	0.00	0.00	0.00	0.00	0.21	2.54	0.00	0.00	0.00	0.00	0.00
35-39	0.00	0.00	0.00	0.00	1990.38	7727.74	2008.67	1335.17	942.92	1139.12	831.74
40-44	0.00	0.00	0.00	0.00	3739.37	60121.63	20965.19	11677.90	7110.66	8115.68	7155.89
45-49	0.00	0.00	0.00	0.00	2018.13	40905.45	70842.10	27161.09	14460.04	10117.12	9438.66
50-54	0.00	0.00	0.00	0.00	1349.65	22233.82	46383.07	73414.38	28247.21	15644.69	9194.43
55-59	0.00	0.00	0.00	0.00	912.71	14808.98	25524.50	47785.71	72916.47	28757.73	13787.24
60-64	0.00	0.00	0.00	0.00	468.80	8762.48	16882.63	26016.42	46969.97	71582.83	24742.76
65-69	0.00	0.00	0.00	0.00	234.09	4298.09	9542.90	16743.27	24859.45	44962.83	57316.88
70-74	0.00	0.00	0.00	0.00	104.55	1973.60	4514.85	8890.15	15278.39	22881.44	30738.35
75-79	0.00	0.00	0.00	0.00	42.53	719.48	1848.48	3852.97	7728.99	13129.90	15413.98
80-84	0.00	0.00	0.00	0.00	9.92	197.59	570.97	1435.24	3050.06	6170.51	8056.69
85+	0.00	0.00	0.00	0.00	3.38	83.30	211.89	516.84	1336.64	2985.76	4778.29
TOTAL	0.00	0.00	0.00	0.00	10873.73	161834.69	199295.24	218829.14	222900.78	225487.62	181454.90

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Exposure Greater Than Zero

AGES	1995+	TOTAL			
15-19	0.00	0.00			
20-24	0.00	0.00			
25-29	0.00	0.00			
30-34	0.00	2.75			
35-39	0.00	15975.73			
40-44	0.00	118886.31			
45-49	0.00	174942.58			
50-54	0.00	196467.26			
55-59	0.00	204493.35			
60-64	0.00	195425.88			
65-69	0.00	157957.52			
70-74	0.00	84381.33			
75-79	0.00	42736.33			
80-84	0.00	19490.99			
85+	0.00	9916.09	1220676.10	1	0.00

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number		Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
1		TUBERCULOSIS	14	16.2231	0.86	0.4714	1.4480
	1	RESPIRATORY TUBERCULOSIS	7	12.3316	0.57	0.2274	1.1696
	2	OTHER TUBERCULOSIS	7	3.8915	1.80	0.7206	3.7064
2		MN OF BUCCAL CAVITY AND PHARYNX	61	60.5635	1.01	0.7704	1.2938
	3	MN OF LIP	0	0.3084	0.00	0.0000	11.9668
	4	MN OF TONGUE	15	14.1535	1.06	0.5927	1.7481
	5	MN OF OTHER PARTS OF BUCCAL CAVITY	17	19.2261	0.88	0.5148	1.4158
	6	MN OF PHARYNX	29	26.8755	1.08	0.7225	1.5498
3		MN OF DIGESTIVE ORGANS AND PERITONEUM	736	1035.4730	0.71**	0.6604	0.7640
	7	MN OF ESOPHAGUS	43	46.8754	0.92	0.6638	1.2357
	8	MN OF STOMACH	70	105.2260	0.67**	0.5186	0.8405
	9	MN OF INTESTINE EXCEPT RECTUM	322	454.8298	0.71**	0.6327	0.7897
	10	MN OF RECTUM	55	78.9252	0.70**	0.5249	0.9071
	11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	58	79.6206	0.73*	0.5531	0.9417
	12	MN OF LIVER NOT SPECIFIED	21	25.4269	0.83	0.5110	1.2625
	13	MN OF PANCREAS	164	224.2744	0.73**	0.6236	0.8521
	14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	3	20.2947	0.15**	0.0305	0.4322
4		MN OF RESPIRATORY SYSTEM	813	911.3207	0.89**	0.8318	0.9556
	15	MN OF LARYNX	14	16.6027	0.84	0.4606	1.4149
	16	MN OF TRACHEA, BRONCHUS, AND LUNG	792	884.8767	0.90**	0.8338	0.9596
	17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	7	9.8414	0.71	0.2850	1.4656
5		MN OF BREAST	739	908.2588	0.81**	0.7560	0.8745
	18	MN OF BREAST	739	908.2588	0.81**	0.7560	0.8745

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
6	MN OF FEMALE GENITAL ORGANS	404	558.0085	0.72**	0.6551	0.7982
19	MN OF CERVIX UTERI	96	117.3378	0.82	0.6627	0.9991
20	MN OF OTHER AND UNSPECIFIED PARTS OF UTERUS	78	129.3911	0.60**	0.4765	0.7524
21	MN OF OVARY, FALLOPIAN TUBE, AND BROAD LIGAMENT	221	293.4379	0.75**	0.6571	0.8593
22	MN OF OTHER FEMALE GENITAL ORGANS	9	17.8417	0.50*	0.2302	0.9576
7	MN OF MALE GENITAL ORGANS	0	0.0007	0.00	0.0000	4957.2427
23	MN OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
24	MN OF OTHER MALE GENITAL ORGANS	0	0.0007	0.00	0.0000	4957.2427
8	MN OF URINARY ORGANS	102	124.5927	0.82*	0.6675	0.9938
25	MN OF KIDNEY	63	71.9251	0.88	0.6730	1.1207
26	MN OF BLADDER AND OTHER URINARY ORGANS	39	52.6676	0.74	0.5265	1.0123
9	MN OF OTHER AND UNSPECIFIED SITES	406	513.7979	0.79**	0.7152	0.8709
27	MN OF SKIN	57	54.6028	1.04	0.7906	1.3525
28	MN OF EYE	3	2.8934	1.04	0.2138	3.0317
29	MN OF BRAIN AND OTHER PARTS OF NERVOUS SYSTEM	76	104.7956	0.73**	0.5714	0.9077
30	MN OF THYROID GLAND	11	12.4724	0.88	0.4397	1.5782
31	MN OF BONE	8	9.0520	0.88	0.3805	1.7415
32	MN OF CONNECTIVE TISSUE AND SOFT TISSUE	13	24.6679	0.53*	0.2803	0.9012
33	MN OF OTHER AND UNSPECIFIED SITES (MINOR)	238	305.3138	0.78**	0.6836	0.8851
10	NEOPLASMS OF LYMPHATIC AND HEMATOPOIETIC TISSUE	288	366.4151	0.79**	0.6978	0.8822
34	LYMPHOSARCOMA AND RETICULOSARCOMA	39	44.4779	0.88	0.6234	1.1987
35	HODGKIN'S DISEASE	14	16.0636	0.87	0.4761	1.4624
36	LEUKEMIA AND ALEUKEMIA	96	129.2568	0.74**	0.6016	0.9070
37	OTHER NEOPLASMS OF LYMPHATIC HEMATOPOIETIC TISSUE	139	176.6169	0.79**	0.6616	0.9293

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
11	BENIGN AND UNSPECIFIED NEOPLASMS	38	62.4077	0.61**	0.4308	0.8358
38	BENIGN NEOPLASMS OF THE EYE, BRAIN, AND OTHER PARTS OF NERVOUS SYS	7	12.0177	0.58	0.2334	1.2002
39	NEOPLASMS OF EYE, BRAIN, & OTHER PARTS OF NERV SYSTEM UNSPECIF. NA	17	24.6394	0.69	0.4017	1.1047
40	OTHER BENIGN AND UNSPECIFIED NATURE NEOPLASMS	14	25.7505	0.54*	0.2970	0.9123
12	DIABETES MELLITUS	252	406.8473	0.62**	0.5453	0.7008
41	DIABETES MELLITUS	252	406.8473	0.62**	0.5453	0.7008
13	DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS	43	57.3976	0.75	0.5421	1.0091
42	PERNICIOUS ANEMIAS	1	1.4089	0.71	0.0180	3.9431
43	ANEMIAS OF OTHER AND UNSPECIFIED TYPE	16	23.9379	0.67	0.3818	1.0855
44	COAGULATION DEFECTS, PURPURA, AND OTHER HEMORRHAGIC CONDITIONS	12	14.6684	0.82	0.4222	1.4291
45	ALL OTHER DISEASES OF BLOOD FORMING ORGANS	14	17.3824	0.81	0.4400	1.3514
14	MENTAL, PSYCHONEUROTIC, AND PERSONALITY DISORDERS	157	106.9487	1.47**	1.2473	1.7164
46	ALCOHOLISM	25	23.8579	1.05	0.6779	1.5469
47	OTHER MENTAL DISORDERS	132	83.0908	1.59**	1.3292	1.8839
15	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	100	230.1356	0.43**	0.3535	0.5285
48	MULTIPLE SCLEROSIS	15	26.7592	0.56*	0.3135	0.9246
49	OTHER DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	85	203.3763	0.42**	0.3338	0.5168
16	DISEASES OF THE HEART	3356	4862.5879	0.69**	0.6670	0.7139
50	RHEUMATIC HEART DISEASE, INCLUDING FEVER	109	128.6782	0.85	0.6955	1.0218
51	ISCHEMIC HEART DISEASE	2728	3537.3323	0.77**	0.7425	0.8007
52	CHRONIC DISEASE OF ENDOCARDIUM	14	64.0462	0.22**	0.1194	0.3668
53	OTHER MYOCARDIAL DEGENERATION	11	22.6112	0.49*	0.2425	0.8705
54	HYPERTENSION WITH HEART DISEASE	65	181.3741	0.36**	0.2766	0.4568
55	OTHER DISEASES OF THE HEART	429	928.5458	0.46**	0.4193	0.5079

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
17	OTHER DISEASES OF CIRCULATORY SYSTEM	1356	1696.6461	0.80**	0.7572	0.8429
56	HYPERTENSION WITHOUT HEART DISEASE	47	64.4245	0.73*	0.5360	0.9702
57	CEREBROVASCULAR DISEASE	982	1220.2762	0.80**	0.7552	0.8567
58	DISEASES OF THE ARTERIES, VEINS, AND PULMONARY CIRCULATION	327	411.9455	0.79**	0.7101	0.8847
18	DISEASES OF THE RESPIRATORY SYSTEM	923	1033.3610	0.89**	0.8365	0.9527
59	ACUTE RESPIRATORY INFECTIONS EXCEPT INFLUENZA AND PNEUMONIA	4	5.8784	0.68	0.1854	1.7403
60	INFLUENZA	13	14.7014	0.88	0.4704	1.5122
61	PNEUMONIA (EXCEPT NEWBORN)	316	363.0524	0.87*	0.7771	0.9719
62	CHRONIC AND UNSPECIFIED BRONCHITIS	32	29.5886	1.08	0.7396	1.5268
63	EMPHYSEMA	107	114.1229	0.94	0.7684	1.1330
64	ASTHMA	26	40.6006	0.64*	0.4182	0.9384
65	PNEUMOCONIOSES AND OTHER RESPIRATORY DISEASES	425	465.4167	0.91	0.8284	1.0042
19	DISEASES OF THE DIGESTIVE SYSTEM	508	654.2505	0.78**	0.7104	0.8470
66	DISEASES OF THE STOMACH AND DUODENUM	45	58.4195	0.77	0.5618	1.0307
67	HERNIA AND INTESTINAL OBSTRUCTION	33	48.1748	0.69*	0.4714	0.9620
68	CIRRHOSIS OF THE LIVER	227	268.7975	0.84*	0.7382	0.9618
69	OTHER DISEASES OF DIGESTIVE SYSTEM	203	278.8589	0.73**	0.6313	0.8353
20	DISEASES OF THE GENITO-URINARY SYSTEM	189	252.8972	0.75**	0.6446	0.8618
70	ACUTE GLOMERULONEPHRITIS, NEPHROTIC SYNDROME, & ACUTE RENAL FAILUR	10	21.3216	0.47*	0.2245	0.8626
71	CHRONIC & UNSPEC. NEPHRITIS, RENAL FAILURE, & OTHER RENAL SCLEROSI	39	108.5531	0.36**	0.2554	0.4912
72	INFECTION OF KIDNEY	19	27.5896	0.69	0.4144	1.0755
73	CALCULI OF URINARY SYSTEM	3	4.6479	0.65	0.1331	1.8873
74	HYPERPLASIA OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
75	OTHER DISEASES OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	0.0000
76	DISEASES OF THE BREAST	0	0.5320	0.00	0.0000	6.9364

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	7	6.7047	1.04	0.4183	2.1512
78	OTHER GENITO-URINARY SYSTEM DISEASES	111	83.5483	1.33**	1.0929	1.6000
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	18	24.6651	0.73	0.4323	1.1534
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	5	5.5551	0.90	0.2913	2.1030
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	13	19.1100	0.68	0.3619	1.1634
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE	84	75.6571	1.11	0.8856	1.3746
81	ARTHRITIS AND SPONDYLITIS	33	29.2350	1.13	0.7769	1.5853
82	OSTEOMYELITIS AND PERIOSTITIS	1	2.5899	0.39	0.0098	2.1451
83	OTHER DISEASES OF MS SYSTEM	50	43.8322	1.14	0.8466	1.5039
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	260	137.3703	1.89**	1.6696	2.1373
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	260	137.3703	1.89**	1.6696	2.1373
24	ACCIDENTS	341	362.0120	0.94	0.8446	1.0474
85	TRANSPORTATION ACCIDENTS	163	157.3868	1.04	0.8828	1.2074
86	ACCIDENTAL POISONING	15	22.5891	0.66	0.3714	1.0953
87	ACCIDENTAL FALLS	59	74.4447	0.79	0.6033	1.0223
88	OTHER ACCIDENTS	94	82.3622	1.14	0.9223	1.3967
89	MEDICAL COMPLICATIONS AND MISADVENTURE	10	25.2292	0.40**	0.1898	0.7290
25	VIOLENCE	161	154.3823	1.04	0.8880	1.2170
90	SUICIDE	114	119.6252	0.95	0.7861	1.1448
91	HOMICIDE	47	34.7570	1.35*	0.9935	1.7982
26	OTHER CAUSES	567	306.4020	1.85**	1.7013	2.0093
92	OTHER CAUSES	567	306.4020	1.85**	1.7013	2.0093

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper
	All Cancers	3549	4478.4307	0.79**	0.7666	0.8190
	All Deaths	11916	14918.6230	0.80**	0.7845	0.8132

