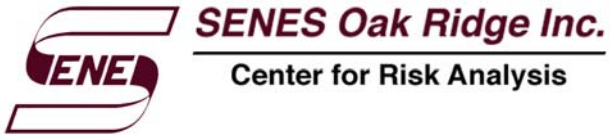
Verification of the NIOSH-IREP Computer Code

Version 5.5.3

July 2009



SENES Oak Ridge, Inc. ● 102 Donner Drive ● Oak Ridge, Tennessee ● 37830 ● Tel: (865) 483-6111

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TABLE OF CONTENTS

APPENDICES

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1. Introduction

On May 2, 2002, the Department of Health and Human Services published its final rule on the guidelines to be used by the Department of Labor (DOL) to determine the probability that a cancer included in a claim under the Energy Employees' Occupational Illness Compensation Program Act of 2000 (EEOICPA; U.S. DHHS 2002) was caused by the worker's exposure to radiation during nuclear weapons production. DOL makes such a determination by estimating the "probability of causation" for each claim using a radiation dose reconstruction completed by the National Institute of Occupational Safety and Health (NIOSH).

To determine probability of causation (PC) for a cancer claim under EEOICPA, DOL uses the NIOSH version of the Interactive Radio-Epidemiological Program (IREP), referred to as NIOSH-IREP, a computer software application developed in collaboration with the National Cancer Institute. This computer software is a science-based tool that allows DOL to determine the probability that a cancer was caused by a person's radiation dose incurred during employment at facilities that support the development, production and testing of nuclear weapons. NIOSH-IREP is tailored to the risks and radiation exposures characteristic of nuclear weapons employees. The actual outcome of a claim depends on a number of important factors such as estimates of the radiation doses from complex exposure histories, the various types of radiation, the age at exposure, gender, the type of cancer and the age at which the cancer was diagnosed.

The methodology for estimation of risk and probability of causation used by NIOSH-IREP was initially developed by a working group of the National Cancer Institute (NCI) and the Centers for Disease Control and Prevention (CDC). The methodology was reviewed internally by NCI and externally by an NCI advisory committee. An additional formal external review was performed by a committee of the National Academy of Sciences (NAS/NRC 2000). The methodology was further reviewed and expanded by the NIOSH Office of Compensation Analysis and Support (NIOSH-OCAS) prior to the adoption of NIOSH-IREP as the main computational tool for estimating PC for individual cancer claims in the EEOICPA compensation program.

The NIOSH-IREP software was adopted and released by NIOSH for use in the EEOICPA compensation program in April 2002. This software has been tested numerous times, by its developers (*SENES* Oak Ridge, Inc.), by NIOSH–OCAS staff (before and after its official release), and by DOL staff who use the code on a daily basis. Comments about the operation of the software have also been received from members of the public who have used NIOSH-IREP. The issues found during testing and the comments received from different users of the code have led to a number of changes to the NIOSH-IREP software. A list of software updates resulting from the comments and from issues found during different phases of testing is available on-line at (www.niosh-irep.com/irep_niosh/update.asp).

This report presents the results of a formal verification effort[1] organized to ensure that the most current version of NIOSH-IREP software (version 5.5.3) calculates risk and probability of causation (PC) according to the methodology agreed upon by NCI and NIOSH. It is important to note that this effort has not attempted to "validate" or question the models and procedures developed by NCI and NIOSH; this effort "verifies" that each part of the NIOSH-IREP code operates according to its intended use described in its technical documentation (NIOSH 2002; Land et al. 2003; Kocher et al. 2008).

An overview of the methodology used to verify that NIOSH-IREP is operating as intended is presented in Section 2. A discussion of the findings, including inconsistencies that were identified, is presented in Section 3. Detailed descriptions of the three phases of testing are given in Sections 4, 5, and 6. Section 7 contains the summary and conclusions. Results of the detailed testing of NIOSH-IREP are presented in the appendices.

[1] The term "verification" refers to the process of determining that the implementation of the methodology in the computer software accurately represents the developer's conceptual description of the models and their solution (in this case, the risk and PC models that describe the relationship between exposure to ionizing radiation and incidence of cancer) (LANL 2004).

2. Overview of the Methodology

The verification efforts described in this report refer to NIOSH-IREP v.5.5.3, the version of the computer code that is currently used by DOL and NIOSH. This verification process was performed by individuals of *SENES* Oak Ridge, Inc. who were not involved in the initial development of the code. The purpose of the verification effort is to ensure that NIOSH-IREP v.5.5.3 operates within the parameters, equations and assumptions of the risk assessment methodology described in the formal documentation of the code (NIOSH 2002; Land et al. 2003; Kocher et al. 2008).

The NIOSH-IREP source code uses the Analytica® programming language and is accessed via an Internet-based user interface. NIOSH-IREP estimates the probability of causation (PC) as PC = ERR/(1+ ERR) where ERR is the excess relative risk of cancer due to previous exposures to radiation. The excess relative risk (ERR) depends on personal information about the exposed individual such as gender, race[2], smoking history[3], and the age at which the cancer was diagnosed. ERR depends also on the exposure history of the exposed individual (i.e., age at exposure, magnitude of radiation doses received, the rate at which doses were delivered and the radiation types involved). The exposure history and personal information are used as input for the risk model associated with the diagnosed cancer (Land et al. 2003; Kocher et al. 2008).

NIOSH-IREP uses Monte-Carlo methods to propagate the uncertainties associated with the parameter values of the risk model and with the parameters of the exposure history. The ERR and PC are estimated as probability distribution functions described numerically by the collection of the ERR and PC values obtained from each Monte-Carlo iteration.

For adjudication of claims in the EEOICPA program, the 99th percentile of PC is compared to a value of 50%. The goal of the verification process is to ensure that the entire probability distributions of ERR and PC, and especially the 99th percentile of ERR and PC, are correctly estimated by the NIOSH-IREP v.5.5.3 computer code. This goal was accomplished by verifying that the equations and numerical data used to calculate

[2] For skin cancer claims only.
[3] For lung cancer claims only.

ERR and PC are correctly implemented in the NIOSH-IREP code, and by comparing the ERR and PC produced by NIOSH-IREP with ERR and PC calculated based on the same risk models encoded in a programming environment independent from Analytica®.

The following steps were taken to test and verify the NIOSH-IREP source code:

1. The mathematical equations of the risk models and any associated numerical data implemented in the NIOSH-IREP source code were compared with the equations described in the documentation of NIOSH-IREP.

2. The mathematical equations and numerical data of the risk models used by NIOSH-IREP were independently programmed using Microsoft Excel® and Crystal Ball®[4], creating a scaled-down version of the code[5] that could be used for verification.

    2a. Values of the risk model parameters closest to the 50th (midpoint) and 99th (upper) percentiles of the ERR and PC produced by NIOSH-IREP were used as input for deterministic calculations in MS Excel, for all cancer types and various selected exposure scenarios. Estimates of the midpoint and upper bound results calculated deterministically in MS Excel were compared to midpoint and upper bound values produced by the NIOSH-IREP code.

    2b. The entire probability distribution functions describing the uncertainty in the ERR and PC for selected cancers and exposure histories were independently produced using MS Excel/Crystal Ball and were compared to the probability distribution functions produced by the NIOSH-IREP code.

[4] Crystal Ball® (Decisioneering 2000) is a specialized software for propagation of uncertainties using Monte-Carlo methods and operates as add-on to MS Excel®

[5] The NIOSH-IREP code is too complex to be easily and completely reprogrammed into a programming environment such as Microsoft Excel®. However, the equations programmed in MS Excel cover, step-by-step, all calculations necessary to estimate probability of causation (PC) starting from a radiation dose received under any assumed single-exposure scenario.

The verification process described above identified three discrepancies between the algorithms implemented in NIOSH-IREP v.5.5.3 and the methodology described in its documentation that required modifications of the source code. The three discrepancies are discussed in detail in Section 3.

The NIOSH-IREP v.5.5.3 source code has been subsequently modified to correct for the three issues identified in Section 3, and the updated version of the software will be referred to in this report as NIOSH-IREP v.5.5.3r (revised). Once the three revisions were made to NIOSH-IREP, the verification steps described above, including the entire set of verification calculations (presented in the appendices), were performed with v.5.5.3r to ensure that the corrections were made properly and that additional discrepancies do not exist.

3.0 Findings of the Verification Exercises

A thorough check of the computer code was performed, involving a line-by-line comparison of the code with the technical documentation that describes how NIOSH-IREP should operate, to ensure that all equations, models, and input parameters have been properly programmed in NIOSH-IREP. In addition, over 400 independent calculations (both deterministic and probabilistic) were performed using a stand-alone, scaled-down version of NIOSH-IREP. In general, the independent testing of NIOSH-IREP v.5.5.3 confirmed that the code operates as intended.

However, the verification effort identified three inconsistencies between the approach implemented in NIOSH-IREP v.5.5.3 and the approach described in its documentation that require modifications of the algorithms implemented in the source code. This section summarizes these findings.

Acute Lymphocytic Leukemia Algorithm

The verification exercises identified that NIOSH-IREP v.5.5.3 contains an algorithm for acute lymphocytic leukemia claims that is programmed incorrectly. For all types of leukemia (including acute lymphocytic leukemia), the dose response obtained from epidemiological data for cases of acute exposure to low-LET radiation is best represented by a linear-quadratic model. A linear dose response should be used for cases of exposure to high-LET radiation or low-LET radiation delivered at low-dose rates (chronic exposures; Land et al. 2003; page 27). If radiation dose is denoted by D, the ERR should be proportional to $[D*(1+D)]$ for acute exposure to low-LET radiation and proportional to D for chronic exposures to low-LET radiation or exposures to high-LET radiation.

Due to a misspelling of the word “lymphocytic” in the source code, NIOSH-IREP v.5.5.3 calculates ERR for acute lymphocytic leukemia as a linear function of dose D for all types of exposure, instead of using the linear-quadratic algorithm for acute exposures to low-LET radiation. This error affects only acute lymphocytic leukemia claims that involved acute exposures to low LET radiation.

The correction of this error has the potential to increase the PC results for acute lymphocytic leukemia claims, if the claim included acute exposures to low-LET radiation. A detailed discussion of this issue and its impact on acute lymphocytic leukemia claims is presented in Appendix A.

Uncertainty in the Modifier for Age Dependency for Selected Cancers

The verification exercises also identified a difference between the IREP source code and its documentation (Land et al. 2003) for the algorithm that describe the uncertainty in the adjustment factor for the dependency of risk on age at exposure and attained age for all cancer types included in Group 2 (also called Approach 2 in Land et al. 2003). Land et al. (2003; page 26) indicate that the uncertainty in the age modifier for Group 2 cancers is described by a lognormal probability distribution with a geometric standard deviation (GSD) given by:

$$GSD=\exp\{[0.0003261\times f(e)^2 -2\times 0.007297\times f(e) \times g(a) +0.5648\times g(a)^2]^{1/2}\}$$

where e = age at exposure

f(e)=-15 for $e\leq 15$; =e-30 for $15 \leq e \leq 30$, and 0 for $e>30$

a = attained age

g(a) = ln(a/50) for $0\leq a\leq 50$, and =0 for $a>50$

The NIOSH-IREP v.5.5.3 code (which was originally programmed in accordance with instructions received from NCI before publication of Land et al. 2003) does not include the multiplier 2 in front of the $-0.007297\times f(e) \times g(a)$ term of the equation above.

For exposures at ages less than 30 and for ages at diagnosis ages less than 50, PC results obtained with the corrected equation are expected to have a slightly lower uncertainty (and thus a slightly lower 99th percentile of PC) than the PC results reported by NIOSH-IREP v.5.5.3. This difference does not affect PC results obtained for any Group 2 cancers diagnosed at ages 50 or older, or for any radiation exposures that occurred at ages 30 or older. A detailed discussion of this issue and its impact on PC results is presented in Appendix A.

Uncertainty in the Modifier for Age Dependency for the NIH Lung Model

The verification exercises further determined that the programming of the algorithm that describes the uncertainty in the adjustment factor for the dependency of risk on age at exposure and attained age for the NIH lung model is different from the algorithm in the documentation of the code (Land et al. 2003).

The age modifier applied to the NIH lung model (Land et al. 2003; page 26) is described by a lognormal distribution with a GSD given by:

$$GSD = \exp\{[0.06250\times s^2 - 2\times 0.0003469\times s\times f(e) + 0.0003301\times f(e)^2 + 2\times 0.008295\times s\times g(a) - 2\times 0.00708\times f(e)\times g(a) + 0.5620\times g(a)^2]^{1/2}\}$$

where s = -0.5 for males and s = +0.5 for females; and f(e) and g(a) are age at exposure (e) and attained age (a) functions described in the previous section:

For males s is -0.5 and GSD becomes:

$$GSD = \exp\{[0.015625 + 2\times 0.00017345\times f(e) + 0.0003301\times f(e)^2 - 2\times 0.0041475\times g(a) - 2\times 0.00708\times f(e)\times g(a) + 0.5620\times g(a)^2]^{1/2}\}$$

For females s is +0.5 and the equation of GSD is:

$$GSD = \exp\{[0.015625 - 2\times 0.00017345\times f(e) + 0.0003301\times f(e)^2 + 2\times 0.0041475\times g(a) - 2\times 0.00708\times f(e)\times g(a) + 0.5620\times g(a)^2]^{1/2}\}$$

In the NIOSH-IREP v.5.5.3 code, the signs (+/-) associated with the f(e) and g(a) terms in the GSD for males are reversed. This has the effect of the expression of GSD for females being applied equally to males. This difference is expected to have only a minimal effect on PC results. A detailed discussion of this issue and its impact on PC results is presented in Appendix A.

4. Verification of Consistency between the Source Code and Its Documentation

A member of the scientific team at *SENES* Oak Ridge, Inc. who had had no prior involvement in the NIOSH-IREP project (Dr. Kathleen Thiessen), served as the independent examiner for investigating the implementation of the code. Dr. Thiessen conducted a study to verify the consistency of the equations, assumptions, and numerical data implemented in the NIOSH-IREP source code, by comparing them with the equations, assumptions, and numerical data included in the formal technical documentation of the code. The primary description of the methodology for NIOSH-IREP is considered to be Land et al. (2003) and Kocher et al. (2005, 2008) with reference to NIOSH (2002) for various details. The review was systematic, involving one section of material at a time. The review concentrated on the parts of the code involved in actual computations (parameter values and distributions, equations, decision points and the main parts for reporting results). Parts of the code used for reporting secondary results, completing summary pages, performing sensitivity or importance analysis, or checking (by the code developers) of sections of the code were not reviewed in detail.

The verification of consistency between the source code and its documentation revealed a number of typographical errors that exist in the published documentation, but which are programmed correctly in the code itself:

a. In the description of the risk model for exposure to radon (Land et al. 2003, page 30) the time since last exposure (t) is said to vary from 5 to 30 years. The correct range of variation for the time since last exposure is 5 to 25 years, as described elsewhere in Land et al. (2003).

b. In the description of the risk model for lung cancer (Land et al. 2003, page 26), the term accounting for the interaction between age at exposure (e) and age at diagnosis (a) is listed with a positive (+) sign, while the same risk model repeated in Table IV.D.3 of Land et al. (2003) has a negative (-) sign for that interaction term. The correct risk model is the one listed in Table IV.D.3 of Land et al. (2003) with a negative (-) sign for the term accounting for the interaction between age at exposure (e) and age at diagnosis (a).

c. In Table IV.D.2 of Land et al. (2003), the 50th percentile of the ERR at 1 Gy for rectal cancer in males is listed as 0.0812, while the correct value is 0.8196 (according to original data files).

d. Kocher et al. (2008, page 136), list the midpoint of the latency period for thyroid cancer as a triangular probability distribution with a minimum of 4.0 years, mode of 4.5 years, and a maximum of 5.5 years [T(4.0, 4.5, 5.5)]. The correct triangular distribution for the midpoint of the latency period for thyroid cancer is a triangular probability distribution with a minimum of 3.0 years (not 4 years), and the same mode of 4.5 years and maximum of 5.5 years [T(3.0, 4.5, 5,5)].

These typographical errors will be corrected by issuing errata statements for each of the supporting documents. However, they do not affect the algorithms, operation, or results of NIOSH-IREP v.5.5.3.

5. Deterministic Verification of Mid and Upper Values of ERR and PC

NIOSH-IREP estimates ERR and PC as probability distribution functions (PDF) which can be interpreted to represent the uncertainty (i.e., the lack of knowledge) about the ERR and PC. These distributions are obtained using Monte-Carlo methods for propagation of uncertainties in all parameters involved in the calculations. A Monte-Carlo method is a numerical approach in which a large number of random samples are generated for each uncertain parameter. The first random sample for the first parameter is combined with the first random sample of all other uncertain parameters to obtain a first estimate of ERR or PC. This process is repeated using a second set of samples, a third set of samples, and so on, until all random samples are used. The iterative process has a number of iterations[6] equal to the number of random samples generated. The collection of all estimates of ERR or PC are summarized as probability distribution functions (PDF) for ERR or PC, respectively. The PDFs are used to estimate any desired percentiles for ERR and PC (e.g., to obtain estimates of the 99th percentile of PC, which is required for the adjudication of individual claims in the EEOICPA program.)

The purpose of the deterministic calculations presented in this section is to verify that the NIOSH-IREP code operates correctly for specific iterations of the Monte-Carlo process. Because the computing time for a single-iteration calculation is small, this verification step has been applied to every cancer type, for both males and females and for a number of selected ages at exposure and ages at diagnosis. For all cases analyzed, the verification has been carried out for two selected iterations from the PDFs obtained with NIOSH-IREP. One of the selected iterations is that which produces a result closest to the 99th percentile (referred to as "upper" throughout this report) of ERR and PC for each studied case. The other selected iteration is that which leads to a result closest to the 50th percentile of ERR and PC (referred to as "mid" throughout this report).

[6] Normally, NIOSH-IREP is operated by DOL and NIOSH using Monte-Carlo runs of 2000 iterations. When the 99th percentile of PC is between 45% and 52%, 30 Monte-Carlo runs of 10,000 iterations each are used.

A verification of the uncertainty propagation algorithms using probabilistic calculations relying on the full Monte-Carlo method was performed for a few selected cancer types, as described in Section 6.

To perform the deterministic verification calculations for ERR and PC, the equations and data documented in Land et al. (2003) and Kocher et al. (2008) were programmed independently in a spreadsheet-based format (Microsoft Excel®). While NIOSH-IREP was not completely re-programmed in a spreadsheet programming environment, the equations programmed in MS Excel include all the steps necessary to estimate ERR and PC starting from a radiation dose received under any assumed single-exposure scenario. A version of the model was also programmed in MS Excel to allow the estimation of ERR and PC from up to 5 exposures (see Section 5.8).

The primary goal of the calculations that were programmed in MS Excel was to assure that the general equations used by NIOSH-IREP were programmed correctly. Two sets of calculations have been performed to produce ERR and PC, but also report several additional intermediate results. Input parameters (obtained from the relevant distributions) used in NIOSH-IREP (v.5.5.3r) to generate results closest to the 50^{th} and 99^{th} percentile values for selected scenarios (defined by cancer type, age, gender, etc.) were used as the input values for the deterministic calculations.

The calculations have been separated into eight sets, each targeted to verify a different aspect of the ERR and PC calculation:

- testing of primary equations for each cancer type
- testing of the equations for minimum latency period
- testing of the implementation of the radiation effectiveness factor
- testing of the implementation of the dose and dose rate effectiveness factor
- testing for the effect of ethnic origin on risk of skin cancer
- testing for the effect of smoking on risk of lung cancer for non-radon exposures
- testing for the effect of smoking on the risk of lung cancer for radon exposures
- testing of the implementation of equations used for multiple exposures

The following sub-sections are dedicated to each of the eight sets of deterministic verification calculations. The results of the deterministic calculations are provided in Appendices B through I. For each calculation, results from NIOSH-IREP v.5.5.3r and the MS Excel calculator are presented side by side for comparison.

5.1 Testing Primary Equations for Each Cancer Type

This set of verification calculations is the most comprehensive group of deterministic calculations, covering all cancer types, both genders and a relevant selection of age at exposure and age at diagnosis.

The cancer types in NIOSH-IREP can be divided into four groups (Kocher et al. 2008). Cancers in Group 1 and 2 have risk models indicating that, for a given age at diagnosis, the risk decreases with increasing age at exposure between ages 15 and 30, with risk being constant for exposures at ages greater than 30. For a given age at exposure, the risk for Group 1 and 2 cancers decreases linearly with increasing age at diagnosis up to age 50, after which risk is constant. The verification calculations for Group 1 and 2 cancers include four scenarios which combine ages at exposure 20 and 40 and ages at diagnosis of 40 and 60, with one scenario for each interval with a specific variation of risk with age.

The combinations of ages at exposure and attained ages for Groups 1 and 2 were also applied for Group 3 cancers, for which the risk models indicate that the risk is constant for all ages at exposure and all ages at diagnosis.

The skin cancers (malignant melanoma, basal cell and squamous cell carcinoma) are part of Group 4. For a given age at diagnosis, their risk decreases with increasing age at exposure between ages 10 and 40, with risk being constant for exposures at ages greater than or equal to 40. The risk of skin cancer does not change with age at diagnosis. Thus, for skin cancers, exposure scenarios with the same combinations of ages at exposure and attained ages used for Groups 1 and 2 have been applied.

For the other five cancers in Group 4 (thyroid, leukemia, ALL, AML, and CML), four exposure scenarios were defined using ages at exposure 20 and 60 and ages at diagnosis 40 and 80 (Table 1). The risk of thyroid cancer does not depend on attained age, but it decreases with increasing age at exposure up to age 55, beyond which the risk is constant. The risk for all leukemia (less CLL), for a fixed time since exposure, decreases with increasing age at exposure up to age 55 and is constant afterwards. The risk of acute lymphocytic leukemia (ALL) is constant for ages at exposure greater than

20, but for ages at exposure less than 20 it decreases exponentially with increasing time since exposure between 5 and 50 years after exposure, beyond which it is constant. Other than ALL, the risk for any of the leukemia types always decreases with increasing time since exposure between 5 and 50 years after exposure, and is constant outside this interval.

All thirty-two cancers listed in NIOSH-IREP were used in this set of verification calculations. Twenty-eight of the cancers had four scenarios; four of the cancers had three scenarios (three of the cancers specific to females and one to males).

All calculations assume a single acute radiation exposure to a dose of 20 cSv of high energy photons (E >250 keV). The radiation type was set to high energy photons (E > 250 keV) because the radiation effectiveness factor (REF) for this radiation type is equal to 1.0 (i.e., no adjustments due to radiation type are needed). Exposure scenarios which include exposures to radiation types with an REF different than 1.0 are addressed in detail in Section 5.3. Similarly, a photon dose of 20 cSv delivered acutely was selected because the application of a DDREF is not necessary for such a dose. A detailed verification of the application of the DDREF is covered in Section 5.4.

Table 1 presents a list of the scenarios considered for this set of deterministic calculations and provides the pages in Appendix B where the results are shown. Table 1 also includes an indication of whether a particular cancer model is dependent on age at exposure, attained age (age at which a cancer was diagnosed), gender, or time since exposure (number of years between exposure and diagnosis). A total of 124 calculations were performed for this specific verification task.

The ERR and PC results obtained with MS Excel verify that the mid and upper estimates given by NIOSH-IREP v.5.5.3r are correct, for all cancer types, both genders and for all exposure scenarios considered.

Table 1. Cancer types and exposure scenarios used for general verification calculations.

Run ID	Cancer Type	Page number in Appendix B			
		AAE[a]=20 ATA[a]=60 Male	AAE=40 ATA=60 Male	AAE=20 ATA=40 Male	AAE=20 ATA=60 Female
1	Oral Cavity and Pharynx	B-1	B-2	B-3	B-4
2	Esophagus	B-5	B-6	B-7	B-8
3	Stomach	B-9	B-10	B-11	B-12
4	Colon	B-13	B-14	B-15	B-16
5	Rectum	B-17	B-18	B-19	B-20
6	All digestive	B-21	B-22	B-23	B-24
7	Liver	B-25	B-26	B-27	B-28
8	Gallbladder	B-29	B-30	B-31	B-32
9	Pancreas	B-33	B-34	B-35	B-36
10	Lung[b]	B-37	B-38	B-39	B-40
11	Other respiratory	B-41	B-42	B-43	B-44
12	Bone	B-45	B-46	B-47	B-48
13	Connective tissue	B-49	B-50	B-51	B-52
14	Malignant melanoma[c]	B-53	B-54	B-55	B-56
15	Non-melanoma (BCC)[c]	B-57	B-58	B-59	B-60
16	Non-melanoma (SCC)[c]	B-61	B-62	B-63	B-64
17	All Male Genitalia	B-65	B-66	B-67	---
18	Bladder	B-68	B-69	B-70	B-71
19	Urinary organs (less bladder)	B-72	B-73	B-74	B-75
20	Eye	B-76	B-77	B-78	B-79
21	Nervous system	B-80	B-81	B-82	B-83
22	Other endocrine	B-84	B-85	B-86	B-87
23	Other and ill-defined sites	B-88	B-89	B-90	B-91
24	Lymphoma & multiple myeloma	B-92	B-93	B-94	B-95

Run ID	Cancer Type	AAE=20 ATA=80 Male	AAE=60 ATA=80 Male	AAE=20 ATA=40 Male	AAE=20 ATA=80 Female
25	Thyroid	B-96	B-97	B-98	B-99
26	Leukemia	B-100	B-101	B-102	B-103
27	Acute Lymphocytic Leukemia	B-104	B-105	B-106	B-107
28	Acute Myeloid Leukemia	B-108	B-109	B-110	B-111
29	Chronic Myeloid Leukemia	B-112	B-113	B-114	B-115

Run ID	Cancer Type	AAE=20 ATA=60 Female	AAE=40 ATA=60 Female	AAE=20 ATA=40 Female
30	Breast	B-116	B-117	B-118
31	Ovary	B-119	B-120	B-121
32	Female Genitalia (less ovary)	B-122	B-123	B-124

[a] AAE = Age at exposure; ATA = Attained age (age at which cancer was diagnosed)

[b] Calculations in Appendix B are representative of the NIOSH lung model. Calculations for the combined (NIOSH and NIH) lung model are described in Section 5.6, and calculations for the lung model used for radon exposures are described in Section 5.7.

[c] Calculations in Appendix B represent White-non-Hispanic; Calculations for other races are described in Section 5.5.

5.2 Testing Equations for Minimum Latency Period

A specific set of calculations was made to verify that the algorithms describing the minimum latency period have been implemented correctly. The minimum latency period represents the minimum time required for a cancer to be observed in a population following a radiation exposure.

In NIOSH-IREP, the excess relative risk for a given cancer is multiplied by an adjustment factor (an S-shaped function of time) to account for the latency period. This function increases from 0 (at the time of exposure) to 1 (after a transition period) and is dependent on cancer type. The latency adjustment is applied for exposures that occurred (1) within 5 years before a diagnosed leukemia, (2) within 8 years before a diagnosed thyroid or bone cancer, and (3) within 11 years before all other solid tumors.

Calculations were completed for leukemia (representative of all types of leukemia), thyroid (also representative of bone cancer), and colon (representative of all other solid tumors) to ensure that the minimum latency period adjustment was programmed properly for each type of cancer.

Calculations were performed for males and females receiving an acute dose of 20 cSv from high energy photons, E > 250 keV. The assumption of an acute exposure to high energy photons causes the radiation effectiveness factor (REF) and the dose and dose rate effectiveness factor (DDREF) to be equal to 1.0. It should also be noted that the level of dose does not affect the minimum latency period adjustment.

Because the latency adjustment is independent of age at time of exposure (AAE), the AAE was kept constant at 20 years. Five different scenarios were considered related to the number of years after exposure that the cancer was diagnosed. The times since exposure (TSE) used for these calculations are 2, 3, 5, 10, and 15 years.

A total of 30 calculations was performed for this specific verification task. Table 2 summarizes the scenarios used in these calculations and presents the page numbers in Appendix C where the results are shown. The results obtained with MS Excel verify that the mid and upper estimates given by NIOSH-IREP v.5.5.3r are correct, for all cancer types, both genders and for all exposure scenarios considered.

Table 2. Cancer types and exposure scenarios[a] used for verification of the implementation of the minimum latency period.

Run Identifier	Gender	TSE[b] (years)	Appendix Page
Leukemia			
latency_leu_m1	Male	2	C-1
latency_leu_m2	Male	3	C-2
latency_leu_m3	Male	5	C-3
latency_leu_m4	Male	10	C-4
latency_leu_m5	Male	15	C-5
latency_leu_f1	Female	2	C-6
latency_leu_f2	Female	3	C-7
latency_leu_f3	Female	5	C-8
latency_leu_f4	Female	10	C-9
latency_leu_f5	Female	15	C-10
Thyroid			
latency_thy_m1	Male	2	C-11
latency_thy_m2	Male	3	C-12
latency_thy_m3	Male	5	C-13
latency_thy_m4	Male	10	C-14
latency_thy_m5	Male	15	C-15
latency_thy_f1	Female	2	C-16
latency_thy_f2	Female	3	C-17
latency_thy_f3	Female	5	C-18
latency_thy_f4	Female	10	C-19
latency_thy_f5	Female	15	C-20
Colon			
latency_col_m1	Male	2	C-21
latency_col_m2	Male	3	C-22
latency_col_m3	Male	5	C-23
latency_col_m4	Male	10	C-24
latency_col_m5	Male	15	C-25
latency_col_f1	Female	2	C-26
latency_col_f2	Female	3	C-27
latency_col_f3	Female	5	C-28
latency_col_f4	Female	10	C-29
latency_col_f5	Female	15	C-30

[a] All exposure scenarios assume a single acute exposure to high-energy photons at age 20.

[b] Each cancer is assumed to be diagnosed between 2 and 15 years after exposure, given as time since exposure (TSE).

5.3 Testing Implementation of the Radiation Effectiveness Factor

A series of calculations have been made to verify that the radiation effectiveness factor (REF) is implemented correctly in NIOSH-IREP. Radiation doses are entered in NIOSH-IREP by radiation type, and IREP converts an organ equivalent dose for a given radiation type in cSv to an absorbed dose (Gy). The radiation effectiveness factor (REF), which represents the biological effectiveness of a given radiation type, is used to modify the absorbed dose.

The equation used to estimate ERR (and thus PC) depends on the radiation and cancer type of concern. For solid cancers, a different equation is used in cases of exposure to photons, electrons, or alpha particles than is used in cases of exposure to neutrons. For leukemia, different equations are used in cases of acute exposure to photons or electrons than are used in cases of chronic exposure to photons or electrons or any exposures to alpha particles or neutrons. A set of calculations have been made, for each of the 11 radiation types defined in NIOSH-IREP, to test the implementation of the REF in cases of leukemia from acute or chronic exposures. An additional set of calculations was performed to test the equations for solid cancers (represented by colon cancer) resulting from acute or chronic exposures.

The equations related to REF do not depend on gender or on the value of the dose; therefore, all calculations were performed for males with an organ equivalent dose of 20 cSv. The age at time of exposure (AAE) was kept constant at 20 years of age, and the age at diagnosis or attained age (ATA) was kept constant at 40 years of age.

A total of 44 calculations was performed for this specific verification task. Table 3 summarizes the scenarios used in these calculations and presents the page numbers in Appendix D where the results are shown. The results obtained with MS Excel verify that the mid and upper estimates given by NIOSH-IREP v.5.5.3r are correct, for all cancer types and for all exposure scenarios considered.

Table 3. Cancer types and exposure scenarios[a] used for verification of the implementation of the radiation effectiveness factor.

Run Identifier	Radiation Type	Appendix Page			
		Leukemia		Colon	
		Acute	Chronic	Acute	Chronic
REF_e1	electrons E < 15 keV	D-1	D-2	D-3	D-4
REF_e2	electrons E > 15 keV	D-5	D-6	D-7	D-8
REF_p1	photons E < 30 keV	D-9	D-10	D-11	D-12
REF_p2	photons E = 30 – 250 keV	D-13	D-14	D-15	D-16
REF_p3	photons E > 250 keV	D-17	D-18	D-19	D-20
REF_n1	neutrons E < 10 keV	D-21	D-22	D-23	D-24
REF_n2	neutrons E = 10 – 100 keV	D-25	D-26	D-27	D-28
REF_n3	neutrons E = 100 keV – 2 MeV	D-29	D-30	D-31	D-32
REF_n4	neutrons E = 2 – 20 MeV	D-33	D-34	D-35	D-36
REF_n5	neutrons E > 20 MeV	D-37	D-38	D-39	D-40
REF_a	alpha	D-41	D-42	D-43	D-44

[a] All exposure scenarios assume a single acute exposure to high-energy photons (E > 250 keV). The exposure is assumed to occur to a male of age 20, with the cancer being diagnosed at age 40.

5.4 Testing Implementation of the Dose and Dose Rate Effectiveness Factor

A set of calculations was performed to verify that the dose and dose rate effectiveness factor (DDREF) has been implemented correctly in NIOSH-IREP. In NIOSH-IREP, the ERR/Sv for all solid cancers (including lymphoma and multiple myeloma) resulting from exposure to low-LET radiations is assumed to depend on dose and dose rate. The DDREF is applied to estimates of ERR/Sv at high doses and high dose rates of high-energy photons in atomic-bomb survivors in order to estimate the ERR/Sv at low doses or low dose rates.

In NIOSH-IREP, the value of the DDREF is applied as a function of the exposure rate (acute or chronic). The DDREF is applied to all chronic exposures. For an acute exposure, the DDREF is applied differently for doses less than 20 cSv than for doses larger than 20 cSv. To test all possible applications of DDREF, a series of calculations has been performed for chronic and acute exposures to each radiation type, assuming doses of 5 cSv and 30 cSv.

The probability distribution of the DDREF in NIOSH-IREP is different for thyroid and breast cancers than for all other solid tumors. No DDREF is applied for any type of leukemia. Thus, separate verification calculations were performed for thyroid cancer, breast cancer, and colon cancer. (Colon cancer was selected to represent solid tumors other than breast and thyroid). The age at exposure (AAE) was kept constant at 20 years of age, and the age at diagnosis (attained age, ATA) was kept constant at 40 years of age. Because the DDREF is independent of gender, males were used for thyroid and colon cancer calculations; however females were used for breast cancer calculations.

A total of 132 calculations was performed for this specific verification task. Table 4 summarizes the scenarios used in these calculations and presents the page numbers in Appendix E where the results are shown. The results obtained with MS Excel verify that the mid and upper estimates given by NIOSH-IREP v.5.5.3r are correct, for all cancer types and for all exposure scenarios considered.

Table 4. Cancer types and exposure scenarios[a] used for verification of the implementation of the dose and dose rate effectiveness factor.

Run Identifier	Radiation Type	Appendix Page			
		Acute dose		Chronic dose	
		5 cSv	30 cSv	5 cSv	30 cSv
Thyroid					
DDREF_e1	electrons E < 15 keV	E-1	E-2	E-3	E-4
DDREF_e2	electrons E > 15 keV	E-13	E-14	E-15	E-16
DDREF_p1	photons E < 30 keV	E-25	E-26	E-27	E-28
DDREF_p2	photons E = 30 – 250 keV	E-37	E-38	E-39	E-40
DDREF_p3	photons E > 250 keV	E-49	E-50	E-51	E-52
DDREF_n1	neutrons E < 10 keV	E-61	E-62	E-63	E-64
DDREF_n2	neutrons E = 10 – 100 keV	E-73	E-74	E-75	E-76
DDREF_n3	neutrons E = 100 keV – 2 MeV	E-85	E-86	E-87	E-88
DDREF_n4	neutrons E = 2 – 20 MeV	E-97	E-98	E-99	E-100
DDREF_n5	neutrons E > 20 MeV	E-109	E-110	E-111	E-112
DDREF_a	alpha	E-121	E-122	E-123	E-124
Colon					
DDREF_e1	electrons E < 15 keV	E-5	E-6	E-7	E-8
DDREF_e2	electrons E > 15 keV	E-17	E-18	E-19	E-20
DDREF_p1	photons E < 30 keV	E-29	E-30	E-31	E-32
DDREF_p2	photons E = 30 – 250 keV	E-41	E-42	E-43	E-44
DDREF_p3	photons E > 250 keV	E-53	E-54	E-55	E-56
DDREF_n1	neutrons E < 10 keV	E-65	E-66	E-67	E-68
DDREF_n2	neutrons E = 10 – 100 keV	E-77	E-78	E-79	E-80
DDREF_n3	neutrons E = 100 keV – 2 MeV	E-89	E-90	E-91	E-92
DDREF_n4	neutrons E = 2 – 20 MeV	E-101	E-102	E-103	E-104
DDREF_n5	neutrons E > 20 MeV	E-113	E-114	E-115	E-116
DDREF_a	alpha	E-125	E-126	E-127	E-128
Breast					
DDREF_e1	electrons E < 15 keV	E-9	E-10	E-11	E-12
DDREF_e2	electrons E > 15 keV	E-21	E-22	E-23	E-24
DDREF_p1	photons E < 30 keV	E-33	E-34	E-35	E-36
DDREF_p2	photons E = 30 – 250 keV	E-45	E-46	E-47	E-48
DDREF_p3	photons E > 250 keV	E-57	E-58	E-59	E-60
DDREF_n1	neutrons E < 10 keV	D69	E-70	E-71	E-72
DDREF_n2	neutrons E = 10 – 100 keV	E-81	E-82	E-83	E-84
DDREF_n3	neutrons E = 100 keV – 2 MeV	E-93	E-94	E-95	E-96
DDREF_n4	neutrons E = 2 – 20 MeV	E-105	E-106	E-107	E-108
DDREF_n5	neutrons E > 20 MeV	E-117	E-118	E-118	E-120
DDREF_a	alpha	E-129	E-130	E-131	E-132

[a] The exposure is assumed to occur at age 20, with the cancer being diagnosed at age 40.

5.5 Testing the Effect of Ethnic Origin on Risk of Skin Cancer

Separate independent calculations have been made to verify that the adjustment accounting for the interaction between ionizing and UV radiation is implemented correctly in NIOSH-IREP. This interaction is modeled in NIOSH-IREP by accounting for ethnic differences in baseline risks of skin cancer for applying ERRs in Japanese atomic-bomb survivors to the U.S. population. This interaction applies to three types of skin cancer: malignant melanoma, basal cell carcinoma, and squamous cell carcinoma.

The effect of ethnic origin does not depend on age, radiation type, or exposure rate (acute or chronic). Thus, the calculations performed for this exercise assume an acute exposure to high energy photons (E>250 keV), the age at exposure (AAE) was kept constant at 20 years, and the attained age (ATA) was kept constant at 40 years. The verification calculations were performed for males only under the assumption of a single acute exposure to a dose of 20 cSv.

A total of 15 calculations was performed for this specific verification task. Table 5 summarizes the scenarios used in these calculations and presents the page numbers in Appendix F where the results are shown. The results obtained with MS Excel verify that the mid and upper estimates given by NIOSH-IREP v.5.5.3r are correct, for all cancer types and for all exposure scenarios considered.

Table 5. Cancer types and exposure scenarios[a] used for verification of the implementation of the effect of ethnic origin.

Run Identifier	Ethnic origin	Appendix Page #
Malignant Melanoma		
Ethnic_MM_1	American Indian	F-1
Ethnic_MM_2	Asian	F-2
Ethnic_MM_3	Black	F-3
Ethnic_MM_4	Hispanic	F-4
Ethnic_MM_5	White non-Hispanic	F-5
Non-melanoma Basal Cell Carcinoma		
Ethnic_BCC_1	American Indian	F-6
Ethnic_BCC_2	Asian	F-7
Ethnic_BCC_3	Black	F-8
Ethnic_BCC_4	Hispanic	F-9
Ethnic_BCC_5	White non-Hispanic	F-10
Non-melanoma Squamous Cell Carcinoma		
Ethnic_SCC_1	American Indian	F-11
Ethnic_SCC_2	Asian	F-12
Ethnic_SCC_3	Black	F-13
Ethnic_SCC_4	Hispanic	F-14
Ethnic_SCC_5	White non-Hispanic	F-15

[a] All scenarios are for a male acutely exposed to 20 cSv of high-energy photons (E > 250 keV) at age 20, with the cancer being diagnosed at age 40.

5.6 Testing the Effect of Smoking on the Risk of Lung Cancer for non-Radon Exposures

A set of calculations has been performed to ensure that the interaction effect between smoking and radiation exposures (non-radon) has been properly programmed in NIOSH-IREP for estimating the risk of lung cancer. NIOSH-IREP incorporates two risk models for lung cancer (the NIH lung model and the pre-2006 NIOSH lung model). The lung cancer model used by NIOSH-IREP is referred to as a "combined" lung model.

Both models to estimate risk for lung cancer due to sources of exposure other than radon take into account an interaction between radiation and smoking history. The calculations have been performed to test the combined lung model and report the 99th percentile PC value that is the largest of the two methods.

Calculations were performed separately for males and females and assume an acute exposure to 20 cSv of high energy photons, E > 250 keV. The age at exposure (AAE) was kept constant at 20 years of age, and the attained age (ATA) was kept constant at 40 years of age. A total of 14 calculations was performed for this specific verification task. Table 6 summarizes the scenarios used in these calculations and presents the page numbers in Appendix G where the results are provided. The results obtained with MS Excel verify that the mid and upper estimates given by NIOSH-IREP v.5.5.3r are correct for both genders and for all exposure scenarios considered.

Table 6. Exposure scenarios[a] used to verify the implementation of the smoking interaction for non-radon exposures.

		Appendix Page #	
Run Identifier	**Smoking Category**	**Male**	**Female**
Lung_other_1	Never smoked	G-1	G-8
Lung_other_2	Former smoker	G-2	G-9
Lung_other_3	?? cigarettes/day	G-3	G-10
Lung_other_4	<10 cigarettes/day	G-4	G-11
Lung_other_5	10-19 cigarettes/day	G-5	G-12
Lung_other_6	20-39 cigarettes/day	G-6	G-13
Lung_other_7	>40 cigarettes/day	G-7	G-14

[a] All scenarios are for an acute exposure to 20 cSv of high-energy photons (E > 250 keV) at age 20, with the cancer being diagnosed at age 40.

5.7 Testing the Effect of Smoking on the Risk of Lung Cancer for Radon Exposures

A series of calculations has been performed to ensure that the interaction effect between smoking and radon exposures has been properly programmed in NIOSH-IREP for estimating the risk of lung cancer. The risk for lung cancer due to exposure to radon is modeled as a function of the cumulative exposure to short-lived, alpha-emitting decay products in units of working level months (WLM).

Although the radon risk model used in NIOSH-IREP is assumed to be independent of gender, calculations were performed separately for males and females, for purposes of verification. As in the models for lung cancer due to sources of exposure other than radon, ERRs for lung cancer due to exposure to radon are assumed to depend on smoking history. However, only two smoking categories are specified in the risk methodology—smokers and nonsmokers (Land et al. 2003).

Smoking history was defined as "never smoked" (to represent a nonsmoker) or having a smoking history of between 20 and 39 cigarettes per day (to represent a smoker). The age at exposure (AAE) was varied between 20 and 75 years, while the attained age (ATA) was varied between 40 and 80 years.

A total of 36 calculations was performed to verify this specific task. Table 7 summarizes the scenarios used in these calculations and provides the page numbers in Appendix H where the detailed results for this exercise are found. The results obtained with MS Excel verify that the mid and upper estimates given by NIOSH-IREP v.5.5.3r are correct, for both genders and for all exposure scenarios considered.

Table 7. Exposure scenarios[a] used to verify the implementation of the smoking interaction for radon exposures.

Run Identifier	AAE[b]	ATA[c]	Appendix Page # Male	Appendix Page # Female
Non-Smoker				
Lung_radon_ns_1	20	40	H-1	H-19
Lung_radon_ns_2	35	40	H-2	H-20
Lung_radon_ns_3	20	60	H-3	H-21
Lung_radon_ns_4	40	60	H-4	H-22
Lung_radon_ns_5	55	60	H-5	H-23
Lung_radon_ns_6	20	80	H-6	H-24
Lung_radon_ns_7	40	80	H-7	H-25
Lung_radon_ns_8	60	80	H-8	H-26
Lung_radon_ns_9	75	80	H-9	H-27
Smoker (20-39 cigarettes/day)				
Lung_radon_sm_1	20	40	H-10	H-28
Lung_radon_sm_2	35	40	H-11	H-29
Lung_radon_sm_3	20	60	H-12	H-30
Lung_radon_sm_4	40	60	H-13	H-31
Lung_radon_sm_5	55	60	H-14	H-32
Lung_radon_sm_6	20	80	H-15	H-33
Lung_radon_sm_7	40	80	H-16	H-34
Lung_radon_sm_8	60	80	H-17	H-35
Lung_radon_sm_9	75	80	H-18	H-36

[a] All scenarios are for a radon exposure at a level of 1 WLM
[b] AAE = Age at exposure
[c] ATA = Attained age (age at which cancer was diagnosed)

5.8 Testing the Implementation of Multiple Exposures Algorithms

NIOSH-IREP has the capability to estimate probability of causation from up to 1,000 exposures. A series of calculations has been performed to ensure that NIOSH-IREP properly estimates PC in cases involving multiple radiation exposures.

A series of 5 calculations was performed for this verification task. Various combinations of gender, cancer type, age at time of exposure, time exposure and diagnosis, organ dose, exposure rate, and radiation type were chosen. Five exposures were assumed for the first 4 scenarios and three exposures were assumed for the 5th scenario. The details of each scenario are described in the results tables presented in Appendix I.

Table 8 summarizes the scenarios used in these calculations and provides the page numbers where the detailed results for this exercise are found. The results obtained with MS Excel verify that the mid and upper estimates given by NIOSH-IREP v.5.5.3r are correct for both genders and for all exposure scenarios considered.

Table 8. Exposure scenarios used to verify the implementation of multiple exposure algorithms.

			NIOSH-IREP v.5.5.3r		MS Excel Calculation	
Run Identifier	**Cancer Type**	**No. of Exposures**	**Mid**	**Upper**	**Mid**	**Upper**
Mult Exp 1	Colon	5	I-1	I-2	I-3	I-4
Mult Exp 2	Breast	5	I-5	I-6	I-7	I-8
Mult Exp 3	Thyroid	5	I-9	I-10	I-11	I-12
Mult Exp 4	Skin (BCC)	5	I-13	I-14	I-15	I-16
Mult Exp 5	Liver	3	I-17	I-18	I-19	I-20

6. Verification of Monte-Carlo Uncertainty Propagation Algorithms

The deterministic calculations described in Section 5 of this report verify that NIOSH-IREP operates correctly for at least two iterations of the Monte-Carlo method for propagation of uncertainties; that is, for the iteration that produces a result closest to the 50th percentile of ERR and PC and for the iteration that produces a result closest to the 99th percentile of ERR and PC.

The purpose of the calculations discussed in this section is to verify that the Monte-Carlo uncertainty propagation algorithm used in NIOSH-IREP operates properly. In these verification calculations, probability distribution functions for ERR and PC produced by NIOSH-IREP are compared to probability distribution functions for ERR and PC obtained from the independent programming of the risk models into Microsoft Excel® combined with Crystal Ball®. The risk models programmed in MS Excel/Crystal Ball contain all parameters defined using the probability distributions listed in the technical documentation of NIOSH-IREP (NIOSH 2002; Land et al. 2003; Kocher et al. 2008).

The verification calculations based on Monte-Carlo sampling procedures are affected by random noise introduced by this numerical sampling method. For example, DOL normally analyzes claims using NIOSH-IREP with Monte-Carlo runs having sample size of 2,000 iterations. In these cases, the 99th percentile of PC can vary by several percentage points if the random seed of the Monte-Carlo sampling procedure is changed. However, for claims in which the 99th percentile of PC from a Monte-Carlo sample size of 2,000 is between 45% and 52%, DOL uses the Enterprise Edition[7] of NIOSH-IREP to produce 30 Monte-Carlo runs of 10,000 iterations each. In this case, the margin of error for the 99th percentile of PC is only about ±0.5 percentage points (i.e., a PC_{99} that is truly equal to 50% may be between a reported PC_{99} of 49.5% and 50.5%). For percentiles closer to the center of the probability distribution, the margin of error is much smaller than the margin of error of the 99th percentile.

[7] The Enterprise Edition of NIOSH-IREP uses the same version of the NIOSH-IREP source code (e.g., v.5.5.3r), but allows the user to repeat runs a number of times. The Enterprise Edition is designed to run NIOSH-IREP thirty times, each run having a sample size of 10,000, and initiated with a different random number seed. The 99th percentile of the combined 30 × 10,000 iterations is obtained as the average of the 99th percentiles from each of the 30 individual 10,000-iteration runs.

An important aspect of this verification exercise is that the random number generators used by Analytica® (the programming language for NIOSH-IREP) and MS Excel/Crystal Ball are different. In addition, NIOSH-IREP uses a Median Latin Hypercube Sampling (LHS) technique, while Crystal Ball® uses a slightly different Random Latin Hypercube Sampling (LHS) technique. This means that, if for a given calculation NIOSH-IREP uses one sequence of random numbers, the exact same calculation in MS Excel/Crystal Ball, using exactly the same random seed, will produce a different set of random numbers. This difference in random numbers has a similar effect to the effect introduced by simply changing the random seed in NIOSH-IREP. Thus, two Monte-Carlo calculations, one in NIOSH-IREP and one in MS Excel/Crystal Ball are not identical, but they should not differ by more than the margin of error for a Monte-Carlo operation (as discussed above).

Verification calculations for this section were performed first using a LHS sample size of 2,000 followed by 30 individual runs of 10,000 iterations each. Comparisons based on the 30 runs of 10,000 iterations minimize the differences in ERR and PC due to differences in the random number generator used by the Analytica® and Crystal Ball® software packages. Because the same Monte-Carlo uncertainty propagation algorithm in NIOSH-IREP applies to all cancers types and exposure scenarios, verification calculations presented in this section were performed only for a few selected cancer types (oral cavity, colon, bladder, and nervous system) and for two combinations of ages at exposure and ages at diagnosis (Table 9). All scenarios considered for this set of verification calculations represent males exposed to an acute dose of 20 cSv of high energy photons (E > 250 keV).

Table 9 summarizes the exposure scenarios and pages in Appendix J where the detailed results can be found. The results of the Monte-Carlo calculations are presented both in tabular and graphical form (Appendix J). The tables of results show the 1^{st}, 5^{th}, 50^{th}, 95^{th} and 99^{th} percentiles of the probability distributions obtained by Monte-Carlo methods in NIOSH-IREP and in MS Excel/Crystal Ball for each of the 30 runs of 10,000 iterations and show the average of the 30 runs at each of the five percentiles selected for verification testing. The graphs included in Appendix J are probability plots comparing

the entire probability distributions for ERR and PC produced by NIOSH-IREP and by MS Excel/Crystal Ball using a Monte-Carlo LHS sample size of 2,000.

The results in Appendix J show that the probability distributions for ERR and PC produced by NIOSH-IREP were successfully reproduced by independent programming of the risk models in MS Excel/Crystal Ball. Any percentile of the probability distributions for ERR and PC produced by MS Excel/Crystal Ball was not different from the same percentile produced by NIOSH-IREP by more than the margin of error introduced by the random noise of the Monte-Carlo method. This was true for either a regular 2,000-iteration run, or cases in which 30 runs of 10,000 iterations were used. The verification calculations produced for this report indicate that the Monte-Carlo uncertainty propagation algorithm in NIOSH-IREP operates properly.

Table 9. Exposure scenarios[a] used for verification of Monte-Carlo uncertainty propagation algorithms

				Appendix Page		
				Tabular Results[d]		**Graphs[e]**
Case	**Cancer Type**	**AAE[b]**	**ATA[c]**	**ERR**	**PC**	**ERR&PC**
1	Oral Cavity & Pharynx	40	60	J-1	J-2	J-4
2	Colon	20	60	J-5	J-6	J-8
3	Bladder	40	60	J-9	J-10	J-12
4	Nervous System	20	60	J-13	J-14	J-16

[a] All scenarios represent males exposed to an acute and constant dose of 20 cSv of high energy photons (E > 250 keV).

[b] AAE = Age at exposure

[c] ATA = Attained age (age at which cancer was diagnosed)

[d] Tabular results compare the 1st, 5th, 50th, 95th, and 99th percentiles from 30 runs of 10,000 iterations each.

[e] Graphical results compare the entire probability distribution from a single run of 2,000 iterations.

7. Summary and Conclusions

This report presents the results of a formal verification exercise designed to ensure that the most current version of the NIOSH-IREP software calculates risk and the probability of causation (PC) according to the methodology described in its technical documentation (NIOSH 2002; Land et al. 2003; Kocher et al. 2008).

The NIOSH-IREP methodology for estimation of risk and probability of causation was developed by a working group of the National Cancer Institute (NCI) and the Centers for Disease Control and Prevention (CDC), and it was reviewed internally by NCI and externally by an NCI advisory committee, by a committee of the National Academy of Sciences (NAS), and by the NIOSH Office of Compensation Analysis and Support (NIOSH-OCAS) prior to the adoption of NIOSH-IREP as the main computational tool in the EEOICPA compensation program.

The NIOSH-IREP software itself has been tested numerous times by its developers (*SENES* Oak Ridge, Inc.), by NIOSH–OCAS staff (before and after its official release in April 2002), and by DOL staff who use the code on a daily basis. Comments about the operation of the software have also been received from members of the public who have used NIOSH-IREP. A list of software updates resulting from previous phases of testing of NIOSH-IREP is posted at (www.niosh-irep.com/irep_niosh/update.asp).

The verification of the NIOSH-IREP source code included the following operations:

1. The mathematical equations of the risk models and associated numerical data implemented in the NIOSH-IREP source code were compared with the equations described in the documentation of NIOSH-IREP.

2. The mathematical equations and numerical data of the risk models used by NIOSH-IREP were independently programmed using MS Excel and Crystal Ball, creating a scaled-down version of the code[8] that could be used for verification.

[8] The equations programmed in MS Excel cover all the steps necessary to estimate probability of causation (PC) starting from a radiation dose received under any assumed single-exposure scenario.

2c. Values of the risk model parameters corresponding to a mid and upper estimate of ERR and PC produced by NIOSH-IREP were used as input for deterministic calculations in MS Excel, for all cancer types and various selected exposure scenarios. Estimates of the mid and upper values calculated deterministically in MS Excel were compared to the results produced by the NIOSH-IREP code.

2d. The entire probability distribution functions describing the uncertainty in the ERR and PC for selected cancers and exposure histories were independently produced using MS Excel/Crystal Ball and were compared to the probability distribution functions produced by the NIOSH-IREP code.

The verification process described above identified three discrepancies between the algorithms implemented in NIOSH-IREP v.5.5.3 and the methodology described in its documentation. NIOSH-IREP v.5.5.3 was subsequently revised to correct for these issues. The updated and revised version of the source code is referred to as NIOSH-IREP v.5.5.3r. The formal verification procedures, including all deterministic and probabilistic calculations, were repeated using NIOSH-IREP v.5.5.3r. All results presented in Appendix B through Appendix J of this report refer to testing conducted on NIOSH-IREP v.5.5.3r.

The verification of consistency between the source code and its documentation revealed four typographical errors that exist in the published documentation, but are programmed correctly in the NIOSH-IREP v.5.5.3 source code itself. These typographical errors will be corrected using errata statements.

More than 400 deterministic verification calculations were performed, covering all cancer types for both genders. Special attention was paid to modifiers of risk related to the minimum latency period, the radiation effectiveness factor (REF), the dose and dose-rate effectiveness factor (DDREF), the effect of ethnic origin on risk of skin cancer, and the effect of smoking on risk of lung cancer. Deterministic calculations were performed to check ERR and PC for all intervals of variation for these modifiers.

The deterministic calculations show that the 50th and 99th percentiles of ERR and PC estimated by NIOSH-IREP were successfully reproduced by independent calculations setup in MS Excel for all cancer types, both genders and for all exposure scenarios considered. This exercise demonstrates that NIOSH-IREP v.5.5.3r operates as intended for two of the percentiles from the probability distribution describing the uncertainty in the ERR and PC.

The Monte-Carlo uncertainty propagation algorithms were verified using a separate set of probabilistic calculations. Probability distribution functions (PDFs) describing the uncertainty in the ERR and PC for selected exposure scenarios were generated by means of Monte-Carlo methods, first in NIOSH-IREP v.5.5.3r and then using the risk models independently programmed in MS Excel/Crystal Ball. The PDFs generated by NIOSH-IREP v.5.5.3r and by MS Excel/Crystal Ball were the same (i.e., they were not different by more than the small margin of error introduced by differences in the Monte-Carlo methods carried out by Analytica® and MS Excel/Crystal Ball.

The results of the probabilistic calculations indicate that Monte-Carlo uncertainty propagation algorithms in NIOSH-IREP v.5.5.3r operate properly. Thus, it is expected that NIOSH-IREP v.5.5.3r produces reliable results not only for the 99th percentile of ERR and PC, but for any other percentile from the probability distribution describing the uncertainty in the ERR and PC.

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VERIFICATION OF NIOSH-IREP COMPUTER CODE

Version 5.5.3

Appendices

July 2009

Deterministic Verification of the 50th and 99th Percentiles of ERR and PC

Probabilistic Verification of Monte-Carlo Uncertainty Propagation

Appendix A

Effects of the Findings on PC results produced by NIOSH-IREP

This Appendix presents an analysis of the magnitude of changes in PC values resulting from the three discrepancies identified during independent testing of NIOSH-IREP v.5.5.3. The analysis of PC was performed using the methods described below.

A revised version of NIOSH-IREP was created that includes all corrections to the issues described in Section 3 of this report. The revised version of the code is referred to NIOSH-IREP v.5.5.3r.

The PC was calculated for a number of selected exposure scenarios using both NIOSH-IREP v.5.5.3 and NIOSH-IREP v.5.5.3r. The exposure scenarios relevant for each of the three findings were selected with the intent of producing the largest possible difference in the PC results. The selected scenarios were kept very simple (e.g., a single exposure to one radiation type) to minimize calculation time. For more realistic exposure histories, such as those in the claims handled by NIOSH and DOL, the differences between NIOSH–IREP v.5.5.3 and v.5.5.3r are expected to be much smaller than the differences presented in this report.

The radiation doses for each exposure scenario were selected so that the 99th percentile of PC produced by NIOSH-IREP v.5.5.3 was near 50%, the level required for compensation of a claim. The results of this analysis indicate whether the modification implemented in NIOSH-IREP v.5.5.3r produces a 99th percentile of PC larger or smaller than that given by NIOSH-IREP v.5.5.3.

To minimize the random noise effect of Monte-Carlo sampling, all testing calculations for v.5.5.3 and v.5.5.3r were performed using 30 runs of 10,000 iterations each (i.e., using the Enterprise Edition for each version of the code). Normally, DOL analyzes claims using NIOSH-IREP runs of 2000 iterations each. In these cases, the 99th percentile of PC can vary by up to ± 5 percentage points if the random seed were changed (i.e., a PC_{99} that is truly equal to 50% may be reported anywhere between 45% to 55%.) However, the PC_{99} estimated from a calculation using 30 runs of 10,000 iterations each will have a margin of error of only about ±0.5 percentage points if a different set of 30 random number seeds was used for each run (i.e., a PC_{99} that is truly equal to 50% may be between a reported PC_{99} of 49.5% and 50.5%). Therefore, the results of this testing

exercise can be considered to represent actual differences introduced by the corrections to the code, and not be due to random noise of the Monte-Carlo calculation. For the purposes of this exercise, the same set of 30 random number seed values was used for all calculations.

Throughout this section, we compare the 99th percentiles of PC estimated by NIOSH-IREP v.5.5.3 to the 99th percentile of PC estimated by NIOSH-IREP v.5.5.3r. To keep the text short and easy to read, we often use an abbreviated language saying that we compare "the PC_{99} estimated by v.5.5.3" to "PC_{99} estimated by v.5.5.3r."

Issue 1: Acute Lymphocytic Leukemia Algorithm

For exposures at age 20 or greater, the risk model for Acute Lymphocytic Leukemia (ALL) does not depend on age at exposure, and it does not depend on attained age, except during the minimum latency period (i.e., at times since exposure less than 5 years; Land et al. 2003, Kocher et al. 2008). For exposures at ages less than 20, the risk has a strong dependency on time since exposure. The testing calculations for ALL (Table A-1) included one set of calculations for ages at exposure 20 and older (two cases with exposures occurring within the latency period and one case with exposures occurring beyond the latency period), and a second set of calculations for exposures at the ages less than 20, with cases being differentiated by the time elapsed until the ALL was diagnosed.

By the nature of the ALL risk model, the difference between v.5.5.3 and v.5.5.3r depends on the magnitude of the dose. Version 5.5.3 reports a $PC_{v.5.5.3} = ERR/(1+ERR)$, with PC being equal to 50% when ERR is equal to 1.0. In version 5.5.3r, the ERR for ALL in cases of acute exposures to low LET radiation is higher than the ERR in v.5.5.3 by a factor of 1+D (where D is dose in Sv). This means that $ERR_{v.5.5.3r} = ERR_{v.5.5.3}(1+D)$ and one can show that:

$$PC_{v.5.5.3r} = PC_{v.5.5.3}*(1+D)/(1+ PC_{v.5.5.3}*D)$$

$PC_{v.5.5.3r} = (1+D)/(2+D)$ when $PC_{v.5.5.3} = 0.5$.

The results presented in this report are for doses that would produce a $PC_{v.5.5.3}$ with a 99th percentile of approximately 50%. For the most common exposure cases encountered among the population of nuclear workers (i.e., at ages 20 or older), v.5.5.3r

produces a PC_{99} greater than that produced by v.5.5.3 by about 4 percentage points (i.e., a PC_{99} of 54% would be obtained with v.5.5.3r instead of a PC_{99} of 50% produced by v.5.5.3; Table A-1). For lower doses, the difference would be lower than 4 percentage points. However, for any dose, the PC_{99} estimated using v.5.5.3r will be larger than the PC_{99} estimated using v.5.5.3.

In cases of exposure at ages less than 20, the PC reported by v.5.5.3r can be significantly higher than that reported by v.5.5.3, depending on the time elapsed between exposure and disease diagnosis.

Table A-1 Average of 99th percentile PC values (%) for acute lymphocytic leukemia from 30 runs of 10,000 iterations each for an acute exposure to high-energy gamma rays.

Age at exposure >=20					
TSE[a]	Dose	Males		Females	
(yr)	(cSv)	v.5.5.3	v.5.5.3r	v.5.5.3	v.5.5.3r
3	19	51.24	55.57	50.4	54.73
5	16	50.56	54.26	49.67	53.38
>=10	16	50.59	54.29	49.70	53.41
Age at exposure < 20					
TSE	Dose	Males		Females	
(yr)	(cSv)	v.5.5.3	v.5.5.3r	v.5.5.3	v.5.5.3r
3	0.28	49.66	49.73	48.74	48.81
5	0.24	49.44	49.50	48.45	48.51
10	0.91	49.92	50.15	48.97	49.19
20	6.5	50.17	51.75	49.24	50.82
30	24	50.11	55.46	49.11	54.47
40	64	49.41	61.56	48.32	60.53
50	160	49.53	71.84	48.59	71.07

[a] TSE = Time Since Exposure

Issue 2: Uncertainty in the Modifier for Age Dependency for Selected Cancers

The risk models for all cancers in Group 2[1] have similar dependencies on age exposure and attained age. For a given age at diagnosis of cancer, the risk decreases with increasing age at exposure between the ages of 15 and 30 and is constant for ages at exposure greater than 30. For a given age at exposure, the risk decreases with increasing age at diagnosis up to age 50, after which it remains constant. The risk is reduced for cancers that are diagnosed during the minimum latency period of the disease. The effects of the reduced risk during the latency period are negligible at times greater than 15 years after an exposure (Land et al, 2003; Kocher et al. 2008).

Testing calculations have been performed for colon cancer in males for a large number of combinations of age at exposure and attained age (age at which cancer was diagnosed; Table A-2). Testing runs for all Group 2 cancers were performed for a representative combination of ages (age 20 at time of exposure and attained age 40; Table A-3).

All calculations assume an acute exposure to high energy gamma radiation. These assumptions were chosen to maximize the contribution of the uncertainty in the modifier for age dependency by eliminating additional uncertainties introduced by the low dose and low dose-rate effectiveness factor (DDREF) or by the relative effectiveness factor (REF).

The testing results show that the PC_{99} reported by version v.5.5.3r is always lower than the PC_{99} obtained under the current v.5.5.3 (Table A-2 and A-3) by less than 3 percentage points when PC_{99} is about 50%. (i.e., if the PC_{99} reported by v.5.5.3 is 50%, then v.5.5.3r would report a PC_{99} of, at most, 47%). Note that there is no difference in PC for exposures at ages 30 or greater or for cancers diagnosed at age 50 of greater.

This finding affects an age modifier that applies in an identical manner to all cancers in Group 2. Thus, it is expected that the PC for all Group 2 cancers would be affected in a rather similar manner (i.e., the change in PC would be similar, but not exactly the same for all cancer types in this Group, because each cancer type has specific parameters with uncertainties that are cancer-specific). Table A-3 presents results of the testing exercise for all cancer types in Group 2. The results for males exposed at age 20

[1] A list of Group 2 cancers is presented in Table A-3.

and diagnosed at age 40 indicate that the PC_{99} estimated by v.5.5.3r is lower than the PC_{99} estimated by v.5.5.3 by about 1 percentage point (i.e., if v.5.5.3 reports a PC_{99} of 50%, v.5.5.3r would report a PC_{99} of about 49%, with small differences between cancer types.)

Table A-2 Average of 99th percentile PC values (%) for colon cancer in males from 30 runs of 10,000 iterations each for an acute exposure to high-energy gamma rays.

Time since exposure = 5 yrs				
AAE[a] (yr)	ATA[b] (yr)	Dose (cSv)	v.5.5.3	v.5.5.3r
18	23	45	50.62	48.87
20	25	58	49.24	47.85
30	35	210	49.56	49.56
35	40	280	49.95	49.95
>=40	>=45	330	48.59	48.59
Time since exposure = 10 yrs				
AAE (yr)	ATA (yr)	Dose (cSv)	v.5.5.3	v.5.5.3r
18	28	12	50.56	47.96
20	30	16	50.24	48.19
30	40	57	50.26	50.26
35	45	74	50.43	50.43
>=40	>=50	89	50.24	50.24
Time since exposure = 20 yrs				
AAE (yr)	ATA (yr)	Dose (cSv)	v.5.5.3	v.5.5.3r
18	38	24	50.41	48.79
20	40	31	50.69	49.55
30	50	85	50.45	50.45
35	55	85	50.45	50.45
>=40	>=60	85	50.45	50.45
Time since exposure = 30 yrs				
AAE (yr)	ATA (yr)	Dose (cSv)	v.5.5.3	v.5.5.3r
18	48	37	50.32	50.07
20	50	45	50.11	50.11
30	60	85	50.45	50.45
35	65	85	50.45	50.45
>=40	>=70	85	50.45	50.45

[a] AAE = Age at exposure

[b] ATA = Attained age (age at which cancer was diagnosed)

Table A-3 Average of 99th percentile PC values (%) for all Group 2 cancers in males (ATA[a]=40 yrs) from 30 runs of 10,000 iterations each for an acute exposure (AAE[b]=20 yrs) to high-energy gamma rays.

Cancer Type	Dose (cSv)	v.5.5.3	v.5.5.3r
Oral Cavity and Pharynx	76	49.79	48.88
Esophagus	28	51.74	50.92
Stomach	21	50.90	50.14
Colon	31	50.69	49.55
Rectum	83	49.77	49.03
Gallbladder	13	51.89	51.29
Pancreas	70	49.87	49.08
Other respiratory	78	50.02	49.37
Ovary (Female)	32	50.69	49.75
All Male Genitalia	47	49.76	49.05
Bladder	38	50.15	49.13
Urinary organs (less bladder)	36	50.00	48.76
Nervous system	73	49.58	48.86
Other and ill-defined sites	39	49.40	48.36
Lymphoma and multiple myeloma	47	49.49	48.93

[a] ATA = Attained age (age at which cancer was diagnosed)

[b] AAE = Age at exposure

Issue 3: Uncertainty in the Modifier for Age Dependency for the NIH Lung Model

For a given age at diagnosis of lung cancer, the NIH risk model for lung cancer decreases with increasing age at exposure between ages of 15 and 30 and is constant for older ages at exposure. For a given age at exposure, the risk predicted by the NIH model decreases with increasing age at diagnosis up to age 50 after which it remains constant. The risk is reduced for attained ages that occur during the minimum latency period of the disease. The effects of the reduced risk during latency period are negligible at times greater than 15 years after an exposure (Land et al. 2003; Kocher et al. 2008).

The calculations comparing v.5.5.3 and v.5.5.3r are for males and are based on various combinations of ages at exposure and ages at diagnosis. No calculations have been carried out for females because v.5.5.3 and v.5.5.3r are identical (See Section 3). All calculations assume an acute exposure to high energy gamma radiation. This assumption is made to eliminate additional uncertainty introduced by the use of a low dose and low dose-rate effectiveness factor (DDREF) or of a relative effectiveness factor (REF), thus maximizing the contribution of the uncertainty in the modifier for age dependency to the uncertainty in PC.

The testing results (Tables A-4, A-5 and A-6) show that, for exposures occurring between ages 15 and 30 and for cancers diagnosed before age 50, the PC_{99} calculated with v.5.5.3r will be ± 0.5 percentage points different than the PC_{99} obtained using v.5.5.3. (i.e., a PC_{99} of 50% produced by v.5.5.3 would be reported by v.5.5.3r as between 49.5% and 50.5%). This type of variation is much lower than the random noise for a NIOSH-IREP run with 2000 iterations, and is of the same magnitude with the random noise of a NIOSH-IREP calculation based on 30 runs of 10,000 iterations each. Version 5.5.3r can produce larger or lower results than v.5.5.3 depending on the combination of ages at exposure and at diagnosis. The differences are similar for all types of smoking histories (Tables A-4, A-5 and A-6).

It is important to note that NIOSH-IREP calculates PC for lung cancer using both the NIH and NIOSH risk models (Kocher et al. 2008). The larger of the two PC_{99} estimates is used for adjudication of claims. In some cases (especially for older ages at exposure), the PC_{99} produced by the NIOSH lung model is larger than the PC_{99} produced by the NIH lung model (with either v.5.5.3 or v.5.5.3r). In these cases, the differences between v.5.5.3 and v.5.5.3r are irrelevant and will not affect the outcome of a claim.

Table A-4 Average of 99th percentile PC values (%) for lung cancer in males who have never smoked from 30 runs of 10,000 iterations each for an acute exposure to high-energy gamma rays.

AAE[a] (yr)	ATA[b] (yr)	Dose (cSv)	NIH lung model v.5.5.3	NIH lung model v.5.5.3r	NIOSH lung model v.5.5.3	NIOSH lung model v.5.5.3r
Time since exposure = 5 yrs						
18	23	58	47.49	47.63	18.76	18.76
20	25	76	46.85	46.98	23.23	23.23
30	35	270	47.50	47.73	51.80	51.80
35	40	360	47.74	47.88	58.89	58.89
>=40	>=45	450	47.82	47.90	64.17	64.17
Time since exposure = 10 yrs						
AAE (yr)	ATA (yr)	Dose (cSv)	NIH lung model v.5.5.3	NIH lung model v.5.5.3r	NIOSH lung model v.5.5.3	NIOSH lung model v.5.5.3r
18	28	18	49.40	49.48	27.78	27.78
20	30	14	36.23	36.33	23.01	23.01
30	40	80	49.10	49.38	63.10	63.10
35	45	100	48.25	48.41	68.12	68.12
>=40	>=50	130	50.08	50.08	73.53	73.53
Time since exposure = 15 yrs						
AAE (yr)	ATA (yr)	Dose (cSv)	NIH lung model v.5.5.3	NIH lung model v.5.5.3r	NIOSH lung model v.5.5.3	NIOSH lung model v.5.5.3r
18	33	26	49.35	49.26	37.02	37.02
20	35	33	48.92	48.85	42.73	42.73
30	45	100	49.53	49.69	69.33	69.33
35	50	140	53.17	53.17	75.99	75.99
Time since exposure = 30 yrs						
AAE (yr)	ATA (yr)	Dose (cSv)	NIH lung model v.5.5.3	NIH lung model v.5.5.3r	NIOSH lung model v.5.5.3	NIOSH lung model v.5.5.3r
18	48	52	49.41	48.87	54.04	54.04
20	50	76	53.98	53.46	63.21	63.21
30	60	140	53.17	53.17	75.99	75.99

[a] AAE = Age at exposure

[b] ATA = Attained age

Table A-5 Average of 99th percentile PC values (%) for lung cancer in males who are former smokers from 30 runs of 10,000 iterations each for an acute exposure to high-energy gamma rays.

Time since exposure = 5 yrs						
AAE[a]	ATA[b]	Dose	NIH lung model		NIOSH lung model	
(yr)	(yr)	(cSv)	v.5.5.3	v.5.5.3r	v.5.5.3	v.5.5.3r
18	23	95	47.47	47.61	13.86	13.86
20	25	120	46.13	46.25	16.89	16.89
30	35	420	47.58	47.71	41.57	41.57
35	40	550	47.79	47.85	48.23	48.23
>=40	>=45	680	47.81	47.84	53.52	53.52
Time since exposure = 10 yrs						
AAE	ATA	Dose	NIH lung model		NIOSH lung model	
(yr)	(yr)	(cSv)	v.5.5.3	v.5.5.3r	v.5.5.3	v.5.5.3r
18	28	23	47.43	47.50	14.96	14.96
20	30	30	47.22	47.29	18.66	18.66
30	40	95	46.87	47.10	42.08	42.08
35	45	120	46.64	46.75	47.85	47.85
>=40	>=50	150	47.58	47.58	53.43	53.43
Time since exposure = 15 yrs						
AAE	ATA	Dose	NIH lung model		NIOSH lung model	
(yr)	(yr)	(cSv)	v.5.5.3	v.5.5.3r	v.5.5.3	v.5.5.3r
18	33	32	47.41	47.34	20.49	20.49
20	35	41	47.48	47.44	24.82	24.82
30	45	120	48.03	48.15	49.14	49.14
35	50	120	43.43	43.43	49.14	49.14
Time since exposure = 30 yrs						
AAE	ATA	Dose	NIH lung model		NIOSH lung model	
(yr)	(yr)	(cSv)	v.5.5.3	v.5.5.3r	v.5.5.3	v.5.5.3r
18	48	63	47.53	47.10	33.66	33.66
20	50	76	47.42	47.01	37.97	37.97
30	60	140	47.25	47.25	52.99	52.99

[a] AAE = Age at exposure

[b] ATA = Attained age

Table A-6 Average of 99th percentile PC values (%) for males with lung cancer (attained age = 50 yrs) from 30 runs of 10,000 iterations each for an acute exposure (age at exposure = 20 yrs) to high-energy gamma rays (sources other than radon).

Smoking History	Dose (cSv)	NIH lung model v.5.5.3	NIH lung model v.5.5.3r	NIOSH lung model v.5.5.3	NIOSH lung model v.5.5.3r
Never smoked	65	50.08	49.56	59.51	59.51
Former smoker	88	51.09	50.67	41.48	41.48
Current smoker (? cig/day)	88	50.57	50.19	37.17	37.17
<10 cig/day (currently)	90	51.67	51.27	42.27	42.27
10-19 cig/day (currently)	91	51.45	51.07	38.18	38.18
20-39 cig/day (currently)	93	51.88	51.50	38.12	38.12
>40 cig/day (currently)	94	52.10	51.72	38.19	38.19

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Appendix B

General Verification Calculations

The set of verification calculations included in this appendix is the most comprehensive group of deterministic calculations, covering all cancer types, both genders and a relevant selection of age at exposure and age at diagnosis. All thirty-two cancers listed in NIOSH-IREP were used in this set of verification calculations. A total of 124 calculations were performed for this specific verification task.

All calculations used a single acute radiation exposure to a dose of 20 cSv of high energy photons (E >250 keV). The radiation type was set to high energy photons (E > 250 keV) because the radiation effectiveness factor (REF) for this radiation type is equal to 1.0 (i.e., no adjustments due to radiation type are needed). Similarly, we selected a photon dose of 20 cSv delivered acutely because for such a dose the application of a DDREF is not necessary.

Further details about this verification task can be found in Section 5.1 of the report. The results for ERR and PC obtained with MS Excel verify the mid and upper bound values of ERR and PC estimated using NIOSH-IREP v.5.5.3r, for all exposure scenarios considered.

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Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**1a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Oral Cavity and Pharynx
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	182	414
Original ERR/Sv	0.1720	0.6389
Adjustment Factors		
Age at exposure, Attained age	1.6949	1.8264
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0667	0.0590
Systematic errors in gamma doses[b]	1.1051	1.1584
Systematic errors in neutron doses[b]	1.0855	1.1204
Systematic errors in RBE neutron doses[b]	1.0480	0.9067
Model Mixture factor for transfer to US pop	0.8765	0.5421
Ratio of Japanese to U.S. baseline cancer rates	0.6833	0.6713
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.048	0.178
Probability of Causation (PC)	4.54	15.14

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.1720	0.6389
ERR/Sv with adjustments		
w/ age adjustment	0.2916	1.1670
w/ latency adjustment	0.2916	1.1670
w/ random errors in dosimetry adj	0.3110	1.2358
w/ systematic errors in dosimetry adj	0.2474	1.0501
adjusted for population transfer	0.2377	0.8921
multiplicative risk model	0.2474	1.0501
additive risk model	0.1690	0.7050
adjusted for smoking history	0.2377	0.8921
adjusted for DDREF	0.2377	0.8921
Final ERR/Sv	0.2377	0.8921
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.048	0.178
Probability of Causation (PC)	4.54	15.14

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**1b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Oral Cavity and Pharynx
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	724	1547
Original ERR/Sv	0.2398	0.4691
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0894	0.0603
Systematic errors in gamma doses[b]	1.2603	1.0530
Systematic errors in neutron doses[b]	1.1178	1.0267
Systematic errors in RBE neutron doses[b]	0.9834	0.9623
Model Mixture factor for transfer to US pop	0.1950	1.0431
Ratio of Japanese to U.S. baseline cancer rates	0.6846	0.6681
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.028	0.097
Probability of Causation (PC)	2.74	8.84

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.2398	0.4691
ERR/Sv with adjustments		
w/ age adjustment	0.2398	0.4691
w/ latency adjustment	0.2398	0.4691
w/ random errors in dosimetry adj	0.2612	0.4974
w/ systematic errors in dosimetry adj	0.1885	0.4781
adjusted for population transfer	0.1407	0.4849
multiplicative risk model	0.1885	0.4781
additive risk model	0.1291	0.3194
adjusted for smoking history	0.1407	0.4849
adjusted for DDREF	0.1407	0.4849
Final ERR/Sv	0.1407	0.4849
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.028	0.097
Probability of Causation (PC)	2.74	8.84

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**1c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Oral Cavity and Pharynx
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	7	1757
Original ERR/Sv	0.2463	0.5123
Adjustment Factors		
Age at exposure, Attained age	2.1156	3.0873
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0948	0.0739
Systematic errors in gamma doses[b]	1.1677	1.0430
Systematic errors in neutron doses[b]	1.0203	1.1100
Systematic errors in RBE neutron doses[b]	0.9851	1.0245
Model Mixture factor for transfer to US pop	0.0745	0.6620
Ratio of Japanese to U.S. baseline cancer rates	0.6786	0.6466
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.068	0.252
Probability of Causation (PC)[d]	6.39	20.14

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.2463	0.5123
ERR/Sv with adjustments		
w/ age adjustment	0.5210	1.5816
w/ latency adjustment	0.5210	1.5816
w/ random errors in dosimetry adj	0.5704	1.6985
w/ systematic errors in dosimetry adj	0.4860	1.4320
adjusted for population transfer	0.3414	1.2610
multiplicative risk model	0.4860	1.4320
additive risk model	0.3298	0.9260
adjusted for smoking history	0.3414	1.2610
adjusted for DDREF	0.3414	1.2610
Final ERR/Sv	0.3414	1.2610
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.068	0.252
Probability of Causation (PC)	6.39	20.14

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**1d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Oral Cavity and Pharynx
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	892	1045
Original ERR/Sv	0.4632	0.9461
Adjustment Factors		
Age at exposure, Attained age	1.7519	1.9970
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0668	0.0881
Systematic errors in gamma doses[b]	1.1261	1.0339
Systematic errors in neutron doses[b]	1.0837	1.0740
Systematic errors in RBE neutron doses[b]	1.0316	0.9609
Model Mixture factor for transfer to US pop	0.4194	1.0138
Ratio of Japanese to U.S. baseline cancer rates	0.5937	0.6772
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.105	0.387
Probability of Causation (PC)[d]	9.51	27.91

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4632	0.9461
ERR/Sv with adjustments		
w/ age adjustment	0.8114	1.8894
w/ latency adjustment	0.8114	1.8894
w/ random errors in dosimetry adj	0.8656	2.0558
w/ systematic errors in dosimetry adj	0.6877	1.9267
adjusted for population transfer	0.5255	1.9353
multiplicative risk model	0.6877	1.9267
additive risk model	0.4083	1.3048
adjusted for smoking history	0.5255	1.9353
adjusted for DDREF	0.5255	1.9353
Final ERR/Sv	0.5255	1.9353
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.105	0.387
Probability of Causation (PC)	9.51	27.91

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**2a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Esophagus
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1194	1668
Original ERR/Sv	0.1986	0.8105
Adjustment Factors		
Age at exposure, Attained age	1.5908	1.8055
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0724	0.1271
Systematic errors in gamma doses[b]	1.0796	1.0239
Systematic errors in neutron doses[b]	1.0354	1.2256
Systematic errors in RBE neutron doses[b]	1.0093	1.0150
Model Mixture factor for transfer to US pop	0.1274	0.1158
Ratio of Japanese to U.S. baseline cancer rates	2.0658	2.0867
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.116	0.508
Probability of Causation (PC)	10.39	33.68

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.1986	0.8105
ERR/Sv with adjustments		
w/ age adjustment	0.3159	1.4634
w/ latency adjustment	0.3159	1.4634
w/ random errors in dosimetry adj	0.3388	1.6494
w/ systematic errors in dosimetry adj	0.3003	1.2950
adjusted for population transfer	0.5795	2.5392
multiplicative risk model	0.3003	1.2950
additive risk model	0.6203	2.7022
adjusted for smoking history	0.5795	2.5392
adjusted for DDREF	0.5795	2.5392
Final ERR/Sv	0.5795	2.5392
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.116	0.508
Probability of Causation (PC)	10.39	33.68

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**2b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Esophagus
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1020	1668
Original ERR/Sv	0.3747	0.8105
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0707	0.1271
Systematic errors in gamma doses[b]	1.2248	1.0239
Systematic errors in neutron doses[b]	1.1026	1.2256
Systematic errors in RBE neutron doses[b]	1.0391	1.0150
Model Mixture factor for transfer to US pop	0.7945	0.1158
Ratio of Japanese to U.S. baseline cancer rates	2.0366	2.0867
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.069	0.281
Probability of Causation (PC)	6.49	21.95

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.3747	0.8105
ERR/Sv with adjustments		
w/ age adjustment	0.3747	0.8105
w/ latency adjustment	0.3747	0.8105
w/ random errors in dosimetry adj	0.4012	0.9135
w/ systematic errors in dosimetry adj	0.2859	0.7172
adjusted for population transfer	0.3468	1.4064
multiplicative risk model	0.2859	0.7172
additive risk model	0.5823	1.4967
adjusted for smoking history	0.3468	1.4064
adjusted for DDREF	0.3468	1.4064
Final ERR/Sv	0.3468	1.4064
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.069	0.281
Probability of Causation (PC)	6.49	21.95

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**2c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Esophagus
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	959	58
Original ERR/Sv	0.2713	0.8702
Adjustment Factors		
Age at exposure, Attained age	2.4591	3.2385
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0799	0.0982
Systematic errors in gamma doses[b]	1.1016	1.1577
Systematic errors in neutron doses[b]	1.0801	1.0775
Systematic errors in RBE neutron doses[b]	0.9761	0.9598
Model Mixture factor for transfer to US pop	0.6444	0.6741
Ratio of Japanese to U.S. baseline cancer rates	1.9778	2.1842
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.167	0.717
Probability of Causation (PC)[d]	14.33	41.74

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.2713	0.8702
ERR/Sv with adjustments		
w/ age adjustment	0.6672	2.8182
w/ latency adjustment	0.6672	2.8182
w/ random errors in dosimetry adj	0.7205	3.0948
w/ systematic errors in dosimetry adj	0.6205	2.5849
adjusted for population transfer	0.8362	3.5826
multiplicative risk model	0.6205	2.5849
additive risk model	1.2272	5.6460
adjusted for smoking history	0.8362	3.5826
adjusted for DDREF	0.8362	3.5826
Final ERR/Sv	0.8362	3.5826
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.167	0.717
Probability of Causation (PC)	14.33	41.74

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**2d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Esophagus
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1117	414
Original ERR/Sv	0.5991	2.4857
Adjustment Factors		
Age at exposure, Attained age	1.8300	1.8264
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0821	0.0766
Systematic errors in gamma doses[b]	1.2331	1.1584
Systematic errors in neutron doses[b]	1.1685	1.1204
Systematic errors in RBE neutron doses[b]	0.9132	0.9067
Model Mixture factor for transfer to US pop	0.1774	0.5421
Ratio of Japanese to U.S. baseline cancer rates	1.0923	1.0099
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.194	0.834
Probability of Causation (PC)[d]	16.25	45.49

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5991	2.4857
ERR/Sv with adjustments		
w/ age adjustment	1.0964	4.5398
w/ latency adjustment	1.0964	4.5398
w/ random errors in dosimetry adj	1.1865	4.8873
w/ systematic errors in dosimetry adj	0.9017	4.1530
adjusted for population transfer	0.9702	4.1718
multiplicative risk model	0.9017	4.1530
additive risk model	0.9849	4.1940
adjusted for smoking history	0.9702	4.1718
adjusted for DDREF	0.9702	4.1718
Final ERR/Sv	0.9702	4.1718
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.194	0.834
Probability of Causation (PC)	16.25	45.49

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**3a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Stomach
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1839	1323
Original ERR/Sv	0.1193	0.1893
Adjustment Factors		
Age at exposure, Attained age	1.2035	2.5461
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0963	0.0788
Systematic errors in gamma doses[b]	1.0828	1.0635
Systematic errors in neutron doses[b]	1.0754	1.1684
Systematic errors in RBE neutron doses[b]	1.0105	1.0115
Model Mixture factor for transfer to US pop	0.7956	0.1807
Ratio of Japanese to U.S. baseline cancer rates	9.2761	9.1963
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.072	0.638
Probability of Causation (PC)	6.72	38.96

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.1193	0.1893
ERR/Sv with adjustments		
w/ age adjustment	0.1435	0.4819
w/ latency adjustment	0.1435	0.4819
w/ random errors in dosimetry adj	0.1574	0.5198
w/ systematic errors in dosimetry adj	0.1338	0.4136
adjusted for population transfer	0.3600	3.1908
multiplicative risk model	0.1338	0.4136
additive risk model	1.2407	3.8035
adjusted for smoking history	0.3600	3.1908
adjusted for DDREF	0.3600	3.1908
Final ERR/Sv	0.3600	3.1908
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.072	0.638
Probability of Causation (PC)	6.72	38.96

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**3b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Stomach
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1799	503
Original ERR/Sv	0.0384	0.2304
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0809	0.1117
Systematic errors in gamma doses[b]	1.1991	1.2575
Systematic errors in neutron doses[b]	1.2623	1.1360
Systematic errors in RBE neutron doses[b]	1.0539	0.9562
Model Mixture factor for transfer to US pop	0.1373	0.0355
Ratio of Japanese to U.S. baseline cancer rates	9.2270	9.5359
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.042	0.346
Probability of Causation (PC)	4.04	25.72

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0384	0.2304
ERR/Sv with adjustments		
w/ age adjustment	0.0384	0.2304
w/ latency adjustment	0.0384	0.2304
w/ random errors in dosimetry adj	0.0415	0.2561
w/ systematic errors in dosimetry adj	0.0260	0.1875
adjusted for population transfer	0.2105	1.7310
multiplicative risk model	0.0260	0.1875
additive risk model	0.2398	1.7879
adjusted for smoking history	0.2105	1.7310
adjusted for DDREF	0.2105	1.7310
Final ERR/Sv	0.2105	1.7310
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.042	0.346
Probability of Causation (PC)	4.04	25.72

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**3c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Stomach
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	277	1932
Original ERR/Sv	0.1452	0.2078
Adjustment Factors		
Age at exposure, Attained age	2.1086	2.8966
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0667	0.0602
Systematic errors in gamma doses[b]	1.0719	1.1305
Systematic errors in neutron doses[b]	1.1461	1.0579
Systematic errors in RBE neutron doses[b]	0.9968	1.0248
Model Mixture factor for transfer to US pop	0.8836	0.0839
Ratio of Japanese to U.S. baseline cancer rates	9.1930	9.4945
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.104	0.914
Probability of Causation (PC)[d]	9.44	47.76

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.1452	0.2078
ERR/Sv with adjustments		
w/ age adjustment	0.3063	0.6018
w/ latency adjustment	0.3063	0.6018
w/ random errors in dosimetry adj	0.3267	0.6381
w/ systematic errors in dosimetry adj	0.2668	0.5206
adjusted for population transfer	0.5211	4.5719
multiplicative risk model	0.2668	0.5206
additive risk model	2.4524	4.9430
adjusted for smoking history	0.5211	4.5719
adjusted for DDREF	0.5211	4.5719
Final ERR/Sv	0.5211	4.5719
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.104	0.914
Probability of Causation (PC)	9.44	47.76

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**3d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Stomach
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	191	1668
Original ERR/Sv	0.5900	1.1958
Adjustment Factors		
Age at exposure, Attained age	1.3985	1.8055
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1104	0.0917
Systematic errors in gamma doses[b]	1.1510	1.0239
Systematic errors in neutron doses[b]	1.1756	1.2256
Systematic errors in RBE neutron doses[b]	0.9467	1.0150
Model Mixture factor for transfer to US pop	0.6383	0.1158
Ratio of Japanese to U.S. baseline cancer rates	9.0052	8.9963
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.557	2.987
Probability of Causation (PC)[d]	35.78	74.92

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5900	1.1958
ERR/Sv with adjustments		
w/ age adjustment	0.8252	2.1591
w/ latency adjustment	0.8252	2.1591
w/ random errors in dosimetry adj	0.9163	2.3570
w/ systematic errors in dosimetry adj	0.7153	1.8505
adjusted for population transfer	2.7862	14.9338
multiplicative risk model	0.7153	1.8505
additive risk model	6.4412	16.6477
adjusted for smoking history	2.7862	14.9338
adjusted for DDREF	2.7862	14.9338
Final ERR/Sv	2.7862	14.9338
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.557	2.987
Probability of Causation (PC)	35.78	74.92

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**4a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1200	329
Original ERR/Sv	0.5300	1.5885
Adjustment Factors		
Age at exposure, Attained age	1.7197	1.6400
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0917	0.0927
Systematic errors in gamma doses[b]	1.2057	1.1850
Systematic errors in neutron doses[b]	1.1065	1.1734
Systematic errors in RBE neutron doses[b]	0.9706	0.9848
Model Mixture factor for transfer to US pop	0.4931	0.3925
Ratio of Japanese to U.S. baseline cancer rates	1.0590	1.1286
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.158	0.448
Probability of Causation (PC)	13.67	30.95

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5300	1.5885
ERR/Sv with adjustments		
w/ age adjustment	0.9114	2.6051
w/ latency adjustment	0.9114	2.6051
w/ random errors in dosimetry adj	0.9951	2.8467
w/ systematic errors in dosimetry adj	0.7685	2.0790
adjusted for population transfer	0.7915	2.2414
multiplicative risk model	0.7685	2.0790
additive risk model	0.8139	2.3463
adjusted for smoking history	0.7915	2.2414
adjusted for DDREF	0.7915	2.2414
Final ERR/Sv	0.7915	2.2414
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.158	0.448
Probability of Causation (PC)	13.67	30.95

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**4b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Colon
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	854	729
Original ERR/Sv	0.5317	1.2115
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0876	0.0590
Systematic errors in gamma doses[b]	1.1403	1.0756
Systematic errors in neutron doses[b]	1.0903	1.1048
Systematic errors in RBE neutron doses[b]	1.0164	0.9889
Model Mixture factor for transfer to US pop	0.7164	0.1081
Ratio of Japanese to U.S. baseline cancer rates	1.0888	1.0966
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.094	0.237
Probability of Causation (PC)	8.58	19.17

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5317	1.2115
ERR/Sv with adjustments		
w/ age adjustment	0.5317	1.2115
w/ latency adjustment	0.5317	1.2115
w/ random errors in dosimetry adj	0.5783	1.2830
w/ systematic errors in dosimetry adj	0.4577	1.0919
adjusted for population transfer	0.4692	1.1859
multiplicative risk model	0.4577	1.0919
additive risk model	0.4983	1.1973
adjusted for smoking history	0.4692	1.1859
adjusted for DDREF	0.4692	1.1859
Final ERR/Sv	0.4692	1.1859
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.094	0.237
Probability of Causation (PC)	8.58	19.17

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**4c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	9	696
Original ERR/Sv	0.3770	1.0795
Adjustment Factors		
Age at exposure, Attained age	3.1638	3.0345
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0940	0.1031
Systematic errors in gamma doses[b]	1.0880	1.1456
Systematic errors in neutron doses[b]	1.1132	1.0861
Systematic errors in RBE neutron doses[b]	0.9508	1.0640
Model Mixture factor for transfer to US pop	0.9232	-0.0929
Ratio of Japanese to U.S. baseline cancer rates	1.1143	1.1538
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.229	0.638
Probability of Causation (PC)[d]	18.61	38.93