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

APPENDIX III TABLE 22: POOLED SMRS, 30 YEARS INDUCTION TIME

PC LIFE TABLE ANALYSIS SYSTEM

G L O B A L   P A R A M E T E R S

STUDY PARAMETER FILE NAME: c:\ltas\all.ltp
LAST COMPLETE STEP: Stratify
STUDY DESCRIPTION: all
STUDY BEGIN DATE: 01/01/1940
STUDY END DATE: 01/01/1994
RATES IN USE: Standard U.S. Deaths 92 Minors 1940 - 99
AGE CATEGORIES: 15\20\25\30\35\40\45\50\55\60\65\70\75\80\85\
CALENDAR CATEGORIES: 1940\1945\1950\1955\1960\1965\1970\1975\1980\1985\1990\1995\
SINGLE CAUSE OF DEATH

V E R I F Y   P A R A M E T E R S

INPUT DEMOGRAPHICS FILE: c:\ltas\all\dem
INPUT WORK HISTORY FILE: c:\ltas\all\wh
OUTPUT DEMOGRAPHICS FILE: c:\ltas\demout1.txt
OUTPUT WORK HISTORY FILE: c:\ltas\whout1.txt
BEGIN PERSON TIME AT LATER OF In-rec / Rate begin
STOP SURVIVORS PERSON TIME AT: END OF STUDY
GENDER/RACE SUBSETTING: KEEP ALL
EXPOSURE LEVEL: All exposed equally (no data)

SUMMARY REPORT FILE: .\summary.rpt
EXCEPTIONS REPORT FILE: .\except.rpt
EXPOSURE REPORT FILE: .\experr.rpt

S T R A T I F Y   P A R A M E T E R S

ANALYSIS TYPE: SMR

DURATION	TIME SINCE FIRST EXPOSURE
MINIMUM->000Y	000Y
005Y	005Y
010Y	010Y
015Y	015Y
020Y	020Y
025Y	025Y
030Y	030Y

LAG PERIOD: 30 Years
PERSON YEARS FILE: C:\LTAS\ALLPY
OBSERVED DEATHS FILE: C:\LTAS\ALLOB

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Entire Exposed Study Group

Duration of Exposure

TSFE	000Y 005Y	005Y 010Y	010Y 015Y	015Y 020Y	020Y 025Y	025Y 030Y	030Y & Over	Total
000Y - 005Y	227250.66	0.00	0.00	0.00	0.00	0.00	0.00	227250.66
005Y - 010Y	172392.18	29973.29	0.00	0.00	0.00	0.00	0.00	202365.47
010Y - 015Y	144439.69	6285.96	12066.96	0.00	0.00	0.00	0.00	162792.61
015Y - 020Y	94168.48	2749.72	974.79	3931.43	0.00	0.00	0.00	101824.42
020Y - 025Y	599.79	18.35	6.00	5.46	25.23	0.00	0.00	654.84
025Y - 030Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
030Y & Over	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	638850.80	39027.32	13047.75	3936.90	25.23	0.00	0.00	694888.00

Zero exposed: 1849545.51 Full Total: 2544433.51

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Zero Exposure Group

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	2011.78	7802.43	2040.06	1350.12	955.33	1151.35	1167.91	1909.80	183.84	0.00	0.00
20-24	3796.20	61080.93	21271.08	11862.92	7218.37	8252.39	8983.06	12645.42	6861.96	183.14	0.00
25-29	2075.49	41984.42	72670.03	27784.94	14765.13	10324.54	12329.59	16832.84	18148.38	6846.27	182.48
30-34	1403.22	23102.77	48331.55	76363.18	29312.46	16115.73	11976.33	16567.85	19895.10	18120.52	6438.72
35-39	958.04	15588.43	27216.12	50739.59	77401.96	30323.26	17239.87	14734.23	18277.38	19814.01	15000.77
40-44	528.03	9523.49	18373.81	28820.57	51493.44	77949.60	31121.39	19157.95	15880.59	18176.91	15879.67
45-49	259.62	4941.51	11021.90	19297.75	29144.08	51592.97	75892.14	24648.37	17890.69	14459.17	13411.07
50-54	126.51	2417.35	5726.26	11260.27	19328.56	28959.42	47446.57	19079.69	11901.66	8209.55	6799.90
55-59	48.41	1008.49	2661.07	5700.31	11130.11	18969.34	26346.72	11010.19	7957.37	5432.87	4229.16
60-64	14.84	318.05	1095.61	2611.09	5504.17	10739.53	17022.14	6581.49	4905.82	4234.58	3100.27
65-69	6.74	110.89	336.15	1032.73	2478.36	5191.39	9181.81	3849.23	2622.50	2406.52	2297.11
70-74	0.00	14.94	108.60	318.30	925.17	2235.92	4255.27	1706.36	1224.58	1008.61	1050.11
75-79	0.00	3.86	15.05	94.60	278.30	794.45	1695.19	686.77	383.29	327.63	325.59
80-84	0.00	0.00	3.86	12.99	81.87	220.00	509.14	173.04	98.31	84.56	67.76
85+	0.00	0.00	0.00	3.86	13.17	84.34	187.24	55.81	17.02	21.85	9.22
TOTAL	11228.88	167897.56	210871.15	237253.23	250030.48	262904.23	265354.38	149639.06	126248.50	99326.20	68791.83

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Zero Exposure Group

AGES	1995+	TOTAL			
15-19	0.00	18572.64			
20-24	0.00	142155.47			
25-29	0.00	223944.12			
30-34	0.00	267627.44			
35-39	0.00	287293.65			
40-44	0.00	286905.45			
45-49	0.00	262559.28			
50-54	0.00	161255.74			
55-59	0.00	94494.04			
60-64	0.00	56127.60			
65-69	0.00	29513.45			
70-74	0.00	12847.88			
75-79	0.00	4604.72			
80-84	0.00	1251.54			
85+	0.00	392.51	1849545.51	1	0.00

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Exposure Greater Than Zero

AGES	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994
15-19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20-24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25-29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30-34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
35-39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40-44	0.00	0.00	0.00	0.00	0.00	0.00	0.21	2.54	0.00	0.00	0.00
45-49	0.00	0.00	0.00	0.00	0.00	0.00	1950.67	7573.46	1966.73	1305.32	774.75
50-54	0.00	0.00	0.00	0.00	0.00	0.00	3644.56	58466.07	20378.98	11444.18	5651.72
55-59	0.00	0.00	0.00	0.00	0.00	0.00	1929.54	39243.60	68013.89	26168.33	11821.16
60-64	0.00	0.00	0.00	0.00	0.00	0.00	1249.24	20525.69	43594.94	69323.19	23158.97
65-69	0.00	0.00	0.00	0.00	0.00	0.00	811.33	13269.40	22721.65	43383.61	55937.53
70-74	0.00	0.00	0.00	0.00	0.00	0.00	388.69	7288.01	14172.07	22110.66	29995.13
75-79	0.00	0.00	0.00	0.00	0.00	0.00	175.67	3190.04	7362.65	12844.41	15149.82
80-84	0.00	0.00	0.00	0.00	0.00	0.00	63.33	1262.20	2951.75	6087.58	7996.45
85+	0.00	0.00	0.00	0.00	0.00	0.00	24.65	461.03	1319.61	2963.91	4769.07
TOTAL	0.00	0.00	0.00	0.00	0.00	0.00	10237.90	151282.05	182482.28	195631.19	155254.59

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

PC LIFE TABLE ANALYSIS SYSTEM

Distribution of Person Years
Study File: ALL.LTP

Race = Combined Gender = Combined
Exposure Greater Than Zero

AGES	1995+	TOTAL
15-19	0.00	0.00
20-24	0.00	0.00
25-29	0.00	0.00
30-34	0.00	0.00
35-39	0.00	0.00
40-44	0.00	2.75
45-49	0.00	13570.93
50-54	0.00	99585.51
55-59	0.00	147176.52
60-64	0.00	157852.04
65-69	0.00	136123.53
70-74	0.00	73954.56
75-79	0.00	38722.59
80-84	0.00	18361.30
85+	0.00	9538.27
TOTAL	0.00	694888.00

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
1	TUBERCULOSIS	7	7.9975	0.88	0.3507	1.8035
1	RESPIRATORY TUBERCULOSIS	3	5.8834	0.51	0.1051	1.4910
2	OTHER TUBERCULOSIS	4	2.1141	1.89	0.5156	4.8391
2	MN OF BUCCAL CAVITY AND PHARYNX	42	45.1664	0.93	0.6701	1.2570
3	MN OF LIP	0	0.2371	0.00	0.0000	15.5647
4	MN OF TONGUE	11	10.4782	1.05	0.5233	1.8785
5	MN OF OTHER PARTS OF BUCCAL CAVITY	10	14.4160	0.69	0.3321	1.2758
6	MN OF PHARYNX	21	20.0351	1.05	0.6486	1.6023
3	MN OF DIGESTIVE ORGANS AND PERITONEUM	557	797.9456	0.70**	0.6413	0.7585
7	MN OF ESOPHAGUS	29	36.8610	0.79	0.5268	1.1299
8	MN OF STOMACH	50	76.3803	0.65**	0.4858	0.8631
9	MN OF INTESTINE EXCEPT RECTUM	245	351.9503	0.70**	0.6117	0.7890
10	MN OF RECTUM	38	56.3191	0.67*	0.4774	0.9261
11	MN OF BILIARY PASSAGES, LIVER, AND GALL BLADDER	42	61.5263	0.68*	0.4919	0.9228
12	MN OF LIVER NOT SPECIFIED	17	18.8389	0.90	0.5254	1.4449
13	MN OF PANCREAS	134	180.0919	0.74**	0.6234	0.8813
14	MN OF PERITONEUM AND OTHER AND UNSPECIFIED OF DIGESTIVE ORGANS	2	15.9779	0.13**	0.0152	0.4519
4	MN OF RESPIRATORY SYSTEM	695	760.3404	0.91*	0.8474	0.9846
15	MN OF LARYNX	12	13.0679	0.92	0.4739	1.6042
16	MN OF TRACHEA, BRONCHUS, AND LUNG	679	740.2314	0.92*	0.8496	0.9889
17	MN OF OTHER PARTS OF RESPIRATORY SYSTEM	4	7.0412	0.57	0.1548	1.4529
5	MN OF BREAST	544	635.4852	0.86**	0.7856	0.9311
18	MN OF BREAST	544	635.4852	0.86**	0.7856	0.9311

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
6	MN OF FEMALE GENITAL ORGANS	262	379.7848	0.69**	0.6088	0.7787
19	MN OF CERVIX UTERI	44	61.4749	0.72*	0.5200	0.9609
20	MN OF OTHER AND UNSPECIFIED PARTS OF UTERUS	51	96.1916	0.53**	0.3947	0.6971
21	MN OF OVARY, FALLOPIAN TUBE, AND BROAD LIGAMENT	159	208.5435	0.76**	0.6485	0.8906
22	MN OF OTHER FEMALE GENITAL ORGANS	8	13.5748	0.59	0.2538	1.1613
7	MN OF MALE GENITAL ORGANS	0	0.0006	0.00	0.0000	6356.7617
23	MN OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
24	MN OF OTHER MALE GENITAL ORGANS	0	0.0006	0.00	0.0000	6356.7617
8	MN OF URINARY ORGANS	83	98.7775	0.84	0.6692	1.0417
25	MN OF KIDNEY	51	56.5932	0.90	0.6709	1.1849
26	MN OF BLADDER AND OTHER URINARY ORGANS	32	42.1843	0.76	0.5188	1.0709
9	MN OF OTHER AND UNSPECIFIED SITES	321	390.8444	0.82**	0.7339	0.9162
27	MN OF SKIN	44	38.7822	1.13	0.8243	1.5231
28	MN OF EYE	2	1.9544	1.02	0.1239	3.6944
29	MN OF BRAIN AND OTHER PARTS OF NERVOUS SYSTEM	57	75.5910	0.75*	0.5711	0.9770
30	MN OF THYROID GLAND	10	9.1513	1.09	0.5231	2.0097
31	MN OF BONE	6	5.7091	1.05	0.3838	2.2876
32	MN OF CONNECTIVE TISSUE AND SOFT TISSUE	7	19.2139	0.36**	0.1460	0.7507
33	MN OF OTHER AND UNSPECIFIED SITES (MINOR)	195	240.4424	0.81**	0.7012	0.9332
10	NEOPLASMS OF LYMPHATIC AND HEMATOPOIETIC TISSUE	219	284.3120	0.77**	0.6716	0.8793
34	LYMPHOSARCOMA AND RETICULOSARCOMA	23	25.8560	0.89	0.5637	1.3348
35	HODGKIN'S DISEASE	6	8.5979	0.70	0.2548	1.5190
36	LEUKEMIA AND ALEUKEMIA	71	98.2085	0.72**	0.5646	0.9119
37	OTHER NEOPLASMS OF LYMPHATIC HEMATOPOIETIC TISSUE	119	151.6496	0.78**	0.6500	0.9390

----- Value too large   * Two-Sided P < 0.05   ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
11	BENIGN AND UNSPECIFIED NEOPLASMS	29	44.5752	0.65*	0.4356	0.9344
38	BENIGN NEOPLASMS OF THE EYE, BRAIN, AND OTHER PARTS OF NERVOUS SYS	6	8.1461	0.74	0.2690	1.6032
39	NEOPLASMS OF EYE, BRAIN, & OTHER PARTS OF NERV SYSTEM UNSPECIF. NA	12	17.6252	0.68	0.3514	1.1894
40	OTHER BENIGN AND UNSPECIFIED NATURE NEOPLASMS	11	18.8039	0.58	0.2916	1.0468
12	DIABETES MELLITUS	200	315.8801	0.63**	0.5484	0.7272
41	DIABETES MELLITUS	200	315.8801	0.63**	0.5484	0.7272
13	DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS	35	44.7931	0.78	0.5442	1.0867
42	PERNICIOUS ANEMIAS	1	0.9169	1.09	0.0276	6.0589
43	ANEMIAS OF OTHER AND UNSPECIFIED TYPE	12	18.5089	0.65	0.3346	1.1326
44	COAGULATION DEFECTS, PURPURA, AND OTHER HEMORRHAGIC CONDITIONS	11	11.5377	0.95	0.4753	1.7060
45	ALL OTHER DISEASES OF BLOOD FORMING ORGANS	11	13.8296	0.80	0.3965	1.4233
14	MENTAL, PSYCHONEUROTIC, AND PERSONALITY DISORDERS	140	90.2703	1.55**	1.3046	1.8301
46	ALCOHOLISM	15	13.5935	1.10	0.6171	1.8201
47	OTHER MENTAL DISORDERS	125	76.6768	1.63**	1.3570	1.9424
15	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	75	186.1542	0.40**	0.3169	0.5050
48	MULTIPLE SCLEROSIS	9	15.5875	0.58	0.2635	1.0961
49	OTHER DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	66	170.5667	0.39**	0.2992	0.4923
16	DISEASES OF THE HEART	2711	3882.1265	0.70**	0.6723	0.7251
50	RHEUMATIC HEART DISEASE, INCLUDING FEVER	74	74.3983	0.99	0.7810	1.2487
51	ISCHEMIC HEART DISEASE	2181	2759.7891	0.79**	0.7575	0.8242
52	CHRONIC DISEASE OF ENDOCARDIUM	13	58.8828	0.22**	0.1174	0.3776
53	OTHER MYOCARDIAL DEGENERATION	7	7.8313	0.89	0.3581	1.8418
54	HYPERTENSION WITH HEART DISEASE	43	139.2102	0.31**	0.2235	0.4161
55	OTHER DISEASES OF THE HEART	393	842.0150	0.47**	0.4217	0.5152