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.3770	1.0795
ERR/Sv with adjustments		
w/ age adjustment	1.1927	3.2757
w/ latency adjustment	1.1927	3.2757
w/ random errors in dosimetry adj	1.3049	3.6133
w/ systematic errors in dosimetry adj	1.1331	2.7292
adjusted for population transfer	1.1430	3.1879
multiplicative risk model	1.1331	2.7292
additive risk model	1.2626	3.1489
adjusted for smoking history	1.1430	3.1879
adjusted for DDREF	1.1430	3.1879
Final ERR/Sv	1.1430	3.1879
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.229	0.638
Probability of Causation (PC)	18.61	38.93

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**4d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	160	1692
Original ERR/Sv	0.5911	1.0607
Adjustment Factors		
Age at exposure, Attained age	1.7050	2.6694
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1006	0.0731
Systematic errors in gamma doses[b]	1.1795	1.1752
Systematic errors in neutron doses[b]	1.1422	1.1113
Systematic errors in RBE neutron doses[b]	0.9768	1.0247
Model Mixture factor for transfer to US pop	0.8726	0.8033
Ratio of Japanese to U.S. baseline cancer rates	0.8206	0.8488
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.165	0.441
Probability of Causation (PC)[d]	14.14	30.59

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5911	1.0607
ERR/Sv with adjustments		
w/ age adjustment	1.0079	2.8315
w/ latency adjustment	1.0079	2.8315
w/ random errors in dosimetry adj	1.1092	3.0386
w/ systematic errors in dosimetry adj	0.8429	2.2706
adjusted for population transfer	0.8237	2.2031
multiplicative risk model	0.8429	2.2706
additive risk model	0.6917	1.9273
adjusted for smoking history	0.8237	2.2031
adjusted for DDREF	0.8237	2.2031
Final ERR/Sv	0.8237	2.2031
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.165	0.441
Probability of Causation (PC)	14.14	30.59

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**5a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Rectum
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	186	1393
Original ERR/Sv	0.0674	0.4494
Adjustment Factors		
Age at exposure, Attained age	1.7576	2.1290
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1045	0.0700
Systematic errors in gamma doses[b]	1.1819	1.2436
Systematic errors in neutron doses[b]	1.0947	1.2485
Systematic errors in RBE neutron doses[b]	1.0468	0.9614
Model Mixture factor for transfer to US pop	-0.0071	0.5701
Ratio of Japanese to U.S. baseline cancer rates	1.4467	1.4329
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.028	0.163
Probability of Causation (PC)	2.72	13.99

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0674	0.4494
ERR/Sv with adjustments		
w/ age adjustment	0.1184	0.9567
w/ latency adjustment	0.1184	0.9567
w/ random errors in dosimetry adj	0.1308	1.0236
w/ systematic errors in dosimetry adj	0.0966	0.6858
adjusted for population transfer	0.1400	0.8134
multiplicative risk model	0.0966	0.6858
additive risk model	0.1397	0.9827
adjusted for smoking history	0.1400	0.8134
adjusted for DDREF	0.1400	0.8134
Final ERR/Sv	0.1400	0.8134
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.028	0.163
Probability of Causation (PC)	2.72	13.99

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**5b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Rectum
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1181	110
Original ERR/Sv	0.0874	0.4291
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0794	0.0818
Systematic errors in gamma doses[b]	1.1419	1.1075
Systematic errors in neutron doses[b]	1.1294	1.1916
Systematic errors in RBE neutron doses[b]	0.9901	1.0102
Model Mixture factor for transfer to US pop	0.7434	0.4145
Ratio of Japanese to U.S. baseline cancer rates	1.5142	1.4542
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.017	0.088
Probability of Causation (PC)	1.65	8.10

Verification Calculations using MS Excel

Personal Information	
Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0874	0.4291
ERR/Sv with adjustments		
w/ age adjustment	0.0874	0.4291
w/ latency adjustment	0.0874	0.4291
w/ random errors in dosimetry adj	0.0944	0.4643
w/ systematic errors in dosimetry adj	0.0739	0.3482
adjusted for population transfer	0.0837	0.4408
multiplicative risk model	0.0739	0.3482
additive risk model	0.1119	0.5064
adjusted for smoking history	0.0837	0.4408
adjusted for DDREF	0.0837	0.4408
Final ERR/Sv	0.0837	0.4408
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.017	0.088
Probability of Causation (PC)	1.65	8.10

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**5c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Rectum
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1338	1393
Original ERR/Sv	0.0751	0.4494
Adjustment Factors		
Age at exposure, Attained age	2.3367	3.0109
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0721	0.0700
Systematic errors in gamma doses[b]	1.2607	1.2436
Systematic errors in neutron doses[b]	1.1352	1.2485
Systematic errors in RBE neutron doses[b]	1.0063	0.9614
Model Mixture factor for transfer to US pop	-0.0660	0.5701
Ratio of Japanese to U.S. baseline cancer rates	1.5137	1.4329
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.040	0.230
Probability of Causation (PC)[d]	3.89	18.70

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0751	0.4494
ERR/Sv with adjustments		
w/ age adjustment	0.1756	1.3530
w/ latency adjustment	0.1756	1.3530
w/ random errors in dosimetry adj	0.1883	1.4477
w/ systematic errors in dosimetry adj	0.1307	0.9699
adjusted for population transfer	0.2023	1.1503
multiplicative risk model	0.1307	0.9699
additive risk model	0.1979	1.3897
adjusted for smoking history	0.2023	1.1503
adjusted for DDREF	0.2023	1.1503
Final ERR/Sv	0.2023	1.1503
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.040	0.230
Probability of Causation (PC)	3.89	18.70

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**5d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Rectum
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	747	912
Original ERR/Sv	0.1443	0.7787
Adjustment Factors		
Age at exposure, Attained age	2.0040	2.1505
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1183	0.0874
Systematic errors in gamma doses[b]	1.1392	1.0955
Systematic errors in neutron doses[b]	1.1485	1.1504
Systematic errors in RBE neutron doses[b]	1.0134	1.0100
Model Mixture factor for transfer to US pop	0.3512	0.4920
Ratio of Japanese to U.S. baseline cancer rates	1.3400	1.3637
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.060	0.339
Probability of Causation (PC)[d]	5.62	25.32

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.1443	0.7787
ERR/Sv with adjustments		
w/ age adjustment	0.2893	1.6745
w/ latency adjustment	0.2893	1.6745
w/ random errors in dosimetry adj	0.3235	1.8208
w/ systematic errors in dosimetry adj	0.2440	1.4307
adjusted for population transfer	0.2978	1.6950
multiplicative risk model	0.2440	1.4307
additive risk model	0.3269	1.9510
adjusted for smoking history	0.2978	1.6950
adjusted for DDREF	0.2978	1.6950
Final ERR/Sv	0.2978	1.6950
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.060	0.339
Probability of Causation (PC)	5.62	25.32

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**6a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	All digestive
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	289	512
Original ERR/Sv	0.2382	0.5301
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0836	0.0825
Systematic errors in gamma doses[b]	1.1331	1.0835
Systematic errors in neutron doses[b]	1.1915	1.2113
Systematic errors in RBE neutron doses[b]	0.9795	0.9687
Model Mixture factor for transfer to US pop	0.1395	-0.0226
Ratio of Japanese to U.S. baseline cancer rates	2.8432	2.7818
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.101	0.255
Probability of Causation (PC)	9.17	20.30

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.2382	0.5301
ERR/Sv with adjustments		
w/ age adjustment	0.2382	0.5301
w/ latency adjustment	0.2382	0.5301
w/ random errors in dosimetry adj	0.2581	0.5738
w/ systematic errors in dosimetry adj	0.1952	0.4514
adjusted for population transfer	0.5048	1.2738
multiplicative risk model	0.1952	0.4514
additive risk model	0.5550	1.2556
adjusted for smoking history	0.5048	1.2738
adjusted for DDREF	0.5048	1.2738
Final ERR/Sv	0.5048	1.2738
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.101	0.255
Probability of Causation (PC)	9.17	20.30

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**6b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	All digestive
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1655	512
Original ERR/Sv	0.1887	0.3321
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0564	0.0825
Systematic errors in gamma doses[b]	1.2971	1.0835
Systematic errors in neutron doses[b]	1.2693	1.2113
Systematic errors in RBE neutron doses[b]	1.0321	0.9687
Model Mixture factor for transfer to US pop	0.0740	-0.0226
Ratio of Japanese to U.S. baseline cancer rates	2.8082	2.7818
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.063	0.160
Probability of Causation (PC)	5.90	13.76

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.1887	0.3321
ERR/Sv with adjustments		
w/ age adjustment	0.1887	0.3321
w/ latency adjustment	0.1887	0.3321
w/ random errors in dosimetry adj	0.1993	0.3595
w/ systematic errors in dosimetry adj	0.1173	0.2828
adjusted for population transfer	0.3137	0.7980
multiplicative risk model	0.1173	0.2828
additive risk model	0.3294	0.7866
adjusted for smoking history	0.3137	0.7980
adjusted for DDREF	0.3137	0.7980
Final ERR/Sv	0.3137	0.7980
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.063	0.160
Probability of Causation (PC)	5.90	13.76

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**6c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	All digestive
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	839	512
Original ERR/Sv	0.5774	0.7683
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0855	0.0825
Systematic errors in gamma doses[b]	1.2640	1.0835
Systematic errors in neutron doses[b]	1.2479	1.2113
Systematic errors in RBE neutron doses[b]	0.9754	0.9687
Model Mixture factor for transfer to US pop	0.5663	-0.0226
Ratio of Japanese to U.S. baseline cancer rates	2.8035	2.7818
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.145	0.369
Probability of Causation (PC)[d]	12.68	26.96

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5774	0.7683
ERR/Sv with adjustments		
w/ age adjustment	0.5774	0.7683
w/ latency adjustment	0.5774	0.7683
w/ random errors in dosimetry adj	0.6267	0.8316
w/ systematic errors in dosimetry adj	0.4074	0.6541
adjusted for population transfer	0.7260	1.8460
multiplicative risk model	0.4074	0.6541
additive risk model	1.1421	1.8197
adjusted for smoking history	0.7260	1.8460
adjusted for DDREF	0.7260	1.8460
Final ERR/Sv	0.7260	1.8460
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.145	0.369
Probability of Causation (PC)	12.68	26.96

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**6d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	All digestive
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	684	245
Original ERR/Sv	0.6698	1.0904
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0896	0.0717
Systematic errors in gamma doses[b]	1.1843	1.0926
Systematic errors in neutron doses[b]	1.1767	1.2530
Systematic errors in RBE neutron doses[b]	1.0769	0.9201
Model Mixture factor for transfer to US pop	0.2731	0.1532
Ratio of Japanese to U.S. baseline cancer rates	1.9286	1.8995
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.163	0.327
Probability of Causation (PC)[d]	14.01	24.63

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6698	1.0904
ERR/Sv with adjustments		
w/ age adjustment	0.6698	1.0904
w/ latency adjustment	0.6698	1.0904
w/ random errors in dosimetry adj	0.7298	1.1686
w/ systematic errors in dosimetry adj	0.4863	0.9277
adjusted for population transfer	0.8145	1.6342
multiplicative risk model	0.4863	0.9277
additive risk model	0.9379	1.7621
adjusted for smoking history	0.8145	1.6342
adjusted for DDREF	0.8145	1.6342
Final ERR/Sv	0.8145	1.6342
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.163	0.327
Probability of Causation (PC)	14.01	24.63

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**7a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Liver
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1742	512
Original ERR/Sv	0.5829	1.0682
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0716	0.0669
Systematic errors in gamma doses[b]	1.2438	1.0835
Systematic errors in neutron doses[b]	1.1077	1.2113
Systematic errors in RBE neutron doses[b]	0.9751	0.9687
Model Mixture factor for transfer to US pop	0.5283	-0.0226
Ratio of Japanese to U.S. baseline cancer rates	8.5053	8.3881
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.422	1.534
Probability of Causation (PC)	29.68	60.53

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5829	1.0682
ERR/Sv with adjustments		
w/ age adjustment	0.5829	1.0682
w/ latency adjustment	0.5829	1.0682
w/ random errors in dosimetry adj	0.6246	1.1396
w/ systematic errors in dosimetry adj	0.4649	0.8964
adjusted for population transfer	2.1106	7.6685
multiplicative risk model	0.4649	0.8964
additive risk model	3.9539	7.5190
adjusted for smoking history	2.1106	7.6685
adjusted for DDREF	2.1106	7.6685
Final ERR/Sv	2.1106	7.6685
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.422	1.534
Probability of Causation (PC)	29.68	60.53

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**7b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Liver
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1556	512
Original ERR/Sv	0.3739	0.6505
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0692	0.0669
Systematic errors in gamma doses[b]	1.2354	1.0835
Systematic errors in neutron doses[b]	1.1470	1.2113
Systematic errors in RBE neutron doses[b]	1.0021	0.9687
Model Mixture factor for transfer to US pop	0.5267	-0.0226
Ratio of Japanese to U.S. baseline cancer rates	8.3211	8.3881
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.251	0.934
Probability of Causation (PC)	20.09	48.30

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.3739	0.6505
ERR/Sv with adjustments		
w/ age adjustment	0.3739	0.6505
w/ latency adjustment	0.3739	0.6505
w/ random errors in dosimetry adj	0.3998	0.6941
w/ systematic errors in dosimetry adj	0.2816	0.5459
adjusted for population transfer	1.2572	4.6703
multiplicative risk model	0.2816	0.5459
additive risk model	2.3428	4.5792
adjusted for smoking history	1.2572	4.6703
adjusted for DDREF	1.2572	4.6703
Final ERR/Sv	1.2572	4.6703
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.251	0.934
Probability of Causation (PC)	20.09	48.30

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**7c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Liver
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1556	512
Original ERR/Sv	0.8948	1.5531
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0692	0.0669
Systematic errors in gamma doses[b]	1.2354	1.0835
Systematic errors in neutron doses[b]	1.1470	1.2113
Systematic errors in RBE neutron doses[b]	1.0021	0.9687
Model Mixture factor for transfer to US pop	0.5267	-0.0226
Ratio of Japanese to U.S. baseline cancer rates	8.3211	8.3881
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.602	2.230
Probability of Causation (PC)[d]	37.56	69.04

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.8948	1.5531
ERR/Sv with adjustments		
w/ age adjustment	0.8948	1.5531
w/ latency adjustment	0.8948	1.5531
w/ random errors in dosimetry adj	0.9566	1.6570
w/ systematic errors in dosimetry adj	0.6737	1.3034
adjusted for population transfer	3.0083	11.1501
multiplicative risk model	0.6737	1.3034
additive risk model	5.6060	10.9327
adjusted for smoking history	3.0083	11.1501
adjusted for DDREF	3.0083	11.1501
Final ERR/Sv	3.0083	11.1501
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.602	2.230
Probability of Causation (PC)	37.56	69.04

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**7d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Liver
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	689	512
Original ERR/Sv	0.7312	1.0682
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0881	0.0669
Systematic errors in gamma doses[b]	1.0640	1.0835
Systematic errors in neutron doses[b]	1.1016	1.2113
Systematic errors in RBE neutron doses[b]	0.9635	0.9687
Model Mixture factor for transfer to US pop	0.7533	-0.0226
Ratio of Japanese to U.S. baseline cancer rates	5.6778	5.7787
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.304	1.055
Probability of Causation (PC)[d]	23.29	51.35

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.7312	1.0682
ERR/Sv with adjustments		
w/ age adjustment	0.7312	1.0682
w/ latency adjustment	0.7312	1.0682
w/ random errors in dosimetry adj	0.7956	1.1396
w/ systematic errors in dosimetry adj	0.7045	0.8964
adjusted for population transfer	1.5177	5.2767
multiplicative risk model	0.7045	0.8964
additive risk model	4.0002	5.1800
adjusted for smoking history	1.5177	5.2767
adjusted for DDREF	1.5177	5.2767
Final ERR/Sv	1.5177	5.2767
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.304	1.055
Probability of Causation (PC)	23.29	51.35

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**8a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Gallbladder
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	210	245
Original ERR/Sv	0.1239	0.3551
Adjustment Factors		
Age at exposure, Attained age	1.3258	1.7081
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0692	0.0705
Systematic errors in gamma doses[b]	1.1832	1.0926
Systematic errors in neutron doses[b]	1.2179	1.2530
Systematic errors in RBE neutron doses[b]	0.9737	0.9201
Model Mixture factor for transfer to US pop	0.7373	0.1532
Ratio of Japanese to U.S. baseline cancer rates	12.4170	12.6065
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.100	1.116
Probability of Causation (PC)	9.10	52.75

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.1239	0.3551
ERR/Sv with adjustments		
w/ age adjustment	0.1643	0.6066
w/ latency adjustment	0.1643	0.6066
w/ random errors in dosimetry adj	0.1757	0.6493
w/ systematic errors in dosimetry adj	0.1252	0.5155
adjusted for population transfer	0.5006	5.5815
multiplicative risk model	0.1252	0.5155
additive risk model	1.5544	6.4982
adjusted for smoking history	0.5006	5.5815
adjusted for DDREF	0.5006	5.5815
Final ERR/Sv	0.5006	5.5815
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.100	1.116
Probability of Causation (PC)	9.10	52.75

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**8b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Gallbladder
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	732	982
Original ERR/Sv	0.0344	0.2962
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1512	0.1187
Systematic errors in gamma doses[b]	1.0596	1.1383
Systematic errors in neutron doses[b]	1.2799	1.0913
Systematic errors in RBE neutron doses[b]	1.0272	1.0339
Model Mixture factor for transfer to US pop	0.1884	-0.0164
Ratio of Japanese to U.S. baseline cancer rates	13.3166	11.7879
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.062	0.617
Probability of Causation (PC)	5.88	38.17

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0344	0.2962
ERR/Sv with adjustments		
w/ age adjustment	0.0344	0.2962
w/ latency adjustment	0.0344	0.2962
w/ random errors in dosimetry adj	0.0396	0.3313
w/ systematic errors in dosimetry adj	0.0284	0.2580
adjusted for population transfer	0.3124	3.0868
multiplicative risk model	0.0284	0.2580
additive risk model	0.3783	3.0411
adjusted for smoking history	0.3124	3.0868
adjusted for DDREF	0.3124	3.0868
Final ERR/Sv	0.3124	3.0868
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.062	0.617
Probability of Causation (PC)	5.88	38.17

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**8c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Gallbladder
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1020	1668
Original ERR/Sv	0.1120	0.3136
Adjustment Factors		
Age at exposure, Attained age	2.3559	2.5833
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1116	0.0998
Systematic errors in gamma doses[b]	1.2248	1.0239
Systematic errors in neutron doses[b]	1.1026	1.2256
Systematic errors in RBE neutron doses[b]	1.0391	1.0150
Model Mixture factor for transfer to US pop	0.7945	0.1158
Ratio of Japanese to U.S. baseline cancer rates	13.0722	12.5374
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.145	1.567
Probability of Causation (PC)[d]	12.70	61.05

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.1120	0.3136
ERR/Sv with adjustments		
w/ age adjustment	0.2638	0.8101
w/ latency adjustment	0.2638	0.8101
w/ random errors in dosimetry adj	0.2932	0.8910
w/ systematic errors in dosimetry adj	0.2090	0.6996
adjusted for population transfer	0.7274	7.8358
multiplicative risk model	0.2090	0.6996
additive risk model	2.7318	8.7707
adjusted for smoking history	0.7274	7.8358
adjusted for DDREF	0.7274	7.8358
Final ERR/Sv	0.7274	7.8358
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.145	1.567
Probability of Causation (PC)	12.70	61.05

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**8d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Gallbladder
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	611	245
Original ERR/Sv	0.3473	0.7848
Adjustment Factors		
Age at exposure, Attained age	1.0655	1.7081
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0811	0.0705
Systematic errors in gamma doses[b]	1.1238	1.0926
Systematic errors in neutron doses[b]	1.0588	1.2530
Systematic errors in RBE neutron doses[b]	0.9736	0.9201
Model Mixture factor for transfer to US pop	0.8044	0.1532
Ratio of Japanese to U.S. baseline cancer rates	6.5015	6.2619
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.143	1.243
Probability of Causation (PC)[d]	12.54	55.42

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.3473	0.7848
ERR/Sv with adjustments		
w/ age adjustment	0.3701	1.3405
w/ latency adjustment	0.3701	1.3405
w/ random errors in dosimetry adj	0.4001	1.4349
w/ systematic errors in dosimetry adj	0.3454	1.1391
adjusted for population transfer	0.7170	6.2146
multiplicative risk model	0.3454	1.1391
additive risk model	2.2455	7.1330
adjusted for smoking history	0.7170	6.2146
adjusted for DDREF	0.7170	6.2146
Final ERR/Sv	0.7170	6.2146
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.143	1.243
Probability of Causation (PC)	12.54	55.42

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**9a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Pancreas
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1412	679
Original ERR/Sv	0.1563	0.5658
Adjustment Factors		
Age at exposure, Attained age	1.3896	2.0544
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0954	0.0789
Systematic errors in gamma doses[b]	1.3309	1.1779
Systematic errors in neutron doses[b]	1.0983	1.2094
Systematic errors in RBE neutron doses[b]	1.0173	1.0298
Model Mixture factor for transfer to US pop	0.2995	0.3402
Ratio of Japanese to U.S. baseline cancer rates	1.2098	1.2347
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.037	0.197
Probability of Causation (PC)	3.54	16.49

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.1563	0.5658
ERR/Sv with adjustments		
w/ age adjustment	0.2172	1.1625
w/ latency adjustment	0.2172	1.1625
w/ random errors in dosimetry adj	0.2379	1.2542
w/ systematic errors in dosimetry adj	0.1600	0.8549
adjusted for population transfer	0.1835	0.9873
multiplicative risk model	0.1600	0.8549
additive risk model	0.1935	1.0556
adjusted for smoking history	0.1835	0.9873
adjusted for DDREF	0.1835	0.9873
Final ERR/Sv	0.1835	0.9873
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.037	0.197
Probability of Causation (PC)	3.54	16.49

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**9b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Pancreas
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1625	863
Original ERR/Sv	0.1443	0.4974
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1037	0.0866
Systematic errors in gamma doses[b]	1.3737	1.1717
Systematic errors in neutron doses[b]	1.1127	1.0944
Systematic errors in RBE neutron doses[b]	0.9683	0.9488
Model Mixture factor for transfer to US pop	0.8902	0.1230
Ratio of Japanese to U.S. baseline cancer rates	1.1395	1.2015
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.022	0.105
Probability of Causation (PC)	2.14	9.46

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.1443	0.4974
ERR/Sv with adjustments		
w/ age adjustment	0.1443	0.4974
w/ latency adjustment	0.1443	0.4974
w/ random errors in dosimetry adj	0.1592	0.5404
w/ systematic errors in dosimetry adj	0.1076	0.4442
adjusted for population transfer	0.1092	0.5227
multiplicative risk model	0.1076	0.4442
additive risk model	0.1226	0.5337
adjusted for smoking history	0.1092	0.5227
adjusted for DDREF	0.1092	0.5227
Final ERR/Sv	0.1092	0.5227
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.022	0.105
Probability of Causation (PC)	2.14	9.46

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**9c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Pancreas
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	733	679
Original ERR/Sv	0.1158	0.5658
Adjustment Factors		
Age at exposure, Attained age	2.5397	2.9127
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0881	0.0789
Systematic errors in gamma doses[b]	1.1592	1.1779
Systematic errors in neutron doses[b]	1.1055	1.2094
Systematic errors in RBE neutron doses[b]	1.0308	1.0298
Model Mixture factor for transfer to US pop	0.3743	0.3402
Ratio of Japanese to U.S. baseline cancer rates	1.1606	1.2347
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.053	0.280
Probability of Causation (PC)[d]	5.06	21.87

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.1158	0.5658
ERR/Sv with adjustments		
w/ age adjustment	0.2941	1.6481
w/ latency adjustment	0.2941	1.6481
w/ random errors in dosimetry adj	0.3200	1.7782
w/ systematic errors in dosimetry adj	0.2423	1.2121
adjusted for population transfer	0.2666	1.3998
multiplicative risk model	0.2423	1.2121
additive risk model	0.2812	1.4966
adjusted for smoking history	0.2666	1.3998
adjusted for DDREF	0.2666	1.3998
Final ERR/Sv	0.2666	1.3998
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.053	0.280
Probability of Causation (PC)	5.06	21.87

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**9d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Pancreas
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	576	1151
Original ERR/Sv	0.3064	1.2042
Adjustment Factors		
Age at exposure, Attained age	1.5717	1.9296
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1081	0.0821
Systematic errors in gamma doses[b]	1.0919	1.1396
Systematic errors in neutron doses[b]	1.1260	1.2304
Systematic errors in RBE neutron doses[b]	1.0812	0.9320
Model Mixture factor for transfer to US pop	0.3721	0.1032
Ratio of Japanese to U.S. baseline cancer rates	0.9333	0.9660
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.077	0.373
Probability of Causation (PC)[d]	7.14	27.17

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.3064	1.2042
ERR/Sv with adjustments		
w/ age adjustment	0.4816	2.3235
w/ latency adjustment	0.4816	2.3235
w/ random errors in dosimetry adj	0.5337	2.5142
w/ systematic errors in dosimetry adj	0.4015	1.9239
adjusted for population transfer	0.3847	1.8653
multiplicative risk model	0.4015	1.9239
additive risk model	0.3747	1.8585
adjusted for smoking history	0.3847	1.8653
adjusted for DDREF	0.3847	1.8653
Final ERR/Sv	0.3847	1.8653
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.077	0.373
Probability of Causation (PC)	7.14	27.17

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**10a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Lung
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	720	1305
Original ERR/Sv	0.6477	0.7451
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1168	0.0928
Systematic errors in gamma doses[b]	1.0722	1.1818
Systematic errors in neutron doses[b]	1.1975	1.0316
Systematic errors in RBE neutron doses[b]	1.0342	0.9563
Model Mixture factor for transfer to US pop	0.1956	0.7841
Ratio of Japanese to U.S. baseline cancer rates	0.7358	0.7121
Smoking history	1.475203	3.548618
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.127	0.465
Probability of Causation (PC)	11.24	31.74

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6477	0.7451
ERR/Sv with adjustments		
w/ age adjustment	0.6477	0.7451
w/ latency adjustment	0.6477	0.7451
w/ random errors in dosimetry adj	0.7233	0.8143
w/ systematic errors in dosimetry adj	0.5448	0.6984
adjusted for population transfer	0.4290	0.6550
multiplicative risk model	0.5448	0.6984
additive risk model	0.4009	0.4974
adjusted for smoking history	0.6329	2.3244
adjusted for DDREF	0.6329	2.3244
Final ERR/Sv	0.6329	2.3244
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.127	0.465
Probability of Causation (PC)	11.24	31.74

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**10b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Lung
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	720	1305
Original ERR/Sv	0.6477	0.7451
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1168	0.0928
Systematic errors in gamma doses[b]	1.0722	1.1818
Systematic errors in neutron doses[b]	1.1975	1.0316
Systematic errors in RBE neutron doses[b]	1.0342	0.9563
Model Mixture factor for transfer to US pop	0.1956	0.7841
Ratio of Japanese to U.S. baseline cancer rates	0.7358	0.7121
Smoking history	1.475203	3.548618
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.127	0.465
Probability of Causation (PC)	11.24	31.74

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6477	0.7451
ERR/Sv with adjustments		
w/ age adjustment	0.6477	0.7451
w/ latency adjustment	0.6477	0.7451
w/ random errors in dosimetry adj	0.7233	0.8143
w/ systematic errors in dosimetry adj	0.5448	0.6984
adjusted for population transfer	0.4290	0.6550
multiplicative risk model	0.5448	0.6984
additive risk model	0.4009	0.4974
adjusted for smoking history	0.6329	2.3244
adjusted for DDREF	0.6329	2.3244
Final ERR/Sv	0.6329	2.3244
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.127	0.465
Probability of Causation (PC)	11.24	31.74

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**10c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	720	1305
Original ERR/Sv	0.6477	0.7451
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1168	0.0928
Systematic errors in gamma doses[b]	1.0722	1.1818
Systematic errors in neutron doses[b]	1.1975	1.0316
Systematic errors in RBE neutron doses[b]	1.0342	0.9563
Model Mixture factor for transfer to US pop	0.1956	0.7841
Ratio of Japanese to U.S. baseline cancer rates	0.7358	0.7121
Smoking history	1.475203	3.548618
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.127	0.465
Probability of Causation (PC)[d]	11.24	31.74

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6477	0.7451
ERR/Sv with adjustments		
w/ age adjustment	0.6477	0.7451
w/ latency adjustment	0.6477	0.7451
w/ random errors in dosimetry adj	0.7233	0.8143
w/ systematic errors in dosimetry adj	0.5448	0.6984
adjusted for population transfer	0.4290	0.6550
multiplicative risk model	0.5448	0.6984
additive risk model	0.4009	0.4974
adjusted for smoking history	0.6329	2.3244
adjusted for DDREF	0.6329	2.3244
Final ERR/Sv	0.6329	2.3244
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.127	0.465
Probability of Causation (PC)	11.24	31.74

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**10d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Lung
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	485	132
Original ERR/Sv	1.6814	2.7666
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0923	0.0715
Systematic errors in gamma doses[b]	1.1067	1.0356
Systematic errors in neutron doses[b]	1.1249	1.1335
Systematic errors in RBE neutron doses[b]	0.9881	0.9714
Model Mixture factor for transfer to US pop	0.5503	1.0184
Ratio of Japanese to U.S. baseline cancer rates	0.3777	0.3659
Smoking history	1.710404	2.426341
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.368	1.276
Probability of Causation (PC)[d]	26.89	56.07

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.6814	2.7666
ERR/Sv with adjustments		
w/ age adjustment	1.6814	2.7666
w/ latency adjustment	1.6814	2.7666
w/ random errors in dosimetry adj	1.8365	2.9645
w/ systematic errors in dosimetry adj	1.4930	2.5998
adjusted for population transfer	1.0752	2.6302
multiplicative risk model	1.4930	2.5998
additive risk model	0.5639	0.9514
adjusted for smoking history	1.8390	6.3818
adjusted for DDREF	1.8390	6.3818
Final ERR/Sv	1.8390	6.3818
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.368	1.276
Probability of Causation (PC)	26.89	56.07

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**11a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Other respiratory
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	449	124
Original ERR/Sv	0.0617	0.7551
Adjustment Factors		
Age at exposure, Attained age	1.5143	1.5553
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1048	0.0614
Systematic errors in gamma doses[b]	1.1937	1.1452
Systematic errors in neutron doses[b]	1.0650	1.1605
Systematic errors in RBE neutron doses[b]	0.9391	0.9577
Model Mixture factor for transfer to US pop	0.3303	0.1378
Ratio of Japanese to U.S. baseline cancer rates	0.9135	0.8934
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.016	0.178
Probability of Causation (PC)	1.60	15.10

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0617	0.7551
ERR/Sv with adjustments		
w/ age adjustment	0.0934	1.1745
w/ latency adjustment	0.0934	1.1745
w/ random errors in dosimetry adj	0.1032	1.2466
w/ systematic errors in dosimetry adj	0.0865	0.9794
adjusted for population transfer	0.0815	0.8894
multiplicative risk model	0.0865	0.9794
additive risk model	0.0790	0.8751
adjusted for smoking history	0.0815	0.8894
adjusted for DDREF	0.0815	0.8894
Final ERR/Sv	0.0815	0.8894
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.016	0.178
Probability of Causation (PC)	1.60	15.10

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**11b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Other respiratory
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	22	932
Original ERR/Sv	0.0704	0.5523
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0906	0.1103
Systematic errors in gamma doses[b]	1.2297	1.0932
Systematic errors in neutron doses[b]	1.1052	1.1202
Systematic errors in RBE neutron doses[b]	0.9885	1.0206
Model Mixture factor for transfer to US pop	0.0245	0.8413
Ratio of Japanese to U.S. baseline cancer rates	0.8380	1.0377
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.010	0.099
Probability of Causation (PC)	0.95	8.98

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0704	0.5523
ERR/Sv with adjustments		
w/ age adjustment	0.0704	0.5523
w/ latency adjustment	0.0704	0.5523
w/ random errors in dosimetry adj	0.0768	0.6132
w/ systematic errors in dosimetry adj	0.0572	0.4906
adjusted for population transfer	0.0481	0.4936
multiplicative risk model	0.0572	0.4906
additive risk model	0.0479	0.5091
adjusted for smoking history	0.0481	0.4936
adjusted for DDREF	0.0481	0.4936
Final ERR/Sv	0.0481	0.4936
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.010	0.099
Probability of Causation (PC)	0.95	8.98

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**11c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Other respiratory
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1040	11
Original ERR/Sv	0.0751	0.6175
Adjustment Factors		
Age at exposure, Attained age	1.8424	2.6641
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1123	0.0920
Systematic errors in gamma doses[b]	1.1925	1.2804
Systematic errors in neutron doses[b]	1.1266	1.0432
Systematic errors in RBE neutron doses[b]	0.9632	0.9935
Model Mixture factor for transfer to US pop	0.7043	0.0553
Ratio of Japanese to U.S. baseline cancer rates	0.9528	0.9342
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.023	0.254
Probability of Causation (PC)[d]	2.29	20.25

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0751	0.6175
ERR/Sv with adjustments		
w/ age adjustment	0.1384	1.6451
w/ latency adjustment	0.1384	1.6451
w/ random errors in dosimetry adj	0.1540	1.7965
w/ systematic errors in dosimetry adj	0.1190	1.3538
adjusted for population transfer	0.1173	1.2697
multiplicative risk model	0.1190	1.3538
additive risk model	0.1134	1.2648
adjusted for smoking history	0.1173	1.2697
adjusted for DDREF	0.1173	1.2697
Final ERR/Sv	0.1173	1.2697
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.023	0.254
Probability of Causation (PC)	2.29	20.25

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**11d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Other respiratory
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	417	389
Original ERR/Sv	0.1369	1.2603
Adjustment Factors		
Age at exposure, Attained age	1.3803	1.6294
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1303	0.0857
Systematic errors in gamma doses[b]	1.0695	1.0389
Systematic errors in neutron doses[b]	1.0948	1.0720
Systematic errors in RBE neutron doses[b]	0.9209	1.0083
Model Mixture factor for transfer to US pop	0.5965	0.8781
Ratio of Japanese to U.S. baseline cancer rates	0.6923	0.7453
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.035	0.385
Probability of Causation (PC)[d]	3.35	27.79

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.1369	1.2603
ERR/Sv with adjustments		
w/ age adjustment	0.1889	2.0536
w/ latency adjustment	0.1889	2.0536
w/ random errors in dosimetry adj	0.2135	2.2296
w/ systematic errors in dosimetry adj	0.1980	1.9856
adjusted for population transfer	0.1734	1.9239
multiplicative risk model	0.1980	1.9856
additive risk model	0.1371	1.4798
adjusted for smoking history	0.1734	1.9239
adjusted for DDREF	0.1734	1.9239
Final ERR/Sv	0.1734	1.9239
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.035	0.385
Probability of Causation (PC)	3.35	27.79

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**12a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Bone
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	755	414
Original ERR/Sv	0.7010	1.2648
Adjustment Factors		
Age at exposure, Attained age	1.3359	1.8264
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0707	0.1039
Systematic errors in gamma doses[b]	1.0985	1.1584
Systematic errors in neutron doses[b]	1.1960	1.1204
Systematic errors in RBE neutron doses[b]	1.0860	0.9067
Model Mixture factor for transfer to US pop	0.7797	0.5421
Ratio of Japanese to U.S. baseline cancer rates	0.6943	0.6579
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.131	0.365
Probability of Causation (PC)	11.59	26.76

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.7010	1.2648
ERR/Sv with adjustments		
w/ age adjustment	0.9365	2.3100
w/ latency adjustment	0.9365	2.3100
w/ random errors in dosimetry adj	1.0027	2.5499
w/ systematic errors in dosimetry adj	0.7027	2.1668
adjusted for population transfer	0.6554	1.8273
multiplicative risk model	0.7027	2.1668
additive risk model	0.4879	1.4255
adjusted for smoking history	0.6554	1.8273
adjusted for DDREF	0.6554	1.8273
Final ERR/Sv	0.6554	1.8273
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.131	0.365
Probability of Causation (PC)	11.59	26.76

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**12b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Bone
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	913	859
Original ERR/Sv	0.5431	1.5814
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0739	0.0772
Systematic errors in gamma doses[b]	1.1857	1.2002
Systematic errors in neutron doses[b]	1.1532	1.2142
Systematic errors in RBE neutron doses[b]	0.9940	1.0619
Model Mixture factor for transfer to US pop	0.6334	0.7071
Ratio of Japanese to U.S. baseline cancer rates	0.7346	0.6862
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.077	0.200
Probability of Causation (PC)	7.19	16.66

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5431	1.5814
ERR/Sv with adjustments		
w/ age adjustment	0.5431	1.5814
w/ latency adjustment	0.5431	1.5814
w/ random errors in dosimetry adj	0.5833	1.7035
w/ systematic errors in dosimetry adj	0.4292	1.1009
adjusted for population transfer	0.3874	0.9997
multiplicative risk model	0.4292	1.1009
additive risk model	0.3153	0.7554
adjusted for smoking history	0.3874	0.9997
adjusted for DDREF	0.3874	0.9997
Final ERR/Sv	0.3874	0.9997
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.077	0.200
Probability of Causation (PC)	7.19	16.66

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**12c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Bone
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	210	1024
Original ERR/Sv	0.6933	0.9663
Adjustment Factors		
Age at exposure, Attained age	1.9387	2.8054
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0727	0.1155
Systematic errors in gamma doses[b]	1.1832	1.0414
Systematic errors in neutron doses[b]	1.2179	1.1006
Systematic errors in RBE neutron doses[b]	0.9737	0.9584
Model Mixture factor for transfer to US pop	0.7373	0.8528
Ratio of Japanese to U.S. baseline cancer rates	0.6935	0.5592
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.189	0.515
Probability of Causation (PC)[d]	15.89	33.99

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6933	0.9663
ERR/Sv with adjustments		
w/ age adjustment	1.3441	2.7109
w/ latency adjustment	1.3441	2.7109
w/ random errors in dosimetry adj	1.4418	3.0240
w/ systematic errors in dosimetry adj	1.0275	2.7532
adjusted for population transfer	0.9448	2.5745
multiplicative risk model	1.0275	2.7532
additive risk model	0.7126	1.5396
adjusted for smoking history	0.9448	2.5745
adjusted for DDREF	0.9448	2.5745
Final ERR/Sv	0.9448	2.5745
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.189	0.515
Probability of Causation (PC)	15.89	33.99

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**12d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Bone
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1359	1236
Original ERR/Sv	0.9597	1.9063
Adjustment Factors		
Age at exposure, Attained age	1.7666	2.1927
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0908	0.1548
Systematic errors in gamma doses[b]	1.0541	1.0517
Systematic errors in neutron doses[b]	1.0770	1.0921
Systematic errors in RBE neutron doses[b]	1.0113	0.9735
Model Mixture factor for transfer to US pop	0.9348	0.7621
Ratio of Japanese to U.S. baseline cancer rates	0.8333	0.5817
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.319	0.778
Probability of Causation (PC)[d]	24.16	43.74

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.9597	1.9063
ERR/Sv with adjustments		
w/ age adjustment	1.6953	4.1799
w/ latency adjustment	1.6953	4.1799
w/ random errors in dosimetry adj	1.8492	4.8270
w/ systematic errors in dosimetry adj	1.6105	4.3174
adjusted for population transfer	1.5930	3.8877
multiplicative risk model	1.6105	4.3174
additive risk model	1.3420	2.5113
adjusted for smoking history	1.5930	3.8877
adjusted for DDREF	1.5930	3.8877
Final ERR/Sv	1.5930	3.8877
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.319	0.778
Probability of Causation (PC)	24.16	43.74

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**13a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Connective tissue
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	140	1609
Original ERR/Sv	0.6082	1.1323
Adjustment Factors		
Age at exposure, Attained age	1.4605	2.0878
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0907	0.0674
Systematic errors in gamma doses[b]	1.2968	1.2678
Systematic errors in neutron doses[b]	1.1011	1.2567
Systematic errors in RBE neutron doses[b]	0.9166	0.9050
Model Mixture factor for transfer to US pop	0.6730	0.9953
Ratio of Japanese to U.S. baseline cancer rates	0.3985	0.4967
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.119	0.349
Probability of Causation (PC)	10.63	25.88

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6082	1.1323
ERR/Sv with adjustments		
w/ age adjustment	0.8883	2.3641
w/ latency adjustment	0.8883	2.3641
w/ random errors in dosimetry adj	0.9689	2.5234
w/ systematic errors in dosimetry adj	0.7403	1.7501
adjusted for population transfer	0.5947	1.7460
multiplicative risk model	0.7403	1.7501
additive risk model	0.2950	0.8693
adjusted for smoking history	0.5947	1.7460
adjusted for DDREF	0.5947	1.7460
Final ERR/Sv	0.5947	1.7460
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.119	0.349
Probability of Causation (PC)	10.63	25.88

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**13b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Connective tissue
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	Mid[d]	Upper[d]
Monte Carlo iteration number	558	1149
Original ERR/Sv	0.7858	1.0882
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1066	0.0726
Systematic errors in gamma doses[b]	1.2018	1.1357
Systematic errors in neutron doses[b]	1.1199	1.0782
Systematic errors in RBE neutron doses[b]	0.9459	1.0024
Model Mixture factor for transfer to US pop	0.1147	1.0293
Ratio of Japanese to U.S. baseline cancer rates	0.4535	0.3993
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1
Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.071	0.194
Probability of Causation (PC)	6.59	16.22

Verification Calculations using MS Excel

Personal Information	
Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	Mid[d]	Upper[d]
Original ERR/Sv	0.7858	1.0882
ERR/Sv with adjustments		
w/ age adjustment	0.7858	1.0882
w/ latency adjustment	0.7858	1.0882
w/ random errors in dosimetry adj	0.8695	1.1672
w/ systematic errors in dosimetry adj	0.6830	0.9510
adjusted for population transfer	0.3525	0.9677
multiplicative risk model	0.6830	0.9510
additive risk model	0.3097	0.3798
adjusted for smoking history	0.3525	0.9677
adjusted for DDREF	0.3525	0.9677
Final ERR/Sv	0.3525	0.9677
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0
Final results calculated in Excel		
Excess relative risk (ERR)	0.071	0.194
Probability of Causation (PC)	6.59	16.22

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**13c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Connective tissue
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	181	1547
Original ERR/Sv	0.3393	1.0065
Adjustment Factors		
Age at exposure, Attained age	3.3005	2.3518
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0779	0.0730
Systematic errors in gamma doses[b]	1.1616	1.0530
Systematic errors in neutron doses[b]	1.1517	1.0267
Systematic errors in RBE neutron doses[b]	0.9763	0.9623
Model Mixture factor for transfer to US pop	0.8660	1.0431
Ratio of Japanese to U.S. baseline cancer rates	0.4360	0.5664
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.171	0.497
Probability of Causation (PC)[d]	14.60	33.22

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.3393	1.0065
ERR/Sv with adjustments		
w/ age adjustment	1.1200	2.3672
w/ latency adjustment	1.1200	2.3672
w/ random errors in dosimetry adj	1.2073	2.5400
w/ systematic errors in dosimetry adj	0.9244	2.4414
adjusted for population transfer	0.8545	2.4869
multiplicative risk model	0.9244	2.4414
additive risk model	0.4031	1.3828
adjusted for smoking history	0.8545	2.4869
adjusted for DDREF	0.8545	2.4869
Final ERR/Sv	0.8545	2.4869
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.171	0.497
Probability of Causation (PC)	14.60	33.22

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**13d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Connective tissue
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	210	1024
Original ERR/Sv	1.5256	2.0368
Adjustment Factors		
Age at exposure, Attained age	1.3258	1.9731
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0710	0.0776
Systematic errors in gamma doses[b]	1.1832	1.0414
Systematic errors in neutron doses[b]	1.2179	1.1006
Systematic errors in RBE neutron doses[b]	0.9737	0.9584
Model Mixture factor for transfer to US pop	0.7373	0.8528
Ratio of Japanese to U.S. baseline cancer rates	0.6903	0.7443
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.284	0.759
Probability of Causation (PC)[d]	22.10	43.15

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.5256	2.0368
ERR/Sv with adjustments		
w/ age adjustment	2.0226	4.0187
w/ latency adjustment	2.0226	4.0187
w/ random errors in dosimetry adj	2.1661	4.3307
w/ systematic errors in dosimetry adj	1.5437	3.9429
adjusted for population transfer	1.4182	3.7945
multiplicative risk model	1.5437	3.9429
additive risk model	1.0657	2.9348
adjusted for smoking history	1.4182	3.7945
adjusted for DDREF	1.4182	3.7945
Final ERR/Sv	1.4182	3.7945
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.284	0.759
Probability of Causation (PC)	22.10	43.15

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**14a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Malignant melanoma
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	423	1325
Original ERR/Sv	4.3731	16.1408
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0727	0.0817
Systematic errors in gamma doses[b]	1.0643	1.0561
Systematic errors in neutron doses[b]	1.1357	1.0828
Systematic errors in RBE neutron doses[b]	1.0143	0.9595
Model Mixture factor for transfer to US pop	0.6251	0.7731
Ratio of Japanese to U.S. baseline cancer rates	0.0328	0.0382
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.488	2.488
Probability of Causation (PC)	32.79	71.33

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	4.3731	16.1408
ERR/Sv with adjustments		
w/ age adjustment	4.3731	16.1408
w/ latency adjustment	4.3731	16.1408
w/ random errors in dosimetry adj	4.6909	17.4598
w/ systematic errors in dosimetry adj	3.8262	15.9123
adjusted for population transfer	2.4389	12.4392
multiplicative risk model	3.8262	15.9123
additive risk model	0.1254	0.6073
adjusted for smoking history	2.4389	12.4392
adjusted for DDREF	2.4389	12.4392
Final ERR/Sv	2.4389	12.4392
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.488	2.488
Probability of Causation (PC)	32.79	71.33

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**14b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Malignant melanoma
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1410	1945
Original ERR/Sv	0.5092	1.5355
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0852	0.1072
Systematic errors in gamma doses[b]	1.1293	1.1230
Systematic errors in neutron doses[b]	1.1194	1.0286
Systematic errors in RBE neutron doses[b]	1.0698	0.9589
Model Mixture factor for transfer to US pop	0.3309	0.7560
Ratio of Japanese to U.S. baseline cancer rates	0.0352	0.0349
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.029	0.235
Probability of Causation (PC)	2.82	19.01

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5092	1.5355
ERR/Sv with adjustments		
w/ age adjustment	0.5092	1.5355
w/ latency adjustment	0.5092	1.5355
w/ random errors in dosimetry adj	0.5526	1.7001
w/ systematic errors in dosimetry adj	0.4087	1.5349
adjusted for population transfer	0.1448	1.1735
multiplicative risk model	0.4087	1.5349
additive risk model	0.0144	0.0535
adjusted for smoking history	0.1448	1.1735
adjusted for DDREF	0.1448	1.1735
Final ERR/Sv	0.1448	1.1735
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.029	0.235
Probability of Causation (PC)	2.82	19.01