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
17	OTHER DISEASES OF CIRCULATORY SYSTEM	1033	1296.7648	0.80**	0.7488	0.8467
56	HYPERTENSION WITHOUT HEART DISEASE	35	50.9896	0.69*	0.4780	0.9547
57	CEREBROVASCULAR DISEASE	738	921.8769	0.80**	0.7438	0.8604
58	DISEASES OF THE ARTERIES, VEINS, AND PULMONARY CIRCULATION	260	323.8983	0.80**	0.7081	0.9065
18	DISEASES OF THE RESPIRATORY SYSTEM	777	877.0289	0.89**	0.8247	0.9505
59	ACUTE RESPIRATORY INFECTIONS EXCEPT INFLUENZA AND PNEUMONIA	4	4.0291	0.99	0.2705	2.5390
60	INFLUENZA	8	9.3769	0.85	0.3674	1.6812
61	PNEUMONIA (EXCEPT NEWBORN)	254	296.6033	0.86*	0.7543	0.9684
62	CHRONIC AND UNSPECIFIED BRONCHITIS	24	22.4405	1.07	0.6850	1.5914
63	EMPHYSEMA	84	92.0772	0.91	0.7276	1.1295
64	ASTHMA	18	30.3003	0.59*	0.3519	0.9389
65	PNEUMOCONIOSES AND OTHER RESPIRATORY DISEASES	385	422.2016	0.91	0.8231	1.0077
19	DISEASES OF THE DIGESTIVE SYSTEM	369	454.6754	0.81**	0.7309	0.8988
66	DISEASES OF THE STOMACH AND DUODENUM	34	42.5933	0.80	0.5527	1.1155
67	HERNIA AND INTESTINAL OBSTRUCTION	24	34.5298	0.70	0.4452	1.0342
68	CIRRHOSIS OF THE LIVER	149	161.6544	0.92	0.7797	1.0822
69	OTHER DISEASES OF DIGESTIVE SYSTEM	162	215.8979	0.75**	0.6392	0.8752
20	DISEASES OF THE GENITO-URINARY SYSTEM	165	199.2876	0.83*	0.7064	0.9644
70	ACUTE GLOMERULONEPHRITIS, NEPHROTIC SYNDROME, & ACUTE RENAL FAILUR	10	18.0415	0.55	0.2654	1.0194
71	CHRONIC & UNSPEC. NEPHRITIS, RENAL FAILURE, & OTHER RENAL SCLEROSI	35	89.2840	0.39**	0.2730	0.5452
72	INFECTION OF KIDNEY	9	13.2853	0.68	0.3091	1.2861
73	CALCULI OF URINARY SYSTEM	3	2.7547	1.09	0.2245	3.1843
74	HYPERPLASIA OF PROSTATE	0	0.0000	0.00	0.0000	0.0000
75	OTHER DISEASES OF MALE GENITAL ORGANS	0	0.0000	0.00	0.0000	0.0000
76	DISEASES OF THE BREAST	0	0.3922	0.00	0.0000	9.4073

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
77	DISEASES OF THE FEMALE GENITAL ORGANS	5	3.0350	1.65	0.5331	3.8491
78	OTHER GENITO-URINARY SYSTEM DISEASES	103	72.4948	1.42**	1.1597	1.7231
21	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	14	19.2710	0.73	0.3968	1.2190
79	INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE	4	4.4608	0.90	0.2443	2.2934
80	OTHER DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	10	14.8103	0.68	0.3232	1.2418
22	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE	64	58.3704	1.10	0.8444	1.4002
81	ARTHRITIS AND SPONDYLITIS	27	23.1130	1.17	0.7696	1.6997
82	OSTEOMYELITIS AND PERIOSTITIS	1	2.2175	0.45	0.0114	2.5053
83	OTHER DISEASES OF MS SYSTEM	36	33.0398	1.09	0.7630	1.5085
23	SYMPTOMS AND ILL-DEFINED CONDITIONS	205	95.7401	2.14**	1.8581	2.4553
84	SYMPTOMS AND ILL-DEFINED CONDITIONS	205	95.7401	2.14**	1.8581	2.4553
24	ACCIDENTS	221	225.2343	0.98	0.8561	1.1195
85	TRANSPORTATION ACCIDENTS	87	87.0842	1.00	0.8002	1.2323
86	ACCIDENTAL POISONING	10	11.6136	0.86	0.4122	1.5836
87	ACCIDENTAL FALLS	48	55.6239	0.86	0.6362	1.1442
88	OTHER ACCIDENTS	70	52.9423	1.32*	1.0307	1.6705
89	MEDICAL COMPLICATIONS AND MISADVENTURE	6	17.9704	0.33**	0.1219	0.7267
25	VIOLENCE	94	76.7429	1.22	0.9898	1.4990
90	SUICIDE	68	58.8678	1.16	0.8970	1.4644
91	HOMICIDE	26	17.8750	1.45	0.9499	2.1313
26	OTHER CAUSES	448	240.7849	1.86**	1.6923	2.0411
92	OTHER CAUSES	448	240.7849	1.86**	1.6923	2.0411

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Summary of Observed and Expected Deaths
Study File: ALL.LTP
Comparison Rates in use: Standard U.S. Deaths 92 Minors 1940 - 99
Race = Combined Gender = Combined
Exposure Greater Than Zero

Category Number	Cause	Observed Deaths	Expected Deaths	Ratio	95% Confidence Limits Lower	Upper
	All Cancers	2723	3392.6565	0.80**	0.7727	0.8333
	All Deaths	9310	11508.3574	0.81**	0.7926	0.8256

----- Value too large * Two-Sided P < 0.05 ** Two-Sided P < 0.01

Appendix IV: Table 1[1]

Characteristics of Hanford Males

	n	%	Person-Years	Mean Year of Hire
	31,480	100	775,194	1957
Entire cohort				
Race	30,306	96	757,779	1957
White	1,174	4	17,413	1970
Nonwhite				
Age at hire	24,299	77	623,983	1958
<40	7,168	23	151,084	1956
40+				
Occupational class	14,267	45	307,275	1963
Professional/technical	2,057	7	51,764	1957
Clerical	13,118	42	360,124	1953
Skilled manual	2,038	6	56,017	1952
Unskilled manual				

1 Baillargeon, Wilkiinson, Rudkin et al, 1998.

Appendix IV: Table 2[1]

Characteristics of Hanford Females

	n	%	Person-Years	Mean Year of Hire
Entire cohort	12,668	100	334,242	1959
Race				
White	12,047	95	312,583	1958
Nonwhite	619	5	9,614	1971
Age at hire				
<40	11,100	88	294,756	1959
40+	1,565	12	39,102	1957
Occupational class				
Professional/technical	3,072	24	75,880	1961
Clerical	8,349	66	214,208	1960
Skilled manual	592	5	12,294	1965
Unskilled manual	647	5	19,194	1953

1 Baillargeon, Wilkiinson, Rudkin et al, 1998.

Appendix IV: Table 3[1]

Hanford Males: SMRs According to Years Since Entering Follow-Up*

	Overall	0-9 Years	10-19 Years	20-29 Years	30+ Years
Entire cohort	0.84 (0.82-0.86)	0.66 (0.62-0.70)	0.81 (0.79-0.83)	0.83 (0.80-0.86)	0.95 (0.92-0.98)
Race	0.84 (0.82-0.86)	0.66 (0.62-0.70)	0.80 (0.76-0.84)	0.84 (0.81-0.87)	0.95 (0.92-0.98)
White	0.58 (0.48-0.71)	0.40 (0.28-0.58)	0.64 (0.46-0.89)	0.53 (0.33-0.85)	0.76 (0.48-1.18)
Nonwhite					
Age at hire	0.81 (0.78-0.84)	0.65 (0.59-0.72)	0.76 (0.70-0.82)	0.72 (0.68-0.72)	0.97 (0.93-1.01)
<40	0.86 (0.83-0.89)	0.67 (0.62-0.73)	0.84 (0.79-0.89)	0.96 (0.91-1.00)	0.91 (0.85-0.97)
40+					
Occupational class	0.64 (0.61-0.67)	0.55 (0.49-0.62)	0.59 (0.53-0.66)	0.59 (0.54-0.65)	0.79 (0.73-0.86)
Professional/technical	0.93 (0.85-1.02)	1.00 (0.99-1.00)	0.88 (0.73-1.06)	0.90 (0.77-1.05)	1.00 (1.00-1.01)
Clerical	0.90 (0.83-0.98)	0.72 (0.66-0.78)	0.88 (0.87-0.93)	0.91 (0.87-0.95)	0.99 (0.95-1.03)
Skilled manual	0.92 (0.86-0.98)	0.57 (0.47-0.69)	0.91 (0.80-1.03)	1.00 (0.99-1.00)	1.10 (0.97-1.25)
Unskilled manual					

1 Baillargeon, Wilkiinson, Rudkin et al, 1998.

*95% Confidence intervals are presented for each estimate in parentheses.

Appendix IV: Table 4[1]

Hanford Females: SMRs According to Years Since Entering Follow-Up*

	Overall	0-9 Years	10-19 Years	20-29 Years	30+ Years
Entire cohort	0.81 (0.77-0.85)	0.57 (0.47-0.69)	0.74 (0.64-0.85)	0.89 (0.81-0.98)	0.84 (0.77-0.91)
Race	0.81 (0.77-0.86)	0.59 (0.49-0.71)	0.73 (0.63-0.84)	0.89 (0.81-0.98)	0.84 (0.77-0.91)
White	0.50 (0.32-0.79)	0.14 (0.04-0.47)	0.58 (0.27-1.29)	0.94 (0.44-2.02)	0.74 (0.28-1.97)
Nonwhite					
Age at hire	0.87 (0.78-0.97)	0.63 (0.50-0.80)	0.81 (0.67-0.97)	0.99 (0.97-1.01)	0.92 (0.83-1.01)
<40	0.78 (0.71-0.85)	0.53 (0.39-0.71)	0.70 (0.57-0.86)	0.91 (0.79-1.05)	0.81 (0.71-0.93)
40+					
Occupational class	0.79 (0.71-0.88)	0.62 (0.43-0.89)	0.69 (0.52-0.92)	0.89 (0.74-1.06)	0.80 (0.68-0.94)
Professional/technical	0.82 (0.76-0.88)	0.70 (0.56-0.87)	0.79 (0.67-0.94)	0.89 (0.80-0.99)	0.81 (0.71-0.92)
Clerical	0.70 (0.55-0.89)	0.33 (0.13-0.84)	0.44 (0.22-0.90)	0.70 (0.46-1.07)	0.97 (0.67-1.39)
Skilled manual	0.88 (0.77-1.01)	0.42 (0.24-0.74)	0.91 (0.66-1.24)	1.00 (1.00-1.01)	0.89 (0.72-1.11)
Unskilled manual					

1 Baillargeon, Wilkiinson, Rudkin et al, 1998.

*95% Confidence intervals are presented for each estimate in parentheses.

Appendix IV: Table 5[1]

SMRs for All Causes of Death in Male Hanford Workers According to Duration of Employment

	Overall	0-9 Years	10-19 Years	20-29 Years	30+ Years
Entire cohort	0.84 (0.82-0.86)	0.85 (0.83-0.87)	0.82 (0.78-0.86)	0.84 (0.79-0.89)	0.75 (0.67-0.85)
Race	0.84 (0.82-0.86)	0.85 (0.83-0.87)	0.82 (0.78-0.86)	0.84 (0.79-0.89)	0.75 (0.67-0.85)
White	0.58 (0.47-0.71)	0.55 (0.43-0.69)	0.74 (0.46-1.19)	0.93 (0.81-1.06)	0.50 (0.04-6.28)
Nonwhite					
Age at hire	0.81 (0.78-0.84)	0.85 (0.82-0.88)	0.67 (0.61-0.74)	0.80 (0.74-0.86)	0.74 (0.65-0.84)
<40	0.86 (0.83-0.89)	0.84 (0.81-0.87)	0.90 (0.84-0.96)	0.93 (0.81-1.06)	0.50 (0.12-1.94)
40+					
Occupational class	0.64 (0.61-0.67)	0.66 (0.62-0.70)	0.55 (0.48-0.63)	0.63 (0.54-0.73)	0.55 (0.43-0.70)
Professional	0.91 (0.88-0.93)	0.93 (0.90-0.96)	0.90 (0.84-0.95)	0.90 (0.84-0.97)	0.84 (0.73-0.97)
Nonprofessional					

1 Baillargeon and Wilkinson, 1999.

*95% Confidence intervals are presented for each estimate in parentheses.

Appendix IV: Table 6[1]

SMRs for All Causes of Death in Female Hanford Workers According to Duration of Employment

	Overall	0-9 Years	10-19 Years	20-29 Years	30+ Years
Entire cohort	0.84 (0.80-0.88)	0.85 (0.81-0.89)	0.82 (0.73-0.91)	0.84 (0.73-0.97)	0.75 (0.48-1.17)
Race					
White	0.84 (0.80-0.88)	0.85 (0.81-0.89)	0.82 (0.73-0.92)	0.84 (0.73-0.97)	0.75 (0.48-1.16)
Nonwhite	0.58 (0.41-0.83)	0.55 (0.35-0.86)	0.33 (0.05-2.17)	0.00	--
Age at hire					
<40	0.81 (0.73-0.89)	0.85 (0.77-0.93)	0.67 (0.39-1.15)	0.80 (0.55-1.16)	0.74 (0.46-1.17)
40+	0.86 (0.82-0.91)	0.84 (0.77-0.91)	0.90 (0.84-0.96)	0.61 (0.39-0.95)	0.00
Occupational class					
Professional	0.79 (0.71-0.88)	0.78 (0.69-0.88)	0.74 (0.55-1.00)	0.97 (0.70-1.34)	0.80 (0.30-2.13)
Nonprofessional	0.82 (0.77-0.87)	0.84 (0.78-0.98)	0.83 (0.70-0.98)	0.60 (0.34-1.40)	0.69 (0.34-1.40)

1 Baillargeon and Wilkinson, 1999.

*95% Confidence intervals are presented for each estimate in parentheses.