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**14c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Malignant melanoma
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	423	1325
Original ERR/Sv	4.3731	16.1408
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0727	0.0817
Systematic errors in gamma doses[b]	1.0643	1.0561
Systematic errors in neutron doses[b]	1.1357	1.0828
Systematic errors in RBE neutron doses[b]	1.0143	0.9595
Model Mixture factor for transfer to US pop	0.6251	0.7731
Ratio of Japanese to U.S. baseline cancer rates	0.0328	0.0382
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.488	2.488
Probability of Causation (PC)[d]	32.79	71.33

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	4.3731	16.1408
ERR/Sv with adjustments		
w/ age adjustment	4.3731	16.1408
w/ latency adjustment	4.3731	16.1408
w/ random errors in dosimetry adj	4.6909	17.4598
w/ systematic errors in dosimetry adj	3.8262	15.9123
adjusted for population transfer	2.4389	12.4392
multiplicative risk model	3.8262	15.9123
additive risk model	0.1254	0.6073
adjusted for smoking history	2.4389	12.4392
adjusted for DDREF	2.4389	12.4392
Final ERR/Sv	2.4389	12.4392
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.488	2.488
Probability of Causation (PC)	32.79	71.33

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**14d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Malignant melanoma
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	423	1325
Original ERR/Sv	4.3731	16.1408
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0727	0.0817
Systematic errors in gamma doses[b]	1.0643	1.0561
Systematic errors in neutron doses[b]	1.1357	1.0828
Systematic errors in RBE neutron doses[b]	1.0143	0.9595
Model Mixture factor for transfer to US pop	0.6251	0.7731
Ratio of Japanese to U.S. baseline cancer rates	0.0403	0.0468
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.490	2.494
Probability of Causation (PC)[d]	32.88	71.38

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	4.3731	16.1408
ERR/Sv with adjustments		
w/ age adjustment	4.3731	16.1408
w/ latency adjustment	4.3731	16.1408
w/ random errors in dosimetry adj	4.6909	17.4598
w/ systematic errors in dosimetry adj	3.8262	15.9123
adjusted for population transfer	2.4497	12.4705
multiplicative risk model	3.8262	15.9123
additive risk model	0.1543	0.7450
adjusted for smoking history	2.4497	12.4705
adjusted for DDREF	2.4497	12.4705
Final ERR/Sv	2.4497	12.4705
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.490	2.494
Probability of Causation (PC)	32.88	71.38

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**15a**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Non-melanoma (BCC)
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1914	1430
Original ERR/Sv	6.5787	13.4140
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0754	0.0587
Systematic errors in gamma doses[b]	1.2660	1.1511
Systematic errors in neutron doses[b]	1.1412	1.0334
Systematic errors in RBE neutron doses[b]	1.0565	0.9946
Model Mixture factor for transfer to US pop	0.5124	1.0471
Ratio of Japanese to U.S. baseline cancer rates	0.0205	0.0267
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.484	2.510
Probability of Causation (PC)	32.63	71.51

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	6.5787	13.4140
ERR/Sv with adjustments		
w/ age adjustment	6.5787	13.4140
w/ latency adjustment	6.5787	13.4140
w/ random errors in dosimetry adj	7.0748	14.2010
w/ systematic errors in dosimetry adj	4.6353	12.0023
adjusted for population transfer	2.4213	12.5519
multiplicative risk model	4.6353	12.0023
additive risk model	0.0949	0.3200
adjusted for smoking history	2.4213	12.5519
adjusted for DDREF	2.4213	12.5519
Final ERR/Sv	2.4213	12.5519
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.484	2.510
Probability of Causation (PC)	32.63	71.51

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**15b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Non-melanoma (BCC)
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1417	1430
Original ERR/Sv	0.7437	1.2386
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0917	0.0587
Systematic errors in gamma doses[b]	1.1690	1.1511
Systematic errors in neutron doses[b]	1.1624	1.0334
Systematic errors in RBE neutron doses[b]	0.9814	0.9946
Model Mixture factor for transfer to US pop	0.2214	1.0471
Ratio of Japanese to U.S. baseline cancer rates	0.0171	0.0203
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.029	0.232
Probability of Causation (PC)	2.78	18.82

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.7437	1.2386
ERR/Sv with adjustments		
w/ age adjustment	0.7437	1.2386
w/ latency adjustment	0.7437	1.2386
w/ random errors in dosimetry adj	0.8119	1.3113
w/ systematic errors in dosimetry adj	0.6089	1.1083
adjusted for population transfer	0.1429	1.1594
multiplicative risk model	0.6089	1.1083
additive risk model	0.0104	0.0225
adjusted for smoking history	0.1429	1.1594
adjusted for DDREF	0.1429	1.1594
Final ERR/Sv	0.1429	1.1594
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.029	0.232
Probability of Causation (PC)	2.78	18.82

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**15c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Non-melanoma (BCC)
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	15	1430
Original ERR/Sv	4.5614	13.4140
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0853	0.0587
Systematic errors in gamma doses[b]	1.1193	1.1511
Systematic errors in neutron doses[b]	1.2012	1.0334
Systematic errors in RBE neutron doses[b]	0.9865	0.9946
Model Mixture factor for transfer to US pop	0.6356	1.0471
Ratio of Japanese to U.S. baseline cancer rates	0.0215	0.0203
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.480	2.511
Probability of Causation (PC)[d]	32.45	71.52

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	4.5614	13.4140
ERR/Sv with adjustments		
w/ age adjustment	4.5614	13.4140
w/ latency adjustment	4.5614	13.4140
w/ random errors in dosimetry adj	4.9504	14.2010
w/ systematic errors in dosimetry adj	3.7325	12.0023
adjusted for population transfer	2.4015	12.5555
multiplicative risk model	3.7325	12.0023
additive risk model	0.0802	0.2433
adjusted for smoking history	2.4015	12.5555
adjusted for DDREF	2.4015	12.5555
Final ERR/Sv	2.4015	12.5555
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.480	2.511
Probability of Causation (PC)	32.45	71.52

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**15d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Non-melanoma (BCC)
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1914	1430
Original ERR/Sv	6.5787	13.4140
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0754	0.0587
Systematic errors in gamma doses[b]	1.2660	1.1511
Systematic errors in neutron doses[b]	1.1412	1.0334
Systematic errors in RBE neutron doses[b]	1.0565	0.9946
Model Mixture factor for transfer to US pop	0.5124	1.0471
Ratio of Japanese to U.S. baseline cancer rates	0.0205	0.0267
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.484	2.510
Probability of Causation (PC)[d]	32.63	71.51

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	6.5787	13.4140
ERR/Sv with adjustments		
w/ age adjustment	6.5787	13.4140
w/ latency adjustment	6.5787	13.4140
w/ random errors in dosimetry adj	7.0748	14.2010
w/ systematic errors in dosimetry adj	4.6353	12.0023
adjusted for population transfer	2.4213	12.5519
multiplicative risk model	4.6353	12.0023
additive risk model	0.0949	0.3200
adjusted for smoking history	2.4213	12.5519
adjusted for DDREF	2.4213	12.5519
Final ERR/Sv	2.4213	12.5519
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.484	2.510
Probability of Causation (PC)	32.63	71.51

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**16a**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Non-melanoma (SCC)
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1	1945
Original ERR/Sv	-0.1915	0.4633
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0865	0.0821
Systematic errors in gamma doses[b]	1.1934	1.1230
Systematic errors in neutron doses[b]	1.0294	1.0286
Systematic errors in RBE neutron doses[b]	0.9363	0.9589
Model Mixture factor for transfer to US pop	0.7027	0.7560
Ratio of Japanese to U.S. baseline cancer rates	0.0250	0.0280
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.000	0.069
Probability of Causation (PC)	0.00	6.46

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0000	0.4633
ERR/Sv with adjustments		
w/ age adjustment	0.0000	0.4633
w/ latency adjustment	0.0000	0.4633
w/ random errors in dosimetry adj	0.0000	0.5014
w/ systematic errors in dosimetry adj	0.0000	0.4526
adjusted for population transfer	0.0000	0.3453
multiplicative risk model	0.0000	0.4526
additive risk model	0.0000	0.0127
adjusted for smoking history	0.0000	0.3453
adjusted for DDREF	0.0000	0.3453
Final ERR/Sv	0.0000	0.3453
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.000	0.069
Probability of Causation (PC)	0.00	6.46

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**16b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Non-melanoma (SCC)
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1	1945
Original ERR/Sv	-0.1915	0.4633
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0865	0.0821
Systematic errors in gamma doses[b]	1.1934	1.1230
Systematic errors in neutron doses[b]	1.0294	1.0286
Systematic errors in RBE neutron doses[b]	0.9363	0.9589
Model Mixture factor for transfer to US pop	0.7027	0.7560
Ratio of Japanese to U.S. baseline cancer rates	0.0189	0.0213
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.000	0.069
Probability of Causation (PC)	0.00	6.45

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0000	0.4633
ERR/Sv with adjustments		
w/ age adjustment	0.0000	0.4633
w/ latency adjustment	0.0000	0.4633
w/ random errors in dosimetry adj	0.0000	0.5014
w/ systematic errors in dosimetry adj	0.0000	0.4526
adjusted for population transfer	0.0000	0.3446
multiplicative risk model	0.0000	0.4526
additive risk model	0.0000	0.0096
adjusted for smoking history	0.0000	0.3446
adjusted for DDREF	0.0000	0.3446
Final ERR/Sv	0.0000	0.3446
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.000	0.069
Probability of Causation (PC)	0.00	6.45

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**16c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Non-melanoma (SCC)
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1	1945
Original ERR/Sv	-0.1915	0.4633
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0865	0.0821
Systematic errors in gamma doses[b]	1.1934	1.1230
Systematic errors in neutron doses[b]	1.0294	1.0286
Systematic errors in RBE neutron doses[b]	0.9363	0.9589
Model Mixture factor for transfer to US pop	0.7027	0.7560
Ratio of Japanese to U.S. baseline cancer rates	0.0189	0.0213
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.000	0.069
Probability of Causation (PC)[d]	0.00	6.45

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0000	0.4633
ERR/Sv with adjustments		
w/ age adjustment	0.0000	0.4633
w/ latency adjustment	0.0000	0.4633
w/ random errors in dosimetry adj	0.0000	0.5014
w/ systematic errors in dosimetry adj	0.0000	0.4526
adjusted for population transfer	0.0000	0.3446
multiplicative risk model	0.0000	0.4526
additive risk model	0.0000	0.0096
adjusted for smoking history	0.0000	0.3446
adjusted for DDREF	0.0000	0.3446
Final ERR/Sv	0.0000	0.3446
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.000	0.069
Probability of Causation (PC)	0.00	6.45

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**16d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Non-melanoma (SCC)
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1	1945
Original ERR/Sv	-0.1915	0.4633
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0865	0.0821
Systematic errors in gamma doses[b]	1.1934	1.1230
Systematic errors in neutron doses[b]	1.0294	1.0286
Systematic errors in RBE neutron doses[b]	0.9363	0.9589
Model Mixture factor for transfer to US pop	0.7027	0.7560
Ratio of Japanese to U.S. baseline cancer rates	0.0250	0.0280
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.000	0.069
Probability of Causation (PC)[d]	0.00	6.46

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0000	0.4633
ERR/Sv with adjustments		
w/ age adjustment	0.0000	0.4633
w/ latency adjustment	0.0000	0.4633
w/ random errors in dosimetry adj	0.0000	0.5014
w/ systematic errors in dosimetry adj	0.0000	0.4526
adjusted for population transfer	0.0000	0.3453
multiplicative risk model	0.0000	0.4526
additive risk model	0.0000	0.0127
adjusted for smoking history	0.0000	0.3453
adjusted for DDREF	0.0000	0.3453
Final ERR/Sv	0.0000	0.3453
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.000	0.069
Probability of Causation (PC)	0.00	6.46

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**17a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	All Male Genitalia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1497	1325
Original ERR/Sv	0.2753	1.0849
Adjustment Factors		
Age at exposure, Attained age	1.4422	1.7256
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0843	0.0942
Systematic errors in gamma doses[b]	1.2382	1.0561
Systematic errors in neutron doses[b]	1.0570	1.0828
Systematic errors in RBE neutron doses[b]	1.0253	0.9595
Model Mixture factor for transfer to US pop	0.5762	0.7731
Ratio of Japanese to U.S. baseline cancer rates	0.0953	0.1002
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.040	0.297
Probability of Causation (PC)	3.81	22.91

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.2753	1.0849
ERR/Sv with adjustments		
w/ age adjustment	0.3970	1.8721
w/ latency adjustment	0.3970	1.8721
w/ random errors in dosimetry adj	0.4305	2.0486
w/ systematic errors in dosimetry adj	0.3208	1.8670
adjusted for population transfer	0.1978	1.4858
multiplicative risk model	0.3208	1.8670
additive risk model	0.0306	0.1870
adjusted for smoking history	0.1978	1.4858
adjusted for DDREF	0.1978	1.4858
Final ERR/Sv	0.1978	1.4858
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.040	0.297
Probability of Causation (PC)	3.81	22.91

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**17b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	All Male Genitalia
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	513	1882
Original ERR/Sv	0.3645	1.0597
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0720	0.0965
Systematic errors in gamma doses[b]	1.2243	1.0399
Systematic errors in neutron doses[b]	1.0799	1.1746
Systematic errors in RBE neutron doses[b]	1.0029	1.0319
Model Mixture factor for transfer to US pop	0.3386	0.9062
Ratio of Japanese to U.S. baseline cancer rates	0.1010	0.1020
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.024	0.169
Probability of Causation (PC)	2.33	14.45

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.3645	1.0597
ERR/Sv with adjustments		
w/ age adjustment	0.3645	1.0597
w/ latency adjustment	0.3645	1.0597
w/ random errors in dosimetry adj	0.3908	1.1619
w/ systematic errors in dosimetry adj	0.2947	0.9219
adjusted for population transfer	0.1195	0.8442
multiplicative risk model	0.2947	0.9219
additive risk model	0.0298	0.0940
adjusted for smoking history	0.1195	0.8442
adjusted for DDREF	0.1195	0.8442
Final ERR/Sv	0.1195	0.8442
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.024	0.169
Probability of Causation (PC)	2.33	14.45

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**17c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	All Male Genitalia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1026	1325
Original ERR/Sv	0.2841	1.0849
Adjustment Factors		
Age at exposure, Attained age	2.0477	2.4768
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0751	0.0942
Systematic errors in gamma doses[b]	1.1036	1.0561
Systematic errors in neutron doses[b]	1.2473	1.0828
Systematic errors in RBE neutron doses[b]	1.0631	0.9595
Model Mixture factor for transfer to US pop	0.6295	0.7731
Ratio of Japanese to U.S. baseline cancer rates	0.1076	0.1002
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.057	0.427
Probability of Causation (PC)[d]	5.41	29.90

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.2841	1.0849
ERR/Sv with adjustments		
w/ age adjustment	0.5817	2.6872
w/ latency adjustment	0.5817	2.6872
w/ random errors in dosimetry adj	0.6253	2.9404
w/ systematic errors in dosimetry adj	0.4273	2.6798
adjusted for population transfer	0.2861	2.1326
multiplicative risk model	0.4273	2.6798
additive risk model	0.0460	0.2685
adjusted for smoking history	0.2861	2.1326
adjusted for DDREF	0.2861	2.1326
Final ERR/Sv	0.2861	2.1326
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.057	0.427
Probability of Causation (PC)	5.41	29.90

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**18a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Bladder
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1413	1281
Original ERR/Sv	0.7343	1.3384
Adjustment Factors		
Age at exposure, Attained age	1.7841	1.9233
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0749	0.0707
Systematic errors in gamma doses[b]	1.3323	1.2567
Systematic errors in neutron doses[b]	1.1227	1.0711
Systematic errors in RBE neutron doses[b]	1.0214	1.0244
Model Mixture factor for transfer to US pop	0.1593	0.7846
Ratio of Japanese to U.S. baseline cancer rates	0.5645	0.5726
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.117	0.363
Probability of Causation (PC)	10.46	26.63

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.7343	1.3384
ERR/Sv with adjustments		
w/ age adjustment	1.3101	2.5742
w/ latency adjustment	1.3101	2.5742
w/ random errors in dosimetry adj	1.4082	2.7561
w/ systematic errors in dosimetry adj	0.9217	1.9989
adjusted for population transfer	0.5842	1.8149
multiplicative risk model	0.9217	1.9989
additive risk model	0.5203	1.1447
adjusted for smoking history	0.5842	1.8149
adjusted for DDREF	0.5842	1.8149
Final ERR/Sv	0.5842	1.8149
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.117	0.363
Probability of Causation (PC)	10.46	26.63

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**18b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Bladder
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	722	1149
Original ERR/Sv	0.5181	1.1115
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0735	0.0977
Systematic errors in gamma doses[b]	1.1079	1.1357
Systematic errors in neutron doses[b]	1.1788	1.0782
Systematic errors in RBE neutron doses[b]	0.9810	1.0024
Model Mixture factor for transfer to US pop	0.5531	1.0293
Ratio of Japanese to U.S. baseline cancer rates	0.5382	0.5447
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.069	0.201
Probability of Causation (PC)	6.45	16.77

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5181	1.1115
ERR/Sv with adjustments		
w/ age adjustment	0.5181	1.1115
w/ latency adjustment	0.5181	1.1115
w/ random errors in dosimetry adj	0.5562	1.2201
w/ systematic errors in dosimetry adj	0.4342	0.9941
adjusted for population transfer	0.3446	1.0074
multiplicative risk model	0.4342	0.9941
additive risk model	0.2337	0.5415
adjusted for smoking history	0.3446	1.0074
adjusted for DDREF	0.3446	1.0074
Final ERR/Sv	0.3446	1.0074
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.069	0.201
Probability of Causation (PC)	6.45	16.77

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**18c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Bladder
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	242	1281
Original ERR/Sv	0.4724	1.3384
Adjustment Factors		
Age at exposure, Attained age	2.5364	2.7396
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1193	0.0707
Systematic errors in gamma doses[b]	1.1372	1.2567
Systematic errors in neutron doses[b]	1.0675	1.0711
Systematic errors in RBE neutron doses[b]	1.0474	1.0244
Model Mixture factor for transfer to US pop	0.5173	0.7846
Ratio of Japanese to U.S. baseline cancer rates	0.5817	0.5726
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.168	0.517
Probability of Causation (PC)[d]	14.41	34.08

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4724	1.3384
ERR/Sv with adjustments		
w/ age adjustment	1.1983	3.6667
w/ latency adjustment	1.1983	3.6667
w/ random errors in dosimetry adj	1.3413	3.9258
w/ systematic errors in dosimetry adj	1.0550	2.8473
adjusted for population transfer	0.8419	2.5852
multiplicative risk model	1.0550	2.8473
additive risk model	0.6136	1.6305
adjusted for smoking history	0.8419	2.5852
adjusted for DDREF	0.8419	2.5852
Final ERR/Sv	0.8419	2.5852
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.168	0.517
Probability of Causation (PC)	14.41	34.08

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**18d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Bladder
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1505	1547
Original ERR/Sv	1.8734	2.4374
Adjustment Factors		
Age at exposure, Attained age	1.6003	1.6321
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0856	0.0906
Systematic errors in gamma doses[b]	1.0729	1.0530
Systematic errors in neutron doses[b]	1.1976	1.0267
Systematic errors in RBE neutron doses[b]	1.0104	0.9623
Model Mixture factor for transfer to US pop	0.0630	1.0431
Ratio of Japanese to U.S. baseline cancer rates	0.4754	0.5091
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.255	0.852
Probability of Causation (PC)[d]	20.31	45.99

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.8734	2.4374
ERR/Sv with adjustments		
w/ age adjustment	2.9981	3.9780
w/ latency adjustment	2.9981	3.9780
w/ random errors in dosimetry adj	3.2548	4.3385
w/ systematic errors in dosimetry adj	2.5070	4.1701
adjusted for population transfer	1.2746	4.2582
multiplicative risk model	2.5070	4.1701
additive risk model	1.1918	2.1232
adjusted for smoking history	1.2746	4.2582
adjusted for DDREF	1.2746	4.2582
Final ERR/Sv	1.2746	4.2582
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.255	0.852
Probability of Causation (PC)	20.31	45.99

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**19a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Urinary organs (less bladder)
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	100	1325
Original ERR/Sv	0.6526	1.1939
Adjustment Factors		
Age at exposure, Attained age	1.5813	1.7256
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0969	0.0823
Systematic errors in gamma doses[b]	1.0752	1.0561
Systematic errors in neutron doses[b]	1.0854	1.0828
Systematic errors in RBE neutron doses[b]	1.0828	0.9595
Model Mixture factor for transfer to US pop	0.4937	0.7731
Ratio of Japanese to U.S. baseline cancer rates	0.6981	0.7105
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.152	0.380
Probability of Causation (PC)	13.18	27.52

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6526	1.1939
ERR/Sv with adjustments		
w/ age adjustment	1.0320	2.0601
w/ latency adjustment	1.0320	2.0601
w/ random errors in dosimetry adj	1.1320	2.2296
w/ systematic errors in dosimetry adj	0.8958	2.0320
adjusted for population transfer	0.7589	1.8985
multiplicative risk model	0.8958	2.0320
additive risk model	0.6253	1.4438
adjusted for smoking history	0.7589	1.8985
adjusted for DDREF	0.7589	1.8985
Final ERR/Sv	0.7589	1.8985
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.152	0.380
Probability of Causation (PC)	13.18	27.52

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**19b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Urinary organs (less bladder)
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1488	1010
Original ERR/Sv	0.7323	1.4363
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0847	0.0812
Systematic errors in gamma doses[b]	1.3354	1.2956
Systematic errors in neutron doses[b]	1.0897	1.1297
Systematic errors in RBE neutron doses[b]	1.0538	1.0430
Model Mixture factor for transfer to US pop	0.6554	0.9524
Ratio of Japanese to U.S. baseline cancer rates	0.6305	0.7050
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.090	0.201
Probability of Causation (PC)	8.29	16.71

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.7323	1.4363
ERR/Sv with adjustments		
w/ age adjustment	0.7323	1.4363
w/ latency adjustment	0.7323	1.4363
w/ random errors in dosimetry adj	0.7943	1.5529
w/ systematic errors in dosimetry adj	0.5179	1.0173
adjusted for population transfer	0.4520	1.0030
multiplicative risk model	0.5179	1.0173
additive risk model	0.3266	0.7172
adjusted for smoking history	0.4520	1.0030
adjusted for DDREF	0.4520	1.0030
Final ERR/Sv	0.4520	1.0030
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.090	0.201
Probability of Causation (PC)	8.29	16.71

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**19c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Urinary organs (less bladder)
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	544	414
Original ERR/Sv	0.4660	1.2791
Adjustment Factors		
Age at exposure, Attained age	2.9470	2.6110
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0749	0.1041
Systematic errors in gamma doses[b]	1.1012	1.1584
Systematic errors in neutron doses[b]	1.1161	1.1204
Systematic errors in RBE neutron doses[b]	0.9331	0.9067
Model Mixture factor for transfer to US pop	0.5245	0.5421
Ratio of Japanese to U.S. baseline cancer rates	0.6830	0.6923
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.219	0.538
Probability of Causation (PC)[d]	17.94	35.00

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4660	1.2791
ERR/Sv with adjustments		
w/ age adjustment	1.3733	3.3397
w/ latency adjustment	1.3733	3.3397
w/ random errors in dosimetry adj	1.4762	3.6874
w/ systematic errors in dosimetry adj	1.2873	3.1334
adjusted for population transfer	1.0933	2.6919
multiplicative risk model	1.2873	3.1334
additive risk model	0.8793	2.1693
adjusted for smoking history	1.0933	2.6919
adjusted for DDREF	1.0933	2.6919
Final ERR/Sv	1.0933	2.6919
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.219	0.538
Probability of Causation (PC)	17.94	35.00

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**19d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Urinary organs (less bladder)
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	390	1236
Original ERR/Sv	1.3552	2.2882
Adjustment Factors		
Age at exposure, Attained age	1.5278	2.1927
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0651	0.0901
Systematic errors in gamma doses[b]	1.0819	1.0517
Systematic errors in neutron doses[b]	1.0743	1.0921
Systematic errors in RBE neutron doses[b]	0.9800	0.9735
Model Mixture factor for transfer to US pop	0.6812	0.7621
Ratio of Japanese to U.S. baseline cancer rates	0.5861	0.5579
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.336	0.876
Probability of Causation (PC)[d]	25.16	46.68

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.3552	2.2882
ERR/Sv with adjustments		
w/ age adjustment	2.0706	5.0173
w/ latency adjustment	2.0706	5.0173
w/ random errors in dosimetry adj	2.2053	5.4695
w/ systematic errors in dosimetry adj	1.9363	4.8920
adjusted for population transfer	1.6808	4.3774
multiplicative risk model	1.9363	4.8920
additive risk model	1.1348	2.7292
adjusted for smoking history	1.6808	4.3774
adjusted for DDREF	1.6808	4.3774
Final ERR/Sv	1.6808	4.3774
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.336	0.875
Probability of Causation (PC)	25.16	46.68

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**20a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Eye
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1031	1430
Original ERR/Sv	0.7899	1.0247
Adjustment Factors		
Age at exposure, Attained age	1.8931	1.8462
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0885	0.0725
Systematic errors in gamma doses[b]	1.1316	1.1511
Systematic errors in neutron doses[b]	1.2026	1.0334
Systematic errors in RBE neutron doses[b]	0.9919	0.9946
Model Mixture factor for transfer to US pop	0.0734	1.0471
Ratio of Japanese to U.S. baseline cancer rates	0.4642	0.3886
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.121	0.353
Probability of Causation (PC)	10.83	26.08

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.7899	1.0247
ERR/Sv with adjustments		
w/ age adjustment	1.4954	1.8917
w/ latency adjustment	1.4954	1.8917
w/ random errors in dosimetry adj	1.6277	2.0288
w/ systematic errors in dosimetry adj	1.2059	1.7147
adjusted for population transfer	0.6073	1.7640
multiplicative risk model	1.2059	1.7147
additive risk model	0.5598	0.6664
adjusted for smoking history	0.6073	1.7640
adjusted for DDREF	0.6073	1.7640
Final ERR/Sv	0.6073	1.7640
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.121	0.353
Probability of Causation (PC)	10.83	26.08

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**20b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Eye
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	682	1820
Original ERR/Sv	0.4674	1.0233
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1237	0.0918
Systematic errors in gamma doses[b]	1.1582	1.0999
Systematic errors in neutron doses[b]	1.1570	1.0686
Systematic errors in RBE neutron doses[b]	1.0564	0.9730
Model Mixture factor for transfer to US pop	0.9337	0.9969
Ratio of Japanese to U.S. baseline cancer rates	0.5867	0.2938
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.072	0.195
Probability of Causation (PC)	6.73	16.32

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4674	1.0233
ERR/Sv with adjustments		
w/ age adjustment	0.4674	1.0233
w/ latency adjustment	0.4674	1.0233
w/ random errors in dosimetry adj	0.5253	1.1173
w/ systematic errors in dosimetry adj	0.3711	0.9770
adjusted for population transfer	0.3609	0.9749
multiplicative risk model	0.3711	0.9770
additive risk model	0.2177	0.2870
adjusted for smoking history	0.3609	0.9749
adjusted for DDREF	0.3609	0.9749
Final ERR/Sv	0.3609	0.9749
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.072	0.195
Probability of Causation (PC)	6.73	16.32

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**20c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Eye
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	485	1430
Original ERR/Sv	0.4419	1.0247
Adjustment Factors		
Age at exposure, Attained age	2.8192	2.6373
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0967	0.0725
Systematic errors in gamma doses[b]	1.1067	1.1511
Systematic errors in neutron doses[b]	1.1249	1.0334
Systematic errors in RBE neutron doses[b]	0.9881	0.9946
Model Mixture factor for transfer to US pop	0.5503	1.0471
Ratio of Japanese to U.S. baseline cancer rates	0.5281	0.3886
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.175	0.504
Probability of Causation (PC)[d]	14.89	33.51

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4419	1.0247
ERR/Sv with adjustments		
w/ age adjustment	1.2457	2.7024
w/ latency adjustment	1.2457	2.7024
w/ random errors in dosimetry adj	1.3662	2.8982
w/ systematic errors in dosimetry adj	1.1106	2.4495
adjusted for population transfer	0.8749	2.5200
multiplicative risk model	1.1106	2.4495
additive risk model	0.5865	0.9519
adjusted for smoking history	0.8749	2.5200
adjusted for DDREF	0.8749	2.5200
Final ERR/Sv	0.8749	2.5200
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.175	0.504
Probability of Causation (PC)	14.89	33.51

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**20d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Eye
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	172	1325
Original ERR/Sv	1.0400	2.3951
Adjustment Factors		
Age at exposure, Attained age	1.7185	1.7256
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0844	0.1053
Systematic errors in gamma doses[b]	1.2903	1.0561
Systematic errors in neutron doses[b]	1.1563	1.0828
Systematic errors in RBE neutron doses[b]	0.9163	0.9595
Model Mixture factor for transfer to US pop	0.6218	0.7731
Ratio of Japanese to U.S. baseline cancer rates	0.3669	0.3073
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.216	0.702
Probability of Causation (PC)[d]	17.74	41.24

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.0400	2.3951
ERR/Sv with adjustments		
w/ age adjustment	1.7873	4.1329
w/ latency adjustment	1.7873	4.1329
w/ random errors in dosimetry adj	1.9380	4.5681
w/ systematic errors in dosimetry adj	1.4177	4.1632
adjusted for population transfer	1.0782	3.5088
multiplicative risk model	1.4177	4.1632
additive risk model	0.5201	1.2792
adjusted for smoking history	1.0782	3.5088
adjusted for DDREF	1.0782	3.5088
Final ERR/Sv	1.0782	3.5088
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.216	0.702
Probability of Causation (PC)	17.74	41.24

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**21a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Nervous system
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	331	414
Original ERR/Sv	0.1940	0.7418
Adjustment Factors		
Age at exposure, Attained age	2.0229	1.8264
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1258	0.0804
Systematic errors in gamma doses[b]	1.3836	1.1584
Systematic errors in neutron doses[b]	1.0678	1.1204
Systematic errors in RBE neutron doses[b]	1.0601	0.9067
Model Mixture factor for transfer to US pop	0.4106	0.5421
Ratio of Japanese to U.S. baseline cancer rates	0.4240	0.4412
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.037	0.185
Probability of Causation (PC)	3.59	15.62

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.1940	0.7418
ERR/Sv with adjustments		
w/ age adjustment	0.3925	1.3548
w/ latency adjustment	0.3925	1.3548
w/ random errors in dosimetry adj	0.4419	1.4638
w/ systematic errors in dosimetry adj	0.2822	1.2438
adjusted for population transfer	0.1864	0.9256
multiplicative risk model	0.2822	1.2438
additive risk model	0.1196	0.5488
adjusted for smoking history	0.1864	0.9256
adjusted for DDREF	0.1864	0.9256
Final ERR/Sv	0.1864	0.9256
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.037	0.185
Probability of Causation (PC)	3.59	15.62

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**21b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Nervous system
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	Mid[d]	Upper[d]
Monte Carlo iteration number	361	132
Original ERR/Sv	0.1962	0.5503
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0561	0.0801
Systematic errors in gamma doses[b]	1.1860	1.0356
Systematic errors in neutron doses[b]	1.1295	1.1335
Systematic errors in RBE neutron doses[b]	0.9725	0.9714
Model Mixture factor for transfer to US pop	0.4376	1.0184
Ratio of Japanese to U.S. baseline cancer rates	0.4641	0.3512
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.022	0.106
Probability of Causation (PC)	2.17	9.54

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	Mid[d]	Upper[d]
Original ERR/Sv	0.1962	0.5503
ERR/Sv with adjustments		
w/ age adjustment	0.1962	0.5503
w/ latency adjustment	0.1962	0.5503
w/ random errors in dosimetry adj	0.2072	0.5943
w/ systematic errors in dosimetry adj	0.1590	0.5212
adjusted for population transfer	0.1111	0.5275
multiplicative risk model	0.1590	0.5212
additive risk model	0.0738	0.1831
adjusted for smoking history	0.1111	0.5275
adjusted for DDREF	0.1111	0.5275
Final ERR/Sv	0.1111	0.5275
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.022	0.105
Probability of Causation (PC)	2.17	9.54

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**21c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Nervous system
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	350	177
Original ERR/Sv	0.1593	0.9189
Adjustment Factors		
Age at exposure, Attained age	2.8914	3.3756
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0964	0.0893
Systematic errors in gamma doses[b]	1.0859	1.1944
Systematic errors in neutron doses[b]	1.2557	1.0927
Systematic errors in RBE neutron doses[b]	0.9551	1.0625
Model Mixture factor for transfer to US pop	0.5228	0.2704
Ratio of Japanese to U.S. baseline cancer rates	0.3473	0.3641
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.053	0.261
Probability of Causation (PC)[d]	5.07	20.71

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.1593	0.9189
ERR/Sv with adjustments		
w/ age adjustment	0.4606	3.1018
w/ latency adjustment	0.4606	3.1018
w/ random errors in dosimetry adj	0.5050	3.3787
w/ systematic errors in dosimetry adj	0.3878	2.4365
adjusted for population transfer	0.2670	1.3061
multiplicative risk model	0.3878	2.4365
additive risk model	0.1347	0.8872
adjusted for smoking history	0.2670	1.3061
adjusted for DDREF	0.2670	1.3061
Final ERR/Sv	0.2670	1.3061
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.053	0.261
Probability of Causation (PC)	5.07	20.71

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**21d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Nervous system
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	881	409
Original ERR/Sv	0.4835	1.3278
Adjustment Factors		
Age at exposure, Attained age	1.7450	1.8890
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0899	0.0692
Systematic errors in gamma doses[b]	1.0432	1.1418
Systematic errors in neutron doses[b]	1.1979	1.1142
Systematic errors in RBE neutron doses[b]	1.0847	1.0277
Model Mixture factor for transfer to US pop	0.4519	1.0549
Ratio of Japanese to U.S. baseline cancer rates	0.4222	0.5498
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.093	0.420
Probability of Causation (PC)[d]	8.48	29.60

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4835	1.3278
ERR/Sv with adjustments		
w/ age adjustment	0.8437	2.5081
w/ latency adjustment	0.8437	2.5081
w/ random errors in dosimetry adj	0.9195	2.6817
w/ systematic errors in dosimetry adj	0.6784	2.0511
adjusted for population transfer	0.4635	2.1018
multiplicative risk model	0.6784	2.0511
additive risk model	0.2864	1.1278
adjusted for smoking history	0.4635	2.1018
adjusted for DDREF	0.4635	2.1018
Final ERR/Sv	0.4635	2.1018
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.093	0.420
Probability of Causation (PC)	8.48	29.60

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**22a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Other endocrine
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1002	679
Original ERR/Sv	0.5188	1.2902
Adjustment Factors		
Age at exposure, Attained age	1.4669	2.0544
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1110	0.1080
Systematic errors in gamma doses[b]	1.1488	1.1779
Systematic errors in neutron doses[b]	1.1141	1.2094
Systematic errors in RBE neutron doses[b]	0.9143	1.0298
Model Mixture factor for transfer to US pop	0.9876	0.3402
Ratio of Japanese to U.S. baseline cancer rates	0.9123	0.9700
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.144	0.393
Probability of Causation (PC)	12.61	28.19

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5188	1.2902
ERR/Sv with adjustments		
w/ age adjustment	0.7611	2.6506
w/ latency adjustment	0.7611	2.6506
w/ random errors in dosimetry adj	0.8456	2.9370
w/ systematic errors in dosimetry adj	0.7226	2.0020
adjusted for population transfer	0.7218	1.9624
multiplicative risk model	0.7226	2.0020
additive risk model	0.6592	1.9419
adjusted for smoking history	0.7218	1.9624
adjusted for DDREF	0.7218	1.9624
Final ERR/Sv	0.7218	1.9624
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.144	0.392
Probability of Causation (PC)	12.61	28.19

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**22b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Other endocrine
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	327	1281
Original ERR/Sv	0.5537	1.2840
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0975	0.1074
Systematic errors in gamma doses[b]	1.2402	1.2567
Systematic errors in neutron doses[b]	1.0337	1.0711
Systematic errors in RBE neutron doses[b]	1.0196	1.0244
Model Mixture factor for transfer to US pop	0.4640	0.7846
Ratio of Japanese to U.S. baseline cancer rates	0.8607	1.0619
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.086	0.209
Probability of Causation (PC)	7.92	17.29

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5537	1.2840
ERR/Sv with adjustments		
w/ age adjustment	0.5537	1.2840
w/ latency adjustment	0.5537	1.2840
w/ random errors in dosimetry adj	0.6077	1.4219
w/ systematic errors in dosimetry adj	0.4649	1.0313
adjusted for population transfer	0.4302	1.0450
multiplicative risk model	0.4649	1.0313
additive risk model	0.4002	1.0951
adjusted for smoking history	0.4302	1.0450
adjusted for DDREF	0.4302	1.0450
Final ERR/Sv	0.4302	1.0450
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.086	0.209
Probability of Causation (PC)	7.92	17.29

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**22c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Other endocrine
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	611	679
Original ERR/Sv	0.7476	1.2902
Adjustment Factors		
Age at exposure, Attained age	1.5823	2.9127
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0735	0.1080
Systematic errors in gamma doses[b]	1.1238	1.1779
Systematic errors in neutron doses[b]	1.0588	1.2094
Systematic errors in RBE neutron doses[b]	0.9736	1.0298
Model Mixture factor for transfer to US pop	0.8044	0.3402
Ratio of Japanese to U.S. baseline cancer rates	0.7242	0.9700
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.207	0.556
Probability of Causation (PC)[d]	17.18	35.75

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.7476	1.2902
ERR/Sv with adjustments		
w/ age adjustment	1.1830	3.7581
w/ latency adjustment	1.1830	3.7581
w/ random errors in dosimetry adj	1.2699	4.1640
w/ systematic errors in dosimetry adj	1.0962	2.8385
adjusted for population transfer	1.0371	2.7823
multiplicative risk model	1.0962	2.8385
additive risk model	0.7939	2.7533
adjusted for smoking history	1.0371	2.7823
adjusted for DDREF	1.0371	2.7823
Final ERR/Sv	1.0371	2.7823
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.207	0.556
Probability of Causation (PC)	17.18	35.75

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**22d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Other endocrine
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1343	695
Original ERR/Sv	1.2543	2.8296
Adjustment Factors		
Age at exposure, Attained age	1.5962	1.6881
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0892	0.0670
Systematic errors in gamma doses[b]	1.2257	1.1203
Systematic errors in neutron doses[b]	1.1151	1.1700
Systematic errors in RBE neutron doses[b]	0.9845	1.0036
Model Mixture factor for transfer to US pop	0.3831	0.4442
Ratio of Japanese to U.S. baseline cancer rates	1.0098	1.1029
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.326	0.819
Probability of Causation (PC)[d]	24.59	45.03

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.2543	2.8296
ERR/Sv with adjustments		
w/ age adjustment	2.0020	4.7765
w/ latency adjustment	2.0020	4.7765
w/ random errors in dosimetry adj	2.1807	5.0964
w/ systematic errors in dosimetry adj	1.6207	3.8742
adjusted for population transfer	1.6305	4.0958
multiplicative risk model	1.6207	3.8742
additive risk model	1.6366	4.2729
adjusted for smoking history	1.6305	4.0958
adjusted for DDREF	1.6305	4.0958
Final ERR/Sv	1.6305	4.0958
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.326	0.819
Probability of Causation (PC)	24.59	45.03

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**23a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Other and ill-defined sites
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	491	1547
Original ERR/Sv	0.4832	1.0065
Adjustment Factors		
Age at exposure, Attained age	1.4632	1.6321
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0933	0.0721
Systematic errors in gamma doses[b]	1.0938	1.0530
Systematic errors in neutron doses[b]	1.2209	1.0267
Systematic errors in RBE neutron doses[b]	1.0260	0.9623
Model Mixture factor for transfer to US pop	0.9909	1.0431
Ratio of Japanese to U.S. baseline cancer rates	0.4764	0.4518
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.112	0.347
Probability of Causation (PC)	10.10	25.74

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4832	1.0065
ERR/Sv with adjustments		
w/ age adjustment	0.7070	1.6427
w/ latency adjustment	0.7070	1.6427
w/ random errors in dosimetry adj	0.7730	1.7611
w/ systematic errors in dosimetry adj	0.5642	1.6927
adjusted for population transfer	0.5615	1.7327
multiplicative risk model	0.5642	1.6927
additive risk model	0.2688	0.7648
adjusted for smoking history	0.5615	1.7327
adjusted for DDREF	0.5615	1.7327
Final ERR/Sv	0.5615	1.7327
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.112	0.347
Probability of Causation (PC)	10.10	25.74

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**23b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Other and ill-defined sites
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1678	409
Original ERR/Sv	0.4124	1.0992
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0928	0.1093
Systematic errors in gamma doses[b]	1.0095	1.1418
Systematic errors in neutron doses[b]	1.0844	1.1142
Systematic errors in RBE neutron doses[b]	1.0163	1.0277
Model Mixture factor for transfer to US pop	0.7049	1.0549
Ratio of Japanese to U.S. baseline cancer rates	0.4243	0.4359
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1
Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.067	0.192
Probability of Causation (PC)	6.30	16.13

Verification Calculations using MS Excel

Personal Information	
Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4124	1.0992
ERR/Sv with adjustments		
w/ age adjustment	0.4124	1.0992
w/ latency adjustment	0.4124	1.0992
w/ random errors in dosimetry adj	0.4506	1.2193
w/ systematic errors in dosimetry adj	0.4051	0.9326
adjusted for population transfer	0.3362	0.9614
multiplicative risk model	0.4051	0.9326
additive risk model	0.1719	0.4065
adjusted for smoking history	0.3362	0.9614
adjusted for DDREF	0.3362	0.9614
Final ERR/Sv	0.3362	0.9614
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0
Final results calculated in Excel		
Excess relative risk (ERR)	0.067	0.192
Probability of Causation (PC)	6.30	16.13

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**23c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Other and ill-define
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	46	1547
Original ERR/Sv	0.4368	1.0065
Adjustment Factors		
Age at exposure, Attained age	2.4084	2.3518
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0773	0.0721
Systematic errors in gamma doses[b]	1.1142	1.0530
Systematic errors in neutron doses[b]	1.1550	1.0267
Systematic errors in RBE neutron doses[b]	1.0416	0.9623
Model Mixture factor for transfer to US pop	0.9315	1.0430
Ratio of Japanese to U.S. baseline cancer rates	0.3472	0.4518
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.162	0.499
Probability of Causation (PC)[d]	13.91	33.30

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4368	1.0065
ERR/Sv with adjustments		
w/ age adjustment	1.0520	2.3672
w/ latency adjustment	1.0520	2.3672
w/ random errors in dosimetry adj	1.1332	2.5378
w/ systematic errors in dosimetry adj	0.8454	2.4393
adjusted for population transfer	0.8076	2.4968
multiplicative risk model	0.8454	2.4393
additive risk model	0.2936	1.1022
adjusted for smoking history	0.8076	2.4968
adjusted for DDREF	0.8076	2.4968
Final ERR/Sv	0.8076	2.4968
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.162	0.499
Probability of Causation (PC)	13.91	33.30

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**23d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Other and ill-defined sites
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1303	1547
Original ERR/Sv	1.3118	2.1087
Adjustment Factors		
Age at exposure, Attained age	2.2353	1.6321
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1128	0.0721
Systematic errors in gamma doses[b]	1.0753	1.0530
Systematic errors in neutron doses[b]	1.1047	1.0267
Systematic errors in RBE neutron doses[b]	1.0651	0.9623
Model Mixture factor for transfer to US pop	0.2220	1.0431
Ratio of Japanese to U.S. baseline cancer rates	0.3031	0.3986
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.236	0.728
Probability of Causation (PC)[d]	19.10	42.12

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.3118	2.1087
ERR/Sv with adjustments		
w/ age adjustment	2.9322	3.4416
w/ latency adjustment	2.9322	3.4416
w/ random errors in dosimetry adj	3.2628	3.6896
w/ systematic errors in dosimetry adj	2.5788	3.5464
adjusted for population transfer	1.1805	3.6382
multiplicative risk model	2.5788	3.5464
additive risk model	0.7815	1.4136
adjusted for smoking history	1.1805	3.6382
adjusted for DDREF	1.1805	3.6382
Final ERR/Sv	1.1805	3.6382
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.236	0.728
Probability of Causation (PC)	19.10	42.12

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**24a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Lymphoma and multiple myeloma
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	216	1609
Original ERR/Sv	0.1690	0.8990
Adjustment Factors		
Age at exposure, Attained age	1.2410	2.0878
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1055	0.1058
Systematic errors in gamma doses[b]	1.1468	1.2678
Systematic errors in neutron doses[b]	1.0611	1.2567
Systematic errors in RBE neutron doses[b]	1.0656	0.9050
Model Mixture factor for transfer to US pop	1.0349	0.9953
Ratio of Japanese to U.S. baseline cancer rates	0.5328	0.5399
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.036	0.287
Probability of Causation (PC)	3.51	22.32

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.1690	0.8990
ERR/Sv with adjustments		
w/ age adjustment	0.2097	1.8768
w/ latency adjustment	0.2097	1.8768
w/ random errors in dosimetry adj	0.2318	2.0754
w/ systematic errors in dosimetry adj	0.1788	1.4394
adjusted for population transfer	0.1817	1.4363
multiplicative risk model	0.1788	1.4394
additive risk model	0.0953	0.7771
adjusted for smoking history	0.1817	1.4363
adjusted for DDREF	0.1817	1.4363
Final ERR/Sv	0.1817	1.4363
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.036	0.287
Probability of Causation (PC)	3.51	22.32

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**24b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Lymphoma and multip
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	628	875
Original ERR/Sv	0.1676	1.1222
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0822	0.0936
Systematic errors in gamma doses[b]	1.1640	1.1572
Systematic errors in neutron doses[b]	1.0924	1.2019
Systematic errors in RBE neutron doses[b]	1.0586	0.9374
Model Mixture factor for transfer to US pop	0.5740	0.7159
Ratio of Japanese to U.S. baseline cancer rates	0.5433	0.5095
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.022	0.162
Probability of Causation (PC)	2.12	13.94

Verification Calculations using MS Excel

Personal Information	
Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.1676	1.1222
ERR/Sv with adjustments		
w/ age adjustment	0.1676	1.1222
w/ latency adjustment	0.1676	1.1222
w/ random errors in dosimetry adj	0.1814	1.2272
w/ systematic errors in dosimetry adj	0.1348	0.9413
adjusted for population transfer	0.1085	0.8101
multiplicative risk model	0.1348	0.9413
additive risk model	0.0732	0.4796
adjusted for smoking history	0.1085	0.8101
adjusted for DDREF	0.1085	0.8101
Final ERR/Sv	0.1085	0.8101
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.022	0.162
Probability of Causation (PC)	2.12	13.94

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**24c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Lymphoma and multiple myeloma
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	501	1325
Original ERR/Sv	0.1527	0.9565
Adjustment Factors		
Age at exposure, Attained age	2.2048	2.4768
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0913	0.0660
Systematic errors in gamma doses[b]	1.1283	1.0561
Systematic errors in neutron doses[b]	1.0970	1.0828
Systematic errors in RBE neutron doses[b]	0.9153	0.9595
Model Mixture factor for transfer to US pop	0.6026	0.7731
Ratio of Japanese to U.S. baseline cancer rates	0.5202	0.5344
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.052	0.412
Probability of Causation (PC)[d]	4.99	29.16

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.1527	0.9565
ERR/Sv with adjustments		
w/ age adjustment	0.3366	2.3692
w/ latency adjustment	0.3366	2.3692
w/ random errors in dosimetry adj	0.3673	2.5256
w/ systematic errors in dosimetry adj	0.3242	2.3018
adjusted for population transfer	0.2624	2.0586
multiplicative risk model	0.3242	2.3018
additive risk model	0.1687	1.2300
adjusted for smoking history	0.2624	2.0586
adjusted for DDREF	0.2624	2.0586
Final ERR/Sv	0.2624	2.0586
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.052	0.412
Probability of Causation (PC)	4.99	29.16

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**24d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Lymphoma and multiple myeloma
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	881	859
Original ERR/Sv	0.1841	1.7579
Adjustment Factors		
Age at exposure, Attained age	1.7450	1.3331
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0779	0.0894
Systematic errors in gamma doses[b]	1.0432	1.2002
Systematic errors in neutron doses[b]	1.1979	1.2142
Systematic errors in RBE neutron doses[b]	1.0847	1.0619
Model Mixture factor for transfer to US pop	0.4519	0.7071
Ratio of Japanese to U.S. baseline cancer rates	0.4068	0.4814
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.034	0.280
Probability of Causation (PC)[d]	3.33	21.87

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.1841	1.7579
ERR/Sv with adjustments		
w/ age adjustment	0.3212	2.3434
w/ latency adjustment	0.3212	2.3434
w/ random errors in dosimetry adj	0.3463	2.5529
w/ systematic errors in dosimetry adj	0.2554	1.6498
adjusted for population transfer	0.1724	1.3992
multiplicative risk model	0.2554	1.6498
additive risk model	0.1039	0.7942
adjusted for smoking history	0.1724	1.3992
adjusted for DDREF	0.1724	1.3992
Final ERR/Sv	0.1724	1.3992
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.034	0.280
Probability of Causation (PC)	3.33	21.87

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**25a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1980
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1102	679
Original ERR/Sv	1.8032	12.4338
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1219	0.1094
Systematic errors in gamma doses[b]	1.2233	1.2719
Systematic errors in neutron doses[b]	1.1344	1.1032
Systematic errors in RBE neutron doses[b]	0.9443	0.9593
Model Mixture factor for transfer to US pop	0.3182	0.9210
Ratio of Japanese to U.S. baseline cancer rates	0.8074	0.8568
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.361	2.487
Probability of Causation (PC)	26.50	71.32

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	80

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.8032	12.4338
ERR/Sv with adjustments		
w/ age adjustment	1.8032	12.4338
w/ latency adjustment	1.8032	12.4338
w/ random errors in dosimetry adj	1.8032	12.4338
w/ systematic errors in dosimetry adj	1.8032	12.4338
adjusted for population transfer	1.8032	12.4338
multiplicative risk model	1.8032	12.4338
additive risk model	1.4559	10.6529
adjusted for smoking history	1.8032	12.4338
adjusted for DDREF	1.8032	12.4338
Final ERR/Sv	1.8032	12.4338
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.361	2.487
Probability of Causation (PC)	26.50	71.32

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**25b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1980
Cancer	Thyroid
Exposure Information	
Exposure year	1960
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1102	679
Original ERR/Sv	0.1507	2.9477
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1219	0.1094
Systematic errors in gamma doses[b]	1.2233	1.2719
Systematic errors in neutron doses[b]	1.1344	1.1032
Systematic errors in RBE neutron doses[b]	0.9443	0.9593
Model Mixture factor for transfer to US pop	0.3182	0.9210
Ratio of Japanese to U.S. baseline cancer rates	0.8074	0.8568
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.030	0.590
Probability of Causation (PC)	2.93	37.09

Verification Calculations using MS Excel

Personal Information

Age at exposure	60
Attained age	80

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.1507	2.9477
ERR/Sv with adjustments		
w/ age adjustment	0.1507	2.9477
w/ latency adjustment	0.1507	2.9477
w/ random errors in dosimetry adj	0.1507	2.9477
w/ systematic errors in dosimetry adj	0.1507	2.9477
adjusted for population transfer	0.1507	2.9477
multiplicative risk model	0.1507	2.9477
additive risk model	0.1217	2.5255
adjusted for smoking history	0.1507	2.9477
adjusted for DDREF	0.1507	2.9477
Final ERR/Sv	0.1507	2.9477
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.030	0.590
Probability of Causation (PC)	2.93	37.09

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**25c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1102	679
Original ERR/Sv	1.8032	12.4338
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1219	0.1094
Systematic errors in gamma doses[b]	1.2233	1.2719
Systematic errors in neutron doses[b]	1.1344	1.1032
Systematic errors in RBE neutron doses[b]	0.9443	0.9593
Model Mixture factor for transfer to US pop	0.3182	0.9210
Ratio of Japanese to U.S. baseline cancer rates	0.8074	0.8568
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.361	2.487
Probability of Causation (PC)[d]	26.50	71.32

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.8032	12.4338
ERR/Sv with adjustments		
w/ age adjustment	1.8032	12.4338
w/ latency adjustment	1.8032	12.4338
w/ random errors in dosimetry adj	1.8032	12.4338
w/ systematic errors in dosimetry adj	1.8032	12.4338
adjusted for population transfer	1.8032	12.4338
multiplicative risk model	1.8032	12.4338
additive risk model	1.4559	10.6529
adjusted for smoking history	1.8032	12.4338
adjusted for DDREF	1.8032	12.4338
Final ERR/Sv	1.8032	12.4338
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.361	2.487
Probability of Causation (PC)	26.50	71.32

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**25d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1980
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1102	679
Original ERR/Sv	1.8032	12.4338
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1219	0.1094
Systematic errors in gamma doses[b]	1.2233	1.2719
Systematic errors in neutron doses[b]	1.1344	1.1032
Systematic errors in RBE neutron doses[b]	0.9443	0.9593
Model Mixture factor for transfer to US pop	0.3182	0.9210
Ratio of Japanese to U.S. baseline cancer rates	1.1314	1.1453
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.361	2.487
Probability of Causation (PC)[d]	26.50	71.32

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	80

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.8032	12.4338
ERR/Sv with adjustments		
w/ age adjustment	1.8032	12.4338
w/ latency adjustment	1.8032	12.4338
w/ random errors in dosimetry adj	1.8032	12.4338
w/ systematic errors in dosimetry adj	1.8032	12.4338
adjusted for population transfer	1.8032	12.4338
multiplicative risk model	1.8032	12.4338
additive risk model	2.0400	14.2399
adjusted for smoking history	1.8032	12.4338
adjusted for DDREF	1.8032	12.4338
Final ERR/Sv	1.8032	12.4338
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.361	2.487
Probability of Causation (PC)	26.50	71.32

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**26a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1980
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1292	1411
Original ERR/Sv	0.0682	0.4845
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0585	0.0464
Systematic errors in gamma doses[b]	1.0766	1.1861
Systematic errors in neutron doses[b]	1.1155	1.1347
Systematic errors in RBE neutron doses[b]	1.0152	0.9811
Model Mixture factor for transfer to US pop	0.4046	-0.0212
Ratio of Japanese to U.S. baseline cancer rates	0.9107	0.8271
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.013	0.076
Probability of Causation (PC)	1.33	7.05

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	80

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0682	0.4845
ERR/Sv with adjustments		
w/ age adjustment	0.0682	0.4845
w/ latency adjustment	0.0682	0.4845
w/ random errors in dosimetry adj	0.0722	0.5069
w/ systematic errors in dosimetry adj	0.0592	0.3839
adjusted for population transfer	0.0560	0.3161
multiplicative risk model	0.0592	0.3839
additive risk model	0.0539	0.3175
adjusted for smoking history	0.0560	0.3161
adjusted for DDREF	0.0560	0.3161
Final ERR/Sv	0.0560	0.3161
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	0.013	0.076
Probability of Causation (PC)	1.33	7.05

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**26b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1980
Cancer	Leukemia
Exposure Information	
Exposure year	1960
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	56	257
Original ERR/Sv	2.1359	4.5382
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0502	0.0752
Systematic errors in gamma doses[b]	1.1565	1.0813
Systematic errors in neutron doses[b]	1.0837	1.0673
Systematic errors in RBE neutron doses[b]	1.0137	0.9347
Model Mixture factor for transfer to US pop	0.9343	0.0878
Ratio of Japanese to U.S. baseline cancer rates	0.8379	0.8171
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.419	0.905
Probability of Causation (PC)	29.54	47.49

Verification Calculations using MS Excel

Personal Information

Age at exposure	60
Attained age	80

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.1359	4.5382
ERR/Sv with adjustments		
w/ age adjustment	2.1359	4.5382
w/ latency adjustment	2.1359	4.5382
w/ random errors in dosimetry adj	2.2431	4.8793
w/ systematic errors in dosimetry adj	1.7657	4.5234
adjusted for population transfer	1.7469	3.7689
multiplicative risk model	1.7657	4.5234
additive risk model	1.4795	3.6963
adjusted for smoking history	1.7469	3.7689
adjusted for DDREF	1.7469	3.7689
Final ERR/Sv	1.7469	3.7689
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	0.419	0.905
Probability of Causation (PC)	29.54	47.49

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**26c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1077	1978
Original ERR/Sv	3.3058	5.0967
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0709	0.0352
Systematic errors in gamma doses[b]	1.1105	1.0251
Systematic errors in neutron doses[b]	1.1839	1.0784
Systematic errors in RBE neutron doses[b]	0.9956	0.9682
Model Mixture factor for transfer to US pop	0.2170	0.8836
Ratio of Japanese to U.S. baseline cancer rates	0.9630	0.8981
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.630	1.169
Probability of Causation (PC)[d]	38.66	53.90

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	3.3058	5.0967
ERR/Sv with adjustments		
w/ age adjustment	3.3058	5.0967
w/ latency adjustment	3.3058	5.0967
w/ random errors in dosimetry adj	3.5400	5.2761
w/ systematic errors in dosimetry adj	2.7044	4.9299
adjusted for population transfer	2.6260	4.8714
multiplicative risk model	2.7044	4.9299
additive risk model	2.6043	4.4273
adjusted for smoking history	2.6260	4.8714
adjusted for DDREF	2.6260	4.8714
Final ERR/Sv	2.6260	4.8714
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	0.630	1.169
Probability of Causation (PC)	38.66	53.90

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**26d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1980
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	601	1391
Original ERR/Sv	0.0635	0.4963
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0564	0.0458
Systematic errors in gamma doses[b]	1.0859	1.2755
Systematic errors in neutron doses[b]	1.1694	1.1278
Systematic errors in RBE neutron doses[b]	1.0224	1.0034
Model Mixture factor for transfer to US pop	0.8149	0.1180
Ratio of Japanese to U.S. baseline cancer rates	0.6654	0.7314
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.012	0.066
Probability of Causation (PC)[d]	1.15	6.18

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	80

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0635	0.4963
ERR/Sv with adjustments		
w/ age adjustment	0.0635	0.4963
w/ latency adjustment	0.0635	0.4963
w/ random errors in dosimetry adj	0.0671	0.5190
w/ systematic errors in dosimetry adj	0.0517	0.3596
adjusted for population transfer	0.0485	0.2744
multiplicative risk model	0.0517	0.3596
additive risk model	0.0344	0.2630
adjusted for smoking history	0.0485	0.2744
adjusted for DDREF	0.0485	0.2744
Final ERR/Sv	0.0485	0.2744
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	0.012	0.066
Probability of Causation (PC)	1.15	6.18

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**27a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1980
Cancer	Acute Lymphocytic Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1555	414
Original ERR/Sv	1.7769	8.2421
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0516	0.0431
Systematic errors in gamma doses[b]	1.0581	1.1584
Systematic errors in neutron doses[b]	1.2187	1.1204
Systematic errors in RBE neutron doses[b]	0.9199	0.9067
Model Mixture factor for transfer to US pop	0.7659	0.5421
Ratio of Japanese to U.S. baseline cancer rates	0.7782	0.7352
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.358	1.541
Probability of Causation (PC)	26.39	60.64

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	80

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.7769	8.2421
ERR/Sv with adjustments		
w/ age adjustment	1.7769	8.2421
w/ latency adjustment	1.7769	8.2421
w/ random errors in dosimetry adj	1.8686	8.5969
w/ systematic errors in dosimetry adj	1.5754	7.3053
adjusted for population transfer	1.4936	6.4194
multiplicative risk model	1.5754	7.3053
additive risk model	1.2259	5.3707
adjusted for smoking history	1.4936	6.4194
adjusted for DDREF	1.4936	6.4194
Final ERR/Sv	1.4936	6.4194
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	0.358	1.541
Probability of Causation (PC)	26.39	60.64

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**27b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1980
Cancer	Acute Lymphocytic Leukemia
Exposure Information	
Exposure year	1960
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1555	414
Original ERR/Sv	1.7769	8.2421
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0516	0.0431
Systematic errors in gamma doses[b]	1.0581	1.1584
Systematic errors in neutron doses[b]	1.2187	1.1204
Systematic errors in RBE neutron doses[b]	0.9199	0.9067
Model Mixture factor for transfer to US pop	0.7659	0.5421
Ratio of Japanese to U.S. baseline cancer rates	0.7782	0.7352
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.358	1.541
Probability of Causation (PC)	26.39	60.64

Verification Calculations using MS Excel

Personal Information

Age at exposure	60
Attained age	80

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.7769	8.2421
ERR/Sv with adjustments		
w/ age adjustment	1.7769	8.2421
w/ latency adjustment	1.7769	8.2421
w/ random errors in dosimetry adj	1.8686	8.5969
w/ systematic errors in dosimetry adj	1.5754	7.3053
adjusted for population transfer	1.4936	6.4194
multiplicative risk model	1.5754	7.3053
additive risk model	1.2259	5.3707
adjusted for smoking history	1.4936	6.4194
adjusted for DDREF	1.4936	6.4194
Final ERR/Sv	1.4936	6.4194
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	0.358	1.541
Probability of Causation (PC)	26.39	60.64

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**27c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Acute Lymphocytic Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1555	414
Original ERR/Sv	1.7769	8.2421
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0516	0.0431
Systematic errors in gamma doses[b]	1.0581	1.1584
Systematic errors in neutron doses[b]	1.2187	1.1204
Systematic errors in RBE neutron doses[b]	0.9199	0.9067
Model Mixture factor for transfer to US pop	0.7659	0.5421
Ratio of Japanese to U.S. baseline cancer rates	0.7782	0.7352
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.358	1.541
Probability of Causation (PC)[d]	26.39	60.64

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.7769	8.2421
ERR/Sv with adjustments		
w/ age adjustment	1.7769	8.2421
w/ latency adjustment	1.7769	8.2421
w/ random errors in dosimetry adj	1.8686	8.5969
w/ systematic errors in dosimetry adj	1.5754	7.3053
adjusted for population transfer	1.4936	6.4194
multiplicative risk model	1.5754	7.3053
additive risk model	1.2259	5.3707
adjusted for smoking history	1.4936	6.4194
adjusted for DDREF	1.4936	6.4194
Final ERR/Sv	1.4936	6.4194
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	0.358	1.541
Probability of Causation (PC)	26.39	60.64

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**27d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1980
Cancer	Acute Lymphocytic Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	521	1391
Original ERR/Sv	2.4867	10.3334
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0419	0.0527
Systematic errors in gamma doses[b]	1.3119	1.2077
Systematic errors in neutron doses[b]	1.1707	1.2119
Systematic errors in RBE neutron doses[b]	1.0465	1.0791
Model Mixture factor for transfer to US pop	0.5432	0.5366
Ratio of Japanese to U.S. baseline cancer rates	0.7653	0.7810
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.345	1.485
Probability of Causation (PC)[d]	25.67	59.76

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	80

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.4867	10.3334
ERR/Sv with adjustments		
w/ age adjustment	2.4867	10.3334
w/ latency adjustment	2.4867	10.3334
w/ random errors in dosimetry adj	2.5908	10.8781
w/ systematic errors in dosimetry adj	1.6121	6.8872
adjusted for population transfer	1.4392	6.1883
multiplicative risk model	1.6121	6.8872
additive risk model	1.2337	5.3790
adjusted for smoking history	1.4392	6.1883
adjusted for DDREF	1.4392	6.1883
Final ERR/Sv	1.4392	6.1883
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	0.345	1.485
Probability of Causation (PC)	25.67	59.76

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**28a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1980
Cancer	Acute Myeloid Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	56	684
Original ERR/Sv	0.4817	2.8327
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0620	0.0588
Systematic errors in gamma doses[b]	1.1565	1.2257
Systematic errors in neutron doses[b]	1.0837	1.2060
Systematic errors in RBE neutron doses[b]	1.0137	0.9766
Model Mixture factor for transfer to US pop	0.9343	0.3980
Ratio of Japanese to U.S. baseline cancer rates	0.7789	0.8536
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.095	0.455
Probability of Causation (PC)	8.70	31.26

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	80

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4817	2.8327
ERR/Sv with adjustments		
w/ age adjustment	0.4817	2.8327
w/ latency adjustment	0.4817	2.8327
w/ random errors in dosimetry adj	0.5116	2.9994
w/ systematic errors in dosimetry adj	0.4027	2.0776
adjusted for population transfer	0.3968	1.8946
multiplicative risk model	0.4027	2.0776
additive risk model	0.3136	1.7735
adjusted for smoking history	0.3968	1.8946
adjusted for DDREF	0.3968	1.8946
Final ERR/Sv	0.3968	1.8946
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	0.095	0.455
Probability of Causation (PC)	8.70	31.26

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**28b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1980
Cancer	Acute Myeloid Leukemia
Exposure Information	
Exposure year	1960
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	676	248
Original ERR/Sv	3.2358	5.7979
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0693	0.0577
Systematic errors in gamma doses[b]	1.1937	1.1441
Systematic errors in neutron doses[b]	1.0738	1.2209
Systematic errors in RBE neutron doses[b]	1.0744	0.9765
Model Mixture factor for transfer to US pop	0.5558	0.9777
Ratio of Japanese to U.S. baseline cancer rates	0.7978	0.8033
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.549	1.074
Probability of Causation (PC)	35.44	51.79

Verification Calculations using MS Excel

Personal Information

Age at exposure	60
Attained age	80

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	3.2358	5.7979
ERR/Sv with adjustments		
w/ age adjustment	3.2358	5.7979
w/ latency adjustment	3.2358	5.7979
w/ random errors in dosimetry adj	3.4600	6.1322
w/ systematic errors in dosimetry adj	2.5124	4.4959
adjusted for population transfer	2.2868	4.4762
multiplicative risk model	2.5124	4.4959
additive risk model	2.0045	3.6116
adjusted for smoking history	2.2868	4.4762
adjusted for DDREF	2.2868	4.4762
Final ERR/Sv	2.2868	4.4762
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	0.549	1.074
Probability of Causation (PC)	35.44	51.79

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**28c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Acute Myeloid Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	676	248
Original ERR/Sv	3.2358	5.7979
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0693	0.0577
Systematic errors in gamma doses[b]	1.1937	1.1441
Systematic errors in neutron doses[b]	1.0738	1.2209
Systematic errors in RBE neutron doses[b]	1.0744	0.9765
Model Mixture factor for transfer to US pop	0.5558	0.9777
Ratio of Japanese to U.S. baseline cancer rates	0.7978	0.8033
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.549	1.074
Probability of Causation (PC)[d]	35.44	51.79

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	3.2358	5.7979
ERR/Sv with adjustments		
w/ age adjustment	3.2358	5.7979
w/ latency adjustment	3.2358	5.7979
w/ random errors in dosimetry adj	3.4600	6.1322
w/ systematic errors in dosimetry adj	2.5124	4.4959
adjusted for population transfer	2.2868	4.4762
multiplicative risk model	2.5124	4.4959
additive risk model	2.0045	3.6116
adjusted for smoking history	2.2868	4.4762
adjusted for DDREF	2.2868	4.4762
Final ERR/Sv	2.2868	4.4762
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	0.549	1.074
Probability of Causation (PC)	35.44	51.79

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**28d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1980
Cancer	Acute Myeloid Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	372	1307
Original ERR/Sv	0.5266	2.9806
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0396	0.0557
Systematic errors in gamma doses[b]	1.1178	1.2421
Systematic errors in neutron doses[b]	1.1356	1.1551
Systematic errors in RBE neutron doses[b]	1.0617	0.9937
Model Mixture factor for transfer to US pop	-0.0255	0.1235
Ratio of Japanese to U.S. baseline cancer rates	0.9628	0.8255
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.094	0.449
Probability of Causation (PC)[d]	8.57	30.97

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	80

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5266	2.9806
ERR/Sv with adjustments		
w/ age adjustment	0.5266	2.9806
w/ latency adjustment	0.5266	2.9806
w/ random errors in dosimetry adj	0.5474	3.1466
w/ systematic errors in dosimetry adj	0.4062	2.2069
adjusted for population transfer	0.3907	1.8693
multiplicative risk model	0.4062	2.2069
additive risk model	0.3911	1.8217
adjusted for smoking history	0.3907	1.8693
adjusted for DDREF	0.3907	1.8693
Final ERR/Sv	0.3907	1.8693
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	0.094	0.449
Probability of Causation (PC)	8.57	30.97

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**29a**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1980
Cancer	Chronic Myeloid Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	505	1411
Original ERR/Sv	0.0005	0.2848
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0389	0.0624
Systematic errors in gamma doses[b]	1.1584	1.1861
Systematic errors in neutron doses[b]	1.0952	1.1347
Systematic errors in RBE neutron doses[b]	0.9712	0.9811
Model Mixture factor for transfer to US pop	0.5800	-0.0212
Ratio of Japanese to U.S. baseline cancer rates	0.6152	0.5624
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.000	0.030
Probability of Causation (PC)	0.01	2.95

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	80

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0005	0.2848
ERR/Sv with adjustments		
w/ age adjustment	0.0005	0.2848
w/ latency adjustment	0.0005	0.2848
w/ random errors in dosimetry adj	0.0005	0.3026
w/ systematic errors in dosimetry adj	0.0004	0.2291
adjusted for population transfer	0.0004	0.1267
multiplicative risk model	0.0004	0.2291
additive risk model	0.0003	0.1289
adjusted for smoking history	0.0004	0.1267
adjusted for DDREF	0.0004	0.1267
Final ERR/Sv	0.0004	0.1267
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	0.000	0.030
Probability of Causation (PC)	0.01	2.95

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**29b**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1980
Cancer	Chronic Myeloid Leukemia
Exposure Information	
Exposure year	1960
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	526	348
Original ERR/Sv	1.0528	5.3493
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0665	0.0567
Systematic errors in gamma doses[b]	1.2091	1.2519
Systematic errors in neutron doses[b]	1.1359	1.1314
Systematic errors in RBE neutron doses[b]	1.0345	1.0526
Model Mixture factor for transfer to US pop	0.1972	0.9551
Ratio of Japanese to U.S. baseline cancer rates	0.6686	0.6749
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.139	0.897
Probability of Causation (PC)	12.22	47.27

Verification Calculations using MS Excel

Personal Information

Age at exposure	60
Attained age	80

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.0528	5.3493
ERR/Sv with adjustments		
w/ age adjustment	1.0528	5.3493
w/ latency adjustment	1.0528	5.3493
w/ random errors in dosimetry adj	1.1228	5.6526
w/ systematic errors in dosimetry adj	0.7903	3.7913
adjusted for population transfer	0.5800	3.7359
multiplicative risk model	0.7903	3.7913
additive risk model	0.5284	2.5587
adjusted for smoking history	0.5800	3.7359
adjusted for DDREF	0.5800	3.7359
Final ERR/Sv	0.5800	3.7359
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	0.139	0.897
Probability of Causation (PC)	12.22	47.27

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**29c**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Chronic Myeloid Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	526	348
Original ERR/Sv	1.0528	5.3493
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0665	0.0567
Systematic errors in gamma doses[b]	1.2091	1.2519
Systematic errors in neutron doses[b]	1.1359	1.1314
Systematic errors in RBE neutron doses[b]	1.0345	1.0526
Model Mixture factor for transfer to US pop	0.1972	0.9551
Ratio of Japanese to U.S. baseline cancer rates	0.6686	0.6749
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.139	0.897
Probability of Causation (PC)[d]	12.22	47.27

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.0528	5.3493
ERR/Sv with adjustments		
w/ age adjustment	1.0528	5.3493
w/ latency adjustment	1.0528	5.3493
w/ random errors in dosimetry adj	1.1228	5.6526
w/ systematic errors in dosimetry adj	0.7903	3.7913
adjusted for population transfer	0.5800	3.7359
multiplicative risk model	0.7903	3.7913
additive risk model	0.5284	2.5587
adjusted for smoking history	0.5800	3.7359
adjusted for DDREF	0.5800	3.7359
Final ERR/Sv	0.5800	3.7359
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	0.139	0.897
Probability of Causation (PC)	12.22	47.27

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**29d**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1980
Cancer	Chronic Myeloid Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	378	1411
Original ERR/Sv	1.1557	15.8844
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0527	0.0624
Systematic errors in gamma doses[b]	1.2352	1.1861
Systematic errors in neutron doses[b]	1.0629	1.1347
Systematic errors in RBE neutron doses[b]	1.0093	0.9811
Model Mixture factor for transfer to US pop	0.5096	-0.0212
Ratio of Japanese to U.S. baseline cancer rates	0.7747	0.6760
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.196	2.052
Probability of Causation (PC)[d]	16.39	67.24

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	80

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.1557	15.8844
ERR/Sv with adjustments		
w/ age adjustment	1.1557	15.8844
w/ latency adjustment	1.1557	15.8844
w/ random errors in dosimetry adj	1.2166	16.8751
w/ systematic errors in dosimetry adj	0.9181	12.7789
adjusted for population transfer	0.8167	8.5507
multiplicative risk model	0.9181	12.7789
additive risk model	0.7112	8.6383
adjusted for smoking history	0.8167	8.5507
adjusted for DDREF	0.8167	8.5507
Final ERR/Sv	0.8167	8.5507
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	0.196	2.052
Probability of Causation (PC)	16.39	67.24

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**30a**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	507	1010
Original ERR/Sv	1.1868	2.4979
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0949	0.0689
Systematic errors in gamma doses[b]	1.1618	1.2956
Systematic errors in neutron doses[b]	1.1715	1.1297
Systematic errors in RBE neutron doses[b]	1.0239	1.0430
Model Mixture factor for transfer to US pop	0.3193	0.9524
Ratio of Japanese to U.S. baseline cancer rates	0.3371	0.3343
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.102	0.339
Probability of Causation (PC)	9.28	25.30

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.1868	2.4979
ERR/Sv with adjustments		
w/ age adjustment	1.1868	2.4979
w/ latency adjustment	1.1868	2.4979
w/ random errors in dosimetry adj	1.2994	2.6700
w/ systematic errors in dosimetry adj	0.9324	1.7490
adjusted for population transfer	0.5117	1.6935
multiplicative risk model	0.9324	1.7490
additive risk model	0.3143	0.5847
adjusted for smoking history	0.5117	1.6935
adjusted for DDREF	0.5117	1.6935
Final ERR/Sv	0.5117	1.6935
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.102	0.339
Probability of Causation (PC)	9.28	25.30

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**30b**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Breast
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	757	6
Original ERR/Sv	1.1446	1.3419
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0742	0.1071
Systematic errors in gamma doses[b]	1.1045	1.1609
Systematic errors in neutron doses[b]	1.1438	1.0821
Systematic errors in RBE neutron doses[b]	0.9289	1.0038
Model Mixture factor for transfer to US pop	0.0000	1.0587
Ratio of Japanese to U.S. baseline cancer rates	0.3407	0.3385
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.071	0.245
Probability of Causation (PC)	6.66	19.66

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.1446	1.3419
ERR/Sv with adjustments		
w/ age adjustment	1.1446	1.3419
w/ latency adjustment	1.1446	1.3419
w/ random errors in dosimetry adj	1.2296	1.4856
w/ systematic errors in dosimetry adj	1.0478	1.1781
adjusted for population transfer	0.3570	1.2238
multiplicative risk model	1.0478	1.1781
additive risk model	0.3570	0.3987
adjusted for smoking history	0.3570	1.2238
adjusted for DDREF	0.3570	1.2238
Final ERR/Sv	0.3570	1.2238
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.071	0.245
Probability of Causation (PC)	6.66	19.66

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**30c**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	558	6
Original ERR/Sv	2.7245	2.9301
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0966	0.1071
Systematic errors in gamma doses[b]	1.2018	1.1609
Systematic errors in neutron doses[b]	1.1199	1.0821
Systematic errors in RBE neutron doses[b]	0.9459	1.0038
Model Mixture factor for transfer to US pop	0.0000	1.0587
Ratio of Japanese to U.S. baseline cancer rates	0.3413	0.3385
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.160	0.534
Probability of Causation (PC)[d]	13.81	34.83

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.7245	2.9301
ERR/Sv with adjustments		
w/ age adjustment	2.7245	2.9301
w/ latency adjustment	2.7245	2.9301
w/ random errors in dosimetry adj	2.9878	3.2439
w/ systematic errors in dosimetry adj	2.3469	2.5724
adjusted for population transfer	0.8009	2.6724
multiplicative risk model	2.3469	2.5724
additive risk model	0.8009	0.8707
adjusted for smoking history	0.8009	2.6724
adjusted for DDREF	0.8009	2.6724
Final ERR/Sv	0.8009	2.6724
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.160	0.534
Probability of Causation (PC)	13.81	34.83

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**31a**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Ovary
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	527	1430
Original ERR/Sv	0.4168	1.2624
Adjustment Factors		
Age at exposure, Attained age	1.9531	1.8462
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0806	0.0811
Systematic errors in gamma doses[b]	1.0394	1.1511
Systematic errors in neutron doses[b]	1.1236	1.0334
Systematic errors in RBE neutron doses[b]	0.9616	0.9946
Model Mixture factor for transfer to US pop	0.4139	1.0471
Ratio of Japanese to U.S. baseline cancer rates	0.5859	0.5244
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.119	0.435
Probability of Causation (PC)	10.61	30.33

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4168	1.2624
ERR/Sv with adjustments		
w/ age adjustment	0.8140	2.3307
w/ latency adjustment	0.8140	2.3307
w/ random errors in dosimetry adj	0.8797	2.5196
w/ systematic errors in dosimetry adj	0.7833	2.1295
adjusted for population transfer	0.5932	2.1771
multiplicative risk model	0.7833	2.1295
additive risk model	0.4590	1.1168
adjusted for smoking history	0.5932	2.1771
adjusted for DDREF	0.5932	2.1771
Final ERR/Sv	0.5932	2.1771
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.119	0.435
Probability of Causation (PC)	10.61	30.33

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**31b**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Ovary
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1269	487
Original ERR/Sv	0.6704	1.4172
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1353	0.0920
Systematic errors in gamma doses[b]	1.0749	1.1482
Systematic errors in neutron doses[b]	1.1567	1.1481
Systematic errors in RBE neutron doses[b]	1.0653	0.9920
Model Mixture factor for transfer to US pop	0.2104	1.0804
Ratio of Japanese to U.S. baseline cancer rates	0.5147	0.4955
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.071	0.246
Probability of Causation (PC)	6.62	19.76

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6704	1.4172
ERR/Sv with adjustments		
w/ age adjustment	0.6704	1.4172
w/ latency adjustment	0.6704	1.4172
w/ random errors in dosimetry adj	0.7611	1.5477
w/ systematic errors in dosimetry adj	0.5746	1.1836
adjusted for population transfer	0.3545	1.2316
multiplicative risk model	0.5746	1.1836
additive risk model	0.2958	0.5864
adjusted for smoking history	0.3545	1.2316
adjusted for DDREF	0.3545	1.2316
Final ERR/Sv	0.3545	1.2316
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.071	0.246
Probability of Causation (PC)	6.62	19.76

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**31c**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Ovary
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	824	1430
Original ERR/Sv	0.6518	1.2624
Adjustment Factors		
Age at exposure, Attained age	2.0613	2.6373
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1058	0.0811
Systematic errors in gamma doses[b]	1.1978	1.1511
Systematic errors in neutron doses[b]	1.0171	1.0334
Systematic errors in RBE neutron doses[b]	0.9984	0.9946
Model Mixture factor for transfer to US pop	0.3600	1.0471
Ratio of Japanese to U.S. baseline cancer rates	0.5331	0.5244
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.171	0.622
Probability of Causation (PC)[d]	14.62	38.35

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6518	1.2624
ERR/Sv with adjustments		
w/ age adjustment	1.3435	3.3294
w/ latency adjustment	1.3435	3.3294
w/ random errors in dosimetry adj	1.4857	3.5993
w/ systematic errors in dosimetry adj	1.2215	3.0420
adjusted for population transfer	0.8565	3.1101
multiplicative risk model	1.2215	3.0420
additive risk model	0.6511	1.5954
adjusted for smoking history	0.8565	3.1101
adjusted for DDREF	0.8565	3.1101
Final ERR/Sv	0.8565	3.1101
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.171	0.622
Probability of Causation (PC)	14.62	38.35

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**32a**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Female Genitalia (less ovary)
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1	414
Original ERR/Sv	-0.2391	0.0858
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0841	0.0963
Systematic errors in gamma doses[b]	1.1934	1.1584
Systematic errors in neutron doses[b]	1.0294	1.1204
Systematic errors in RBE neutron doses[b]	0.9363	0.9067
Model Mixture factor for transfer to US pop	0.7027	0.5421
Ratio of Japanese to U.S. baseline cancer rates	0.6401	0.6730
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.000	0.014
Probability of Causation (PC)	0.00	1.34

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0000	0.0858
ERR/Sv with adjustments		
w/ age adjustment	0.0000	0.0858
w/ latency adjustment	0.0000	0.0858
w/ random errors in dosimetry adj	0.0000	0.0940
w/ systematic errors in dosimetry adj	0.0000	0.0799
adjusted for population transfer	0.0000	0.0679
multiplicative risk model	0.0000	0.0799
additive risk model	0.0000	0.0538
adjusted for smoking history	0.0000	0.0679
adjusted for DDREF	0.0000	0.0679
Final ERR/Sv	0.0000	0.0679
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.000	0.014
Probability of Causation (PC)	0.00	1.34

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**32b**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Female Genitalia (less ovary)
Exposure Information	
Exposure year	1940
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1	414
Original ERR/Sv	-0.2391	0.0858
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0841	0.0963
Systematic errors in gamma doses[b]	1.1934	1.1584
Systematic errors in neutron doses[b]	1.0294	1.1204
Systematic errors in RBE neutron doses[b]	0.9363	0.9067
Model Mixture factor for transfer to US pop	0.7027	0.5421
Ratio of Japanese to U.S. baseline cancer rates	0.6401	0.6730
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.000	0.014
Probability of Causation (PC)	0.00	1.34

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0000	0.0858
ERR/Sv with adjustments		
w/ age adjustment	0.0000	0.0858
w/ latency adjustment	0.0000	0.0858
w/ random errors in dosimetry adj	0.0000	0.0940
w/ systematic errors in dosimetry adj	0.0000	0.0799
adjusted for population transfer	0.0000	0.0679
multiplicative risk model	0.0000	0.0799
additive risk model	0.0000	0.0538
adjusted for smoking history	0.0000	0.0679
adjusted for DDREF	0.0000	0.0679
Final ERR/Sv	0.0000	0.0679
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.000	0.014
Probability of Causation (PC)	0.00	1.34

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**32c**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Female Genitalia (less ovary)
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1	414
Original ERR/Sv	-0.2391	0.0858
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0841	0.0963
Systematic errors in gamma doses[b]	1.1934	1.1584
Systematic errors in neutron doses[b]	1.0294	1.1204
Systematic errors in RBE neutron doses[b]	0.9363	0.9067
Model Mixture factor for transfer to US pop	0.7027	0.5421
Ratio of Japanese to U.S. baseline cancer rates	0.6401	0.6730
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP[d]		
Excess relative risk (ERR)	0.000	0.014
Probability of Causation (PC)[d]	0.00	1.34

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0000	0.0858
ERR/Sv with adjustments		
w/ age adjustment	0.0000	0.0858
w/ latency adjustment	0.0000	0.0858
w/ random errors in dosimetry adj	0.0000	0.0940
w/ systematic errors in dosimetry adj	0.0000	0.0799
adjusted for population transfer	0.0000	0.0679
multiplicative risk model	0.0000	0.0799
additive risk model	0.0000	0.0538
adjusted for smoking history	0.0000	0.0679
adjusted for DDREF	0.0000	0.0679
Final ERR/Sv	0.0000	0.0679
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.000	0.014
Probability of Causation (PC)	0.00	1.34

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Refers to errors in doses assigned to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Appendix C

Verification of the Implementation of the Minimum Latency Period for Leukemia, Thyroid, and Solid Tumor Cancers

The set of calculations documented in this appendix was performed to verify that the algorithms describing the minimum latency period have been implemented correctly. A series of 30 calculations was performed for this specific verification task.

Calculations were completed for leukemia (representative of all types of leukemia), thyroid (also representative of bone cancer), and colon (representative of all other solid tumors) because the minimum latency adjustment is different for each of these three groupings of cancer.

Calculations were performed for males and females receiving an acute dose of 20 cSv from high energy photons, E > 250 keV. The assumption of an acute exposure to high energy photons causes the radiation effectiveness factor (REF) and the dose and dose rate effectiveness factor (DDREF) to be equal to 1.0. It should also be noted that the level of dose does not affect the minimum latency period adjustment.

Because the latency adjustment is independent of age at time of exposure (AAE), the AAE was kept constant at 20 years. Five different scenarios were considered related to the number of years after exposure that the cancer was diagnosed. The times since exposure (TSE) used for these calculations are 2, 3, 5, 10, and 15 years.

Further details about this verification task can be found in Section 5.2 of the report. The results for ERR and PC obtained with MS Excel verify the mid and upper bound values of ERR and PC estimated using NIOSH-IREP v.5.5.3r, for all exposure scenarios considered.

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Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_leu_m1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1922
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	3	1237
Original ERR/Sv	19.7233	52.3505
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	0.3715	0.3832
Random errors in doses[b]	0.0685	0.0504
Systematic errors in gamma doses[b]	1.1069	1.0519
Systematic errors in neutron doses[b]	1.0720	1.1956
Systematic errors in RBE neutron doses[b]	1.0378	0.9728
Model Mixture factor for transfer to US pop	0.8099	0.6328
Ratio of Japanese to U.S. baseline cancer rates	0.9068	0.9498
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	1.499	4.057
Probability of Causation (PC)	59.98	80.23

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	22

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	19.7233	52.3505
ERR/Sv with adjustments		
w/ age adjustment	19.7233	52.3505
w/ latency adjustment	7.3276	20.0582
w/ random errors in dosimetry adj	7.8299	21.0697
w/ systematic errors in dosimetry adj	6.3584	17.2220
adjusted for population transfer	6.2458	16.9046
multiplicative risk model	6.3584	17.2220
additive risk model	5.7658	16.3578
adjusted for smoking history	6.2458	16.9046
adjusted for DDREF	6.2458	16.9046
Final ERR/Sv	6.2458	16.9046
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	1.499	4.057
Probability of Causation (PC)	59.98	80.23

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_leu_m2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1923
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	467	1068
Original ERR/Sv	19.4432	52.5682
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	0.8537	0.9041
Random errors in doses[b]	0.0629	0.0480
Systematic errors in gamma doses[b]	1.0686	1.1888
Systematic errors in neutron doses[b]	1.0323	1.0882
Systematic errors in RBE neutron doses[b]	1.0260	0.9595
Model Mixture factor for transfer to US pop	0.6565	0.2599
Ratio of Japanese to U.S. baseline cancer rates	1.0122	0.9642
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	3.757	9.376
Probability of Causation (PC)	78.98	90.36

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	23

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	19.4432	52.5682
ERR/Sv with adjustments		
w/ age adjustment	19.4432	52.5682
w/ latency adjustment	16.5990	47.5261
w/ random errors in dosimetry adj	17.6423	49.8086
w/ systematic errors in dosimetry adj	15.5874	40.1300
adjusted for population transfer	15.6527	39.0668
multiplicative risk model	15.5874	40.1300
additive risk model	15.7774	38.6934
adjusted for smoking history	15.6527	39.0668
adjusted for DDREF	15.6527	39.0668
Final ERR/Sv	15.6527	39.0668
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	3.757	9.376
Probability of Causation (PC)	78.98	90.36

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_leu_m3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1925
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1478	1307
Original ERR/Sv	22.5457	64.6187
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	0.9991	0.9991
Random errors in doses[b]	0.0520	0.0582
Systematic errors in gamma doses[b]	1.1780	1.2421
Systematic errors in neutron doses[b]	1.0737	1.1551
Systematic errors in RBE neutron doses[b]	0.9905	0.9937
Model Mixture factor for transfer to US pop	0.2407	0.1235
Ratio of Japanese to U.S. baseline cancer rates	0.9401	0.9536
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	4.334	11.033
Probability of Causation (PC)	81.25	91.69

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	25

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	22.5457	64.6187
ERR/Sv with adjustments		
w/ age adjustment	22.5457	64.6187
w/ latency adjustment	22.5254	64.5624
w/ random errors in dosimetry adj	23.6977	68.3226
w/ systematic errors in dosimetry adj	18.9147	47.9184
adjusted for population transfer	18.0543	45.9687
multiplicative risk model	18.9147	47.9184
additive risk model	17.7815	45.6939
adjusted for smoking history	18.0543	45.9687
adjusted for DDREF	18.0543	45.9687
Final ERR/Sv	18.0543	45.9687
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	4.333	11.032
Probability of Causation (PC)	81.25	91.69

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_leu_m4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1930
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	835	257
Original ERR/Sv	12.7894	23.9340
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0759	0.0752
Systematic errors in gamma doses[b]	1.1948	1.0813
Systematic errors in neutron doses[b]	1.0708	1.0673
Systematic errors in RBE neutron doses[b]	1.0510	0.9347
Model Mixture factor for transfer to US pop	0.1494	0.0878
Ratio of Japanese to U.S. baseline cancer rates	0.9172	0.8171
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	2.283	4.771
Probability of Causation (PC)	69.54	82.67

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	30

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	12.7894	23.9340
ERR/Sv with adjustments		
w/ age adjustment	12.7894	23.9340
w/ latency adjustment	12.7894	23.9340
w/ random errors in dosimetry adj	13.7602	25.7329
w/ systematic errors in dosimetry adj	10.2331	23.8561
adjusted for population transfer	9.5121	19.8767
multiplicative risk model	10.2331	23.8561
additive risk model	9.3855	19.4938
adjusted for smoking history	9.5121	19.8767
adjusted for DDREF	9.5121	19.8767
Final ERR/Sv	9.5121	19.8767
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	2.283	4.770
Probability of Causation (PC)	69.54	82.67

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_leu_m5**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1935
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1466	257
Original ERR/Sv	7.1284	11.2723
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0485	0.0752
Systematic errors in gamma doses[b]	1.1621	1.0813
Systematic errors in neutron doses[b]	1.2190	1.0673
Systematic errors in RBE neutron doses[b]	1.0016	0.9347
Model Mixture factor for transfer to US pop	0.4194	0.0878
Ratio of Japanese to U.S. baseline cancer rates	0.9103	0.8171
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	1.198	2.247
Probability of Causation (PC)	54.51	69.20

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	35

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	7.1284	11.2723
ERR/Sv with adjustments		
w/ age adjustment	7.1284	11.2723
w/ latency adjustment	7.1284	11.2723
w/ random errors in dosimetry adj	7.4743	12.1196
w/ systematic errors in dosimetry adj	5.2676	11.2356
adjusted for population transfer	4.9932	9.3614
multiplicative risk model	5.2676	11.2356
additive risk model	4.7949	9.1811
adjusted for smoking history	4.9932	9.3614
adjusted for DDREF	4.9932	9.3614
Final ERR/Sv	4.9932	9.3614
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	1.198	2.247
Probability of Causation (PC)	54.51	69.20

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_leu_f1**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1922
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1455	1228
Original ERR/Sv	19.6164	51.7196
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	0.3138	0.3534
Random errors in doses[b]	0.0548	0.0566
Systematic errors in gamma doses[b]	1.0563	1.0414
Systematic errors in neutron doses[b]	1.1513	1.2215
Systematic errors in RBE neutron doses[b]	0.9968	1.0197
Model Mixture factor for transfer to US pop	1.0537	1.0358
Ratio of Japanese to U.S. baseline cancer rates	0.7024	0.6195
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	1.306	3.622
Probability of Causation (PC)	56.64	78.36

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	22

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	19.6164	51.7196
ERR/Sv with adjustments		
w/ age adjustment	19.6164	51.7196
w/ latency adjustment	6.1553	18.2770
w/ random errors in dosimetry adj	6.4929	19.3115
w/ systematic errors in dosimetry adj	5.3565	14.8894
adjusted for population transfer	5.4421	15.0922
multiplicative risk model	5.3565	14.8894
additive risk model	3.7624	9.2243
adjusted for smoking history	5.4421	15.0922
adjusted for DDREF	5.4421	15.0922
Final ERR/Sv	5.4421	15.0922
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	1.306	3.622
Probability of Causation (PC)	56.64	78.36

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_leu_f2**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1923
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	676	1174
Original ERR/Sv	24.6924	57.0444
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	0.8351	0.8291
Random errors in doses[b]	0.0419	0.0494
Systematic errors in gamma doses[b]	1.1937	1.1336
Systematic errors in neutron doses[b]	1.0738	1.0334
Systematic errors in RBE neutron doses[b]	1.0744	1.0245
Model Mixture factor for transfer to US pop	0.5558	0.5960
Ratio of Japanese to U.S. baseline cancer rates	0.7013	0.6435
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	3.246	8.496
Probability of Causation (PC)	76.45	89.47

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	23

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	24.6924	57.0444
ERR/Sv with adjustments		
w/ age adjustment	24.6924	57.0444
w/ latency adjustment	20.6203	47.2953
w/ random errors in dosimetry adj	21.4835	49.6341
w/ systematic errors in dosimetry adj	15.5994	41.3522
adjusted for population transfer	13.5299	35.3956
multiplicative risk model	15.5994	41.3522
additive risk model	10.9402	26.6090
adjusted for smoking history	13.5299	35.3956
adjusted for DDREF	13.5299	35.3956
Final ERR/Sv	13.5299	35.3956
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	3.247	8.495
Probability of Causation (PC)	76.45	89.47

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_leu_f3**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1925
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	497	696
Original ERR/Sv	27.8680	48.9323
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	0.9991	0.9988
Random errors in doses[b]	0.0704	0.0654
Systematic errors in gamma doses[b]	1.3507	1.0995
Systematic errors in neutron doses[b]	1.0348	1.0579
Systematic errors in RBE neutron doses[b]	0.9409	0.9022
Model Mixture factor for transfer to US pop	0.0657	0.3303
Ratio of Japanese to U.S. baseline cancer rates	0.6702	0.7432
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	3.763	9.861
Probability of Causation (PC)	79.01	90.79