K

APPENDIX K. Table K-1: Relation between NIOSH 92 death categories and International Classification of Disease (ICD) groupings

Major	Minor	NIOSH 92 Death Categories TITLE	5th Revision 1940-1948	6th Revision 1949	6th, 7th Rev. 1950-1967	8th Revision 1968-1978	9th Revision 1979-
01		Tuberculosis					
	01	Respiratory Tuberculosis	013	001- 008	001- 008	010- 012	010- 012
	02	Other Tuberculosis	014- 022	010- 019	010- 019	013- 019	013- 018
02		Malignant Neoplasms (Mn) of Buccal Cavity and Pharynx					
	03	Mn of Lip	045A	140	140	140	140
	04	Mn of Tongue	045B	141	141	141	141
	05	Mn of Other Parts of Buccal Cavity	045C,E	142- 144	142- 144	142- 145	142- 145
	06	Mn of Pharynx	045F	145- 148	145- 148	146- 149	146- 149
03		Mn of Digestive Organs and Peritoneum					
	07	Mn of Esophagus	046A	150	150	150	150
	08	Mn of Stomach	046B	151	151	151	151
	09	Mn of Intestine Except Rectum	046C,E	152, 153	152, 153	152, 153	152, 153
	10	Mn of Rectum	046D	154	154	154	154
	11	Mn of Biliary Passages and Liver	046F	155, 156, 156A, 156.1	155	155, 156	155.0, 155.1, 156
	12	Mn of Liver Not Specified	No rates	No rates	156, 156A, 156.1	197.8	155.2
	13	Mn of Pancreas	046G	157	157	157	157
	14	Mn of Peritoneum and Unspecified of Digestive Organs	046H,M	158, 159	158, 159	158, 159	158, 159
04		Mn of Respiratory System					
	15	Mn of Larynx	047A	161	161	161	161
	16	Mn of Trachea, Bronchus, and Lung	047B- F	162, 163	162, 163	162	162
	17	Mn of Other Parts of Respiratory System	No rates	No rates	160, 164	160, 163	160, 163-165
05		Mn of Breast					
	18	Mn of Breast	050	170	170	174	174- 175
06		Mn of Female Genital Organs					
	19	Mn of Cervix Uteri	No rates	No rates	171	180	180
	20	Mn of Other Parts of Uterus	048	172- 174	172- 174	181, 182	179, 181, 182
	21	Mn of Ovary, Fallopian Tube, and Broad Ligament	049A,B	175	175	183	183
06		Mn of Female Genital Organs					
	22	Mn of Other Female Genital Organs	049C- E	176	176	184	184
07		Mn of Male Genital Organs					

Major	Minor	NIOSH 92 Death Categories TITLE	5th Revision 1940-1948	6th Revision 1949	6th, 7th Rev. 1950-1967	8th Revision 1968-1978	9th Revision 1979-
	23	Mn of Prostate	051B	177	177	185	185
	24	Mn of Other Male Genital Organs	051A, 051C- E	178- 179	178- 179	172.5, 173.5, 186, 187	186, 187
08		Mn of Urinary Organs					
	25	Mn of Kidney	052A	180	180	189.0- 189.2	189.0- 189.2
	26	Mn of Bladder and Other Urinary Organs	052B,C	181	181	188, 189.9	188, 189.3- 189.9
09		Mn of Other and Unspecified Sites					
	27	Mn of Skin	053	190, 191	190, 191	172.0- 172.4, 172.6- 172.9, 173.0- 173.4, 173.6- 173.9,	172, 173
	28	Mn of Eye	No rates	No rates	192	190	190
	29	Mn of Brain and Other Parts of Nervous System	054	193	193	191, 192	191, 192
	30	Mn of Thyroid Gland	No rates	No rates	194	193	193
	31	Mn of Bone	No rates	No rates	196	170	170
	32	Mn of Connective Tissue	No rates	No rates	197	171	171
	33	Mn of Other and Unspecified Sites (Minor)	045D, 055	156B, 156.2, 160, 164, 165, 192, 194- 203, 205	156B, 156.2, 165, 195, 198, 199	194- 196, 197.0- 197.7, 197.9, 198, 199	194- 199
10		Neoplasms of Lymphatic and Hematopoietic Tissue					
	34	Lymphosarcoma and Reticulosarcoma	No rates	No rates	200	200	200
	35	Hodgkin's Disease	No rates	No rates	201	201	201
	36	Leukemia and Aleukemia	074	204	204	204- 207	204- 208
	37	Other Neoplasms of Lymphatic and Hematopoietic Tissue	No Rates	No rates	202, 203, 205	202, 203	202, 203
11		Benign and Unspecified Neoplasms of the Brain					
	38	Benign Neoplasms of the Eye, Brain, and Other Parts of Nervous System	056D	223	223	224, 225	224, 225
11		Benign and Unspecified Neoplasms of the Brain					

Major	Minor	NIOSH 92 Death Categories TITLE	5th Revision 1940-1948	6th Revision 1949	6th, 7th Rev. 1950-1967	8th Revision 1968-1978	9th Revision 1979-
	39	Neoplasms of Unspecified Nature of Eye, Brain, and Other Parts of Nervous System	057D	237	237	238, 743.4	237.5-237.9, 239.6-239.7
	40	Other Benign and Unspecified Nature Neoplasms	056A- C, 056, 057A- C, 057	210- 222, 224- 236, 238- 239	210- 222, 224- 236, 238- 239	208, 210-223, 226- 237, 239	210-223, 226-237.4, 238.0-239.5, 239.8-239.9
12		Diabetes Mellitus					
	41	Diabetes Mellitus	061	260	260	250	250
13		Diseases of the Blood and Blood Forming Organs					
	42	Pernicious Anemias	073A	290	290	281.0, 281.9	281.1, 281.9
	43	Anemias of Other and Unspecified Type	073B- D	291- 293	291- 293	280, 281.1-281.4, 282- 285	280, 281.1-281.8, 282- 285
	44	Coagulation Defects, Purpura and Other Hemorrhagic Conditions	072	296	296	286, 287	286, 287
	45	All Other Diseases of Blood Forming Organs	075, 076	294, 295, 297- 299	294, 295, 297- 299	209, 288, 289	288, 289
14		Mental, Psychoneurotic, and Personality Disorders					
	46	Alcoholism	077	322	322	303	303
	47	Other Mental Disorders	079, 084	300- 321, 323- 326	300- 321, 323- 326	290- 302, 304- 315	290- 302, 304- 319
15		Disorders of the Nervous System and Sense Organs					
	48	Multiple Sclerosis	087	345	345	340	340
	49	Other Diseases of the Nervous System and Sense Organs	080- 082, 085- 086, 088, 089	340- 344, 350- 398	340- 344, 350- 398	320- 333, 341- 389	320- 337, 341- 389
16		Diseases of the Heart					
	50	Rheumatic Heart Disease, Including Fever	058, 090A, 092B-092C, 093C, 095B	400- 402, 410- 416	400- 402, 410- 416	390- 398	390- 398
	51	Ischemic Heart Disease	093D, 094	420	420	410- 414	410- 414
	52	Chronic Disease of Endocardium	091C, 092A, 092D, 092E	421	421	424	424
	53	Other Myocardial Degeneration	093B, 093E	422	422	428	429.0, 429.1

Major	Minor	NIOSH 92 Death Categories TITLE	5th Revision 1940-1948	6th Revision 1949	6th, 7th Rev. 1950-1967	8th Revision 1968-1978	9th Revision 1979-
	54	Hypertension with Heart Disease	131A	440- 443	440- 443	400.1, 400.9, 402, 404	402, 404
	55	Other Diseases of the Heart	090B, 091A, 091B, 093A, 095A,C	430- 434	430- 434	420- 423, 425- 427, 429	420- 423, 425- 428, 429.2- 424.9
17		Other Diseases of the Circulatory System					
	56	Hypertension without Heart Disease	102	444- 447	444- 447	400, 400.2,400 .3, 401, 403	401, 403, 405
	57	Cerebrovascular Disease	083	330- 334	330- 334	430- 438	430- 438
	58	Diseases of the Arteries, Veins, and Pulmonary Circulation	096- 101, 103	450- 468	450- 468	440- 444.1, 444.3- 458	415- 417, 440- 459
18		Diseases of the Respiratory System					
	59	Acute Respiratory Infections Except Influenza and Pneumonia	104, 105	470- 475, 500	470- 475, 500	460- 466	460- 466
	60	Influenza	033	480- 483	480- 483	470- 474	487
	61	Pneumonia (except newborn)	107- 109	490- 493	490- 493	480- 486	480- 486
	62	Chronic and Unspecified Bronchitis	106	501, 502	501, 502	490, 491	490, 491
	63	Emphysema	113	527.1	527.1	492	492
	64	Asthma	112	241	241	493	493
	65	Pneumoconiosis and Other Respiratory Diseases	110, 111, 114A- E	510- 527.0, 527.2	510- 527.0, 527.2	500- 519	470- 478, 494- 519
19		Diseases of the Digestive System					
	66	Diseases of the Stomach and Duodenum	117, 118	540, 541, 543	540, 541, 543	531- 537	531- 537
	67	Hernia and Intestinal Obstruction	122	560, 561, 570	560, 561, 570	550- 553, 560	550- 553, 560
	68	Cirrhosis of the Liver	124	581	581	571	571
	69	Other Diseases of Digestive System	115, 116, 119- 121, 123, 125- 129	530- 539, 542, 544, 545, 550- 553, 571- 578, 580, 582- 587	530- 539, 542, 544, 545, 550- 553, 571- 578, 580, 582- 587	444.2, 520- 530, 540- 543, 561- 570, 572- 577	520- 530, 540- 543, 555- 558, 562- 570, 572- 579
20		Diseases of the Genito-urinary System					

Major	Minor	NIOSH 92 Death Categories TITLE	5th Revision 1940-1948	6th Revision 1949	6th, 7th Rev. 1950-1967	8th Revision 1968-1978	9th Revision 1979-
	70	Acute Glomerulonephritis Nephrotic Syndrome and Acute Renal Failure	130	590	590, 591	580, 581	580, 581 584
	71	Chronic and Unspecified Nephritis and Renal Failure and Other Renal Sclerosis	131B, 132	592- 594	592- 594	582- 584	582, 583 585- 587
	72	Infection of Kidney	133	600	600	590	590
	73	Calculi of Urinary System	134	602, 604	602, 604	592, 594	592, 594
	74	Hyperplasia of Prostate	137	610	610	600	600
	75	Other Diseases of Male Genital Organs	138	611- 617	611- 617	601- 607	601- 608
	76	Diseases of the Breast	No rates	No rates	620, 621	610, 611	610, 611
	77	Diseases of the Female Genital Organs. (Contains breast disease prior to 1950)	139	620- 637	622- 637	612- 629	614- 629
	78	Other Genito- Urinary System Organs	135- 136	591, 601 603 605- 609	601, 603 605- 609	591, 593 595- 599	588, 589 591, 593 595- 599
21		Diseases of the Skin and Subcutaneous Tissue					
	79	Infections of the Skin and Subcutaneous Tissue	151- 152	690- 698	690- 698	680- 686	680- 686
	80	Other Diseases of the Skin and Subcutaneous Tissue	153	700- 716	700- 716	690- 708	690- 709
22		Disease of the Musculoskeletal System and Connective Tissue					
	81	Arthritis and Spondylitis	59	720- 727	720- 725	710- 715	711- 716 720, 721
	82	Osteomyelitis and Periostitis	154	730	730	720	730
	83	Other Diseases of MS System	155, 156	731- 749	731- 749 726- 727	716- 718 721- 738	710, 717- 719 722- 729 731- 739
23		Symptoms and Ill- defined Conditions					
	84	Symptoms and Ill- Defined Conditions	162, 199 200	780- 793 795	780- 793 795	780- 793 795, 796	780- 796, 798 799
24		Accidents					
	85	Transportation Accidents	169- 173	E800- E866	E800- E866	E800- E845 E940- E941	E800- E848 E929.0- E929.1

Major	Minor	NIOSH 92 Death Categories TITLE	5th Revision 1940-1948	6th Revision 1949	6th, 7th Rev. 1950-1967	8th Revision 1968-1978	9th Revision 1979-
	86	Accidental Poisoning	078, 178 179	E870- E895	E870- E895	E850- E877 E942	E850- E869 E929.2
	87	Accidental Falls	186A	E900- 904	E900- 904	E880- E887 E943	E880- E888 E929.3
	88	Other Accidents	174- 177 180- 185 186B- 194 195C- E	E910- E936 E960- E962	E910- E936 E960- E962	E890- E929 E944- E946	E890- E928 E929.4- E929.9
	89	Medical Complications and Misadventure	195A,B	E940- E959	E940- E959	E930- E936 E947- E949	E870- E879 E930- E949
25		Violence					
	90	Suicide	163, 164	E963 E970- E979	E963 E970- E979	E950- E959	E950- E959
	91	Homicide	165- 168 198	E964 E980- E985	E964 E980- E985	E960- E978	E960- E978
26		Other Causes					
	92	Other Causes	Residual and blank	Residual and blank	Residual and blank	Residual and blank	Residual and blank

L

APPENDIX L. Table L-1: Expanded NIOSH Death Categories: NIOSH 99

Major	Minor	Expanded NIOSH 99 Death Categories TITLE	6th, 7th Rev. 1950-1967	8th Revision 1968-1978	9th Revision 1979-
01		Tuberculosis			
	01	Respiratory Tuberculosis	001- 008	010- 012	010- 012
	02	Other Tuberculosis	010- 019	013- 019	013- 018
02		Malignant Neoplasms (Mn) of Buccal Cavity and Pharynx			
	03	Mn of Lip	140	140	140
	04	Mn of Tongue	141	141	141
	05	Mn of Other Parts of Buccal Cavity	142- 144	142- 145	142- 145
	06	Mn of Pharynx	145- 148	146- 149	146- 149
03		Mn of Digestive of Organs and Peritoneum			
	07	Mn of Esophagus	150	150	150
	08	Mn of Stomach	151	151	151
	09	Mn of Intestine Except Rectum	152, 153	152, 153	152, 153
	10	Mn of Rectum	154	154	154
	11	Mn of Biliary Passages, Liver, & Gall Bladder	155	155, 156	155.0, 155.1, 156
	12	Mn of Liver Not Specified	156A, 156.1	197.8	155.2
	13	Mn of Pancreas	157	157	157
	14	Mn of Peritoneum & Other & Unspecified of Digestive Organs	158, 159	158, 159	158, 159
04		Mn of Respiratory System			
	15	Mn of Larynx	161	161	161
	16	Mn of Trachea, Bronchus & Lung	162, 163	162	162
	17	Mn of Other Parts of Respiratory	160, 164	160, 163	160, 163-165
05		Mn of Breast			
	18	Mn of Breast	170	174	174- 175
06		Mn of Female Genital Organs			
	19	Mn of Cervix Uteri	171	180	180
	20	Mn of Other Unspecified Parts of Uterus	172, 174	181, 182	179, 181-182
	21	Mn of Ovary, Fallopian Tube, & Broad Ligament	175	183	183
	22	Mn of Other Female Genital Organs	176	184	184
07		Mn of Male Genital Organs			
	23	Mn of Prostate	177	185	185
	24	Mn of Testes	178	172.5, 173.5, 186	186
08		Mn of Urinary Organs			
	25	Mn of Kidney	180	189.0- 189.2	189.0- 189.2
	26	Mn of Bladder & Other Urinary Organs	181	188, 189.9	188, 189.3-189.9

Major	Minor	Expanded NIOSH 99 Death Categories TITLE	6th, 7th Rev. 1950-1967	8th Revision 1968-1978	9th Revision 1979-
09		Mn of Other and Unspecified Sites			
	27	Melanoma	190	172.0- 172.4, 172.6- 172.9	172
	28	Other Mn of Skin	191	173.0- 173.4, 173.6- 173.9	173
	29	Mn of Eye	192	190	190
	30	Mn of Brain & Other Parts of Nervous System	193	191, 192	191, 192
	31	Mn of Thyroid Gland	194	193	193
	32	Mn of Bone	196	170	170
	33	Mn of Connective Tissue	197	171	171
	34	Mn of Other & Unspecified Sites (Minor)	156B, 156.2, 165, 179, 195, 198, 199	187, 194- 196, 197.0- 197.7, 197.9, 198, 199	187, 194- 199
10		Neoplasms of Lymphatic and Hematopoietic Tissue			
	35	Non-Hodgkin's Lymphoma	200, 205	200, 202	200, 202
	36	Hodgkin's Disease	201	201	201
	37	Leukemia & Aleukemia	204	204- 207	204- 208
	38	Myeloma	202, 203	203	203
11		Benign and Unspecified Neoplasms of the Brain			
	39	Benign Neoplasms of the Eye, Brain, & Other Parts of Nervous System	223	224, 225	224, 225
	40	Neoplasms of Unspecified Nature of Eye, Brain & Other Parts of Nervous System	237	238, 743.4	237.5- 237.9, 239.6- 239.7
	41	Other Benign & Unspecified Nature Neoplasms	210- 222, 224- 236, 238- 239	208, 210- 223, 226- 237, 239	210- 223, 226- 237.4, 238.0- 239.5
12		Diabetes Mellitus			
	42	Diabetes Mellitus	260	250	250
13		Diseases of the Blood and Blood Forming Organs			
	43	Pernicious Anemias	290	281.0, 281.9	281.0, 281.9
	44	Anemias of Other & Unspecified Type	291- 293	280, 281.1- 281.4	280, 281.1- 281.8, 282- 285
13		Diseases of the Blood and Blood Forming Organs			
	45	Coagulation Defects, Purpura & Other Hemorrhagic Conditions	296	286, 287	286, 287
	46	All Other Disease of Blood Forming Organs	294, 295, 297- 299	209, 288, 289	288, 289
14		Mental Psychoneurotic and Personality Disorders			
	47	Alcoholism	322	303	303

Major	Minor	Expanded NIOSH 99 Death Categories TITLE	6th, 7th Rev. 1950-1967	8th Revision 1968-1978	9th Revision 1979-
	48	Other Mental Disorder	300- 321, 323- 326	290- 302, 304- 315	290- 302, 304- 319
15		Diseases of the Nervous System and Sense Organs			
	49	Multiple Sclerosis	345	340	340
	50	Other Diseases of the Nervous System & Sense Organs	340- 344, 350- 398	320- 333, 341- 389	320- 337, 341- 389
16		Diseases of the Heart			
	51	Rheumatic Heart Disease, Including Fever	400- 402, 410- 416	390- 398	390- 398
	52	Ischemic Heart Disease	420	410- 414	410- 414, 429.2
	53	Chronic Disease of Endocardium	421	424	424
	54	Other Myocardial Degeneration	422	428	429.0, 429.1
	55	Hypertension with Heart Disease	440- 443	400.1, 400.9, 402, 404	402, 404
	56	Cardiomyopathy*	no code	425	425
	57	Conductive Disorder	433- 433.2	427.3- 427.9	426, 427
	58	Other Disease of the Heart	430- 432, 433.3- 434.9	420- 423, 426- 427.2	420- 423, 428, 429
17		Other Diseases of the Circulatory System			
	59	Hypertension without Heart Disease	444- 447	400.0, 400.2, 400.3, 401, 403	401, 403, 405
	60	Cerebrovascular Disease	330- 334	430- 438	430- 438
	61	Diseases of the Arteries, Veins & Pulmonary Circulation	450- 468	440- 444.1, 444.3- 458	415- 417, 440- 459
18		Diseases of the Respiratory System			
	62	Acute Respiratory Infections Except Influenza & Pneumonia	470- 475, 500	460- 466	460- 466
	63	Influenza	480- 483	470- 474	487
	64	Pneumonia (except newborn)	490- 493	480- 486	480- 486
	65	Chronic & Unspecified Bronchitis	501, 502	490, 491	490, 491
	66	Emphysema	527.1	492	492
	67	Asthma	241	493	493
	68	Asbestosis	523.3	515.2	501
	69	Silicosis	523.0	515.0	502
	70	Other Pneumoconioses	523.1- 523.2, 523.4- 523.9	515.1, 515.3- 516.0	500, 503, 505
	71	Other Respiratory Diseases	510- 522, 524- 527.0, 527.2	500- 514, 516.1- 519	470- 478, 494- 499, 504, 506- 519

Major	Minor	Expanded NIOSH 99 Death Categories TITLE	6th, 7th Rev. 1950-1967	8th Revision 1968-1978	9th Revision 1979-
19		Diseases of the Digestive System			
	72	Diseases of the Stomach & Duodenum	540, 541, 543	531- 537	531- 537
	73	Hernia & Intestinal Obstruction	560, 561, 570	550- 553, 560	550- 553, 560
	74	Cirrhosis of the Liver	581	571	571
	75	Other Diseases of Digestive System	530- 539, 542, 544, 545, 550- 553, 571- 578, 580, 582- 587	444.2, 520- 530, 540- 543, 561- 570, 572- 577	520- 530, 540- 543, 555- 558, 562- 570, 572- 579
20		Diseases of the Genito- urinary System			
	76	Acute Glomerulonephritis Nephrotic Syndrome & Acute Renal Failure	590, 591	580, 581	580, 581, 584
	77	Chronic & Unspecified Nephritis & Renal Failure & Other Renal Sclerosis	592- 594	582- 584	582, 583, 585- 587
	78	Infection Kidney	600	590	590
	79	Calculi of Urinary System	602, 604	592, 594	592, 594
	80	Hyperplasia o Prostate	610	600	600
	81	Other Diseases of Male Genital Organs	611- 617	601- 607	601- 608
	82	Diseases of the Breast	620, 621	610, 611	610, 611
	83	Diseases of the Female Genital Organs	622- 637	612- 629	614- 629
	84	Other Genito- Urinary System Diseases	601, 603, 605- 609	591, 593, 595- 599	588, 589, 591, 593, 595- 599
21		Diseases of the Skin and Subcutaneous Tissue			
	85	Infections of the Skin & Subcutaneous Tissue	690- 698	680- 686	680- 686
	86	Other Diseases of the Skin &Subcutaneous Tissues	700- 716	690- 708	690- 709
22		Diseases of the Musculoskeletal System and Connective System			
	87	Arthritis & Spondylitis	720- 725	710- 715	711- 716, 720, 721
	88	Osteomyelitis & Periperiostitis	730	720	730
	89	Other Diseases of the MS System	726- 727	716- 718	710, 717- 719
23		Symptoms and Ill- defined Conditions			
	90	Symptoms & Ill- Defined Conditions	780- 793, 795	780- 793, 795, 796	780- 796, 798, 799
24		Accidents			
	91	Transportation Accidents	E800- E866	E800- E845, E940- E941	E800- E848, E929.0- E929.1

Major	Minor	Expanded NIOSH 99 Death Categories TITLE	6th, 7th Rev. 1950-1967	8th Revision 1968-1978	9th Revision 1979-
	92	Accidental Poisoning	E870- E895	E850- E877, E942	E800- E848, E929.0- E929.1
	93	Accidental Falls	E900- E904	E880- E887, E943	E880- E888, E929.3
	94	Other Accidents	E910- E936, E960- E962	E890- E929, E944- E946	E890- E928, E929.4- E929.9
	95	Medical Complications & Misadventure	E940- E959	E930- E936, E947- E949	E870- E879, E930- E949
25		Violence			
	96	Suicide	E963, E970- E979	E950- E959	E950- E959
	97	Homicide	E964, E980- E985	E960- E978	E960- E978
26		HIV-related			
	98	HIV-related	no code	no code	042- 044**
27		Other Causes			
	99	Other Causes	residual & blank	residual & blank	residual & blank

* NIOSH rates for 1965-1969 are an underestimate of actual rates, as only 2 years of data are available. However observed should conform to expected, absent any exposure effect. No rates are available prior to 1965.

** NIOSH rates for 1975-1979 are an underestimate, as data are available fr only 1979. However observed should conform to expected, absent any exposure effect. No rates are available prior to 1975.

Characteristics of the Healthy Survivor Effect Among Male and Female Hanford Workers

Jacques Baillargeon, PhD,[1*] and Gregg S. Wilkinson, PhD[2]

Background: *The healthy survivor effect is a selection process whereby healthy workers are selectively retained in the work force while unhealthy workers are removed. Understanding this phenomenon is integral to the accurate assessment of exposure effects in occupational cohorts. To date, scarce information has been published on the descriptive characteristics of the healthy survivor effect.*
Methods: *Follow-up mortality data on 44,154 employees from the Hanford nuclear facility for the period of 1944–1986 were used to estimate the healthy survivor effect according to frequently measured sociodemographic characteristics.*
Results: *While Hanford employees did not exhibit a stepwise decline in standardized mortality ratios according to duration of employment, workers in the longest employment duration category demonstrated a substantial survival advantage compared to the rest of the cohort. This effect was present in both males and females, and in all but the following subgroups: males hired at or after age 40, females hired before age 40, and females classified as both professional and nonprofessional.*
Conclusion: *The findings of the present study suggest that investigators should consider the potential confounding role of the healthy survivor effect when relying on SMRs, or other methods, to assess the adverse health effects of exposure in occupational cohorts. Further studies should be conducted, however, to assess variation in the healthy survivor effect according to sociodemographic characteristics.* Am. J. Ind. Med. 35:343–347, 1999. *© 1999 Wiley-Liss, Inc.*

KEY WORDS: epidemiologic methods; industry; mortality; occupations; healthy worker effect; healthy survivor effect

INTRODUCTION

The adverse health effects of occupational exposures are often assessed by comparing mortality of an occupational cohort with that of the general US population. Because the general US population includes people whose state of poor health may hinder their ability to seek, gain, and maintain employment, the mortality rates of most work forces are lower than those of the general population. This phenomenon, referred to as the "healthy worker effect," consists of two selection processes: the healthy hire effect and the healthy survivor effect [Arrighi and Hertz-Picciotto, 1994]. The healthy hire effect is the initial selection process whereby healthy individuals are more likely to seek and gain employment than are less healthy individuals. The healthy survivor effect is the continuing selection process whereby healthy workers are more likely to be retained in the workforce over time than are less healthy individuals [Arrighi and Hertz-Picciotto, 1994].

Because length of employment is reported to be highly correlated with most occupational exposures [Gilbert, 1982],

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Contract grant sponsor: NIOSH; Contract grant numbers: OHHS 5R01 OH03274-02, OHHS 5R01 OH-54-001.
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Accepted 14 December 1998.

understanding how mortality rates change according to duration of employment will help investigators assess its potential confounding effect in occupational mortality studies. To that end, learning about the patterns of the healthy survivor effect may allow investigators to more accurately estimate mortality among occupational cohorts. While a number of investigators [Baillargeon et al., 1998; Choi, 1992; Howe et al., 1988; McMichael, 1976] have described characteristics of the healthy worker effect, scant information exists on the healthy survivor effect. Moreover, little is known about how its expression is modified according to sociodemographic factors. The purpose of the present investigation, therefore, was to assess the expression of the healthy survivor effect according to sociodemographic characteristics in a large occupational cohort.

METHODS

Study Population

The study population consisted of 44,154 male and female workers of the Hanford nuclear facility who were hired between 1944 and 1978 and followed until 1986. The major activities of the Hanford site, which is located in southeastern Washington State, include: plutonium production, nuclear power generation, advanced reactor generation, advanced reactor design, basic scientific research, research related to the development of nuclear weapons, waste management, and environmental restoration [US DOE, 1995].

Previous investigations [Gilbert et al., 1993] of the Hanford cohort reported that there was no association between cumulative exposure to radiation and mortality from all causes of death. Using the proportional hazards model, the present study showed that there was no association between exposure to ionizing radiation and all-cause mortality in either males (hazard ratio (HR) = 1.00, 95% confidence interval (CI) = 0.99–1.00) or in females (HR = 1.00, 95% CI = 0.98–1.00) after adjusting for duration of employment, occupational class, and age at hire. Consequently, exposure to ionizing radiation was not adjusted for in this study. Moreover, because information on exposures other than radiation was not available for the Hanford study cohort, it was not possible to adjust for such factors in the present investigation.

Data Source

The data used in this investigation consisted of computerized files containing demographic, work history, vital status, and radiation exposure information for the Hanford cohort. These files were obtained from the Comprehensive Epidemiologic Data Resource (CEDR), a public use database established by the Department of Energy in 1992. Vital status ascertainment for the study population consisted of searches conducted by Gilbert and colleagues [1993] of the Social Security Administration (SSA) earnings and benefits files; deaths reported to the US National Death Index (NDI); and computerized vital statistics files for Washington and California for 1960–1983. For workers on whom vital status information was missing, person-years were counted until the end of study date.

Design and Analysis

A retrospective mortality cohort design was employed in this investigation. Each worker contributed person-years of observation from their date of hire at Hanford until their date of death or the end of the study date (1986). In order to ensure that all workers had the opportunity to accumulate at least 8 years of follow-up, workers hired after 1978 were not included in the study cohort.