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	25

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	27.8680	48.9323
ERR/Sv with adjustments		
w/ age adjustment	27.8680	48.9323
w/ latency adjustment	27.8422	48.8755
w/ random errors in dosimetry adj	29.8030	52.0729
w/ systematic errors in dosimetry adj	22.6626	49.6217
adjusted for population transfer	15.6795	41.0873
multiplicative risk model	22.6626	49.6217
additive risk model	15.1881	36.8776
adjusted for smoking history	15.6795	41.0873
adjusted for DDREF	15.6795	41.0873
Final ERR/Sv	15.6795	41.0873
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	3.763	9.861
Probability of Causation (PC)	79.01	90.79

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_leu_f4**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1930
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1316	355
Original ERR/Sv	11.7623	22.3211
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0666	0.0641
Systematic errors in gamma doses[b]	1.0552	1.2293
Systematic errors in neutron doses[b]	1.0719	1.0671
Systematic errors in RBE neutron doses[b]	1.0674	1.0085
Model Mixture factor for transfer to US pop	0.4810	1.0301
Ratio of Japanese to U.S. baseline cancer rates	0.6011	0.5584
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	1.978	4.366
Probability of Causation (PC)	66.42	81.36

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	30

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	11.7623	22.3211
ERR/Sv with adjustments		
w/ age adjustment	11.7623	22.3211
w/ latency adjustment	11.7623	22.3211
w/ random errors in dosimetry adj	12.5458	23.7514
w/ systematic errors in dosimetry adj	10.3917	17.9529
adjusted for population transfer	8.2406	18.1912
multiplicative risk model	10.3917	17.9529
additive risk model	6.2468	10.0243
adjusted for smoking history	8.2406	18.1912
adjusted for DDREF	8.2406	18.1912
Final ERR/Sv	8.2406	18.1912
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	1.978	4.366
Probability of Causation (PC)	66.42	81.36

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_leu_f5**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1935
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1497	355
Original ERR/Sv	4.8961	10.6383
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0516	0.0641
Systematic errors in gamma doses[b]	1.0658	1.2293
Systematic errors in neutron doses[b]	1.1082	1.0671
Systematic errors in RBE neutron doses[b]	1.0072	1.0085
Model Mixture factor for transfer to US pop	1.0008	1.0301
Ratio of Japanese to U.S. baseline cancer rates	0.5869	0.5584
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	1.039	2.081
Probability of Causation (PC)	50.96	67.54

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	35

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	4.8961	10.6383
ERR/Sv with adjustments		
w/ age adjustment	4.8961	10.6383
w/ latency adjustment	4.8961	10.6383
w/ random errors in dosimetry adj	5.1488	11.3200
w/ systematic errors in dosimetry adj	4.3283	8.5564
adjusted for population transfer	4.3296	8.6700
multiplicative risk model	4.3283	8.5564
additive risk model	2.5404	4.7776
adjusted for smoking history	4.3296	8.6700
adjusted for DDREF	4.3296	8.6700
Final ERR/Sv	4.3296	8.6700
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	1.039	2.081
Probability of Causation (PC)	50.96	67.54

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_thy_m1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1922
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	960	615
Original ERR/Sv	0.4732	3.5684
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	0.0534	0.1331
Random errors in doses[b]	0.1023	0.0771
Systematic errors in gamma doses[b]	1.1296	1.3284
Systematic errors in neutron doses[b]	1.1135	1.1353
Systematic errors in RBE neutron doses[b]	1.0736	1.0160
Model Mixture factor for transfer to US pop	0.7093	0.4805
Ratio of Japanese to U.S. baseline cancer rates	1.0998	0.8829
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.005	0.095
Probability of Causation (PC)	0.50	8.67

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	22

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4732	3.5684
ERR/Sv with adjustments		
w/ age adjustment	0.4732	3.5684
w/ latency adjustment	0.0252	0.4749
w/ random errors in dosimetry adj	0.0252	0.4749
w/ systematic errors in dosimetry adj	0.0252	0.4749
adjusted for population transfer	0.0252	0.4749
multiplicative risk model	0.0252	0.4749
additive risk model	0.0278	0.4193
adjusted for smoking history	0.0252	0.4749
adjusted for DDREF	0.0252	0.4749
Final ERR/Sv	0.0252	0.4749
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.005	0.095
Probability of Causation (PC)	0.50	8.67

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_thy_m2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1923
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	33	177
Original ERR/Sv	1.2389	17.5745
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	0.1158	0.1132
Random errors in doses[b]	0.0711	0.0862
Systematic errors in gamma doses[b]	1.1007	1.1073
Systematic errors in neutron doses[b]	1.0791	1.0935
Systematic errors in RBE neutron doses[b]	1.0171	0.9887
Model Mixture factor for transfer to US pop	0.6482	0.5877
Ratio of Japanese to U.S. baseline cancer rates	0.9051	0.7928
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.029	0.398
Probability of Causation (PC)	2.79	28.47

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	23

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.2389	17.5745
ERR/Sv with adjustments		
w/ age adjustment	1.2389	17.5745
w/ latency adjustment	0.1435	1.9897
w/ random errors in dosimetry adj	0.1435	1.9897
w/ systematic errors in dosimetry adj	0.1435	1.9897
adjusted for population transfer	0.1435	1.9897
multiplicative risk model	0.1435	1.9897
additive risk model	0.1299	1.5774
adjusted for smoking history	0.1435	1.9897
adjusted for DDREF	0.1435	1.9897
Final ERR/Sv	0.1435	1.9897
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.029	0.398
Probability of Causation (PC)	2.79	28.47

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_thy_m3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1925
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	501	110
Original ERR/Sv	1.6360	13.1733
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	0.7816	0.7333
Random errors in doses[b]	0.1249	0.0725
Systematic errors in gamma doses[b]	1.1130	1.2467
Systematic errors in neutron doses[b]	1.1438	1.1138
Systematic errors in RBE neutron doses[b]	1.0497	0.9199
Model Mixture factor for transfer to US pop	0.8638	1.0601
Ratio of Japanese to U.S. baseline cancer rates	0.9507	1.0616
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.256	1.932
Probability of Causation (PC)	20.37	65.89

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	25

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.6360	13.1733
ERR/Sv with adjustments		
w/ age adjustment	1.6360	13.1733
w/ latency adjustment	1.2787	9.6604
w/ random errors in dosimetry adj	1.2787	9.6604
w/ systematic errors in dosimetry adj	1.2787	9.6604
adjusted for population transfer	1.2787	9.6604
multiplicative risk model	1.2787	9.6604
additive risk model	1.2157	10.2551
adjusted for smoking history	1.2787	9.6604
adjusted for DDREF	1.2787	9.6604
Final ERR/Sv	1.2787	9.6604
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.256	1.932
Probability of Causation (PC)	20.37	65.89

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_thy_m4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1930
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1102	679
Original ERR/Sv	1.8032	12.4338
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	0.9999	1.0000
Random errors in doses[b]	0.1219	0.1094
Systematic errors in gamma doses[b]	1.2233	1.2719
Systematic errors in neutron doses[b]	1.1344	1.1032
Systematic errors in RBE neutron doses[b]	0.9443	0.9593
Model Mixture factor for transfer to US pop	0.3182	0.9210
Ratio of Japanese to U.S. baseline cancer rates	0.8074	0.8568
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.361	2.487
Probability of Causation (PC)	26.50	71.32

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	30

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.8032	12.4338
ERR/Sv with adjustments		
w/ age adjustment	1.8032	12.4338
w/ latency adjustment	1.8031	12.4337
w/ random errors in dosimetry adj	1.8031	12.4337
w/ systematic errors in dosimetry adj	1.8031	12.4337
adjusted for population transfer	1.8031	12.4337
multiplicative risk model	1.8031	12.4337
additive risk model	1.4558	10.6528
adjusted for smoking history	1.8031	12.4337
adjusted for DDREF	1.8031	12.4337
Final ERR/Sv	1.8031	12.4337
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.361	2.487
Probability of Causation (PC)	26.50	71.32

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_thy_m5**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1935
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1102	679
Original ERR/Sv	1.8032	12.4338
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1219	0.1094
Systematic errors in gamma doses[b]	1.2233	1.2719
Systematic errors in neutron doses[b]	1.1344	1.1032
Systematic errors in RBE neutron doses[b]	0.9443	0.9593
Model Mixture factor for transfer to US pop	0.3182	0.9210
Ratio of Japanese to U.S. baseline cancer rates	0.8074	0.8568
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.361	2.487
Probability of Causation (PC)	26.50	71.32

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	35

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.8032	12.4338
ERR/Sv with adjustments		
w/ age adjustment	1.8032	12.4338
w/ latency adjustment	1.8032	12.4338
w/ random errors in dosimetry adj	1.8032	12.4338
w/ systematic errors in dosimetry adj	1.8032	12.4338
adjusted for population transfer	1.8032	12.4338
multiplicative risk model	1.8032	12.4338
additive risk model	1.4559	10.6529
adjusted for smoking history	1.8032	12.4338
adjusted for DDREF	1.8032	12.4338
Final ERR/Sv	1.8032	12.4338
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.361	2.487
Probability of Causation (PC)	26.50	71.32

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_thy_f1**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1922
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	960	615
Original ERR/Sv	0.4732	3.5684
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	0.0534	0.1331
Random errors in doses[b]	0.1023	0.0771
Systematic errors in gamma doses[b]	1.1296	1.3284
Systematic errors in neutron doses[b]	1.1135	1.1353
Systematic errors in RBE neutron doses[b]	1.0736	1.0160
Model Mixture factor for transfer to US pop	0.7093	0.4805
Ratio of Japanese to U.S. baseline cancer rates	1.0998	0.8829
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.005	0.095
Probability of Causation (PC)	0.50	8.67

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	22

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4732	3.5684
ERR/Sv with adjustments		
w/ age adjustment	0.4732	3.5684
w/ latency adjustment	0.0252	0.4749
w/ random errors in dosimetry adj	0.0252	0.4749
w/ systematic errors in dosimetry adj	0.0252	0.4749
adjusted for population transfer	0.0252	0.4749
multiplicative risk model	0.0252	0.4749
additive risk model	0.0278	0.4193
adjusted for smoking history	0.0252	0.4749
adjusted for DDREF	0.0252	0.4749
Final ERR/Sv	0.0252	0.4749
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.005	0.095
Probability of Causation (PC)	0.50	8.67

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_thy_f2**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1923
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	33	177
Original ERR/Sv	1.2389	17.5745
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	0.1158	0.1132
Random errors in doses[b]	0.0711	0.0862
Systematic errors in gamma doses[b]	1.1007	1.1073
Systematic errors in neutron doses[b]	1.0791	1.0935
Systematic errors in RBE neutron doses[b]	1.0171	0.9887
Model Mixture factor for transfer to US pop	0.6482	0.5877
Ratio of Japanese to U.S. baseline cancer rates	0.9051	0.7928
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.029	0.398
Probability of Causation (PC)	2.79	28.47

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	23

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.2389	17.5745
ERR/Sv with adjustments		
w/ age adjustment	1.2389	17.5745
w/ latency adjustment	0.1435	1.9897
w/ random errors in dosimetry adj	0.1435	1.9897
w/ systematic errors in dosimetry adj	0.1435	1.9897
adjusted for population transfer	0.1435	1.9897
multiplicative risk model	0.1435	1.9897
additive risk model	0.1299	1.5774
adjusted for smoking history	0.1435	1.9897
adjusted for DDREF	0.1435	1.9897
Final ERR/Sv	0.1435	1.9897
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.029	0.398
Probability of Causation (PC)	2.79	28.47

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_thy_f3**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1925
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	501	110
Original ERR/Sv	1.6360	13.1733
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	0.7816	0.7333
Random errors in doses[b]	0.1249	0.0725
Systematic errors in gamma doses[b]	1.1130	1.2467
Systematic errors in neutron doses[b]	1.1438	1.1138
Systematic errors in RBE neutron doses[b]	1.0497	0.9199
Model Mixture factor for transfer to US pop	0.8638	1.0601
Ratio of Japanese to U.S. baseline cancer rates	1.1264	1.1110
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.256	1.932
Probability of Causation (PC)	20.37	65.89

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	25

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.6360	13.1733
ERR/Sv with adjustments		
w/ age adjustment	1.6360	13.1733
w/ latency adjustment	1.2787	9.6604
w/ random errors in dosimetry adj	1.2787	9.6604
w/ systematic errors in dosimetry adj	1.2787	9.6604
adjusted for population transfer	1.2787	9.6604
multiplicative risk model	1.2787	9.6604
additive risk model	1.4403	10.7326
adjusted for smoking history	1.2787	9.6604
adjusted for DDREF	1.2787	9.6604
Final ERR/Sv	1.2787	9.6604
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.256	1.932
Probability of Causation (PC)	20.37	65.89

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_thy_f4**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1930
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1102	679
Original ERR/Sv	1.8032	12.4338
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	0.9999	1.0000
Random errors in doses[b]	0.1219	0.1094
Systematic errors in gamma doses[b]	1.2233	1.2719
Systematic errors in neutron doses[b]	1.1344	1.1032
Systematic errors in RBE neutron doses[b]	0.9443	0.9593
Model Mixture factor for transfer to US pop	0.3182	0.9210
Ratio of Japanese to U.S. baseline cancer rates	1.1314	1.1453
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.361	2.487
Probability of Causation (PC)	26.50	71.32

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	30

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.8032	12.4338
ERR/Sv with adjustments		
w/ age adjustment	1.8032	12.4338
w/ latency adjustment	1.8031	12.4337
w/ random errors in dosimetry adj	1.8031	12.4337
w/ systematic errors in dosimetry adj	1.8031	12.4337
adjusted for population transfer	1.8031	12.4337
multiplicative risk model	1.8031	12.4337
additive risk model	2.0399	14.2398
adjusted for smoking history	1.8031	12.4337
adjusted for DDREF	1.8031	12.4337
Final ERR/Sv	1.8031	12.4337
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.361	2.487
Probability of Causation (PC)	26.50	71.32

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_thy_f5**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1935
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1102	679
Original ERR/Sv	1.8032	12.4338
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1219	0.1094
Systematic errors in gamma doses[b]	1.2233	1.2719
Systematic errors in neutron doses[b]	1.1344	1.1032
Systematic errors in RBE neutron doses[b]	0.9443	0.9593
Model Mixture factor for transfer to US pop	0.3182	0.9210
Ratio of Japanese to U.S. baseline cancer rates	1.1314	1.1453
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.361	2.487
Probability of Causation (PC)	26.50	71.32

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	35

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.8032	12.4338
ERR/Sv with adjustments		
w/ age adjustment	1.8032	12.4338
w/ latency adjustment	1.8032	12.4338
w/ random errors in dosimetry adj	1.8032	12.4338
w/ systematic errors in dosimetry adj	1.8032	12.4338
adjusted for population transfer	1.8032	12.4338
multiplicative risk model	1.8032	12.4338
additive risk model	2.0400	14.2399
adjusted for smoking history	1.8032	12.4338
adjusted for DDREF	1.8032	12.4338
Final ERR/Sv	1.8032	12.4338
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.361	2.487
Probability of Causation (PC)	26.50	71.32

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_col_m1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1922
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1792	1305
Original ERR/Sv	1.0605	0.9368
Adjustment Factors		
Age at exposure, Attained age	5.9686	7.6236
Minimum latency for cancer induction	0.0004	0.0090
Random errors in doses[b]	0.0951	0.0791
Systematic errors in gamma doses[b]	1.2682	1.1818
Systematic errors in neutron doses[b]	1.1225	1.0316
Systematic errors in RBE neutron doses[b]	0.9776	0.9563
Model Mixture factor for transfer to US pop	0.9782	0.7841
Ratio of Japanese to U.S. baseline cancer rates	1.1513	1.1033
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.000	0.012
Probability of Causation (PC)	0.04	1.20

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	22

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.0605	0.9368
ERR/Sv with adjustments		
w/ age adjustment	6.3300	7.1420
w/ latency adjustment	0.0023	0.0642
w/ random errors in dosimetry adj	0.0025	0.0692
w/ systematic errors in dosimetry adj	0.0018	0.0594
adjusted for population transfer	0.0018	0.0607
multiplicative risk model	0.0018	0.0594
additive risk model	0.0021	0.0655
adjusted for smoking history	0.0018	0.0607
adjusted for DDREF	0.0018	0.0607
Final ERR/Sv	0.0018	0.0607
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.000	0.012
Probability of Causation (PC)	0.04	1.20

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_col_m2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1923
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	188	1923
Original ERR/Sv	0.6274	0.5908
Adjustment Factors		
Age at exposure, Attained age	8.4962	35.2508
Minimum latency for cancer induction	0.0016	0.0104
Random errors in doses[b]	0.0772	0.0613
Systematic errors in gamma doses[b]	1.3327	1.0740
Systematic errors in neutron doses[b]	1.0737	1.1482
Systematic errors in RBE neutron doses[b]	1.0262	0.9735
Model Mixture factor for transfer to US pop	0.9788	0.5712
Ratio of Japanese to U.S. baseline cancer rates	1.0889	1.1418
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.001	0.040
Probability of Causation (PC)	0.13	3.89

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	23

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6274	0.5908
ERR/Sv with adjustments		
w/ age adjustment	5.3305	20.8257
w/ latency adjustment	0.0087	0.2157
w/ random errors in dosimetry adj	0.0094	0.2289
w/ systematic errors in dosimetry adj	0.0064	0.1907
adjusted for population transfer	0.0064	0.2023
multiplicative risk model	0.0064	0.1907
additive risk model	0.0070	0.2177
adjusted for smoking history	0.0064	0.2023
adjusted for DDREF	0.0064	0.2023
Final ERR/Sv	0.0064	0.2023
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.001	0.040
Probability of Causation (PC)	0.13	3.89

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_col_m3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1925
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	449	389
Original ERR/Sv	0.5450	1.2675
Adjustment Factors		
Age at exposure, Attained age	3.9627	4.7570
Minimum latency for cancer induction	0.0364	0.2948
Random errors in doses[b]	0.0608	0.1133
Systematic errors in gamma doses[b]	1.1937	1.0389
Systematic errors in neutron doses[b]	1.0650	1.0720
Systematic errors in RBE neutron doses[b]	0.9391	1.0083
Model Mixture factor for transfer to US pop	0.3303	0.8781
Ratio of Japanese to U.S. baseline cancer rates	1.1618	1.0707
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.015	0.355
Probability of Causation (PC)	1.53	26.22

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	25

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5450	1.2675
ERR/Sv with adjustments		
w/ age adjustment	2.1597	6.0294
w/ latency adjustment	0.0787	1.7772
w/ random errors in dosimetry adj	0.0835	1.9786
w/ systematic errors in dosimetry adj	0.0699	1.7620
adjusted for population transfer	0.0775	1.7772
multiplicative risk model	0.0699	1.7620
additive risk model	0.0812	1.8866
adjusted for smoking history	0.0775	1.7772
adjusted for DDREF	0.0775	1.7772
Final ERR/Sv	0.0775	1.7772
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.015	0.355
Probability of Causation (PC)	1.53	26.22

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_col_m4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1930
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	100	679
Original ERR/Sv	0.5280	1.3131
Adjustment Factors		
Age at exposure, Attained age	3.4389	5.5058
Minimum latency for cancer induction	0.9807	0.9936
Random errors in doses[b]	0.1172	0.0806
Systematic errors in gamma doses[b]	1.0752	1.1779
Systematic errors in neutron doses[b]	1.0854	1.2094
Systematic errors in RBE neutron doses[b]	1.0828	1.0298
Model Mixture factor for transfer to US pop	0.4937	0.3402
Ratio of Japanese to U.S. baseline cancer rates	1.1011	1.1122
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.331	1.137
Probability of Causation (PC)	24.87	53.20

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	30

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5280	1.3131
ERR/Sv with adjustments		
w/ age adjustment	1.8157	7.2297
w/ latency adjustment	1.7807	7.1836
w/ random errors in dosimetry adj	1.9894	7.7623
w/ systematic errors in dosimetry adj	1.5743	5.2913
adjusted for population transfer	1.6549	5.6830
multiplicative risk model	1.5743	5.2913
additive risk model	1.7334	5.8850
adjusted for smoking history	1.6549	5.6830
adjusted for DDREF	1.6549	5.6830
Final ERR/Sv	1.6549	5.6830
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.331	1.137
Probability of Causation (PC)	24.87	53.20

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_col_m5**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1935
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	8	863
Original ERR/Sv	0.7674	1.2030
Adjustment Factors		
Age at exposure, Attained age	1.9150	3.6410
Minimum latency for cancer induction	0.9994	1.0000
Random errors in doses[b]	0.1118	0.0980
Systematic errors in gamma doses[b]	1.1480	1.1717
Systematic errors in neutron doses[b]	1.1154	1.0944
Systematic errors in RBE neutron doses[b]	0.9422	0.9488
Model Mixture factor for transfer to US pop	0.5063	0.1230
Ratio of Japanese to U.S. baseline cancer rates	1.0805	1.0680
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.281	0.838
Probability of Causation (PC)	21.96	45.58

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	35

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.7674	1.2030
ERR/Sv with adjustments		
w/ age adjustment	1.4696	4.3802
w/ latency adjustment	1.4687	4.3801
w/ random errors in dosimetry adj	1.6330	4.8095
w/ systematic errors in dosimetry adj	1.3534	3.9530
adjusted for population transfer	1.4072	4.1886
multiplicative risk model	1.3534	3.9530
additive risk model	1.4623	4.2216
adjusted for smoking history	1.4072	4.1886
adjusted for DDREF	1.4072	4.1886
Final ERR/Sv	1.4072	4.1886
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.281	0.838
Probability of Causation (PC)	21.96	45.58

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_col_f1**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1922
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1486	285
Original ERR/Sv	0.9995	0.6834
Adjustment Factors		
Age at exposure, Attained age	6.4592	19.0859
Minimum latency for cancer induction	0.0004	0.0060
Random errors in doses[b]	0.0850	0.0804
Systematic errors in gamma doses[b]	1.3053	1.2404
Systematic errors in neutron doses[b]	1.1119	1.0918
Systematic errors in RBE neutron doses[b]	0.9955	0.9589
Model Mixture factor for transfer to US pop	0.3897	0.8759
Ratio of Japanese to U.S. baseline cancer rates	0.8809	0.8251
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.000	0.013
Probability of Causation (PC)	0.04	1.26

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	22

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.9995	0.6834
ERR/Sv with adjustments		
w/ age adjustment	6.4563	13.0439
w/ latency adjustment	0.0028	0.0784
w/ random errors in dosimetry adj	0.0030	0.0847
w/ systematic errors in dosimetry adj	0.0021	0.0652
adjusted for population transfer	0.0019	0.0638
multiplicative risk model	0.0021	0.0652
additive risk model	0.0018	0.0538
adjusted for smoking history	0.0019	0.0638
adjusted for DDREF	0.0019	0.0638
Final ERR/Sv	0.0019	0.0638
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.000	0.013
Probability of Causation (PC)	0.04	1.26

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_col_f2**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1923
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	65	1923
Original ERR/Sv	0.4099	0.6986
Adjustment Factors		
Age at exposure, Attained age	10.4110	35.2508
Minimum latency for cancer induction	0.0015	0.0104
Random errors in doses[b]	0.0763	0.0613
Systematic errors in gamma doses[b]	1.0138	1.0740
Systematic errors in neutron doses[b]	1.0806	1.1482
Systematic errors in RBE neutron doses[b]	0.9483	0.9735
Model Mixture factor for transfer to US pop	0.9749	0.5712
Ratio of Japanese to U.S. baseline cancer rates	0.8199	0.8180
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.001	0.042
Probability of Causation (PC)	0.14	3.99

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	23

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4099	0.6986
ERR/Sv with adjustments		
w/ age adjustment	4.2672	24.6274
w/ latency adjustment	0.0066	0.2551
w/ random errors in dosimetry adj	0.0071	0.2707
w/ systematic errors in dosimetry adj	0.0068	0.2255
adjusted for population transfer	0.0068	0.2079
multiplicative risk model	0.0068	0.2255
additive risk model	0.0056	0.1845
adjusted for smoking history	0.0068	0.2079
adjusted for DDREF	0.0068	0.2079
Final ERR/Sv	0.0068	0.2079
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.001	0.042
Probability of Causation (PC)	0.14	3.99

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_col_f3**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1925
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	936	1923
Original ERR/Sv	1.0225	0.6986
Adjustment Factors		
Age at exposure, Attained age	5.0850	25.0307
Minimum latency for cancer induction	0.0205	0.1309
Random errors in doses[b]	0.1372	0.0613
Systematic errors in gamma doses[b]	1.1892	1.0740
Systematic errors in neutron doses[b]	1.0776	1.1482
Systematic errors in RBE neutron doses[b]	0.9998	0.9735
Model Mixture factor for transfer to US pop	0.0867	0.5712
Ratio of Japanese to U.S. baseline cancer rates	0.8526	0.8180
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.016	0.373
Probability of Causation (PC)	1.61	27.18

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	25

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.0225	0.6986
ERR/Sv with adjustments		
w/ age adjustment	5.1993	17.4873
w/ latency adjustment	0.1066	2.2892
w/ random errors in dosimetry adj	0.1212	2.4296
w/ systematic errors in dosimetry adj	0.0946	2.0240
adjusted for population transfer	0.0819	1.8660
multiplicative risk model	0.0946	2.0240
additive risk model	0.0806	1.6556
adjusted for smoking history	0.0819	1.8660
adjusted for DDREF	0.0819	1.8660
Final ERR/Sv	0.0819	1.8660
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.016	0.373
Probability of Causation (PC)	1.61	27.18

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_col_f4**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1930
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	877	1048
Original ERR/Sv	1.0566	0.7934
Adjustment Factors		
Age at exposure, Attained age	2.5890	8.3950
Minimum latency for cancer induction	0.9933	0.9602
Random errors in doses[b]	0.0871	0.1301
Systematic errors in gamma doses[b]	1.3478	1.1156
Systematic errors in neutron doses[b]	1.1307	1.0635
Systematic errors in RBE neutron doses[b]	0.9983	0.9614
Model Mixture factor for transfer to US pop	0.2225	0.4904
Ratio of Japanese to U.S. baseline cancer rates	0.8480	0.7949
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.343	1.135
Probability of Causation (PC)	25.51	53.16

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	30

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.0566	0.7934
ERR/Sv with adjustments		
w/ age adjustment	2.7356	6.6608
w/ latency adjustment	2.7173	6.3959
w/ random errors in dosimetry adj	2.9539	7.2277
w/ systematic errors in dosimetry adj	1.9418	6.3367
adjusted for population transfer	1.7124	5.6745
multiplicative risk model	1.9418	6.3367
additive risk model	1.6467	5.0373
adjusted for smoking history	1.7124	5.6745
adjusted for DDREF	1.7124	5.6745
Final ERR/Sv	1.7124	5.6745
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.342	1.135
Probability of Causation (PC)	25.51	53.16

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**latency_col_f5**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1935
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1068	264
Original ERR/Sv	0.7971	1.2210
Adjustment Factors		
Age at exposure, Attained age	2.2995	4.9568
Minimum latency for cancer induction	0.9994	1.0000
Random errors in doses[b]	0.0947	0.0843
Systematic errors in gamma doses[b]	1.0315	1.1285
Systematic errors in neutron doses[b]	1.1507	1.1858
Systematic errors in RBE neutron doses[b]	1.0170	1.0553
Model Mixture factor for transfer to US pop	0.1444	-0.0481
Ratio of Japanese to U.S. baseline cancer rates	0.8598	0.8858
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.292	0.818
Probability of Causation (PC)	22.63	45.00

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	35

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.7971	1.2210
ERR/Sv with adjustments		
w/ age adjustment	1.8330	6.0520
w/ latency adjustment	1.8319	6.0520
w/ random errors in dosimetry adj	2.0054	6.5622
w/ systematic errors in dosimetry adj	1.6614	4.6466
adjusted for population transfer	1.4621	4.0906
multiplicative risk model	1.6614	4.6466
additive risk model	1.4285	4.1161
adjusted for smoking history	1.4621	4.0906
adjusted for DDREF	1.4621	4.0906
Final ERR/Sv	1.4621	4.0906
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.292	0.818
Probability of Causation (PC)	22.63	45.00

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Appendix D

Verification of the Implementation of the Radiation Effectiveness Factors (REF) for Exposure to Alpha Radiation, Neutrons, and Low Energy Photons and Beta Particles

The calculations documented in this appendix were performed to verify that the algorithms describing the radiation effectiveness factor (REF) have been implemented correctly. A total of 44 calculations was performed for this specific verification task.

The equations related to REF do not depend on gender or on the value of the dose; therefore, all calculations were performed for males with an organ equivalent dose of 20 cSv. The age at time of exposure (AAE) was kept constant at 20 years of age, and the age at diagnosis or attained age (ATA) was kept constant at 40 years of age.

Further details about this verification task can be found in Section 5.3 of the report. The results for ERR and PC obtained with MS Excel verify the mid and upper bound values of ERR and PC estimated using NIOSH-IREP v.5.5.3r, for all exposure scenarios considered.

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Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_e1_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	electrons E<15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	737	1719
Original ERR/Sv	3.3313	3.9564
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0509	0.0420
Systematic errors in gamma doses[b]	1.2158	1.2031
Systematic errors in neutron doses[b]	1.0891	1.0979
Systematic errors in RBE neutron doses[b]	1.0236	1.0288
Model Mixture factor for transfer to US pop	0.8490	0.9898
Ratio of Japanese to U.S. baseline cancer rates	0.9251	0.8702
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	2.45392	5.78338

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	1.868	7.558
Probability of Causation (PC)	65.14	88.31

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	3.3313	3.9564
ERR/Sv with adjustments		
w/ age adjustment	3.3313	3.9564
w/ latency adjustment	3.3313	3.9564
w/ random errors in dosimetry adj	3.5007	4.1227
w/ systematic errors in dosimetry adj	2.5829	3.0337
adjusted for population transfer	2.5537	3.0297
multiplicative risk model	2.5829	3.0337
additive risk model	2.3894	2.6399
adjusted for smoking history	2.5537	3.0297
adjusted for DDREF	2.5537	3.0297
Final ERR/Sv	2.5537	3.0297
Organ equivalent dose (Sv)	0.490784	1.156676
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	1.868	7.558
Probability of Causation (PC)	65.14	88.31

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_e1_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	electrons E<15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	122	463
Original ERR/Sv	4.0647	4.0786
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0515	0.0501
Systematic errors in gamma doses[b]	1.2085	1.1953
Systematic errors in neutron doses[b]	1.1858	1.1792
Systematic errors in RBE neutron doses[b]	0.9589	0.9679
Model Mixture factor for transfer to US pop	0.4469	0.2236
Ratio of Japanese to U.S. baseline cancer rates	0.9424	0.9426
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	2.11051	6.22876

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	1.271	3.737
Probability of Causation (PC)	55.97	78.89

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	4.0647	4.0786
ERR/Sv with adjustments		
w/ age adjustment	4.0647	4.0786
w/ latency adjustment	4.0647	4.0786
w/ random errors in dosimetry adj	4.2741	4.2827
w/ systematic errors in dosimetry adj	3.1103	3.1395
adjusted for population transfer	3.0111	2.9996
multiplicative risk model	3.1103	3.1395
additive risk model	2.9310	2.9593
adjusted for smoking history	3.0111	2.9996
adjusted for DDREF	3.0111	2.9996
Final ERR/Sv	3.0111	2.9996
Organ equivalent dose (Sv)	0.422102	1.245752
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	1.271	3.737
Probability of Causation (PC)	55.97	78.89

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_e1_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	electrons E<15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	648	742
Original ERR/Sv	0.5517	1.5568
Adjustment Factors		
Age at exposure, Attained age	2.1502	3.0225
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0778	0.0793
Systematic errors in gamma doses[b]	1.2410	1.1807
Systematic errors in neutron doses[b]	1.1699	1.0411
Systematic errors in RBE neutron doses[b]	1.0205	0.9463
Model Mixture factor for transfer to US pop	0.0768	0.5217
Ratio of Japanese to U.S. baseline cancer rates	1.1072	1.1039
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	2.88282	2.41056

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.547	2.210
Probability of Causation (PC)	35.35	68.84

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5517	1.5568
ERR/Sv with adjustments		
w/ age adjustment	1.1862	4.7055
w/ latency adjustment	1.1862	4.7055
w/ random errors in dosimetry adj	1.2785	5.0786
w/ systematic errors in dosimetry adj	0.8630	4.3660
adjusted for population transfer	0.9484	4.5830
multiplicative risk model	0.8630	4.3660
additive risk model	0.9555	4.8198
adjusted for smoking history	0.9484	4.5830
adjusted for DDREF	0.9484	4.5830
Final ERR/Sv	0.9484	4.5830
Organ equivalent dose (Sv)	0.576564	0.482112
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.547	2.210
Probability of Causation (PC)	35.35	68.84

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_e1_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	electrons E<15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	573	803
Original ERR/Sv	0.2982	0.6278
Adjustment Factors		
Age at exposure, Attained age	2.7782	2.2604
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1031	0.0861
Systematic errors in gamma doses[b]	1.1026	1.1119
Systematic errors in neutron doses[b]	1.0388	1.2424
Systematic errors in RBE neutron doses[b]	0.9684	0.9452
Model Mixture factor for transfer to US pop	0.9513	0.5630
Ratio of Japanese to U.S. baseline cancer rates	1.1277	1.1453
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	0.7
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1.97823	5.06335

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.328	1.816
Probability of Causation (PC)	24.70	64.49

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.2982	0.6278
ERR/Sv with adjustments		
w/ age adjustment	0.8284	1.4190
w/ latency adjustment	0.8284	1.4190
w/ random errors in dosimetry adj	0.9138	1.5411
w/ systematic errors in dosimetry adj	0.8238	1.1803
adjusted for population transfer	0.8290	1.2552
multiplicative risk model	0.8238	1.1803
additive risk model	0.9290	1.3517
adjusted for smoking history	0.8290	1.2552
adjusted for DDREF	0.8290	1.7931
Final ERR/Sv	0.8290	1.7931
Organ equivalent dose (Sv)	0.395646	1.01267
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.328	1.816
Probability of Causation (PC)	24.70	64.49

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_e2_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	electrons E>15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1077	1978
Original ERR/Sv	3.3058	5.0967
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0709	0.0352
Systematic errors in gamma doses[b]	1.1105	1.0251
Systematic errors in neutron doses[b]	1.1839	1.0784
Systematic errors in RBE neutron doses[b]	0.9956	0.9682
Model Mixture factor for transfer to US pop	0.2170	0.8836
Ratio of Japanese to U.S. baseline cancer rates	0.9630	0.8981
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.630	1.169
Probability of Causation (PC)	38.66	53.90

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	3.3058	5.0967
ERR/Sv with adjustments		
w/ age adjustment	3.3058	5.0967
w/ latency adjustment	3.3058	5.0967
w/ random errors in dosimetry adj	3.5400	5.2761
w/ systematic errors in dosimetry adj	2.7044	4.9299
adjusted for population transfer	2.6260	4.8714
multiplicative risk model	2.7044	4.9299
additive risk model	2.6043	4.4273
adjusted for smoking history	2.6260	4.8714
adjusted for DDREF	2.6260	4.8714
Final ERR/Sv	2.6260	4.8714
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	0.630	1.169
Probability of Causation (PC)	38.66	53.90

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_e2_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	electrons E>15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	409	1978
Original ERR/Sv	3.3387	5.0967
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0371	0.0352
Systematic errors in gamma doses[b]	1.1373	1.0251
Systematic errors in neutron doses[b]	1.0313	1.0784
Systematic errors in RBE neutron doses[b]	1.0864	0.9682
Model Mixture factor for transfer to US pop	0.4211	0.8836
Ratio of Japanese to U.S. baseline cancer rates	0.9421	0.8981
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.525	0.974
Probability of Causation (PC)	34.44	49.35

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	3.3387	5.0967
ERR/Sv with adjustments		
w/ age adjustment	3.3387	5.0967
w/ latency adjustment	3.3387	5.0967
w/ random errors in dosimetry adj	3.4627	5.2761
w/ systematic errors in dosimetry adj	2.7175	4.9299
adjusted for population transfer	2.6263	4.8714
multiplicative risk model	2.7175	4.9299
additive risk model	2.5600	4.4273
adjusted for smoking history	2.6263	4.8714
adjusted for DDREF	2.6263	4.8714
Final ERR/Sv	2.6263	4.8714
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.525	0.974
Probability of Causation (PC)	34.44	49.35

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_e2_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	electrons E>15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	9	696
Original ERR/Sv	0.3770	1.0795
Adjustment Factors		
Age at exposure, Attained age	3.1638	3.0345
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0940	0.1031
Systematic errors in gamma doses[b]	1.0880	1.1456
Systematic errors in neutron doses[b]	1.1132	1.0861
Systematic errors in RBE neutron doses[b]	0.9508	1.0640
Model Mixture factor for transfer to US pop	0.9232	-0.0929
Ratio of Japanese to U.S. baseline cancer rates	1.1143	1.1538
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.229	0.638
Probability of Causation (PC)	18.61	38.93

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.3770	1.0795
ERR/Sv with adjustments		
w/ age adjustment	1.1927	3.2757
w/ latency adjustment	1.1927	3.2757
w/ random errors in dosimetry adj	1.3049	3.6133
w/ systematic errors in dosimetry adj	1.1331	2.7292
adjusted for population transfer	1.1430	3.1879
multiplicative risk model	1.1331	2.7292
additive risk model	1.2626	3.1489
adjusted for smoking history	1.1430	3.1879
adjusted for DDREF	1.1430	3.1879
Final ERR/Sv	1.1430	3.1879
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.229	0.638
Probability of Causation (PC)	18.61	38.93

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_e2_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	electrons E>15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	965	170
Original ERR/Sv	0.5957	0.7732
Adjustment Factors		
Age at exposure, Attained age	2.5536	2.4700
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0882	0.0738
Systematic errors in gamma doses[b]	1.0737	1.2620
Systematic errors in neutron doses[b]	1.0794	1.1310
Systematic errors in RBE neutron doses[b]	1.0961	0.9808
Model Mixture factor for transfer to US pop	0.6108	0.4277
Ratio of Japanese to U.S. baseline cancer rates	1.1488	1.1088
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	2	0.5
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.138	0.623
Probability of Causation (PC)	12.11	38.37

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5957	0.7732
ERR/Sv with adjustments		
w/ age adjustment	1.5211	1.9099
w/ latency adjustment	1.5211	1.9099
w/ random errors in dosimetry adj	1.6552	2.0509
w/ systematic errors in dosimetry adj	1.3030	1.4652
adjusted for population transfer	1.3784	1.5564
multiplicative risk model	1.3030	1.4652
additive risk model	1.4969	1.6246
adjusted for smoking history	1.3784	1.5564
adjusted for DDREF	0.6892	3.1128
Final ERR/Sv	0.6892	3.1128
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.138	0.623
Probability of Causation (PC)	12.11	38.37

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_p1_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E<30keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1169	1938
Original ERR/Sv	2.9781	3.6460
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0476	0.0596
Systematic errors in gamma doses[b]	1.0453	1.0848
Systematic errors in neutron doses[b]	1.0910	1.0775
Systematic errors in RBE neutron doses[b]	0.9730	0.9269
Model Mixture factor for transfer to US pop	0.2979	0.1708
Ratio of Japanese to U.S. baseline cancer rates	0.9277	0.9357
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	2.31869	6.56067

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	1.812	10.242
Probability of Causation (PC)	64.43	91.10

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.9781	3.6460
ERR/Sv with adjustments		
w/ age adjustment	2.9781	3.6460
w/ latency adjustment	2.9781	3.6460
w/ random errors in dosimetry adj	3.1198	3.8634
w/ systematic errors in dosimetry adj	2.8116	3.5658
adjusted for population transfer	2.6688	3.3758
multiplicative risk model	2.8116	3.5658
additive risk model	2.6082	3.3366
adjusted for smoking history	2.6688	3.3758
adjusted for DDREF	2.6688	3.3758
Final ERR/Sv	2.6688	3.3758
Organ equivalent dose (Sv)	0.463738	1.312134
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	1.812	10.241
Probability of Causation (PC)	64.43	91.10

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_p1_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E<30keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	194	1351
Original ERR/Sv	4.0856	3.5182
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0637	0.0469
Systematic errors in gamma doses[b]	1.0418	1.1737
Systematic errors in neutron doses[b]	1.2238	1.2482
Systematic errors in RBE neutron doses[b]	0.9571	1.0363
Model Mixture factor for transfer to US pop	0.5839	0.3287
Ratio of Japanese to U.S. baseline cancer rates	0.9174	1.0169
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1.76404	8.98501

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	1.213	4.409
Probability of Causation (PC)	54.82	81.51

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	4.0856	3.5182
ERR/Sv with adjustments		
w/ age adjustment	4.0856	3.5182
w/ latency adjustment	4.0856	3.5182
w/ random errors in dosimetry adj	4.3459	3.6831
w/ systematic errors in dosimetry adj	3.5615	2.4260
adjusted for population transfer	3.4391	2.4535
multiplicative risk model	3.5615	2.4260
additive risk model	3.2675	2.4670
adjusted for smoking history	3.4391	2.4535
adjusted for DDREF	3.4391	2.4535
Final ERR/Sv	3.4391	2.4535
Organ equivalent dose (Sv)	0.352808	1.797002
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	1.213	4.409
Probability of Causation (PC)	54.82	81.51

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_p1_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E<30keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	819	11
Original ERR/Sv	0.3887	1.3219
Adjustment Factors		
Age at exposure, Attained age	2.4669	2.6641
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0781	0.0767
Systematic errors in gamma doses[b]	1.1033	1.2804
Systematic errors in neutron doses[b]	1.1649	1.0432
Systematic errors in RBE neutron doses[b]	1.0168	0.9935
Model Mixture factor for transfer to US pop	0.3765	0.0553
Ratio of Japanese to U.S. baseline cancer rates	1.1739	1.0601
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	3.01924	4.27865

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.529	2.584
Probability of Causation (PC)	34.62	72.10

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.3887	1.3219
ERR/Sv with adjustments		
w/ age adjustment	0.9589	3.5216
w/ latency adjustment	0.9589	3.5216
w/ random errors in dosimetry adj	1.0339	3.7919
w/ systematic errors in dosimetry adj	0.7912	2.8575
adjusted for population transfer	0.8769	3.0198
multiplicative risk model	0.7912	2.8575
additive risk model	0.9287	3.0293
adjusted for smoking history	0.8769	3.0198
adjusted for DDREF	0.8769	3.0198
Final ERR/Sv	0.8769	3.0198
Organ equivalent dose (Sv)	0.603848	0.85573
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.530	2.584
Probability of Causation (PC)	34.62	72.10

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_p1_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E<30keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	652	1377
Original ERR/Sv	0.8167	0.8327
Adjustment Factors		
Age at exposure, Attained age	2.0983	2.8883
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0722	0.0703
Systematic errors in gamma doses[b]	1.1633	1.0857
Systematic errors in neutron doses[b]	1.1408	1.2234
Systematic errors in RBE neutron doses[b]	1.0234	1.0486
Model Mixture factor for transfer to US pop	0.2000	0.2792
Ratio of Japanese to U.S. baseline cancer rates	1.0550	1.1675
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	3	0.7
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	3.32002	3.77768

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.313	2.236
Probability of Causation (PC)	23.82	69.09

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.8167	0.8327
ERR/Sv with adjustments		
w/ age adjustment	1.7137	2.4051
w/ latency adjustment	1.7137	2.4051
w/ random errors in dosimetry adj	1.8374	2.5741
w/ systematic errors in dosimetry adj	1.3529	1.8481
adjusted for population transfer	1.4124	2.0712
multiplicative risk model	1.3529	1.8481
additive risk model	1.4273	2.1576
adjusted for smoking history	1.4124	2.0712
adjusted for DDREF	0.4708	2.9589
Final ERR/Sv	0.4708	2.9589
Organ equivalent dose (Sv)	0.664004	0.755536
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.313	2.236
Probability of Causation (PC)	23.82	69.09

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_p2_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E=30-250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1044	1611
Original ERR/Sv	4.5775	2.9268
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0695	0.0815
Systematic errors in gamma doses[b]	1.3013	1.0567
Systematic errors in neutron doses[b]	1.1558	1.1848
Systematic errors in RBE neutron doses[b]	0.9824	0.9876
Model Mixture factor for transfer to US pop	0.1813	0.8616
Ratio of Japanese to U.S. baseline cancer rates	0.8135	0.8954
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1.72976	6.01692

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	1.307	6.691
Probability of Causation (PC)	56.66	87.00

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	4.5775	2.9268
ERR/Sv with adjustments		
w/ age adjustment	4.5775	2.9268
w/ latency adjustment	4.5775	2.9268
w/ random errors in dosimetry adj	4.8956	3.1653
w/ systematic errors in dosimetry adj	3.3136	2.5603
adjusted for population transfer	2.8077	2.5232
multiplicative risk model	3.3136	2.5603
additive risk model	2.6957	2.2925
adjusted for smoking history	2.8077	2.5232
adjusted for DDREF	2.8077	2.5232
Final ERR/Sv	2.8077	2.5232
Organ equivalent dose (Sv)	0.345952	1.203384
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	1.307	6.690
Probability of Causation (PC)	56.66	87.00

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_p2_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E=30-250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	237	260
Original ERR/Sv	2.8315	4.2577
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0643	0.0636
Systematic errors in gamma doses[b]	1.2214	1.0534
Systematic errors in neutron doses[b]	1.0413	1.1018
Systematic errors in RBE neutron doses[b]	0.9613	0.9425
Model Mixture factor for transfer to US pop	0.4200	0.2803
Ratio of Japanese to U.S. baseline cancer rates	0.8450	0.9478
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	2.10433	4.20469

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.944	3.350
Probability of Causation (PC)	48.56	77.01

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.8315	4.2577
ERR/Sv with adjustments		
w/ age adjustment	2.8315	4.2577
w/ latency adjustment	2.8315	4.2577
w/ random errors in dosimetry adj	3.0136	4.5283
w/ systematic errors in dosimetry adj	2.4650	4.1397
adjusted for population transfer	2.2434	3.9842
multiplicative risk model	2.4650	4.1397
additive risk model	2.0829	3.9236
adjusted for smoking history	2.2434	3.9842
adjusted for DDREF	2.2434	3.9842
Final ERR/Sv	2.2434	3.9842
Organ equivalent dose (Sv)	0.420866	0.840938
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.944	3.350
Probability of Causation (PC)	48.56	77.01

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_p2_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E=30-250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1156	798
Original ERR/Sv	0.8940	0.6767
Adjustment Factors		
Age at exposure, Attained age	2.7928	3.0582
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1013	0.0956
Systematic errors in gamma doses[b]	1.2140	1.1105
Systematic errors in neutron doses[b]	1.1691	1.1341
Systematic errors in RBE neutron doses[b]	1.0110	0.9501
Model Mixture factor for transfer to US pop	0.4678	0.5927
Ratio of Japanese to U.S. baseline cancer rates	1.1351	1.1392
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	4.78512

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.411	1.916
Probability of Causation (PC)	29.12	65.71