To assess the healthy survivor effect in the study population, standardized mortality ratios (SMRs), were calculated as follows: the ratio of the number of deaths from all causes observed among the study cohort members to the number of deaths expected (based on US rates) with age and calendar year taken into account [Gilbert et al., 1989; Checkoway et al., 1989]. The United States Death Rates (USDR) computer program [Monson, 1974], which contains age, sex, calendar year, and race-specific death rates (per 1,000 population per year) from the US vital statistics, was used to perform all SMR analyses. Ninety-five percent confidence intervals were generated for each of the SMRs [Monson, 1974]. Because SMRs are indirectly standardized to different person-time weighting structures, comparison of SMRs across subgroups may produce misleading results [Rothman, 1986]. For this reason, the present investigation avoided formal statistical tests and instead relied on a descriptive assessment of the healthy survivor effect consistent with the method employed in previous investigations [Baillargeon et al., 1998; Choi, 1992; Howe et al., 1988; McMichael, 1976].

The healthy survivor effect was assessed by examining SMRs according to length of employment in a time-dependent fashion. Using this methodology, a worker could contribute person-years at risk to several length of employment strata [Carpenter, 1987; Gilbert, 1982; Monson, 1986]. For example, a person employed for 25 years could contribute person-time to 0–9 years, 10–19 years, and 20–24 years strata. The observed event, however, was only included in the final employment stratum [Howe et al., 1988; McMichael, 1976; Monson, 1986].

RESULTS

Tables I and II, which present descriptive information on the Hanford occupational cohort, show that there are

TABLE I. Sociodemographic Characteristics of Male Hanford Employees

Variable	n	Percent	Person-years	Mean year of hire
Entire cohort	31,480	100	775,194	1957
Race				
White	30,306	96	757,779	1957
Nonwhite	1,174	4	17,413	1970
Age at hire				
<40	24,299	77	623,933	1953
40+	7,168	23	151,084	1956
Occupational class				
Professional	14,267	45	307,275	1963
Nonprofessional	17,213	55	467,919	1955

TABLE II. Sociodemographic Characteristics of Female Hanford Employees

Variable	n	Percent	Person-years	Mean year of hire
Entire cohort	12,662	100	324,242	1959
Race				
White	12,047	95	312,583	1958
Nonwhite	519	5	9,614	1971
Age at hire				
<40	11,100	88	294,756	1959
40+	1,565	12	39,102	1957
Occupational class				
Professional	3,072	24	75,280	1961
Nonprofessional	9,596	76	254,696	1959

more than twice as many male as female workers. For both sexes, the majority of workers are white and were hired before age 40. Among males, the number of professional and nonprofessional workers are evenly divided. Among females, however, the majority of workers are nonprofessional. Assessment of the final column shows that among both males and females, nonwhites entered the study cohort substantially later than whites. Moreover, among males, nonprofessional workers were hired, on average, 8 years earlier than professional workers.

Tables III and IV present SMRs according to race and age at hire for the Hanford males and females, respectively. In each table, the first column presents the overall SMR and the subsequent columns present SMRs according to years of employment. Examination of how SMRs change across length of employment strata is important because it permits assessment of how the health selection forces, which characterize the healthy survivor effect, operate in a working cohort over time. The tables show that among both males and females the SMRs remain relatively stable for the first three decades, then drop substantially following 30 years of employment. These findings suggest a substantial survival advantage among workers in the longest employment duration subgroups. It is important to note, however, that the small sample size among females in the final employment stratum result in a point estimate with limited precision, as reflected by the wide 95% CI that includes one.

Row 2 of each table presents SMRs according to race. The race-specific SMRs indicate that for both sexes the white subgroups exhibit a healthy survivor effect pattern similar to that of the entire cohort. That is, the healthy worker effect remains relatively stable through years 0–29 and then becomes substantially stronger after 30+ years of employment. The similarity of this pattern to that of the entire cohort is not surprising given that white males and females constitute approximately 95% of their respective cohorts. Among the nonwhite subgroups, however, a different pattern emerges. The comparatively later entry of nonwhites into the study in both sex cohorts results in a substantially shorter follow-up period for these subgroups. In fact, the 30+ year stratum for nonwhite females yields insufficient numbers upon which to conduct analyses. Nevertheless, nonwhite males and females exhibit their most substantial decrease in mortality in the longest employment duration category.

Row 3 of each table presents SMRs according to age at hire. Among males, those who were hired before 40 years of age show no pattern according to duration of employment. In fact, the lowest SMR occurs among workers who were employed 10–19 years. Among males who were hired after the age of 40, those who remained employed for more than 30 years demonstrate a distinct survival advantage. Interestingly, the SMR pattern present in the first three length of employment strata is opposite that typically characterized by the healthy survivor effect. Among females, there appears to be no pattern of decreasing mortality according to length of employment for those hired before 40 years of age. Among women hired after the age of 40, however, those employed for 30 years experience longer survival. In fact, no deaths are observed among this subgroup.

Row 4 of each table presents SMRs according to occupational class. Among males, both the professional and nonprofessional subgroups exhibit a moderate survival advantage for those employed at least 30 years. Professional workers demonstrate a stronger overall HWE, and therefore have less potential for improvement in survival over time. Among females, neither the professional nor the nonprofessional workers experience a clear pattern of decreasing mortality with length of survival.

TABLE III. SMRs for All Causes of Death in Male Hanford Workers According to Duration of Employment

	Overall	0–9 years	10–19 years	20–29 years	30+ years
I. Entire cohort	0.34 (0.82–0.86)	0.85 (0.83–0.87)	0.82 (0.78–0.86)	0.84 (0.79–0.89)	0.75 (0.67–0.85)
II. Race					
White	0.84 (0.82–0.86)	0.85 (0.83–0.87)	0.82 (0.78–0.85)	0.84 (0.79–0.89)	0.75 (0.67–0.85)
Nonwhite	0.58 (0.47–0.71)	0.55 (0.43–0.69)	0.74 (0.46–1.19)	0.93 (0.81–1.06)	0.50 (0.04–5.28)
III. Age at hire					
<40	0.81 (0.78–0.84)	0.85 (0.82–0.88)	0.67 (0.61–0.74)	0.80 (0.74–0.85)	0.74 (0.65–0.84)
40+	0.86 (0.83–0.89)	0.84 (0.81–0.87)	0.90 (0.84–0.96)	0.93 (0.81–1.06)	0.50 (0.12–1.94)
IV. Occupational class					
Professional	0.64 (0.61–0.67)	0.66 (0.62–0.70)	0.55 (0.48–0.63)	0.63 (0.54–0.73)	0.55 (0.43–0.70)
Nonprofessional	0.91 (0.88–0.93)	0.93 (0.90–0.96)	0.90 (0.84–0.95)	0.90 (0.84–0.97)	0.84 (0.73–0.97)

95% CIs are presented for each estimate in parentheses.

TABLE IV. SMRs for All Causes of Death in Female Hanford Workers According to Duration of Employment

	Overall	0–9 years	10–19 years	20–29 years	30+ years
I. Entire cohort	0.84 (0.80–0.88)	0.85 (0.81–0.89)	0.82 (0.73–0.91)	0.84 (0.73–0.97)	0.75 (0.48–1.17)
II. Race					
White	0.84 (0.80–0.88)	0.85 (0.81–0.89)	0.82 (0.73–0.92)	0.84 (0.73–0.97)	0.75 (0.49–1.16)
Nonwhite	0.58 (0.41–0.83)	0.55 (0.35–0.86)	0.33 (0.05–2.17)	0.00	—
III. Age at hire					
<40	0.81 (0.73–0.89)	0.85 (0.77–0.93)	0.67 (0.39–1.15)	0.80 (0.55–1.16)	0.74 (0.46–1.17)
40+	0.86 (0.82–0.91)	0.84 (0.77–0.91)	0.90 (0.84–0.96)	0.57 (0.39–0.85)	0.00
IV. Occupational class					
Professional	0.79 (0.71–0.88)	0.73 (0.63–0.82)	0.74 (0.55–1.00)	0.97 (0.70–1.34)	0.80 (0.30–2.13)
Nonprofessional	0.82 (0.77–0.87)	0.84 (0.78–0.93)	0.83 (0.70–0.95)	0.60 (0.34–1.40)	0.69 (0.34–1.40)

95% CIs are presented for each estimate in parentheses.

DISCUSSION

A number of investigators have reported a strong correlation between length of employment and occupational exposures [Checkoway et al., 1989; Gilbert, 1982]. Consequently, it is important to understand how length of employment may confound estimates of the exposure–mortality association. Because there is no association between cumulative exposure to ionizing radiation and mortality from all causes of death among Hanford workers, this cohort provides a unique opportunity to assess the healthy survivor effect independent of occupational exposure effects to ionizing radiation.

Our finding that the HWE is strongest for the longest periods of employment is consistent with the findings of previous studies [McMichael, 1976; Nicholson, 1988; Peto et al., 1985]. These investigators reported that individuals employed for long periods of time demonstrate substantially lower mortality than those employed for comparatively short periods. Examination of the healthy survivor effect according to sociodemographic categories revealed that the survival advantage in the final length of employment stratum persisted for some subgroups but not for others. Among Hanford males, all of the subgroups under study demonstrated a survival advantage in the 30+ year stratum except those hired at or after age 40. Among Hanford females, a number of subgroups failed to demonstrate a survival advantage in the longest duration of employment stratum: these include workers hired before age 40, as well as both professional and nonprofessional workers. In interpreting these findings it is important to point out that unmeasured exposures are also likely to be highly correlated with duration of employment. If such exposure effects are substantial and are unmeasured in a study population, then it may be difficult to discern the independent contributions of the healthy survivor effect versus exposure effects to mortality estimates over time. It is possible that in the Hanford cohort such unmeasured exposures may have resulted in a weakened healthy survivor effect.

The healthy survivor effect is described as a phenomenon whereby, over time, unhealthy workers are selectively removed from the workforce while healthy individuals are selectively retained [Carpenter, 1987]. It has been speculated that short-term workers may comprise a subset of the working cohort who are likely to engage in behaviors that have adverse health consequences [Checkoway et al., 1989; Doll, 1988]. Alternatively, long-term employees are reported to comprise a uniquely healthy subgroup of the working population selected into the long-term employment subgroup by way of good health status [Doll, 1988; Gilbert, 1982]. Steady long-term employment and all of its associated benefits, such as better health care and financial security, may contribute to the healthy survivor effect by actually exerting a beneficial effect on workers' health [Arrighi and Hertz-Picciotto, 1994; Choi, 1992; Doll, 1988; McMichael, 1976].

Occurrence of the healthy survivor effect in occupational cohorts is analogous to a form of survival bias that occurs in studies of toxicological exposures in animals. Such survival bias results when animals that are the healthiest at baseline are able to sustain greater doses of exposure before experiencing the outcome under study. This phenomenon results in an attenuated exposure–disease association. Unlike subjects in controlled experiments, however, members of occupational cohorts are often subject to substantial variations in the type, duration, and intensities of exposures over time. Therefore, the task of assessing the independent contributions of health status and exposure to survival may be considerably more difficult for the investigator of an occupational cohort than for the experimental researcher.

Assessment of exposure in a time-dependent fashion while controlling for duration of employment and other potential confounders provides a valid form of exposure assessment in the occupational cohort. However, the retrospective nature of most occupational cohort studies, generally requiring employee records, often precludes such a detailed and sophisticated analysis. Most investigators of occupational cohorts are forced to rely on less precise forms of measurement and cruder forms of analysis (e.g., SMRs). For these investigators, a better understanding of the healthy survivor effect will permit a more meaningful interpretation of analyses that rely on external comparisons and SMRs. To this end, it will be important for future investigators to continue to explore and describe characteristics of the healthy survivor effect.

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Characteristics of the Healthy Worker Effect: A Comparison of Male and Female Occupational Cohorts

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The healthy worker effect (HWE) poses a serious methodological problem to investigators of occupational cohorts in that it may mask mortality excesses that result from occupational exposures. This problem is further complicated by the fact that the strength of the HWE generally varies according to sociodemographic, employment, and time-related factors. While the HWE has been well documented among numerous cohorts of male workers, little is known about its expression among female occupational workers. Follow-up mortality data on 44,154 employees from the Hanford nuclear facility for the period of 1944–1986 were examined using standardized mortality ratio (SMR) analysis to assess whether modifiers of the HWE were expressed differently in females than in males. Results of this analysis show that while the HWE was modified by race, age at hire, occupational class, and length of follow-up in both male and female cohorts, different patterns of modification emerged across the two subgroups. Learning about how gender differentiates expression of the HWE will help investigators more precisely assess the confounding effect of the HWE in studies of working cohorts. Therefore, this study's findings are relevant for designing and interpreting future occupational cohort studies.

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1076-2752/98/4004-036853.00/0

The effect of occupational exposures on mortality is frequently assessed by comparing the mortality experience of a working cohort with that of the general US population. Since the general population includes people whose poor health may prevent them from seeking and gaining employment, the mortality rates of any given working population are typically lower than those of the US population.[1–4] This phenomenon, referred to as the healthy worker effect (HWE), poses a serious problem to investigators of occupational cohorts in that it may partially or completely mask mortality excesses resulting from occupational exposures.[1] Understanding how the strength of the HWE varies according to sociodemographic, employment, and time-related factors will help future investigators critically assess the extent to which the HWE is likely to be operative in a given cohort under study. In view of this, a number of investigators have examined modification of the HWE. Their findings indicate that the HWE is particularly strong among nonwhite workers;[4–6] employees hired after age 40,[7,8] and workers of high occupational class.[1,3,9,10] Furthermore, the HWE is reported to become weaker with increased length of follow-up.[1,3,11,12] Comparatively little is known, however, about how the HWE is modified among female working cohorts. The purpose of this investigation is to address this deficit in the literature by comparing modification of the

HWE in the male and female occupational cohorts.

Methods

Study Population

The study population consisted of 44,154 male and female workers of the Hanford nuclear facility who were hired between 1944 to 1978 and followed until 1986. The major activities of the Hanford site, which is located in southeastern Washington State, include plutonium production, nuclear power generation, advanced reactor generation, advanced reactor design, basic scientific research, research related to the development of nuclear weapons, waste management, and environmental restoration.[13]

The data used in this investigation consisted of analytic files containing demographic, work history, vital status, and radiation exposure information on the Hanford cohort. These files were obtained from the Comprehensive Epidemiologic Data Resource (CEDR), a public-use database established by the department of Energy (DOE) in 1992. Vital status ascertainment for the study population consisted of searches conducted by Gilbert[14] of the Social Security Administration (SSA) earnings and benefits files, deaths reported to the US National Death Index (NDI), and computerized vital statistics files for Washington and California for 1960–1983. For workers on whom vital status information was missing, person-years were counted until the end of study date.

The following occupational class categories were assigned to the study population on the basis of three-digit occupational codes used by the Bureau of Census: (a) professional and technical workers, (b) clerical workers, (c) skilled manual workers, and (d) unskilled manual workers.[14] Workers were assigned to the general category in which they had spent the longest period of time from initiation of employment through the end of 1985.

Using the proportional hazards model, the present study showed that there was no association (hazard ratio = 1.00, 95% confidence interval = 0.99–1.00) between exposure to ionizing radiation and all-cause mortality. Moreover, previous investigators[15] of the Hanford cohort also reported no association between cumulative exposure to radiation and all-cause mortality. Therefore, exposure to ionizing radiation was not adjusted for in this study. Because information on exposures other than radiation was not available for the Hanford study cohort, it was not possible to adjust for the potentially adverse effects of such factors in the present investigation.

Design and Analysis

A retrospective mortality cohort design was utilized in this investigation. Each worker contributed person-years of observation from their date of hire at Hanford until their date of death or the end of the study date (1986). In order to ensure that all workers had the opportunity to accumulate at least eight years of follow-up, workers hired after 1978 were not included in the study cohort.

To estimate the HWE in the study population, standardized mortality ratios (SMRs), were calculated as follows: the ratio of the number of deaths from all causes observed among the study cohort members to the number of deaths expected (based on US rates) with age and calendar year taken into account.[16,17] The United States Death Rates (USDR) computer program,[18] which contains age-, sex-, calendar year–, and race-specific death rates (per 1000 population per year) from the US vital statistics, was used to perform all SMR analyses. Ninety-five percent confidence intervals were generated for each of the SMRs.[18]

Because SMRs are indirectly standardized to different person-time weighting structures, comparison of SMRs across subgroups may produce misleading results.[19] For this reason, the present investigation avoided formal statistical tests and instead relied on a descriptive assessment of the HWE consistent with the method utilized by previous investigations.[3,4,18] Moreover, each study subgroup was examined to assess the extent to which other study factors may have confounded the relationship between the variable of interest and the HWE.

Results

Tables 1 and 2 present descriptive information on male and female Hanford employees respectively. The tables show that for both gender cohorts, the majority of Hanford workers are white and were hired before age 40. Some substantial differences between the two groups are also apparent. For example, while the majority of females are classified as clerical workers, most male workers belong to either the professional/technical or skilled manual occupational classes. Moreover, among males, the subgroups with the latest mean year of hire, and thus the shortest potential follow-up period, are the nonwhite and professional/technical subgroups. Among females, however, nonwhite and skilled manual workers entered the study population substantially later than the other subgroups. These discrepancies may affect the extent to which the HWE is operative in a given subcohort and are therefore important to consider in interpreting the SMR analysis.

Tables 3 and 4 present subgroup-specific SMRs for Hanford males and females, respectively. In each table, the first column presents the overall SMR, and the subsequent columns present SMRs according to length of time since entering the follow-up. Examination of how the HWE changes across length of follow-up strata is important because it permits assessment of how health-selection forces operate in a working cohort over time.[1] Such information is helpful to investigators relying on

TABLE 1
Characteristics of Hanford Males

Variable	n	%	Person-Years	Mean Year of Hire
Entire cohort	31,480	100	775,194	1957
Race				
White	30,306	96	757,779	1957
Nonwhite	1,174	4	17,413	1970
Age at hire				
<40	24,299	77	623,983	1958
40+	7,168	23	151,084	1956
Occupational class				
Professional/technical	14,267	45	307,275	1963
Clerical	2,057	7	51,764	1957
Skilled manual	13,118	42	360,124	1953
Unskilled manual	2,038	6	56,017	1952

TABLE 2
Characteristics of Hanford Females

Variable	n	%	Person-Years	Mean Year of Hire
Entire cohort	12,668	100	334,242	1959
Race				
White	12,047	95	312,583	1958
Nonwhite	619	5	9,614	1971
Age at hire				
<40	11,100	88	294,756	1959
40+	1,565	12	39,102	1957
Occupational class				
Professional/technical	3,072	24	75,880	1961
Clerical	8,349	66	214,208	1960
Skilled manual	592	5	12,294	1965
Unskilled manual	647	5	19,194	1953

SMRs to assess the exposure-disease association in an occupational cohort.

The tables show that both male and female Hanford workers exhibit a strong HWE. Although females exhibit a slightly stronger HWE than males, the point estimates and 95% confidence intervals indicate minimal difference between the two subgroups. The time-related SMRs indicate that Hanford males exhibit a monotonic decrease in the strength of the HWE across the length of follow-up strata. While Hanford females exhibit a similar pattern of monotonic attenuation in the first three strata, they demonstrate an actual increase in the strength of the HWE in the final stratum.

Row 2 of each table, which presents SMRs according to race, shows that in both gender cohorts, nonwhites exhibit a dramatically stronger HWE than whites. Among males the 95% confidence intervals surrounding the race-specific estimates do not overlap. The time-related SMRs show that among males, the white subcohort exhibits a weakening of the HWE over time, while the nonwhite subgroup exhibits no such pattern. It is important to note, however, that because nonwhites entered the follow-up, on average, much later than whites, they had less opportunity for the HWE to wear off. In the female study cohort, both white and nonwhite subgroups exhibit a pattern similar to that of the entire female cohort; that is, a monotonic decrease in the strength of the HWE for the first three decades of follow-up.

Row 3, which presents SMRs according to age at hire, shows that among females, the 40+ subgroup exhibits a stronger HWE than the <40 subgroup, but among males the reverse pattern is exhibited. The time-related SMRs show that among males, no clear pattern was exhibited according to time since entering the follow-up. Among females, both age at hire subgroups exhibit a pattern similar to the entire female cohort.

Row 4, which presents SMRs according to occupational class, shows that the strength of the HWE does not increase monotonically by occupational class for either males or females. The time-related SMRs show that among males all occupational class subgroups except clerical exhibit a monotonic attenuation of the HWE over time. In the professional/technical subgroup, the HWE remains strong, even after 30 years of follow-up. Among females, all of the subgroups except the skilled manual workers exhibit an attenuation of the HWE until the last decade of follow-up, a pattern which is reflective of that exhibited by the entire female cohort.

Discussion

It is widely recognized that the HWE poses a methodological problem to investigators of occupational cohorts.[1–4] Many researchers attempt to circumvent the HWE by utilizing internal comparisons; that is, by directly comparing the mortality experience of subgroups within a defined occupational cohort to one another. Unfortunately, internal comparisons often result in subsamples too small to yield adequate statistical power.[3] Moreover, if an occupational cohort is relatively homogeneous with regard to the occupational exposure under study, identifying meaningful gradations of exposure is not always possible.[11] Finally, if employees are selected on the basis of health-related factors into subgroups that serve as the basis for internal comparisons, then internal comparison bias may occur.[4,14]

TABLE 3
Hanford Males: SMRs According to Years Since Entering Follow-Up*

	Overall	0–9 Years	10–19 Years	20–29 Years	30+ Years
Entire cohort	0.84 (0.82–0.86)	0.66 (0.62–0.70)	0.81 (0.79–0.83)	0.83 (0.80–0.86)	0.95 (0.92–0.98)
Race					
White	0.84 (0.82–0.86)	0.66 (0.62–0.70)	0.80 (0.76–0.84)	0.84 (0.81–0.87)	0.95 (0.92–0.98)
Nonwhite	0.58 (0.48–0.71)	0.40 (0.28–0.58)	0.64 (0.46–0.89)	0.53 (0.33–0.85)	0.76 (0.48–1.18)
Age at hire					
>40	0.81 (0.78–0.84)	0.65 (0.59–0.72)	0.76 (0.70–0.82)	0.72 (0.68–0.72)	0.97 (0.93–1.01)
40+	0.86 (0.83–0.89)	0.67 (0.62–0.73)	0.84 (0.79–0.89)	0.96 (0.91–1.00)	0.91 (0.85–0.97)
Occupational class					
Professional/technical	0.64 (0.61–0.67)	0.55 (0.49–0.62)	0.59 (0.53–0.66)	0.59 (0.54–0.65)	0.79 (0.73–0.86)
Clerical	0.93 (0.85–1.02)	1.00 (0.99–1.00)	0.88 (0.73–1.06)	0.90 (0.77–1.05)	1.00 (1.00–1.01)
Skilled manual	0.90 (0.83–0.98)	0.72 (0.66–0.78)	0.88 (0.87–0.93)	0.91 (0.87–0.95)	0.99 (0.95–1.03)
Unskilled manual	0.92 (0.86–0.96)	0.57 (0.47–0.69)	0.91 (0.80–1.03)	1.00 (0.99–1.00)	1.10 (0.97–1.25)

* 95% Confidence intervals are presented for each estimate in parentheses.

TABLE 4
Females: SMRs According to Years Since Entering Follow-Up*

	Overall	0–9 Years	10–19 Years	20–29 Years	30+ Years
Entire cohort	0.81 (0.77–0.85)	0.57 (0.47–0.69)	0.74 (0.64–0.85)	0.89 (0.81–0.98)	0.84 (0.77–0.91)
Race					
White	0.81 (0.77–0.86)	0.59 (0.49–0.71)	0.73 (0.63–0.84)	0.89 (0.81–0.98)	0.84 (0.77–0.91)
Nonwhite	0.50 (0.32–0.79)	0.14 (0.04–0.47)	0.58 (0.27–1.29)	0.94 (0.44–2.02)	0.74 (0.28–1.97)
Age at hire					
>40	0.87 (0.78–0.97)	0.63 (0.50–0.80)	0.81 (0.67–0.97)	0.99 (0.97–1.01)	0.92 (0.83–1.01)
40+	0.78 (0.71–0.85)	0.53 (0.39–0.71)	0.70 (0.57–0.86)	0.91 (0.79–1.05)	0.81 (0.71–0.93)
Occupational class					
Professional/technical	0.79 (0.71–0.88)	0.62 (0.43–0.89)	0.69 (0.52–0.92)	0.89 (0.74–1.06)	0.80 (0.68–0.94)
Clerical	0.82 (0.76–0.88)	0.70 (0.56–0.87)	0.79 (0.67–0.94)	0.89 (0.80–0.99)	0.81 (0.71–0.92)
Skilled manual	0.70 (0.55–0.89)	0.33 (0.13–0.84)	0.44 (0.22–0.90)	0.70 (0.46–1.07)	0.97 (0.67–1.39)
Unskilled manual	0.88 (0.77–1.01)	0.42 (0.24–0.74)	0.91 (0.66–1.24)	1.00 (1.00–1.01)	0.89 (0.72–1.11)

* 95% Confidence intervals are presented for each estimate in parentheses.

Oftentimes, even when internal comparisons are feasible, it is informative to compare the mortality experience of a given cohort under study to that of the general population. In view of the aforementioned reasons for utilizing external comparisons, a number of investigators have sought to elucidate the HWE.[2,4,8,11,12] While this phenomenon has been relatively unexplored among male occupational cohorts, little is known about how the HWE is expressed among female cohorts[1,3] or particularly how expression of the HWE differs according to gender. The present investigation examined characteristics of the HWE in a cohort of 44,154 male and female workers at the Hanford nuclear facility in southeastern Washington State.

The strength of the HWE estimates reported for both male and female Hanford workers are consistent with the vast majority of occupational cohort studies[20] and with the findings of nuclear worker cohorts in particular.[21–24] The minimal difference in the strength of the overall HWE between males and females at the Hanford site is consistent with the finding of Carpenter[1] among British nuclear workers, but inconsistent with the findings of Howe and colleagues[3] among a Canadian occupational cohort in which females exhibited dramatically lower all-cause SMRs than males.

A number of investigators[1,3,11,12] have reported that the HWE is strongest during the initial period of follow-up and attenuates steadily over time. This pattern indicates that a strong health-selection force is operative at the time of hire but becomes increasingly less operative over time.[1] For Hanford workers, the attenuation pattern of the HWE is generally consistent with the findings of previous investigations.[1,3,11,12] However, while males exhibited a monotonic decrease in the strength of the HWE throughout the entire follow-up period, females exhibited a stepwise decrease in the HWE for only the first three strata. According to Carpenter,[1] an HWE that fails to attenuate in the later years of follow-up indicates that stable selection forces such as social class or health-related behaviors are operating to confer a health advantage to the working cohort. This, of course, is in contrast to a health-selection effect, which exists exclusively at the time of hire. These discrepant attenuation patterns in Hanford males and females indicate that relative to the general population, Hanford female workers may be more likely than male workers to either exhibit behavior or be part of a social class that confers a health advantage. It will be important to establish whether such gender-differentiated attenuation patterns continue to persist in future occupational cohorts.

Sterling and Weinkam[12] hold that the attenuation of the HWE over time may be attributable in part to accumulation of exposures in the work environment. In view of the lack of association between cumulative exposure to radiation and all-cause mortality among Hanford workers,[14,15] it is unlikely that radiation-exposure effects contributed substantially to the time-related attenuation of the HWE in the present study. However, because data on occupational exposures other than radiation have not been assessed among Hanford workers, their existence and potential confounding effect could not be examined.

This investigation's findings of strong race differences in the HWE are consistent with those of previous investigations among both male[4–6] and female[6] occupational cohorts. The HWE is typically stronger among nonwhite workers because the evaluation of race-specific HWEs is confounded by social class differences in the general US population.[4] In other words, while white workers are compared with the national average white population (with average socioeconomic status), nonwhite workers are compared with the national average nonwhite population (with low socioeconomic status). In short, the social class disparity between employed and unemployed nonwhites is reported to be greater than that between employed and unemployed whites.[4] Given the well-established inverse relationship between social class and mortality,[25,26] it follows that social class differentials across reference populations are likely to result in an amplified HWE for nonwhite workers. This finding suggests that the potential confounding effect of social class on race-specific SMRs should be considered by investigators utilizing external comparisons to assess exposure effects among both male or female occupational cohorts.

While the modifying effect of age at hire on the HWE has not been reported among female workforces, a number of investigators[7,8] have reported that male workers hired after age 40 exhibit a stronger HWE than their peers. Checkoway and colleagues[18] theorized that a worker who seeks and gains employment at an older age is exhibiting nontraditional behavior and is therefore likely to exhibit a level of health superior to that of his/her same-age peers from the general US population. By contrast, a worker who seeks and gains employment at a younger age is less extraordinary in comparison to his/her same-age peers from the general US population. Consistent with previous investigations,[7,8] Hanford females who were 40 or older exhibited a stronger HWE than workers hired before age 40. Interestingly, Hanford males, however, exhibited the reverse pattern. Given that the association between age at hire and the HWE has been relatively well established among male cohorts,[7,8,18] it is likely that the pattern exhibited by Hanford males is anomalous. It will be important, however, to determine whether the present study's findings persist among future cohorts of female workers.