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.8940	0.6767
ERR/Sv with adjustments		
w/ age adjustment	2.4966	2.0694
w/ latency adjustment	2.4966	2.0694
w/ random errors in dosimetry adj	2.7495	2.2672
w/ systematic errors in dosimetry adj	1.9162	1.8948
adjusted for population transfer	2.0539	2.0022
multiplicative risk model	1.9162	1.8948
additive risk model	2.1751	2.1586
adjusted for smoking history	2.0539	2.0022
adjusted for DDREF	2.0539	2.0022
Final ERR/Sv	2.0539	2.0022
Organ equivalent dose (Sv)	0.2	0.957024
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.411	1.916
Probability of Causation (PC)	29.12	65.71

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_p2_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E=30-250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	732	125
Original ERR/Sv	0.4447	1.0690
Adjustment Factors		
Age at exposure, Attained age	2.3892	3.1212
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0754	0.0787
Systematic errors in gamma doses[b]	1.0596	1.2258
Systematic errors in neutron doses[b]	1.2799	1.1103
Systematic errors in RBE neutron doses[b]	1.0272	0.9891
Model Mixture factor for transfer to US pop	0.1884	1.0301
Ratio of Japanese to U.S. baseline cancer rates	1.1271	1.1039
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	2	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	2.64536	3.17219

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.239	1.691
Probability of Causation (PC)	19.31	62.84

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4447	1.0690
ERR/Sv with adjustments		
w/ age adjustment	1.0625	3.3365
w/ latency adjustment	1.0625	3.3365
w/ random errors in dosimetry adj	1.1426	3.5989
w/ systematic errors in dosimetry adj	0.8203	2.6733
adjusted for population transfer	0.9049	2.6649
multiplicative risk model	0.8203	2.6733
additive risk model	0.9246	2.9511
adjusted for smoking history	0.9049	2.6649
adjusted for DDREF	0.4525	2.6649
Final ERR/Sv	0.4525	2.6649
Organ equivalent dose (Sv)	0.529072	0.634438
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.239	1.691
Probability of Causation (PC)	19.31	62.84

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_p3_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1077	1978
Original ERR/Sv	3.3058	5.0967
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0709	0.0352
Systematic errors in gamma doses[b]	1.1105	1.0251
Systematic errors in neutron doses[b]	1.1839	1.0784
Systematic errors in RBE neutron doses[b]	0.9956	0.9682
Model Mixture factor for transfer to US pop	0.2170	0.8836
Ratio of Japanese to U.S. baseline cancer rates	0.9630	0.8981
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.630	1.169
Probability of Causation (PC)	38.66	53.90

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	3.3058	5.0967
ERR/Sv with adjustments		
w/ age adjustment	3.3058	5.0967
w/ latency adjustment	3.3058	5.0967
w/ random errors in dosimetry adj	3.5400	5.2761
w/ systematic errors in dosimetry adj	2.7044	4.9299
adjusted for population transfer	2.6260	4.8714
multiplicative risk model	2.7044	4.9299
additive risk model	2.6043	4.4273
adjusted for smoking history	2.6260	4.8714
adjusted for DDREF	2.6260	4.8714
Final ERR/Sv	2.6260	4.8714
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	1	1

Final results calculated in Excel		
Excess relative risk (ERR)	0.630	1.169
Probability of Causation (PC)	38.66	53.90

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_p3_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	409	1978
Original ERR/Sv	3.3387	5.0967
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0371	0.0352
Systematic errors in gamma doses[b]	1.1373	1.0251
Systematic errors in neutron doses[b]	1.0313	1.0784
Systematic errors in RBE neutron doses[b]	1.0864	0.9682
Model Mixture factor for transfer to US pop	0.4211	0.8836
Ratio of Japanese to U.S. baseline cancer rates	0.9421	0.8981
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.525	0.974
Probability of Causation (PC)	34.44	49.35

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	3.3387	5.0967
ERR/Sv with adjustments		
w/ age adjustment	3.3387	5.0967
w/ latency adjustment	3.3387	5.0967
w/ random errors in dosimetry adj	3.4627	5.2761
w/ systematic errors in dosimetry adj	2.7175	4.9299
adjusted for population transfer	2.6263	4.8714
multiplicative risk model	2.7175	4.9299
additive risk model	2.5600	4.4273
adjusted for smoking history	2.6263	4.8714
adjusted for DDREF	2.6263	4.8714
Final ERR/Sv	2.6263	4.8714
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.525	0.974
Probability of Causation (PC)	34.44	49.35

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_p3_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	9	696
Original ERR/Sv	0.3770	1.0795
Adjustment Factors		
Age at exposure, Attained age	3.1638	3.0345
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0940	0.1031
Systematic errors in gamma doses[b]	1.0880	1.1456
Systematic errors in neutron doses[b]	1.1132	1.0861
Systematic errors in RBE neutron doses[b]	0.9508	1.0640
Model Mixture factor for transfer to US pop	0.9232	-0.0929
Ratio of Japanese to U.S. baseline cancer rates	1.1143	1.1538
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.229	0.638
Probability of Causation (PC)	18.61	38.93

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.3770	1.0795
ERR/Sv with adjustments		
w/ age adjustment	1.1927	3.2757
w/ latency adjustment	1.1927	3.2757
w/ random errors in dosimetry adj	1.3049	3.6133
w/ systematic errors in dosimetry adj	1.1331	2.7292
adjusted for population transfer	1.1430	3.1879
multiplicative risk model	1.1331	2.7292
additive risk model	1.2626	3.1489
adjusted for smoking history	1.1430	3.1879
adjusted for DDREF	1.1430	3.1879
Final ERR/Sv	1.1430	3.1879
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.229	0.638
Probability of Causation (PC)	18.61	38.93

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_p3_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	965	170
Original ERR/Sv	0.5957	0.7732
Adjustment Factors		
Age at exposure, Attained age	2.5536	2.4700
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0882	0.0738
Systematic errors in gamma doses[b]	1.0737	1.2620
Systematic errors in neutron doses[b]	1.0794	1.1310
Systematic errors in RBE neutron doses[b]	1.0961	0.9808
Model Mixture factor for transfer to US pop	0.6108	0.4277
Ratio of Japanese to U.S. baseline cancer rates	1.1488	1.1088
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	2	0.5
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.138	0.623
Probability of Causation (PC)	12.11	38.37

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5957	0.7732
ERR/Sv with adjustments		
w/ age adjustment	1.5211	1.9099
w/ latency adjustment	1.5211	1.9099
w/ random errors in dosimetry adj	1.6552	2.0509
w/ systematic errors in dosimetry adj	1.3030	1.4652
adjusted for population transfer	1.3784	1.5564
multiplicative risk model	1.3030	1.4652
additive risk model	1.4969	1.6246
adjusted for smoking history	1.3784	1.5564
adjusted for DDREF	0.6892	3.1128
Final ERR/Sv	0.6892	3.1128
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.138	0.623
Probability of Causation (PC)	12.11	38.37

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n1_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E<10keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1168	1863
Original ERR/Sv	2.9794	4.6321
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0492	0.0768
Systematic errors in gamma doses[b]	1.0505	1.3579
Systematic errors in neutron doses[b]	1.1730	1.0876
Systematic errors in RBE neutron doses[b]	0.9428	0.9552
Model Mixture factor for transfer to US pop	0.8297	0.7434
Ratio of Japanese to U.S. baseline cancer rates	0.9281	1.0099
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	2.6639	22.6404

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.283	3.210
Probability of Causation (PC)	22.07	76.25

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.9794	4.6321
ERR/Sv with adjustments		
w/ age adjustment	2.9794	4.6321
w/ latency adjustment	2.9794	4.6321
w/ random errors in dosimetry adj	3.1261	4.9878
w/ systematic errors in dosimetry adj	2.6907	3.5357
adjusted for population transfer	2.6577	3.5447
multiplicative risk model	2.6907	3.5357
additive risk model	2.4971	3.5707
adjusted for smoking history	2.6577	3.5447
adjusted for DDREF	2.6577	3.5447
Final ERR/Sv	2.6577	3.5447
Organ equivalent dose (Sv)	0.106556	0.905616
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.283	3.210
Probability of Causation (PC)	22.07	76.25

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n1_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E<10keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	893	1304
Original ERR/Sv	3.1962	4.2474
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0443	0.0535
Systematic errors in gamma doses[b]	1.1447	1.1349
Systematic errors in neutron doses[b]	1.1528	1.0862
Systematic errors in RBE neutron doses[b]	0.9818	1.0232
Model Mixture factor for transfer to US pop	0.0031	0.8253
Ratio of Japanese to U.S. baseline cancer rates	0.9136	0.8827
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	4.01062	37.3473

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.378	5.191
Probability of Causation (PC)	27.41	83.85

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	3.1962	4.2474
ERR/Sv with adjustments		
w/ age adjustment	3.1962	4.2474
w/ latency adjustment	3.1962	4.2474
w/ random errors in dosimetry adj	3.3377	4.4745
w/ systematic errors in dosimetry adj	2.5762	3.5474
adjusted for population transfer	2.3543	3.4748
multiplicative risk model	2.5762	3.5474
additive risk model	2.3536	3.1314
adjusted for smoking history	2.3543	3.4748
adjusted for DDREF	2.3543	3.4748
Final ERR/Sv	2.3543	3.4748
Organ equivalent dose (Sv)	0.160425	1.493892
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.378	5.191
Probability of Causation (PC)	27.41	83.85

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n1_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E<10keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	598	1860
Original ERR/Sv	0.5684	0.9772
Adjustment Factors		
Age at exposure, Attained age	2.8842	2.8812
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0609	0.0708
Systematic errors in gamma doses[b]	1.0084	1.1318
Systematic errors in neutron doses[b]	1.2024	1.1584
Systematic errors in RBE neutron doses[b]	1.0384	1.0082
Model Mixture factor for transfer to US pop	0.9023	0.1087
Ratio of Japanese to U.S. baseline cancer rates	1.0547	1.1275
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	1.57945	7.5624

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.088	0.768
Probability of Causation (PC)	8.07	43.45

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5684	0.9772
ERR/Sv with adjustments		
w/ age adjustment	1.6394	2.8154
w/ latency adjustment	1.6394	2.8154
w/ random errors in dosimetry adj	1.7393	3.0149
w/ systematic errors in dosimetry adj	1.3815	2.2808
adjusted for population transfer	1.3889	2.5399
multiplicative risk model	1.3815	2.2808
additive risk model	1.4570	2.5715
adjusted for smoking history	1.3889	2.5399
adjusted for DDREF	1.3889	2.5399
Final ERR/Sv	1.3889	2.5399
Organ equivalent dose (Sv)	0.063178	0.302496
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.088	0.768
Probability of Causation (PC)	8.07	43.45

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n1_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E<10keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1841	695
Original ERR/Sv	1.0539	1.4381
Adjustment Factors		
Age at exposure, Attained age	2.5868	2.4267
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1036	0.0711
Systematic errors in gamma doses[b]	1.1265	1.1203
Systematic errors in neutron doses[b]	1.1562	1.1700
Systematic errors in RBE neutron doses[b]	0.9531	1.0036
Model Mixture factor for transfer to US pop	0.7082	0.4442
Ratio of Japanese to U.S. baseline cancer rates	1.1403	1.1330
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	1.17055	10.5672

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.118	1.290
Probability of Causation (PC)	10.56	56.33

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.0539	1.4381
ERR/Sv with adjustments		
w/ age adjustment	2.7262	3.4898
w/ latency adjustment	2.7262	3.4898
w/ random errors in dosimetry adj	3.0087	3.7378
w/ systematic errors in dosimetry adj	2.4238	2.8414
adjusted for population transfer	2.5230	3.0515
multiplicative risk model	2.4238	2.8414
additive risk model	2.7637	3.2194
adjusted for smoking history	2.5230	3.0515
adjusted for DDREF	2.5230	3.0515
Final ERR/Sv	2.5230	3.0515
Organ equivalent dose (Sv)	0.046822	0.422688
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.118	1.290
Probability of Causation (PC)	10.56	56.33

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n2_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=10-100keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	622	593
Original ERR/Sv	2.6089	5.1231
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0398	0.0597
Systematic errors in gamma doses[b]	1.2127	1.1261
Systematic errors in neutron doses[b]	1.2244	1.0806
Systematic errors in RBE neutron doses[b]	0.9883	1.0099
Model Mixture factor for transfer to US pop	0.8413	0.6944
Ratio of Japanese to U.S. baseline cancer rates	0.8503	0.9341
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	7.833	26.344

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.283	2.281
Probability of Causation (PC)	22.04	69.52

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.6089	5.1231
ERR/Sv with adjustments		
w/ age adjustment	2.6089	5.1231
w/ latency adjustment	2.6089	5.1231
w/ random errors in dosimetry adj	2.7127	5.4290
w/ systematic errors in dosimetry adj	1.8484	4.4178
adjusted for population transfer	1.8045	4.3288
multiplicative risk model	1.8484	4.4178
additive risk model	1.5718	4.1267
adjusted for smoking history	1.8045	4.3288
adjusted for DDREF	1.8045	4.3288
Final ERR/Sv	1.8045	4.3288
Organ equivalent dose (Sv)	0.15666	0.52688
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.283	2.281
Probability of Causation (PC)	22.04	69.52

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n2_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=10-100keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	360	1240
Original ERR/Sv	4.2680	3.6240
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0551	0.0516
Systematic errors in gamma doses[b]	1.2367	1.0589
Systematic errors in neutron doses[b]	1.0740	1.0536
Systematic errors in RBE neutron doses[b]	1.0052	0.9136
Model Mixture factor for transfer to US pop	0.4348	0.6218
Ratio of Japanese to U.S. baseline cancer rates	0.8916	0.8410
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	5.849	54.564

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.370	3.835
Probability of Causation (PC)	27.03	79.32

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	4.2680	3.6240
ERR/Sv with adjustments		
w/ age adjustment	4.2680	3.6240
w/ latency adjustment	4.2680	3.6240
w/ random errors in dosimetry adj	4.5031	3.8109
w/ systematic errors in dosimetry adj	3.3728	3.7388
adjusted for population transfer	3.1661	3.5140
multiplicative risk model	3.3728	3.7388
additive risk model	3.0071	3.1445
adjusted for smoking history	3.1661	3.5140
adjusted for DDREF	3.1661	3.5140
Final ERR/Sv	3.1661	3.5140
Organ equivalent dose (Sv)	0.11698	1.09128
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.370	3.835
Probability of Causation (PC)	27.03	79.32

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n2_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=10-100keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1544	1522
Original ERR/Sv	0.4755	0.9747
Adjustment Factors		
Age at exposure, Attained age	2.2541	3.0469
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1047	0.0859
Systematic errors in gamma doses[b]	1.1994	1.0911
Systematic errors in neutron doses[b]	1.0822	1.0725
Systematic errors in RBE neutron doses[b]	1.0532	0.9942
Model Mixture factor for transfer to US pop	0.4497	0.2467
Ratio of Japanese to U.S. baseline cancer rates	1.1004	1.0967
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	4.6205	12.6988

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.084	0.755
Probability of Causation (PC)	7.79	43.03

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4755	0.9747
ERR/Sv with adjustments		
w/ age adjustment	1.0718	2.9697
w/ latency adjustment	1.0718	2.9697
w/ random errors in dosimetry adj	1.1839	3.2247
w/ systematic errors in dosimetry adj	0.8661	2.7719
adjusted for population transfer	0.9139	2.9737
multiplicative risk model	0.8661	2.7719
additive risk model	0.9530	3.0398
adjusted for smoking history	0.9139	2.9737
adjusted for DDREF	0.9139	2.9737
Final ERR/Sv	0.9139	2.9737
Organ equivalent dose (Sv)	0.09241	0.253976
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.084	0.755
Probability of Causation (PC)	7.79	43.03

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n2_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=10-100keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	836	1983
Original ERR/Sv	0.6472	0.6421
Adjustment Factors		
Age at exposure, Attained age	2.3423	2.2287
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1045	0.0785
Systematic errors in gamma doses[b]	1.0813	1.1324
Systematic errors in neutron doses[b]	1.0119	1.0973
Systematic errors in RBE neutron doses[b]	1.0015	1.0345
Model Mixture factor for transfer to US pop	0.0482	0.8187
Ratio of Japanese to U.S. baseline cancer rates	1.0916	1.1006
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	3.3185	45.2512

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.110	1.107
Probability of Causation (PC)	9.93	52.53

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6472	0.6421
ERR/Sv with adjustments		
w/ age adjustment	1.5159	1.4310
w/ latency adjustment	1.5159	1.4310
w/ random errors in dosimetry adj	1.6743	1.5433
w/ systematic errors in dosimetry adj	1.5278	1.2006
adjusted for population transfer	1.6611	1.2225
multiplicative risk model	1.5278	1.2006
additive risk model	1.6678	1.3215
adjusted for smoking history	1.6611	1.2225
adjusted for DDREF	1.6611	1.2225
Final ERR/Sv	1.6611	1.2225
Organ equivalent dose (Sv)	0.06637	0.905024
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.110	1.106
Probability of Causation (PC)	9.93	52.53

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n3_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=100keV-2MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	544	338
Original ERR/Sv	3.7446	4.7970
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0587	0.0495
Systematic errors in gamma doses[b]	1.1399	1.2731
Systematic errors in neutron doses[b]	1.1989	1.0970
Systematic errors in RBE neutron doses[b]	1.0023	0.9664
Model Mixture factor for transfer to US pop	0.8792	0.5602
Ratio of Japanese to U.S. baseline cancer rates	0.8427	0.9557
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	9.73919	64.6956

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.277	2.366
Probability of Causation (PC)	21.66	70.29

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	3.7446	4.7970
ERR/Sv with adjustments		
w/ age adjustment	3.7446	4.7970
w/ latency adjustment	3.7446	4.7970
w/ random errors in dosimetry adj	3.9645	5.0346
w/ systematic errors in dosimetry adj	2.8944	3.7301
adjusted for population transfer	2.8394	3.6574
multiplicative risk model	2.8944	3.7301
additive risk model	2.4391	3.5649
adjusted for smoking history	2.8394	3.6574
adjusted for DDREF	2.8394	3.6574
Final ERR/Sv	2.8394	3.6574
Organ equivalent dose (Sv)	0.097392	0.646956
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.277	2.366
Probability of Causation (PC)	21.66	70.29

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n3_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=100keV-2MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1415	777
Original ERR/Sv	5.0816	3.6332
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0562	0.0554
Systematic errors in gamma doses[b]	1.0425	1.0906
Systematic errors in neutron doses[b]	1.1652	1.1231
Systematic errors in RBE neutron doses[b]	0.9861	0.9829
Model Mixture factor for transfer to US pop	0.6224	0.6092
Ratio of Japanese to U.S. baseline cancer rates	0.9760	0.9136
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	8.48347	116.022

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.377	3.571
Probability of Causation (PC)	27.36	78.12

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	5.0816	3.6332
ERR/Sv with adjustments		
w/ age adjustment	5.0816	3.6332
w/ latency adjustment	5.0816	3.6332
w/ random errors in dosimetry adj	5.3674	3.8344
w/ systematic errors in dosimetry adj	4.4806	3.1849
adjusted for population transfer	4.4400	3.0774
multiplicative risk model	4.4806	3.1849
additive risk model	4.3732	2.9097
adjusted for smoking history	4.4400	3.0774
adjusted for DDREF	4.4400	3.0774
Final ERR/Sv	4.4400	3.0774
Organ equivalent dose (Sv)	0.084835	1.16022
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.377	3.570
Probability of Causation (PC)	27.36	78.12

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n3_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=100keV-2MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	84	1942
Original ERR/Sv	0.3028	0.7333
Adjustment Factors		
Age at exposure, Attained age	2.2976	3.4879
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0788	0.0840
Systematic errors in gamma doses[b]	1.1116	1.2736
Systematic errors in neutron doses[b]	1.1072	1.2174
Systematic errors in RBE neutron doses[b]	0.9297	1.0778
Model Mixture factor for transfer to US pop	0.0591	-0.0184
Ratio of Japanese to U.S. baseline cancer rates	1.1250	1.0689
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	11.5544	31.4083

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.085	0.558
Probability of Causation (PC)	7.81	35.80

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.3028	0.7333
ERR/Sv with adjustments		
w/ age adjustment	0.6956	2.5576
w/ latency adjustment	0.6956	2.5576
w/ random errors in dosimetry adj	0.7504	2.7724
w/ systematic errors in dosimetry adj	0.6557	1.6592
adjusted for population transfer	0.7329	1.7757
multiplicative risk model	0.6557	1.6592
additive risk model	0.7377	1.7735
adjusted for smoking history	0.7329	1.7757
adjusted for DDREF	0.7329	1.7757
Final ERR/Sv	0.7329	1.7757
Organ equivalent dose (Sv)	0.115544	0.314083
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.085	0.558
Probability of Causation (PC)	7.81	35.80

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n3_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=100keV-2MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1342	1677
Original ERR/Sv	0.5755	0.5693
Adjustment Factors		
Age at exposure, Attained age	2.8218	2.5114
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0822	0.0640
Systematic errors in gamma doses[b]	1.0515	1.3633
Systematic errors in neutron doses[b]	1.1182	1.1657
Systematic errors in RBE neutron doses[b]	0.9619	0.9583
Model Mixture factor for transfer to US pop	1.0013	0.6983
Ratio of Japanese to U.S. baseline cancer rates	1.0458	1.1528
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	7.20048	84.3799

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.112	0.882
Probability of Causation (PC)	10.06	46.86

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5755	0.5693
ERR/Sv with adjustments		
w/ age adjustment	1.6240	1.4298
w/ latency adjustment	1.6240	1.4298
w/ random errors in dosimetry adj	1.7574	1.5213
w/ systematic errors in dosimetry adj	1.5538	0.9990
adjusted for population transfer	1.5537	1.0450
multiplicative risk model	1.5538	0.9990
additive risk model	1.6249	1.1516
adjusted for smoking history	1.5537	1.0450
adjusted for DDREF	1.5537	1.0450
Final ERR/Sv	1.5537	1.0450
Organ equivalent dose (Sv)	0.072005	0.843799
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.112	0.882
Probability of Causation (PC)	10.06	46.86

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n4_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=2-20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1330	848
Original ERR/Sv	3.9286	3.7270
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0607	0.0814
Systematic errors in gamma doses[b]	1.0105	1.0466
Systematic errors in neutron doses[b]	1.1462	1.1090
Systematic errors in RBE neutron doses[b]	1.0447	1.0196
Model Mixture factor for transfer to US pop	0.9997	0.6125
Ratio of Japanese to U.S. baseline cancer rates	0.8063	0.9474
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	4.117	39.672

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.284	2.647
Probability of Causation (PC)	22.09	72.58

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	3.9286	3.7270
ERR/Sv with adjustments		
w/ age adjustment	3.9286	3.7270
w/ latency adjustment	3.9286	3.7270
w/ random errors in dosimetry adj	4.1670	4.0302
w/ systematic errors in dosimetry adj	3.4437	3.4055
adjusted for population transfer	3.4435	3.3361
multiplicative risk model	3.4437	3.4055
additive risk model	2.7767	3.2263
adjusted for smoking history	3.4435	3.3361
adjusted for DDREF	3.4435	3.3361
Final ERR/Sv	3.4435	3.3361
Organ equivalent dose (Sv)	0.08234	0.79344
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.284	2.647
Probability of Causation (PC)	22.09	72.58

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n4_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=2-20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1352	212
Original ERR/Sv	4.1628	2.4097
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0520	0.0519
Systematic errors in gamma doses[b]	1.3059	1.0644
Systematic errors in neutron doses[b]	1.2961	1.0915
Systematic errors in RBE neutron doses[b]	0.9392	1.0587
Model Mixture factor for transfer to US pop	0.3534	0.5250
Ratio of Japanese to U.S. baseline cancer rates	0.9087	0.8805
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	7.1775	105

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.372	4.082
Probability of Causation (PC)	27.12	80.32

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	4.1628	2.4097
ERR/Sv with adjustments		
w/ age adjustment	4.1628	2.4097
w/ latency adjustment	4.1628	2.4097
w/ random errors in dosimetry adj	4.3792	2.5347
w/ systematic errors in dosimetry adj	2.7547	2.0608
adjusted for population transfer	2.5922	1.9438
multiplicative risk model	2.7547	2.0608
additive risk model	2.5033	1.8146
adjusted for smoking history	2.5922	1.9438
adjusted for DDREF	2.5922	1.9438
Final ERR/Sv	2.5922	1.9438
Organ equivalent dose (Sv)	0.14355	2.1
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.372	4.082
Probability of Causation (PC)	27.12	80.32

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n4_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=2-20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1393	1859
Original ERR/Sv	1.3824	0.6075
Adjustment Factors		
Age at exposure, Attained age	3.0109	3.3570
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0782	0.0662
Systematic errors in gamma doses[b]	1.2436	1.0871
Systematic errors in neutron doses[b]	1.2485	1.2190
Systematic errors in RBE neutron doses[b]	0.9614	0.9553
Model Mixture factor for transfer to US pop	0.5701	0.2671
Ratio of Japanese to U.S. baseline cancer rates	1.1490	1.0708
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	1.3075	19.3287

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.084	0.698
Probability of Causation (PC)	7.72	41.12

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.3824	0.6075
ERR/Sv with adjustments		
w/ age adjustment	4.1621	2.0393
w/ latency adjustment	4.1621	2.0393
w/ random errors in dosimetry adj	4.4875	2.1742
w/ systematic errors in dosimetry adj	3.0064	1.7174
adjusted for population transfer	3.1990	1.8065
multiplicative risk model	3.0064	1.7174
additive risk model	3.4545	1.8390
adjusted for smoking history	3.1990	1.8065
adjusted for DDREF	3.1990	1.8065
Final ERR/Sv	3.1990	1.8065
Organ equivalent dose (Sv)	0.02615	0.386574
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.084	0.698
Probability of Causation (PC)	7.72	41.12

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n4_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=2-20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	499	1616
Original ERR/Sv	1.0031	0.5636
Adjustment Factors		
Age at exposure, Attained age	2.0506	2.1769
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0876	0.0979
Systematic errors in gamma doses[b]	1.2327	1.1245
Systematic errors in neutron doses[b]	1.0945	1.1433
Systematic errors in RBE neutron doses[b]	1.0042	1.0494
Model Mixture factor for transfer to US pop	0.5091	0.0993
Ratio of Japanese to U.S. baseline cancer rates	1.1264	1.1090
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	3.0885	48.6938

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.108	1.068
Probability of Causation (PC)	9.77	51.64

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.0031	0.5636
ERR/Sv with adjustments		
w/ age adjustment	2.0570	1.2268
w/ latency adjustment	2.0570	1.2268
w/ random errors in dosimetry adj	2.2372	1.3469
w/ systematic errors in dosimetry adj	1.6512	0.9985
adjusted for population transfer	1.7537	1.0965
multiplicative risk model	1.6512	0.9985
additive risk model	1.8600	1.1073
adjusted for smoking history	1.7537	1.0965
adjusted for DDREF	1.7537	1.0965
Final ERR/Sv	1.7537	1.0965
Organ equivalent dose (Sv)	0.06177	0.973876
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.108	1.068
Probability of Causation (PC)	9.77	51.64

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n5_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E>20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	370	856
Original ERR/Sv	2.8287	3.9754
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0543	0.0410
Systematic errors in gamma doses[b]	1.1338	1.1938
Systematic errors in neutron doses[b]	1.0611	1.1015
Systematic errors in RBE neutron doses[b]	0.9953	0.9459
Model Mixture factor for transfer to US pop	1.0089	0.4552
Ratio of Japanese to U.S. baseline cancer rates	0.9016	1.0162
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	2.9003	21.8771

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.289	2.937
Probability of Causation (PC)	22.43	74.60

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.8287	3.9754
ERR/Sv with adjustments		
w/ age adjustment	2.8287	3.9754
w/ latency adjustment	2.8287	3.9754
w/ random errors in dosimetry adj	2.9822	4.1385
w/ systematic errors in dosimetry adj	2.4908	3.3272
adjusted for population transfer	2.4930	3.3567
multiplicative risk model	2.4908	3.3272
additive risk model	2.2458	3.3812
adjusted for smoking history	2.4930	3.3567
adjusted for DDREF	2.4930	3.3567
Final ERR/Sv	2.4930	3.3567
Organ equivalent dose (Sv)	0.116012	0.875084
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.289	2.937
Probability of Causation (PC)	22.43	74.60

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n5_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E>20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1009	579
Original ERR/Sv	4.8044	2.8521
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0584	0.0438
Systematic errors in gamma doses[b]	1.1298	1.0203
Systematic errors in neutron doses[b]	1.2266	1.1806
Systematic errors in RBE neutron doses[b]	0.9622	0.9353
Model Mixture factor for transfer to US pop	0.5927	0.2264
Ratio of Japanese to U.S. baseline cancer rates	0.9283	0.8916
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	2.5301	49.4733

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.375	4.792
Probability of Causation (PC)	27.26	82.73

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	4.8044	2.8521
ERR/Sv with adjustments		
w/ age adjustment	4.8044	2.8521
w/ latency adjustment	4.8044	2.8521
w/ random errors in dosimetry adj	5.0851	2.9771
w/ systematic errors in dosimetry adj	3.8135	2.6428
adjusted for population transfer	3.7022	2.4211
multiplicative risk model	3.8135	2.6428
additive risk model	3.5402	2.3563
adjusted for smoking history	3.7022	2.4211
adjusted for DDREF	3.7022	2.4211
Final ERR/Sv	3.7022	2.4211
Organ equivalent dose (Sv)	0.101204	1.978932
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.375	4.791
Probability of Causation (PC)	27.26	82.73

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n5_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E>20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	351	724
Original ERR/Sv	0.5076	0.6082
Adjustment Factors		
Age at exposure, Attained age	2.2086	3.2598
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0830	0.1079
Systematic errors in gamma doses[b]	1.1474	1.2603
Systematic errors in neutron doses[b]	1.0988	1.1178
Systematic errors in RBE neutron doses[b]	0.9136	0.9834
Model Mixture factor for transfer to US pop	0.3820	0.1950
Ratio of Japanese to U.S. baseline cancer rates	1.1041	1.0805
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	2.0186	11.676

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.091	0.788
Probability of Causation (PC)	8.31	44.09

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5076	0.6082
ERR/Sv with adjustments		
w/ age adjustment	1.1211	1.9825
w/ latency adjustment	1.1211	1.9825
w/ random errors in dosimetry adj	1.2141	2.1964
w/ systematic errors in dosimetry adj	1.0540	1.5854
adjusted for population transfer	1.1219	1.6882
multiplicative risk model	1.0540	1.5854
additive risk model	1.1638	1.7131
adjusted for smoking history	1.1219	1.6882
adjusted for DDREF	1.1219	1.6882
Final ERR/Sv	1.1219	1.6882
Organ equivalent dose (Sv)	0.080744	0.46704
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.091	0.788
Probability of Causation (PC)	8.31	44.09

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n5_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E>20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	432	1507
Original ERR/Sv	0.4875	0.5911
Adjustment Factors		
Age at exposure, Attained age	2.2446	2.3776
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0942	0.0824
Systematic errors in gamma doses[b]	1.0921	1.0788
Systematic errors in neutron doses[b]	1.1829	1.1847
Systematic errors in RBE neutron doses[b]	0.9534	0.9811
Model Mixture factor for transfer to US pop	0.7527	0.8814
Ratio of Japanese to U.S. baseline cancer rates	1.1555	1.1216
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	2.9871	23.148

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.121	1.140
Probability of Causation (PC)	10.76	53.26

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4875	0.5911
ERR/Sv with adjustments		
w/ age adjustment	1.0942	1.4054
w/ latency adjustment	1.0942	1.4054
w/ random errors in dosimetry adj	1.1973	1.5212
w/ systematic errors in dosimetry adj	0.9721	1.2132
adjusted for population transfer	1.0094	1.2307
multiplicative risk model	0.9721	1.2132
additive risk model	1.1232	1.3608
adjusted for smoking history	1.0094	1.2307
adjusted for DDREF	1.0094	1.2307
Final ERR/Sv	1.0094	1.2307
Organ equivalent dose (Sv)	0.119484	0.92592
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.121	1.140
Probability of Causation (PC)	10.76	53.26

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n6_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons (fission)

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1962	392
Original ERR/Sv	3.7716	3.7433
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0475	0.0399
Systematic errors in gamma doses[b]	1.1686	1.0834
Systematic errors in neutron doses[b]	1.1274	1.0940
Systematic errors in RBE neutron doses[b]	0.9343	0.9412
Model Mixture factor for transfer to US pop	0.0729	0.6906
Ratio of Japanese to U.S. baseline cancer rates	0.9703	0.8852
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	9.0345	66.4965

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.282	2.238
Probability of Causation (PC)	22.00	69.12

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	3.7716	3.7433
ERR/Sv with adjustments		
w/ age adjustment	3.7716	3.7433
w/ latency adjustment	3.7716	3.7433
w/ random errors in dosimetry adj	3.9509	3.8927
w/ systematic errors in dosimetry adj	3.2099	3.4896
adjusted for population transfer	3.1214	3.3657
multiplicative risk model	3.2099	3.4896
additive risk model	3.1145	3.0890
adjusted for smoking history	3.1214	3.3657
adjusted for DDREF	3.1214	3.3657
Final ERR/Sv	3.1214	3.3657
Organ equivalent dose (Sv)	0.090345	0.664965
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.282	2.238
Probability of Causation (PC)	22.00	69.12

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n6_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons (fission)

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	397	1634
Original ERR/Sv	3.0166	3.4252
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0601	0.0904
Systematic errors in gamma doses[b]	1.0692	1.2198
Systematic errors in neutron doses[b]	1.1698	1.2133
Systematic errors in RBE neutron doses[b]	0.9271	0.9175
Model Mixture factor for transfer to US pop	0.0383	0.3798
Ratio of Japanese to U.S. baseline cancer rates	0.8795	0.9022
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	15.4292	137.73

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.376	3.559
Probability of Causation (PC)	27.34	78.06

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	3.0166	3.4252
ERR/Sv with adjustments		
w/ age adjustment	3.0166	3.4252
w/ latency adjustment	3.0166	3.4252
w/ random errors in dosimetry adj	3.1978	3.7349
w/ systematic errors in dosimetry adj	2.7578	2.7507
adjusted for population transfer	2.4383	2.5839
multiplicative risk model	2.7578	2.7507
additive risk model	2.4256	2.4818
adjusted for smoking history	2.4383	2.5839
adjusted for DDREF	2.4383	2.5839
Final ERR/Sv	2.4383	2.5839
Organ equivalent dose (Sv)	0.154292	1.3773
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.376	3.559
Probability of Causation (PC)	27.34	78.06

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n6_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons (fission)

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	489	373
Original ERR/Sv	0.5552	0.6401
Adjustment Factors		
Age at exposure, Attained age	1.7826	3.4286
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0622	0.1128
Systematic errors in gamma doses[b]	1.1836	1.1025
Systematic errors in neutron doses[b]	1.2389	1.1238
Systematic errors in RBE neutron doses[b]	1.0387	0.9770
Model Mixture factor for transfer to US pop	0.0361	0.5190
Ratio of Japanese to U.S. baseline cancer rates	1.1376	1.1051
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	10.5991	27.15

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.083	0.575
Probability of Causation (PC)	7.65	36.53

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5552	0.6401
ERR/Sv with adjustments		
w/ age adjustment	0.9898	2.1947
w/ latency adjustment	0.9898	2.1947
w/ random errors in dosimetry adj	1.0513	2.4423
w/ systematic errors in dosimetry adj	0.6902	2.0176
adjusted for population transfer	0.7818	2.1196
multiplicative risk model	0.6902	2.0176
additive risk model	0.7852	2.2297
adjusted for smoking history	0.7818	2.1196
adjusted for DDREF	0.7818	2.1196
Final ERR/Sv	0.7818	2.1196
Organ equivalent dose (Sv)	0.105991	0.2715
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.083	0.575
Probability of Causation (PC)	7.65	36.53

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_n6_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons (fission)

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	350	1056
Original ERR/Sv	0.4610	1.2579
Adjustment Factors		
Age at exposure, Attained age	2.8914	1.9648
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0721	0.1035
Systematic errors in gamma doses[b]	1.0859	1.0797
Systematic errors in neutron doses[b]	1.2557	1.0394
Systematic errors in RBE neutron doses[b]	0.9551	1.0406
Model Mixture factor for transfer to US pop	0.5228	0.8622
Ratio of Japanese to U.S. baseline cancer rates	1.0910	1.0618
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	9.49538	36.6631

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.109	0.864
Probability of Causation (PC)	9.81	46.34

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4610	1.2579
ERR/Sv with adjustments		
w/ age adjustment	1.3328	2.4715
w/ latency adjustment	1.3328	2.4715
w/ random errors in dosimetry adj	1.4289	2.7272
w/ systematic errors in dosimetry adj	1.0973	2.3353
adjusted for population transfer	1.1449	2.3552
multiplicative risk model	1.0973	2.3353
additive risk model	1.1971	2.4796
adjusted for smoking history	1.1449	2.3552
adjusted for DDREF	1.1449	2.3552
Final ERR/Sv	1.1449	2.3552
Organ equivalent dose (Sv)	0.094954	0.366631
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.109	0.863
Probability of Causation (PC)	9.81	46.34

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_a_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	alpha

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	436	1016
Original ERR/Sv	3.0031	4.6532
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0685	0.0664
Systematic errors in gamma doses[b]	1.2503	1.3301
Systematic errors in neutron doses[b]	1.1177	1.1065
Systematic errors in RBE neutron doses[b]	1.0324	0.9486
Model Mixture factor for transfer to US pop	0.1153	0.6015
Ratio of Japanese to U.S. baseline cancer rates	0.7859	0.7885
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	5.86772	55.7569

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.106	1.815
Probability of Causation (PC)	9.57	64.47

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	3.0031	4.6532
ERR/Sv with adjustments		
w/ age adjustment	3.0031	4.6532
w/ latency adjustment	3.0031	4.6532
w/ random errors in dosimetry adj	3.2088	4.9620
w/ systematic errors in dosimetry adj	2.2242	3.5540
adjusted for population transfer	1.8028	3.2544
multiplicative risk model	2.2242	3.5540
additive risk model	1.7479	2.8022
adjusted for smoking history	1.8028	3.2544
adjusted for DDREF	1.8028	3.2544
Final ERR/Sv	1.8028	3.2544
Organ equivalent dose (Sv)	0.058677	0.557569
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.106	1.815
Probability of Causation (PC)	9.57	64.47

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_a_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Leukemia
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	alpha

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	436	1016
Original ERR/Sv	3.0031	4.6532
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0685	0.0664
Systematic errors in gamma doses[b]	1.2503	1.3301
Systematic errors in neutron doses[b]	1.1177	1.1065
Systematic errors in RBE neutron doses[b]	1.0324	0.9486
Model Mixture factor for transfer to US pop	0.1153	0.6015
Ratio of Japanese to U.S. baseline cancer rates	0.7859	0.7885
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	5.86772	55.7569

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.106	1.815
Probability of Causation (PC)	9.57	64.47

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	3.0031	4.6532
ERR/Sv with adjustments		
w/ age adjustment	3.0031	4.6532
w/ latency adjustment	3.0031	4.6532
w/ random errors in dosimetry adj	3.2088	4.9620
w/ systematic errors in dosimetry adj	2.2242	3.5540
adjusted for population transfer	1.8028	3.2544
multiplicative risk model	2.2242	3.5540
additive risk model	1.7479	2.8022
adjusted for smoking history	1.8028	3.2544
adjusted for DDREF	1.8028	3.2544
Final ERR/Sv	1.8028	3.2544
Organ equivalent dose (Sv)	0.058677	0.557569
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.106	1.815
Probability of Causation (PC)	9.57	64.47

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_a_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	alpha

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1340	1578
Original ERR/Sv	0.6137	0.1953
Adjustment Factors		
Age at exposure, Attained age	2.8105	2.3685
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0749	0.0894
Systematic errors in gamma doses[b]	1.2032	1.1181
Systematic errors in neutron doses[b]	1.1500	1.2571
Systematic errors in RBE neutron doses[b]	0.9499	1.0063
Model Mixture factor for transfer to US pop	1.0248	0.7791
Ratio of Japanese to U.S. baseline cancer rates	1.1054	1.1194
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	3	0.7
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	25.8258	285.559

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.121	1.492
Probability of Causation (PC)	10.80	59.86

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6137	0.1953
ERR/Sv with adjustments		
w/ age adjustment	1.7248	0.4625
w/ latency adjustment	1.7248	0.4625
w/ random errors in dosimetry adj	1.8541	0.5039
w/ systematic errors in dosimetry adj	1.4108	0.3562
adjusted for population transfer	1.4071	0.3656
multiplicative risk model	1.4108	0.3562
additive risk model	1.5595	0.3988
adjusted for smoking history	1.4071	0.3656
adjusted for DDREF	0.4690	0.5223
Final ERR/Sv	0.4690	0.5223
Organ equivalent dose (Sv)	0.258258	2.85559
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.121	1.492
Probability of Causation (PC)	10.80	59.86

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**REF_a_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	alpha

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1340	1578
Original ERR/Sv	0.6137	0.1953
Adjustment Factors		
Age at exposure, Attained age	2.8105	2.3685
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0749	0.0894
Systematic errors in gamma doses[b]	1.2032	1.1181
Systematic errors in neutron doses[b]	1.1500	1.2571
Systematic errors in RBE neutron doses[b]	0.9499	1.0063
Model Mixture factor for transfer to US pop	1.0248	0.7791
Ratio of Japanese to U.S. baseline cancer rates	1.1054	1.1194
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	3	0.7
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	25.8258	285.559

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.121	1.492
Probability of Causation (PC)	10.80	59.86

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6137	0.1953
ERR/Sv with adjustments		
w/ age adjustment	1.7248	0.4625
w/ latency adjustment	1.7248	0.4625
w/ random errors in dosimetry adj	1.8541	0.5039
w/ systematic errors in dosimetry adj	1.4108	0.3562
adjusted for population transfer	1.4071	0.3656
multiplicative risk model	1.4108	0.3562
additive risk model	1.5595	0.3988
adjusted for smoking history	1.4071	0.3656
adjusted for DDREF	0.4690	0.5223
Final ERR/Sv	0.4690	0.5223
Organ equivalent dose (Sv)	0.258258	2.85559
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.121	1.492
Probability of Causation (PC)	10.80	59.86

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Appendix E

Verification of the Implementation of the DDREF for Low Dose and High Dose Acute and Chronic Exposures

The calculations documented in this appendix were performed to verify that the dose and dose rate effectiveness factor (DDREF) has been implemented correctly. A total of 132 calculations was performed for this specific verification task.

To test all possible applications of DDREF, a series of calculations has been performed for chronic and acute exposures to each radiation type, assuming doses of 5 cSv and 30 cSv. Separate verification calculations were performed for thyroid cancer, breast cancer, and colon cancer (colon cancer was selected to represent solid tumors other than breast and thyroid), because DDREF is different for each of these cancer groupings. The age at exposure (AAE) was kept constant at 20 years of age, and the age at diagnosis (attained age, ATA) was kept constant at 40 years of age. Because the DDREF is independent of gender, males were used for thyroid and colon cancer calculations; however females were used for breast cancer calculations.

Further details about this verification task can be found in Section 5.4 of the report. The results for ERR and PC obtained with MS Excel verify the mid and upper bound values of ERR and PC estimated using NIOSH-IREP v.5.5.3r, for all exposure scenarios considered.