Axelson[9] stated that because health-selection forces are more stringent for more highly qualified jobs, the HWE is generally stronger for higher than for lower-class occupations. Consistent with Axelson's theory, investigators of male and mixed cohorts[1,3,10] have reported that the strength of the HWE increases monotonically with occupational class. The findings of the present investigation show that neither males nor females exhibit patterns consistent with the aforementioned investigations,[1,3,10] that is, a positive and monotonic association between occupational class and the HWE. While Hanford female workers exhibit no discernible pattern between occupational class and the HWE, Hanford males demonstrate a HWE that is considerably stronger in the highest occupational class than in the three lower occupational class subgroups, two of which have relatively small sample sizes. It is important to note that the occupational classification systems used in this study were not identical to those reportedly utilized by previous investigators.[1,3,10] However, in view of the fact that inconsistencies in occupational class criteria did not result in inconsistent findings among the previous investigations, it is unlikely that this investigation's anomalous findings are attributable to measurement inconsistency with previous investigations.

Assessment of time-related expression of the HWE according to occupational class reveals yields some interesting results. Among Hanford females, the skilled manual occupational subgroup, which constitutes only 5% of the total female sample, is the only subgroup to exhibit a monotonic attenuation of the HWE over time. Among Hanford males, the clerical subgroup, which constitutes only 7% of the entire male workforce, is the only subgroup that does not exhibit a pattern of monotonic attenuation over time. Interestingly, the clerical subgroup constitutes the majority (66%) of the female Hanford workforce, while the skilled manual subgroup constitutes 42% of the male Hanford subgroup. In short, these findings suggest that occupational class may be a driving force behind gender-differentiated HWE trajectories over time. Investigation of occupational cohorts that have a more equal distribution of occupations across gender may provide an opportunity to assess whether gender attenuation discrepancies are confounded by occupational class.

Conclusion

The results of these analyses show that while the overall HWE is comparable in the Hanford male and female cohorts, noteworthy gender differences emerge when examining how the HWE is expressed across sociodemographic and time-related factors. In particular, this investigation reveals some potentially important findings with regard to gender and occupational class differentiated trajectories in the HWE over time. The finding that HWE attenuation patterns differ according to gender and occupational class indicates that health-selection processes may operate differently within these subgroups of the study population. Because external comparisons play a prominent role in the assessment of occupational exposure, understanding the characteristics of the HWE will continue to be integral to the proper design and analysis of occupational cohort studies. It will be important to assess whether the patterns revealed in the present investigation persist among future occupational cohort studies. Such information will ultimately help investigators more meaningfully use SMRs to assess the adverse health effects of occupational exposure in both male and female cohorts.

Acknowledgment

This study was supported by NIOSH grants DHHS 5R01 OH03274-02 and DHHS 5R01 OH-94-001 (Gregg S. Wilkinson, PhD, principal investigator).

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American Journal of Epidemiology
Vol. 145, No. 6
Printed in U.S.A.

Invited Commentary: Are Low Radiation Doses or Occupational Exposures Really Risk Factors for Malignant Melanoma?

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Concerns about a possible association between melanoma and employment in the nuclear industry first surfaced in the early 1980s (1), and even earlier with regard to employment in other industries (2). Although occupationally related skin disorders were first observed in the 1700s (3), and although radiation-induced skin erythemas and skin cancers were observed among early radiation workers as well as among populations undergoing radiation therapy (4, 5), observations regarding the possible association between occupational exposures and melanoma have tended to receive little credence (6).

In 1981, Austin et al. (1) reported results from a retrospective cohort study, including a fourfold increase in the incidence of melanoma, among workers at the Lawrence Livermore National Laboratory (LLNL) in Livermore, California. These findings generated concern that other nuclear workers might be similarly subject to increased risk of melanoma, perhaps due to job-related exposures to low doses of ionizing radiation. Studies carried out at a sister laboratory, Los Alamos National Laboratory (LANL) (7, 8), indicated that increased melanoma incidence did not exist among LANL workers as a whole (7), and further that only increasing education level was clearly associated with the occurrence of incident melanoma within this cohort (8).

The case-control study reported by Austin and Reynolds (9) in this issue of the *Journal* continues the analysis of melanoma among LLNL workers that was originally reported in 1981 (1). The current investigation expands the total number of melanoma cases from the 19 reported in the 1981 study to 31. The study window for case ascertainment is also increased from 1972–1977 to 1969–1980. The new study adds to our understanding of risk factors for cutaneous malignant melanoma experienced by LLNL workers by considering a variety of occupational and nonoccupational exposures, as well as biologic, demographic, and other characteristics.

Data were collected by reviewing personnel and medical records obtained from LLNL, by means of mailed questionnaires, and by face-to-face interviews. Unfortunately, health physics records, which contained dosimetry information on individual workers, were not made available to Austin and Reynolds, even though they were allowed access to medical and personnel records. In my experience, medical records (and perhaps records having to do with security clearances) have always been considered to be more sensitive in terms of privacy issues than have radiation dosimetry records. The end result of this restriction of access to dosimetry data is that Austin and Reynolds were forced to rely on self-reports of work with radioactive materials rather than on individual dosimetry data. The availability of individual dosimetry for ionizing radiation is one of the strengths of research on effects of exposures to low radiation doses. Strangely, LLNL released the dosimetry data, after reviewing the findings reported by Austin and Reynolds, to a separate group of investigators. These investigators, with funding from LLNL, conducted an evaluation of Austin and Reynolds' finding of an association between melanoma and self-reports of work with radioactive materials. The report by the other investigators, Schwartzbaum et al. (10), was published in another journal before the substantive findings reported in this issue of the *Journal* could be published. The findings of the Schwartzbaum et al. evaluation (10) do, however, essentially support the validity of the association between melanoma and self-reports of ever having worked with ionizing radiation reported by Austin and Reynolds, thereby decreasing concerns that this finding is due to random error, bias, or confounding. In fact, Schwartzbaum et al. (10) report an odds ratio considerably higher but with a wider confidence interval (odds ratio (OR) = 10.8, 95 percent confidence

Received for publication September 25, 1995, and accepted for publication November 1, 1996.

Abbreviations: AEA, Atomic Energy Authority; CI, confidence interval; LANL, Los Alamos National Laboratory; LLNL, Lawrence Livermore National Laboratory; OR, odds ratio; SIR, standardized incidence ratio; UV, ultraviolet.

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interval (CI) 1.4–85.1) than do Austin and Reynolds (9) (OR = 3.7, 95 percent CI 1.6–8.6).

Restriction by Austin and Reynolds to cases diagnosed only while employed limits the investigation to early effects of radiation or other occupational exposures if such effects exist. If the average induction times for non-melanotic skin cancers among radiation-treated populations of 25–30 years (4) apply to the induction of radiation-induced melanoma, many melanomas may not yet have occurred among LLNL workers.

What are the findings of studies of similar populations, such as studies of other nuclear workers and of participants in nuclear tests? The results from mortality studies of three large nuclear worker cohorts in the United Kingdom (11, 12) have been inconsistent. The most recent of these studies (11), a combined analysis of three different cohorts, reported an elevated risk of melanoma and other skin cancers among employees of the Atomic Energy Authority (AEA), but not among employees of the Atomic Weapons Establishment (the facility most similar to LLNL and LANL) or British Nuclear Fuels. Results from a retrospective cohort mortality study of registrants of the National Registry of Radiation Workers in the United Kingdom, which included some workers reported in the above-mentioned studies, found neither evidence of excess melanoma mortality nor evidence of an association with cumulative radiation exposures (12). Studies of US nuclear workers have reported inconsistent results. Furthermore, most of these studies have found no, or very small, overall increases in melanoma mortality or no evidence of associations with radiation exposure (13–19).

Increased mortality from melanoma was found among a cohort of all white male workers at the Mound Facility (20), and among workers at this same facility who were monitored for penetrating radiation (21), as well as among employees at a nuclear fabrication facility (22). But, again, no clear association was observed with exposure to ionizing radiation (21, 22).

Perhaps most relevant to the findings for LLNL workers are the results of studies conducted of employees at LLNL's sister laboratory, Los Alamos National Laboratory (LANL). A study of melanoma incidence among LANL workers (7), which included follow-up from 1969 through 1978, concluded that no excesses were present among white male workers (standardized incidence ratio (SIR) = 68 based on 3 observed cases). Although an elevated risk (SIR = 200, 90 percent CI 49–569) was observed among white females of other than Hispanic descent, this finding was based on only 2 observed cases. A matched case-control study (8) expanded case ascertainment from 1969 through 1981. However, contrary to the results for the LLNL workers, no association was found between melanoma and employment as a chemist. An odds ratio of 1.7 (crude OR = 1.4, 95 percent CI 0.3–6.1) was found for physicists, however, and an odds ratio of 3.0 (crude OR = 2.0, 95 percent CI 0.7–6.5) was observed for workers defined as professionals. In regard to exposures to ionizing radiation, matched odds ratios of 1.1 for beta radiation and 1.4 for total penetrating radiation were observed among males. No exposed cases were observed among females, and no plutonium-exposed cases were seen among either males or females. The most interesting finding, however, was a trend between the relative risk of melanoma and increasing education. Compared with workers with less than a college degree, standardized rate ratios increased from 2.1 for workers with college degrees to 3.2 for those with a graduate degree (Mantel-Haenszel test for trend, $p = 0.04$).

Several studies of participants of nuclear tests and of civilians residing downwind of such tests (23–25) have reported interesting, but imprecise, findings. Johnson (23), found an increased incidence of melanoma among Utah residents, based on unconfirmed self-reports. This study, however, has proven to be controversial and may be flawed (26). Caldwell et al. (24) described small to moderate increases in both incidence and mortality from melanoma experienced by US military personnel who participated in the Smoky nuclear test. Darby et al. (25) reported a very small increase in relative risk of mortality from melanoma among participants in atmospheric nuclear tests conducted by the United Kingdom. However, in both the Smoky study (25) and the United Kingdom study (26), the lower confidence limits were well below unity.

When the results from all of these studies are considered together, they offer little support to hypotheses either of an excess of melanoma among all nuclear workers, of an association with low dose ionizing radiation, or of an association with job-related exposures. The findings do, however, suggest that either the increase in melanoma observed at LLNL is spurious, or, if the LLNL findings are real, the risk factors that contribute to this increase are not present at LANL or at most other nuclear facilities.

A range of occupations and some occupational exposures have been associated with increased risks of malignant melanoma (27). Unfortunately, with some exceptions, the relative risks found for melanoma are often not clearly related to specific exposures but rather are linked with broad categories of workers, such as chemists, physicists, scientists, petrochemical workers, and electronics industry employees (8, 27). The exceptions appear to be workers exposed to polychlorinated biphenyls (2, 28), fluorescent lighting (29), organic chemicals (30), and perhaps ionizing radiation (1, 9–11, 21), although results are by no means consistent. This potpourri of occupations and potential exposures, which does not take into account the large number of negative studies among similar occupational groups, or of known nonoccupational risk factors, suggests to me that occupation is of less concern than the risk factors for melanoma that are more commonly recognized, i.e., ultraviolet (UV) sunlight exposure, and genetic, biologic, and life-style characteristics.

The paper by Austin and Reynolds (9) raises some issues concerning the conduct of epidemiologic research in the nuclear weapons complex and similar settings. One concern that needs to be addressed is the manner in which data on workers are sometimes restricted to certain investigators but released to other investigators under contract to the employer. Data-sharing, debate, replication, and open discussion of research results are necessary to enable the self-correcting process inherent to science to work. Furthermore, Austin and Reynolds report that their work was subjected to a tedious and overly extensive review. If the work of other epidemiologists is subjected to such a review, this may seriously impact on the timeliness of reporting results of epidemiologic research (31).

Issues of a scientific nature raised by Austin and Reynolds (9) include the manner in which life-style, genetic, and socioeconomic factors modify the effect that occupational exposures, including the possible role of ionizing radiation, exert on the occurrence of melanoma. That exposure to sunlight is the major etiologic factor for the development of melanoma cannot be denied (32). However, sunlight exposure is not the only risk factor (32). The interaction between UV exposure and other causal factors remains to be clarified, because the relation between malignant melanoma and UV sunlight is more complex than that for non-melanotic skin cancers (27, 32).

Austin and Reynolds' characterization of the association between melanoma and ionizing radiation among LLNL workers as their "most notable" finding (9, p. 530) is arguable. It would seem to me that an odds ratio of almost 15 for more than 6 moles $> 1/2$ cm is more notable than the risk implied by an odds ratio less than 4.0 for work with radioactive materials, especially when surrogate measures of exposure do not substantiate this result. The findings of Schwartzbaum et al. (10) do lend credence to Austin and Reynolds' results of an association between melanoma and radiation exposure (9), a finding which at this time appears to be limited primarily to LLNL and perhaps Mound workers in the United States, and AEA workers in the United Kingdom. As described above, most studies of other nuclear worker populations have not found employment at these facilities or radiation exposures to be associated with increased risks of melanoma. Important caveats are that most studies have moderate average lengths of follow-up and that the most common health endpoint in these studies is mortality. Both of these characteristics may decrease chances of finding clear associations between these exposures and melanoma. Some studies that have considered both incidence and mortality have reported similar results for these two endpoints (25).

A related issue, also mentioned by Schwartzbaum et al. (10), concerns the excess of incident melanomas among LLNL workers in the absence of excesses for tumor sites that are well known to be related to ionizing radiation. Are we to accept that among LLNL workers, melanoma is induced by very low doses of ionizing radiation but leukemia is not? What are we to make of the absence of increased incidence for other well-known radiation-sensitive organ sites such as the female breast, thyroid gland, and bone?

Another statement with which I take issue is Austin and Reynolds' conclusion that the results of their study provide "compelling evidence for an occupational component to risk for malignant melanoma" (9, p. 531). As evidenced by their own analyses of occupational and nonoccupational risk factors, the strongest associations that they report are for the presence of moles among the LLNL workers and for history of skin cancer among the parents of cases and among the cases themselves. These findings fall into the general categories of biologic and life-style factors involving solar exposure, which are the most consistent types of risk factors found in other epidemiologic studies of melanoma occurrence. In the future, certain occupational exposures will probably be substantiated as risk factors for melanoma. Attention should be directed to identifying and estimating the amount of risk associated with such exposures, as well as the degree to which biologic and life-style characteristics modify the risk associated with those exposures. Nevertheless, genetic, racial, and life-style risk factors and their interactions with UV sunlight exposures will continue to be of far greater importance for understanding the etiology of the vast majority of malignant melanoma cases.

ACKNOWLEDGMENTS

Supported in part by NIOSH grant nos. R01 OH03274 and R01/CCR612934.

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