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Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e1_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	electrons E<15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	129	1391
Original ERR/Sv	2.3208	16.2426
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1220	0.1065
Systematic errors in gamma doses[b]	1.1863	1.1565
Systematic errors in neutron doses[b]	1.1265	1.0677
Systematic errors in RBE neutron doses[b]	0.9612	0.9794
Model Mixture factor for transfer to US pop	0.4876	0.0245
Ratio of Japanese to U.S. baseline cancer rates	1.0796	0.8537
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1.00377	1.00505
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1.86856	2.28727

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.216	1.848
Probability of Causation (PC)	17.76	64.89

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.3208	16.2426
ERR/Sv with adjustments		
w/ age adjustment	2.3208	16.2426
w/ latency adjustment	2.3208	16.2426
w/ random errors in dosimetry adj	2.3208	16.2426
w/ systematic errors in dosimetry adj	2.3208	16.2426
adjusted for population transfer	2.3208	16.2426
multiplicative risk model	2.3208	16.2426
additive risk model	2.5056	13.8656
adjusted for smoking history	2.3208	16.2426
adjusted for DDREF	2.3121	16.1610
Final ERR/Sv	2.3121	16.1610
Organ equivalent dose (Sv)	0.093428	0.114364
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.216	1.848
Probability of Causation (PC)	17.76	64.89

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e1_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	electrons E<15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	653	518
Original ERR/Sv	1.4938	13.4257
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1201	0.0751
Systematic errors in gamma doses[b]	1.1795	1.2005
Systematic errors in neutron doses[b]	1.1274	1.1817
Systematic errors in RBE neutron doses[b]	1.0274	0.9702
Model Mixture factor for transfer to US pop	0.7764	0.0823
Ratio of Japanese to U.S. baseline cancer rates	0.9425	0.9138
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	2.91823	2.76582

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	1.308	11.140
Probability of Causation (PC)	56.67	91.76

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.4938	13.4257
ERR/Sv with adjustments		
w/ age adjustment	1.4938	13.4257
w/ latency adjustment	1.4938	13.4257
w/ random errors in dosimetry adj	1.4938	13.4257
w/ systematic errors in dosimetry adj	1.4938	13.4257
adjusted for population transfer	1.4938	13.4257
multiplicative risk model	1.4938	13.4257
additive risk model	1.4079	12.2687
adjusted for smoking history	1.4938	13.4257
adjusted for DDREF	1.4938	13.4257
Final ERR/Sv	1.4938	13.4257
Organ equivalent dose (Sv)	0.875469	0.829746
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	1.308	11.140
Probability of Causation (PC)	56.67	91.76

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e1_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	electrons E<15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1531	1549
Original ERR/Sv	3.2512	14.5269
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0879	0.0751
Systematic errors in gamma doses[b]	1.1607	1.1460
Systematic errors in neutron doses[b]	1.1767	1.0969
Systematic errors in RBE neutron doses[b]	1.0663	0.9483
Model Mixture factor for transfer to US pop	1.0126	0.0823
Ratio of Japanese to U.S. baseline cancer rates	0.9593	0.8413
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	2	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1.82871	2.15662

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.149	1.566
Probability of Causation (PC)	12.94	61.04

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	3.2512	14.5269
ERR/Sv with adjustments		
w/ age adjustment	3.2512	14.5269
w/ latency adjustment	3.2512	14.5269
w/ random errors in dosimetry adj	3.2512	14.5269
w/ systematic errors in dosimetry adj	3.2512	14.5269
adjusted for population transfer	3.2512	14.5269
multiplicative risk model	3.2512	14.5269
additive risk model	3.1188	12.2208
adjusted for smoking history	3.2512	14.5269
adjusted for DDREF	1.6256	14.5269
Final ERR/Sv	1.6256	14.5269
Organ equivalent dose (Sv)	0.091436	0.107831
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.149	1.566
Probability of Causation (PC)	12.94	61.04

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e1_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	electrons E<15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1531	1549
Original ERR/Sv	3.2512	14.5269
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0879	0.0751
Systematic errors in gamma doses[b]	1.1607	1.1460
Systematic errors in neutron doses[b]	1.1767	1.0969
Systematic errors in RBE neutron doses[b]	1.0663	0.9483
Model Mixture factor for transfer to US pop	1.0126	0.0823
Ratio of Japanese to U.S. baseline cancer rates	0.9593	0.8413
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	2	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1.82871	2.15662

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.892	9.399
Probability of Causation (PC)	47.14	90.38

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	3.2512	14.5269
ERR/Sv with adjustments		
w/ age adjustment	3.2512	14.5269
w/ latency adjustment	3.2512	14.5269
w/ random errors in dosimetry adj	3.2512	14.5269
w/ systematic errors in dosimetry adj	3.2512	14.5269
adjusted for population transfer	3.2512	14.5269
multiplicative risk model	3.2512	14.5269
additive risk model	3.1188	12.2208
adjusted for smoking history	3.2512	14.5269
adjusted for DDREF	1.6256	14.5269
Final ERR/Sv	1.6256	14.5269
Organ equivalent dose (Sv)	0.548613	0.646986
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.892	9.399
Probability of Causation (PC)	47.14	90.38

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e1_5**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	electrons E<15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	149	742
Original ERR/Sv	0.5761	1.5568
Adjustment Factors		
Age at exposure, Attained age	2.5804	3.0225
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0978	0.0793
Systematic errors in gamma doses[b]	1.1692	1.1807
Systematic errors in neutron doses[b]	1.1334	1.0411
Systematic errors in RBE neutron doses[b]	1.0507	0.9463
Model Mixture factor for transfer to US pop	0.9980	0.5217
Ratio of Japanese to U.S. baseline cancer rates	1.1122	1.1039
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	2.30753	2.41056

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.135	0.552
Probability of Causation (PC)	11.92	35.58

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5761	1.5568
ERR/Sv with adjustments		
w/ age adjustment	1.4867	4.7055
w/ latency adjustment	1.4867	4.7055
w/ random errors in dosimetry adj	1.6321	5.0786
w/ systematic errors in dosimetry adj	1.1722	4.3660
adjusted for population transfer	1.1725	4.5830
multiplicative risk model	1.1722	4.3660
additive risk model	1.3038	4.8198
adjusted for smoking history	1.1725	4.5830
adjusted for DDREF	1.1725	4.5830
Final ERR/Sv	1.1725	4.5830
Organ equivalent dose (Sv)	0.115377	0.120528
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.135	0.552
Probability of Causation (PC)	11.92	35.58

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e1_6**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	electrons E<15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	648	742
Original ERR/Sv	0.5517	1.5568
Adjustment Factors		
Age at exposure, Attained age	2.1502	3.0225
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0778	0.0793
Systematic errors in gamma doses[b]	1.2410	1.1807
Systematic errors in neutron doses[b]	1.1699	1.0411
Systematic errors in RBE neutron doses[b]	1.0205	0.9463
Model Mixture factor for transfer to US pop	0.0768	0.5217
Ratio of Japanese to U.S. baseline cancer rates	1.1072	1.1039
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	2.88282	2.41056

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.820	3.314
Probability of Causation (PC)	45.06	76.82

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5517	1.5568
ERR/Sv with adjustments		
w/ age adjustment	1.1862	4.7055
w/ latency adjustment	1.1862	4.7055
w/ random errors in dosimetry adj	1.2785	5.0786
w/ systematic errors in dosimetry adj	0.8630	4.3660
adjusted for population transfer	0.9484	4.5830
multiplicative risk model	0.8630	4.3660
additive risk model	0.9555	4.8198
adjusted for smoking history	0.9484	4.5830
adjusted for DDREF	0.9484	4.5830
Final ERR/Sv	0.9484	4.5830
Organ equivalent dose (Sv)	0.864846	0.723168
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.820	3.314
Probability of Causation (PC)	45.06	76.82

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e1_7**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	electrons E<15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	573	803
Original ERR/Sv	0.2982	0.6278
Adjustment Factors		
Age at exposure, Attained age	2.7782	2.2604
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1031	0.0861
Systematic errors in gamma doses[b]	1.1026	1.1119
Systematic errors in neutron doses[b]	1.0388	1.2424
Systematic errors in RBE neutron doses[b]	0.9684	0.9452
Model Mixture factor for transfer to US pop	0.9513	0.5630
Ratio of Japanese to U.S. baseline cancer rates	1.1277	1.1453
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	0.7
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1.97823	5.06335

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.082	0.454
Probability of Causation (PC)	7.58	31.22

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.2982	0.6278
ERR/Sv with adjustments		
w/ age adjustment	0.8284	1.4190
w/ latency adjustment	0.8284	1.4190
w/ random errors in dosimetry adj	0.9138	1.5411
w/ systematic errors in dosimetry adj	0.8238	1.1803
adjusted for population transfer	0.8290	1.2552
multiplicative risk model	0.8238	1.1803
additive risk model	0.9290	1.3517
adjusted for smoking history	0.8290	1.2552
adjusted for DDREF	0.8290	1.7931
Final ERR/Sv	0.8290	1.7931
Organ equivalent dose (Sv)	0.098912	0.253168
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.082	0.454
Probability of Causation (PC)	7.58	31.22

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e1_8**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	electrons E<15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	573	803
Original ERR/Sv	0.2982	0.6278
Adjustment Factors		
Age at exposure, Attained age	2.7782	2.2604
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1031	0.0861
Systematic errors in gamma doses[b]	1.1026	1.1119
Systematic errors in neutron doses[b]	1.0388	1.2424
Systematic errors in RBE neutron doses[b]	0.9684	0.9452
Model Mixture factor for transfer to US pop	0.9513	0.5630
Ratio of Japanese to U.S. baseline cancer rates	1.1277	1.1453
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	0.7
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1.97823	5.06335

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.492	2.724
Probability of Causation (PC)	32.97	73.15

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.2982	0.6278
ERR/Sv with adjustments		
w/ age adjustment	0.8284	1.4190
w/ latency adjustment	0.8284	1.4190
w/ random errors in dosimetry adj	0.9138	1.5411
w/ systematic errors in dosimetry adj	0.8238	1.1803
adjusted for population transfer	0.8290	1.2552
multiplicative risk model	0.8238	1.1803
additive risk model	0.9290	1.3517
adjusted for smoking history	0.8290	1.2552
adjusted for DDREF	0.8290	1.7931
Final ERR/Sv	0.8290	1.7931
Organ equivalent dose (Sv)	0.593469	1.519005
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.492	2.724
Probability of Causation (PC)	32.97	73.15

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e1_9**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	electrons E<15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	151	963
Original ERR/Sv	2.6115	2.3979
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0642	0.0920
Systematic errors in gamma doses[b]	1.2948	1.1052
Systematic errors in neutron doses[b]	1.2574	1.0994
Systematic errors in RBE neutron doses[b]	0.9160	0.9081
Model Mixture factor for transfer to US pop	0.0000	0.7247
Ratio of Japanese to U.S. baseline cancer rates	0.3499	0.3395
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	3.14489	4.66376

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.103	0.453
Probability of Causation (PC)	9.30	31.17

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.6115	2.3979
ERR/Sv with adjustments		
w/ age adjustment	2.6115	2.3979
w/ latency adjustment	2.6115	2.3979
w/ random errors in dosimetry adj	2.7792	2.6185
w/ systematic errors in dosimetry adj	1.8637	2.3733
adjusted for population transfer	0.6521	1.9417
multiplicative risk model	1.8637	2.3733
additive risk model	0.6521	0.8058
adjusted for smoking history	0.6521	1.9417
adjusted for DDREF	0.6521	1.9417
Final ERR/Sv	0.6521	1.9417
Organ equivalent dose (Sv)	0.157245	0.233188
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.103	0.453
Probability of Causation (PC)	9.30	31.17

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Calculations using MS Excel

Verification Run Identifier	**DDREF_e1_10**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	electrons E<15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	863	963
Original ERR/Sv	3.4742	2.3979
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1033	0.0920
Systematic errors in gamma doses[b]	1.1717	1.1052
Systematic errors in neutron doses[b]	1.0944	1.0994
Systematic errors in RBE neutron doses[b]	0.9488	0.9081
Model Mixture factor for transfer to US pop	0.0000	0.7247
Ratio of Japanese to U.S. baseline cancer rates	0.3399	0.3395
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1.92951	4.66376

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.620	2.717
Probability of Causation (PC)	38.27	73.09

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	3.4742	2.3979
ERR/Sv with adjustments		
w/ age adjustment	3.4742	2.3979
w/ latency adjustment	3.4742	2.3979
w/ random errors in dosimetry adj	3.8331	2.6185
w/ systematic errors in dosimetry adj	3.1505	2.3733
adjusted for population transfer	1.0709	1.9417
multiplicative risk model	3.1505	2.3733
additive risk model	1.0709	0.8058
adjusted for smoking history	1.0709	1.9417
adjusted for DDREF	1.0709	1.9417
Final ERR/Sv	1.0709	1.9417
Organ equivalent dose (Sv)	0.578853	1.399128
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.620	2.717
Probability of Causation (PC)	38.27	73.09

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e1_11**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	electrons E<15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	850	613
Original ERR/Sv	2.5892	2.2594
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0980	0.0845
Systematic errors in gamma doses[b]	1.0423	1.1004
Systematic errors in neutron doses[b]	1.0753	1.1466
Systematic errors in RBE neutron doses[b]	0.9889	0.9671
Model Mixture factor for transfer to US pop	0.0000	1.0164
Ratio of Japanese to U.S. baseline cancer rates	0.3294	0.3353
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1.5	1.5
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	2.52453	5.74215

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.071	0.389
Probability of Causation (PC)	6.64	27.98

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.5892	2.2594
ERR/Sv with adjustments		
w/ age adjustment	2.5892	2.2594
w/ latency adjustment	2.5892	2.2594
w/ random errors in dosimetry adj	2.8430	2.4504
w/ systematic errors in dosimetry adj	2.5651	2.0083
adjusted for population transfer	0.8449	2.0302
multiplicative risk model	2.5651	2.0083
additive risk model	0.8449	0.6733
adjusted for smoking history	0.8449	2.0302
adjusted for DDREF	0.5633	1.3535
Final ERR/Sv	0.5633	1.3535
Organ equivalent dose (Sv)	0.126227	0.287108
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.071	0.389
Probability of Causation (PC)	6.64	27.98

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e1_12**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	electrons E<15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	850	613
Original ERR/Sv	2.5892	2.2594
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0980	0.0845
Systematic errors in gamma doses[b]	1.0423	1.1004
Systematic errors in neutron doses[b]	1.0753	1.1466
Systematic errors in RBE neutron doses[b]	0.9889	0.9671
Model Mixture factor for transfer to US pop	0.0000	1.0164
Ratio of Japanese to U.S. baseline cancer rates	0.3294	0.3353
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1.5	1.5
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	2.52453	5.74215

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.427	2.332
Probability of Causation (PC)	29.90	69.98

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.5892	2.2594
ERR/Sv with adjustments		
w/ age adjustment	2.5892	2.2594
w/ latency adjustment	2.5892	2.2594
w/ random errors in dosimetry adj	2.8430	2.4504
w/ systematic errors in dosimetry adj	2.5651	2.0083
adjusted for population transfer	0.8449	2.0302
multiplicative risk model	2.5651	2.0083
additive risk model	0.8449	0.6733
adjusted for smoking history	0.8449	2.0302
adjusted for DDREF	0.5633	1.3535
Final ERR/Sv	0.5633	1.3535
Organ equivalent dose (Sv)	0.757359	1.722645
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.427	2.332
Probability of Causation (PC)	29.90	69.98

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e2_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	electrons E>15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	790	414
Original ERR/Sv	1.6054	11.6797
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0674	0.0824
Systematic errors in gamma doses[b]	1.0591	1.1505
Systematic errors in neutron doses[b]	1.0960	1.1152
Systematic errors in RBE neutron doses[b]	1.0738	1.0054
Model Mixture factor for transfer to US pop	0.8314	0.2115
Ratio of Japanese to U.S. baseline cancer rates	0.8237	0.9015
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.080	0.584
Probability of Causation (PC)	7.43	36.87

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.6054	11.6797
ERR/Sv with adjustments		
w/ age adjustment	1.6054	11.6797
w/ latency adjustment	1.6054	11.6797
w/ random errors in dosimetry adj	1.6054	11.6797
w/ systematic errors in dosimetry adj	1.6054	11.6797
adjusted for population transfer	1.6054	11.6797
multiplicative risk model	1.6054	11.6797
additive risk model	1.3225	10.5295
adjusted for smoking history	1.6054	11.6797
adjusted for DDREF	1.6054	11.6797
Final ERR/Sv	1.6054	11.6797
Organ equivalent dose (Sv)	0.05	0.05
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.080	0.584
Probability of Causation (PC)	7.43	36.87

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e2_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	electrons E>15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1102	679
Original ERR/Sv	1.8032	12.4338
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1219	0.1094
Systematic errors in gamma doses[b]	1.2233	1.2719
Systematic errors in neutron doses[b]	1.1344	1.1032
Systematic errors in RBE neutron doses[b]	0.9443	0.9593
Model Mixture factor for transfer to US pop	0.3182	0.9210
Ratio of Japanese to U.S. baseline cancer rates	0.8074	0.8568
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.541	3.730
Probability of Causation (PC)	35.11	78.86

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.8032	12.4338
ERR/Sv with adjustments		
w/ age adjustment	1.8032	12.4338
w/ latency adjustment	1.8032	12.4338
w/ random errors in dosimetry adj	1.8032	12.4338
w/ systematic errors in dosimetry adj	1.8032	12.4338
adjusted for population transfer	1.8032	12.4338
multiplicative risk model	1.8032	12.4338
additive risk model	1.4559	10.6529
adjusted for smoking history	1.8032	12.4338
adjusted for DDREF	1.8032	12.4338
Final ERR/Sv	1.8032	12.4338
Organ equivalent dose (Sv)	0.3	0.3
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.541	3.730
Probability of Causation (PC)	35.11	78.86

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e2_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	electrons E>15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	548	605
Original ERR/Sv	1.2206	10.6068
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0652	0.1271
Systematic errors in gamma doses[b]	1.0207	1.3331
Systematic errors in neutron doses[b]	1.2289	1.2075
Systematic errors in RBE neutron doses[b]	0.9508	1.0048
Model Mixture factor for transfer to US pop	0.8264	0.1246
Ratio of Japanese to U.S. baseline cancer rates	0.8425	0.9005
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.061	0.530
Probability of Causation (PC)	5.75	34.66

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.2206	10.6068
ERR/Sv with adjustments		
w/ age adjustment	1.2206	10.6068
w/ latency adjustment	1.2206	10.6068
w/ random errors in dosimetry adj	1.2206	10.6068
w/ systematic errors in dosimetry adj	1.2206	10.6068
adjusted for population transfer	1.2206	10.6068
multiplicative risk model	1.2206	10.6068
additive risk model	1.0283	9.5513
adjusted for smoking history	1.2206	10.6068
adjusted for DDREF	1.2206	10.6068
Final ERR/Sv	1.2206	10.6068
Organ equivalent dose (Sv)	0.05	0.05
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.061	0.530
Probability of Causation (PC)	5.75	34.66

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e2_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	electrons E>15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	548	605
Original ERR/Sv	1.2206	10.6068
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0652	0.1271
Systematic errors in gamma doses[b]	1.0207	1.3331
Systematic errors in neutron doses[b]	1.2289	1.2075
Systematic errors in RBE neutron doses[b]	0.9508	1.0048
Model Mixture factor for transfer to US pop	0.8264	0.1246
Ratio of Japanese to U.S. baseline cancer rates	0.8425	0.9005
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.366	3.183
Probability of Causation (PC)	26.80	76.09

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.2206	10.6068
ERR/Sv with adjustments		
w/ age adjustment	1.2206	10.6068
w/ latency adjustment	1.2206	10.6068
w/ random errors in dosimetry adj	1.2206	10.6068
w/ systematic errors in dosimetry adj	1.2206	10.6068
adjusted for population transfer	1.2206	10.6068
multiplicative risk model	1.2206	10.6068
additive risk model	1.0283	9.5513
adjusted for smoking history	1.2206	10.6068
adjusted for DDREF	1.2206	10.6068
Final ERR/Sv	1.2206	10.6068
Organ equivalent dose (Sv)	0.3	0.3
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.366	3.182
Probability of Causation (PC)	26.80	76.09

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e2_5**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	electrons E>15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	59	884
Original ERR/Sv	0.6618	0.7539
Adjustment Factors		
Age at exposure, Attained age	2.8088	2.8682
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0988	0.0948
Systematic errors in gamma doses[b]	1.1571	1.1472
Systematic errors in neutron doses[b]	1.2106	1.0827
Systematic errors in RBE neutron doses[b]	1.0112	0.9222
Model Mixture factor for transfer to US pop	0.8495	0.2940
Ratio of Japanese to U.S. baseline cancer rates	1.0934	1.1242
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1.45989	0.735022
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.050	0.153
Probability of Causation (PC)	4.77	13.26

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6618	0.7539
ERR/Sv with adjustments		
w/ age adjustment	1.8589	2.1622
w/ latency adjustment	1.8589	2.1622
w/ random errors in dosimetry adj	2.0426	2.3672
w/ systematic errors in dosimetry adj	1.4421	2.0667
adjusted for population transfer	1.4623	2.2479
multiplicative risk model	1.4421	2.0667
additive risk model	1.5768	2.3234
adjusted for smoking history	1.4623	2.2479
adjusted for DDREF	1.0017	3.0583
Final ERR/Sv	1.0017	3.0583
Organ equivalent dose (Sv)	0.05	0.05
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.050	0.153
Probability of Causation (PC)	4.77	13.26

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e2_6**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	electrons E>15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	9	696
Original ERR/Sv	0.3770	1.0795
Adjustment Factors		
Age at exposure, Attained age	3.1638	3.0345
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0940	0.1031
Systematic errors in gamma doses[b]	1.0880	1.1456
Systematic errors in neutron doses[b]	1.1132	1.0861
Systematic errors in RBE neutron doses[b]	0.9508	1.0640
Model Mixture factor for transfer to US pop	0.9232	-0.0929
Ratio of Japanese to U.S. baseline cancer rates	1.1143	1.1538
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.343	0.956
Probability of Causation (PC)	25.54	48.88

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.3770	1.0795
ERR/Sv with adjustments		
w/ age adjustment	1.1927	3.2757
w/ latency adjustment	1.1927	3.2757
w/ random errors in dosimetry adj	1.3049	3.6133
w/ systematic errors in dosimetry adj	1.1331	2.7292
adjusted for population transfer	1.1430	3.1879
multiplicative risk model	1.1331	2.7292
additive risk model	1.2626	3.1489
adjusted for smoking history	1.1430	3.1879
adjusted for DDREF	1.1430	3.1879
Final ERR/Sv	1.1430	3.1879
Organ equivalent dose (Sv)	0.3	0.3
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.343	0.956
Probability of Causation (PC)	25.54	48.88

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e2_7**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	electrons E>15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	965	170
Original ERR/Sv	0.5957	0.7732
Adjustment Factors		
Age at exposure, Attained age	2.5536	2.4700
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0882	0.0738
Systematic errors in gamma doses[b]	1.0737	1.2620
Systematic errors in neutron doses[b]	1.0794	1.1310
Systematic errors in RBE neutron doses[b]	1.0961	0.9808
Model Mixture factor for transfer to US pop	0.6108	0.4277
Ratio of Japanese to U.S. baseline cancer rates	1.1488	1.1088
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	2	0.5
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.034	0.156
Probability of Causation (PC)	3.33	13.47

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5957	0.7732
ERR/Sv with adjustments		
w/ age adjustment	1.5211	1.9099
w/ latency adjustment	1.5211	1.9099
w/ random errors in dosimetry adj	1.6552	2.0509
w/ systematic errors in dosimetry adj	1.3030	1.4652
adjusted for population transfer	1.3784	1.5564
multiplicative risk model	1.3030	1.4652
additive risk model	1.4969	1.6246
adjusted for smoking history	1.3784	1.5564
adjusted for DDREF	0.6892	3.1128
Final ERR/Sv	0.6892	3.1128
Organ equivalent dose (Sv)	0.05	0.05
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.034	0.156
Probability of Causation (PC)	3.33	13.47

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e2_8**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	electrons E>15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	965	170
Original ERR/Sv	0.5957	0.7732
Adjustment Factors		
Age at exposure, Attained age	2.5536	2.4700
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0882	0.0738
Systematic errors in gamma doses[b]	1.0737	1.2620
Systematic errors in neutron doses[b]	1.0794	1.1310
Systematic errors in RBE neutron doses[b]	1.0961	0.9808
Model Mixture factor for transfer to US pop	0.6108	0.4277
Ratio of Japanese to U.S. baseline cancer rates	1.1488	1.1088
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	2	0.5
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.207	0.934
Probability of Causation (PC)	17.13	48.29

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5957	0.7732
ERR/Sv with adjustments		
w/ age adjustment	1.5211	1.9099
w/ latency adjustment	1.5211	1.9099
w/ random errors in dosimetry adj	1.6552	2.0509
w/ systematic errors in dosimetry adj	1.3030	1.4652
adjusted for population transfer	1.3784	1.5564
multiplicative risk model	1.3030	1.4652
additive risk model	1.4969	1.6246
adjusted for smoking history	1.3784	1.5564
adjusted for DDREF	0.6892	3.1128
Final ERR/Sv	0.6892	3.1128
Organ equivalent dose (Sv)	0.3	0.3
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.207	0.934
Probability of Causation (PC)	17.13	48.29

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Calculations using MS Excel

Verification Run Identifier	**DDREF_e2_9**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	electrons E>15keV

Personal Information	
Age at exposure	20
Attained age	40

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	788	231
Original ERR/Sv	2.4376	3.1266
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0993	0.0898
Systematic errors in gamma doses[b]	1.1376	1.3255
Systematic errors in neutron doses[b]	1.0768	1.0747
Systematic errors in RBE neutron doses[b]	1.0039	0.9074
Model Mixture factor for transfer to US pop	0.0000	0.9518
Ratio of Japanese to U.S. baseline cancer rates	0.3359	0.3294
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.4376	3.1266
ERR/Sv with adjustments		
w/ age adjustment	2.4376	3.1266
w/ latency adjustment	2.4376	3.1266
w/ random errors in dosimetry adj	2.6797	3.4074
w/ systematic errors in dosimetry adj	2.1791	2.6362
adjusted for population transfer	0.7320	2.5510
multiplicative risk model	2.1791	2.6362
additive risk model	0.7320	0.8684
adjusted for smoking history	0.7320	2.5510
adjusted for DDREF	0.7320	2.5510
Final ERR/Sv	0.7320	2.5510
Organ equivalent dose (Sv)	0.05	0.05
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.037	0.128
Probability of Causation (PC)	3.53	11.31

Final results calculated in Excel		
Excess relative risk (ERR)	0.037	0.128
Probability of Causation (PC)	3.53	11.31

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e2_10**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	electrons E>15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	558	6
Original ERR/Sv	2.7245	2.9301
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0966	0.1071
Systematic errors in gamma doses[b]	1.2018	1.1609
Systematic errors in neutron doses[b]	1.1199	1.0821
Systematic errors in RBE neutron doses[b]	0.9459	1.0038
Model Mixture factor for transfer to US pop	0.0000	1.0587
Ratio of Japanese to U.S. baseline cancer rates	0.3413	0.3385
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.240	0.802
Probability of Causation (PC)	19.37	44.50

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.7245	2.9301
ERR/Sv with adjustments		
w/ age adjustment	2.7245	2.9301
w/ latency adjustment	2.7245	2.9301
w/ random errors in dosimetry adj	2.9878	3.2439
w/ systematic errors in dosimetry adj	2.3469	2.5724
adjusted for population transfer	0.8009	2.6724
multiplicative risk model	2.3469	2.5724
additive risk model	0.8009	0.8707
adjusted for smoking history	0.8009	2.6724
adjusted for DDREF	0.8009	2.6724
Final ERR/Sv	0.8009	2.6724
Organ equivalent dose (Sv)	0.3	0.3
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.240	0.802
Probability of Causation (PC)	19.37	44.50

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e2_11**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	electrons E>15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	259	273
Original ERR/Sv	1.7740	2.0978
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0806	0.0688
Systematic errors in gamma doses[b]	1.0444	1.0758
Systematic errors in neutron doses[b]	1.1114	1.1710
Systematic errors in RBE neutron doses[b]	0.9150	0.9779
Model Mixture factor for transfer to US pop	0.0000	1.0205
Ratio of Japanese to U.S. baseline cancer rates	0.3266	0.3388
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	0.7
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.029	0.132
Probability of Causation (PC)	2.86	11.64

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.7740	2.0978
ERR/Sv with adjustments		
w/ age adjustment	1.7740	2.0978
w/ latency adjustment	1.7740	2.0978
w/ random errors in dosimetry adj	1.9170	2.2421
w/ systematic errors in dosimetry adj	1.8050	1.8199
adjusted for population transfer	0.5895	1.8446
multiplicative risk model	1.8050	1.8199
additive risk model	0.5895	0.6166
adjusted for smoking history	0.5895	1.8446
adjusted for DDREF	0.5895	2.6351
Final ERR/Sv	0.5895	2.6351
Organ equivalent dose (Sv)	0.05	0.05
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.029	0.132
Probability of Causation (PC)	2.86	11.64

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_e2_12**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	electrons E>15keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	259	273
Original ERR/Sv	1.7740	2.0978
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0806	0.0688
Systematic errors in gamma doses[b]	1.0444	1.0758
Systematic errors in neutron doses[b]	1.1114	1.1710
Systematic errors in RBE neutron doses[b]	0.9150	0.9779
Model Mixture factor for transfer to US pop	0.0000	1.0205
Ratio of Japanese to U.S. baseline cancer rates	0.3266	0.3388
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	0.7
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.177	0.791
Probability of Causation (PC)	15.03	44.15

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.7740	2.0978
ERR/Sv with adjustments		
w/ age adjustment	1.7740	2.0978
w/ latency adjustment	1.7740	2.0978
w/ random errors in dosimetry adj	1.9170	2.2421
w/ systematic errors in dosimetry adj	1.8050	1.8199
adjusted for population transfer	0.5895	1.8446
multiplicative risk model	1.8050	1.8199
additive risk model	0.5895	0.6166
adjusted for smoking history	0.5895	1.8446
adjusted for DDREF	0.5895	2.6351
Final ERR/Sv	0.5895	2.6351
Organ equivalent dose (Sv)	0.3	0.3
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.177	0.791
Probability of Causation (PC)	15.03	44.15

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p1_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E<30keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	202	1290
Original ERR/Sv	3.3262	7.1230
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0935	0.0776
Systematic errors in gamma doses[b]	1.2772	1.2338
Systematic errors in neutron doses[b]	1.1395	1.0999
Systematic errors in RBE neutron doses[b]	1.0023	0.9466
Model Mixture factor for transfer to US pop	0.2913	0.6636
Ratio of Japanese to U.S. baseline cancer rates	0.9479	1.0830
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1.30038	5.36297

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.216	1.910
Probability of Causation (PC)	17.78	65.64

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	3.3262	7.1230
ERR/Sv with adjustments		
w/ age adjustment	3.3262	7.1230
w/ latency adjustment	3.3262	7.1230
w/ random errors in dosimetry adj	3.3262	7.1230
w/ systematic errors in dosimetry adj	3.3262	7.1230
adjusted for population transfer	3.3262	7.1230
multiplicative risk model	3.3262	7.1230
additive risk model	3.1530	7.7139
adjusted for smoking history	3.3262	7.1230
adjusted for DDREF	3.3262	7.1230
Final ERR/Sv	3.3262	7.1230
Organ equivalent dose (Sv)	0.065019	0.268149
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.216	1.910
Probability of Causation (PC)	17.78	65.64

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p1_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E<30keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	315	1290
Original ERR/Sv	1.0408	7.1230
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0843	0.1406
Systematic errors in gamma doses[b]	1.2633	1.2594
Systematic errors in neutron doses[b]	1.1776	1.1597
Systematic errors in RBE neutron doses[b]	1.0326	1.0321
Model Mixture factor for transfer to US pop	0.6691	0.3160
Ratio of Japanese to U.S. baseline cancer rates	0.9039	0.9300
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	4.2401	5.36297

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	1.324	11.460
Probability of Causation (PC)	56.97	91.97

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.0408	7.1230
ERR/Sv with adjustments		
w/ age adjustment	1.0408	7.1230
w/ latency adjustment	1.0408	7.1230
w/ random errors in dosimetry adj	1.0408	7.1230
w/ systematic errors in dosimetry adj	1.0408	7.1230
adjusted for population transfer	1.0408	7.1230
multiplicative risk model	1.0408	7.1230
additive risk model	0.9408	6.6243
adjusted for smoking history	1.0408	7.1230
adjusted for DDREF	1.0408	7.1230
Final ERR/Sv	1.0408	7.1230
Organ equivalent dose (Sv)	1.27203	1.608891
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	1.324	11.460
Probability of Causation (PC)	56.97	91.97

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p1_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E<30keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	774	1207
Original ERR/Sv	1.8317	4.0535
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0761	0.0798
Systematic errors in gamma doses[b]	1.3088	1.1142
Systematic errors in neutron doses[b]	1.0529	1.2417
Systematic errors in RBE neutron doses[b]	1.0063	1.0192
Model Mixture factor for transfer to US pop	0.0328	0.1835
Ratio of Japanese to U.S. baseline cancer rates	1.1069	0.9320
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1.5	0.7
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	2.30175	5.8013

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.141	1.680
Probability of Causation (PC)	12.32	62.68

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.8317	4.0535
ERR/Sv with adjustments		
w/ age adjustment	1.8317	4.0535
w/ latency adjustment	1.8317	4.0535
w/ random errors in dosimetry adj	1.8317	4.0535
w/ systematic errors in dosimetry adj	1.8317	4.0535
adjusted for population transfer	1.8317	4.0535
multiplicative risk model	1.8317	4.0535
additive risk model	2.0274	3.7780
adjusted for smoking history	1.8317	4.0535
adjusted for DDREF	1.2211	5.7908
Final ERR/Sv	1.2211	5.7908
Organ equivalent dose (Sv)	0.115088	0.290065
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.141	1.680
Probability of Causation (PC)	12.32	62.68

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Calculations using MS Excel

Verification Run Identifier	**DDREF_p1_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E<30keV

Personal Information	
Age at exposure	20
Attained age	40

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	774	1207
Original ERR/Sv	1.8317	4.0535
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0761	0.0798
Systematic errors in gamma doses[b]	1.3088	1.1142
Systematic errors in neutron doses[b]	1.0529	1.2417
Systematic errors in RBE neutron doses[b]	1.0063	1.0192
Model Mixture factor for transfer to US pop	0.0328	0.1835
Ratio of Japanese to U.S. baseline cancer rates	1.1069	0.9320
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1.5	0.7
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	2.30175	5.8013

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.8317	4.0535
ERR/Sv with adjustments		
w/ age adjustment	1.8317	4.0535
w/ latency adjustment	1.8317	4.0535
w/ random errors in dosimetry adj	1.8317	4.0535
w/ systematic errors in dosimetry adj	1.8317	4.0535
adjusted for population transfer	1.8317	4.0535
multiplicative risk model	1.8317	4.0535
additive risk model	2.0274	3.7780
adjusted for smoking history	1.8317	4.0535
adjusted for DDREF	1.2211	5.7908
Final ERR/Sv	1.2211	5.7908
Organ equivalent dose (Sv)	0.690525	1.74039
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.843	10.080
Probability of Causation (PC)	45.75	90.97

Final results calculated in Excel		
Excess relative risk (ERR)	0.843	10.078
Probability of Causation (PC)	45.75	90.97

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p1_5**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E<30keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1013	11
Original ERR/Sv	0.8745	1.3219
Adjustment Factors		
Age at exposure, Attained age	2.6726	2.6641
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1076	0.0767
Systematic errors in gamma doses[b]	1.1924	1.2804
Systematic errors in neutron doses[b]	1.0591	1.0432
Systematic errors in RBE neutron doses[b]	1.0008	0.9935
Model Mixture factor for transfer to US pop	0.8116	0.0553
Ratio of Japanese to U.S. baseline cancer rates	1.0985	1.0601
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1.24381	4.27865

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.130	0.646
Probability of Causation (PC)	11.4851	39.25

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.8745	1.3219
ERR/Sv with adjustments		
w/ age adjustment	2.3371	3.5216
w/ latency adjustment	2.3371	3.5216
w/ random errors in dosimetry adj	2.5887	3.7919
w/ systematic errors in dosimetry adj	2.0484	2.8575
adjusted for population transfer	2.0864	3.0198
multiplicative risk model	2.0484	2.8575
additive risk model	2.2501	3.0293
adjusted for smoking history	2.0864	3.0198
adjusted for DDREF	2.0864	3.0198
Final ERR/Sv	2.0864	3.0198
Organ equivalent dose (Sv)	0.062191	0.213933
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.130	0.646
Probability of Causation (PC)	11.4850	39.25

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p1_6**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E<30keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	819	11
Original ERR/Sv	0.3887	1.3219
Adjustment Factors		
Age at exposure, Attained age	2.4669	2.6641
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0781	0.0767
Systematic errors in gamma doses[b]	1.1033	1.2804
Systematic errors in neutron doses[b]	1.1649	1.0432
Systematic errors in RBE neutron doses[b]	1.0168	0.9935
Model Mixture factor for transfer to US pop	0.3765	0.0553
Ratio of Japanese to U.S. baseline cancer rates	1.1739	1.0601
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	3.01924	4.27865

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.794	3.876
Probability of Causation (PC)	44.27	79.49

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.3887	1.3219
ERR/Sv with adjustments		
w/ age adjustment	0.9589	3.5216
w/ latency adjustment	0.9589	3.5216
w/ random errors in dosimetry adj	1.0339	3.7919
w/ systematic errors in dosimetry adj	0.7912	2.8575
adjusted for population transfer	0.8769	3.0198
multiplicative risk model	0.7912	2.8575
additive risk model	0.9287	3.0293
adjusted for smoking history	0.8769	3.0198
adjusted for DDREF	0.8769	3.0198
Final ERR/Sv	0.8769	3.0198
Organ equivalent dose (Sv)	0.905772	1.283595
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.794	3.876
Probability of Causation (PC)	44.27	79.49

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p1_7**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E<30keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	652	1377
Original ERR/Sv	0.8167	0.8327
Adjustment Factors		
Age at exposure, Attained age	2.0983	2.8883
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0722	0.0703
Systematic errors in gamma doses[b]	1.1633	1.0857
Systematic errors in neutron doses[b]	1.1408	1.2234
Systematic errors in RBE neutron doses[b]	1.0234	1.0486
Model Mixture factor for transfer to US pop	0.2000	0.2792
Ratio of Japanese to U.S. baseline cancer rates	1.0550	1.1675
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	3	0.7
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	3.32002	3.77768

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.078	0.559
Probability of Causation (PC)	7.25	35.85

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.8167	0.8327
ERR/Sv with adjustments		
w/ age adjustment	1.7137	2.4051
w/ latency adjustment	1.7137	2.4051
w/ random errors in dosimetry adj	1.8374	2.5741
w/ systematic errors in dosimetry adj	1.3529	1.8481
adjusted for population transfer	1.4124	2.0712
multiplicative risk model	1.3529	1.8481
additive risk model	1.4273	2.1576
adjusted for smoking history	1.4124	2.0712
adjusted for DDREF	0.4708	2.9589
Final ERR/Sv	0.4708	2.9589
Organ equivalent dose (Sv)	0.166001	0.188884
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.078	0.559
Probability of Causation (PC)	7.25	35.85

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p1_8**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E<30keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	652	1377
Original ERR/Sv	0.8167	0.8327
Adjustment Factors		
Age at exposure, Attained age	2.0983	2.8883
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0722	0.0703
Systematic errors in gamma doses[b]	1.1633	1.0857
Systematic errors in neutron doses[b]	1.1408	1.2234
Systematic errors in RBE neutron doses[b]	1.0234	1.0486
Model Mixture factor for transfer to US pop	0.2000	0.2792
Ratio of Japanese to U.S. baseline cancer rates	1.0550	1.1675
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	3	0.7
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	3.32002	3.77768

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.469	3.353
Probability of Causation (PC)	31.92	77.03

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.8167	0.8327
ERR/Sv with adjustments		
w/ age adjustment	1.7137	2.4051
w/ latency adjustment	1.7137	2.4051
w/ random errors in dosimetry adj	1.8374	2.5741
w/ systematic errors in dosimetry adj	1.3529	1.8481
adjusted for population transfer	1.4124	2.0712
multiplicative risk model	1.3529	1.8481
additive risk model	1.4273	2.1576
adjusted for smoking history	1.4124	2.0712
adjusted for DDREF	0.4708	2.9589
Final ERR/Sv	0.4708	2.9589
Organ equivalent dose (Sv)	0.996006	1.133304
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.469	3.353
Probability of Causation (PC)	31.92	77.03

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p1_9**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E<30keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	564	1908
Original ERR/Sv	2.5345	2.6636
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0575	0.0989
Systematic errors in gamma doses[b]	1.1241	1.1341
Systematic errors in neutron doses[b]	1.1631	1.2213
Systematic errors in RBE neutron doses[b]	1.0455	0.9332
Model Mixture factor for transfer to US pop	0.0000	0.6900
Ratio of Japanese to U.S. baseline cancer rates	0.3300	0.3452
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	3.14463	5.75091

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.102	0.519
Probability of Causation (PC)	9.23	34.17

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.5345	2.6636
ERR/Sv with adjustments		
w/ age adjustment	2.5345	2.6636
w/ latency adjustment	2.5345	2.6636
w/ random errors in dosimetry adj	2.6803	2.9271
w/ systematic errors in dosimetry adj	1.9608	2.2645
adjusted for population transfer	0.6471	1.8049
multiplicative risk model	1.9608	2.2645
additive risk model	0.6471	0.7817
adjusted for smoking history	0.6471	1.8049
adjusted for DDREF	0.6471	1.8049
Final ERR/Sv	0.6471	1.8049
Organ equivalent dose (Sv)	0.157232	0.287546
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.102	0.519
Probability of Causation (PC)	9.23	34.17

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p1_10**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E<30keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	168	1908
Original ERR/Sv	2.9698	2.6636
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1011	0.0989
Systematic errors in gamma doses[b]	1.1307	1.1341
Systematic errors in neutron doses[b]	1.0886	1.2213
Systematic errors in RBE neutron doses[b]	1.0185	0.9332
Model Mixture factor for transfer to US pop	0.4541	0.6900
Ratio of Japanese to U.S. baseline cancer rates	0.3420	0.3452
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1.23821	5.75091

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.621	3.114
Probability of Causation (PC)	38.30	75.69

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.9698	2.6636
ERR/Sv with adjustments		
w/ age adjustment	2.9698	2.6636
w/ latency adjustment	2.9698	2.6636
w/ random errors in dosimetry adj	3.2699	2.9271
w/ systematic errors in dosimetry adj	2.6083	2.2645
adjusted for population transfer	1.6714	1.8049
multiplicative risk model	2.6083	2.2645
additive risk model	0.8921	0.7817
adjusted for smoking history	1.6714	1.8049
adjusted for DDREF	1.6714	1.8049
Final ERR/Sv	1.6714	1.8049
Organ equivalent dose (Sv)	0.371463	1.725273
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.621	3.114
Probability of Causation (PC)	38.30	75.69

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p1_11**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E<30keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	256	1995
Original ERR/Sv	2.3043	2.3629
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0664	0.1033
Systematic errors in gamma doses[b]	1.1478	1.3079
Systematic errors in neutron doses[b]	1.1798	1.0255
Systematic errors in RBE neutron doses[b]	0.9291	1.0194
Model Mixture factor for transfer to US pop	0.0000	0.2830
Ratio of Japanese to U.S. baseline cancer rates	0.3369	0.3324
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	2.11591	9.71223

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.070	0.483
Probability of Causation (PC)	6.51	32.56

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.3043	2.3629
ERR/Sv with adjustments		
w/ age adjustment	2.3043	2.3629
w/ latency adjustment	2.3043	2.3629
w/ random errors in dosimetry adj	2.4574	2.6069
w/ systematic errors in dosimetry adj	1.9533	1.9066
adjusted for population transfer	0.6580	0.9940
multiplicative risk model	1.9533	1.9066
additive risk model	0.6580	0.6338
adjusted for smoking history	0.6580	0.9940
adjusted for DDREF	0.6580	0.9940
Final ERR/Sv	0.6580	0.9940
Organ equivalent dose (Sv)	0.105796	0.485612
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.070	0.483
Probability of Causation (PC)	6.51	32.56

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p1_12**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E<30keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	256	1995
Original ERR/Sv	2.3043	2.3629
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0664	0.1033
Systematic errors in gamma doses[b]	1.1478	1.3079
Systematic errors in neutron doses[b]	1.1798	1.0255
Systematic errors in RBE neutron doses[b]	0.9291	1.0194
Model Mixture factor for transfer to US pop	0.0000	0.2830
Ratio of Japanese to U.S. baseline cancer rates	0.3369	0.3324
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	2.11591	9.71223

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.418	2.896
Probability of Causation (PC)	29.46	74.33

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.3043	2.3629
ERR/Sv with adjustments		
w/ age adjustment	2.3043	2.3629
w/ latency adjustment	2.3043	2.3629
w/ random errors in dosimetry adj	2.4574	2.6069
w/ systematic errors in dosimetry adj	1.9533	1.9066
adjusted for population transfer	0.6580	0.9940
multiplicative risk model	1.9533	1.9066
additive risk model	0.6580	0.6338
adjusted for smoking history	0.6580	0.9940
adjusted for DDREF	0.6580	0.9940
Final ERR/Sv	0.6580	0.9940
Organ equivalent dose (Sv)	0.634773	2.913669
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.418	2.896
Probability of Causation (PC)	29.46	74.33

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p2_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E=30-250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1763	1076
Original ERR/Sv	1.7082	10.2832
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0912	0.0714
Systematic errors in gamma doses[b]	1.1999	1.2052
Systematic errors in neutron doses[b]	1.2055	1.0255
Systematic errors in RBE neutron doses[b]	0.9858	0.9595
Model Mixture factor for transfer to US pop	0.9870	0.9458
Ratio of Japanese to U.S. baseline cancer rates	0.8279	0.7518
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1.90845	2.85954

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.163	1.470
Probability of Causation (PC)	14.02	59.52

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.7082	10.2832
ERR/Sv with adjustments		
w/ age adjustment	1.7082	10.2832
w/ latency adjustment	1.7082	10.2832
w/ random errors in dosimetry adj	1.7082	10.2832
w/ systematic errors in dosimetry adj	1.7082	10.2832
adjusted for population transfer	1.7082	10.2832
multiplicative risk model	1.7082	10.2832
additive risk model	1.4142	7.7306
adjusted for smoking history	1.7082	10.2832
adjusted for DDREF	1.7082	10.2832
Final ERR/Sv	1.7082	10.2832
Organ equivalent dose (Sv)	0.095423	0.142977
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.163	1.470
Probability of Causation (PC)	14.02	59.52

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p2_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E=30-250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	670	1076
Original ERR/Sv	1.4246	10.2832
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1013	0.0797
Systematic errors in gamma doses[b]	1.2272	1.2901
Systematic errors in neutron doses[b]	1.0988	1.1920
Systematic errors in RBE neutron doses[b]	1.0591	1.0205
Model Mixture factor for transfer to US pop	0.8341	-0.0308
Ratio of Japanese to U.S. baseline cancer rates	1.0842	0.9452
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	2.35844	2.85954

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	1.008	8.826
Probability of Causation (PC)	50.20	89.82

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.4246	10.2832
ERR/Sv with adjustments		
w/ age adjustment	1.4246	10.2832
w/ latency adjustment	1.4246	10.2832
w/ random errors in dosimetry adj	1.4246	10.2832
w/ systematic errors in dosimetry adj	1.4246	10.2832
adjusted for population transfer	1.4246	10.2832
multiplicative risk model	1.4246	10.2832
additive risk model	1.5445	9.7199
adjusted for smoking history	1.4246	10.2832
adjusted for DDREF	1.4246	10.2832
Final ERR/Sv	1.4246	10.2832
Organ equivalent dose (Sv)	0.707532	0.857862
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	1.008	8.822
Probability of Causation (PC)	50.20	89.82

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p2_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E=30-250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	30	805
Original ERR/Sv	0.9762	10.0752
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0896	0.0785
Systematic errors in gamma doses[b]	1.1524	1.1510
Systematic errors in neutron doses[b]	1.1364	1.2396
Systematic errors in RBE neutron doses[b]	0.9169	1.0611
Model Mixture factor for transfer to US pop	0.7780	0.8946
Ratio of Japanese to U.S. baseline cancer rates	0.8579	0.7953
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	2.26151	2.53024

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.110	1.275
Probability of Causation (PC)	9.94	56.04

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.9762	10.0752
ERR/Sv with adjustments		
w/ age adjustment	0.9762	10.0752
w/ latency adjustment	0.9762	10.0752
w/ random errors in dosimetry adj	0.9762	10.0752
w/ systematic errors in dosimetry adj	0.9762	10.0752
adjusted for population transfer	0.9762	10.0752
multiplicative risk model	0.9762	10.0752
additive risk model	0.8374	8.0126
adjusted for smoking history	0.9762	10.0752
adjusted for DDREF	0.9762	10.0752
Final ERR/Sv	0.9762	10.0752
Organ equivalent dose (Sv)	0.113076	0.126512
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.110	1.275
Probability of Causation (PC)	9.94	56.04

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p2_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E=30-250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	30	805
Original ERR/Sv	0.9762	10.0752
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0896	0.0785
Systematic errors in gamma doses[b]	1.1524	1.1510
Systematic errors in neutron doses[b]	1.1364	1.2396
Systematic errors in RBE neutron doses[b]	0.9169	1.0611
Model Mixture factor for transfer to US pop	0.7780	0.8946
Ratio of Japanese to U.S. baseline cancer rates	0.8579	0.7953
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	2.26151	2.53024

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.662	7.648
Probability of Causation (PC)	39.84	88.44

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.9762	10.0752
ERR/Sv with adjustments		
w/ age adjustment	0.9762	10.0752
w/ latency adjustment	0.9762	10.0752
w/ random errors in dosimetry adj	0.9762	10.0752
w/ systematic errors in dosimetry adj	0.9762	10.0752
adjusted for population transfer	0.9762	10.0752
multiplicative risk model	0.9762	10.0752
additive risk model	0.8374	8.0126
adjusted for smoking history	0.9762	10.0752
adjusted for DDREF	0.9762	10.0752
Final ERR/Sv	0.9762	10.0752
Organ equivalent dose (Sv)	0.678453	0.759072
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.662	7.648
Probability of Causation (PC)	39.84	88.44

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p2_5**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E=30-250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	121	798
Original ERR/Sv	0.4529	0.6767
Adjustment Factors		
Age at exposure, Attained age	2.3362	3.0582
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0922	0.0956
Systematic errors in gamma doses[b]	1.3565	1.1105
Systematic errors in neutron doses[b]	1.0142	1.1341
Systematic errors in RBE neutron doses[b]	1.0100	0.9501
Model Mixture factor for transfer to US pop	0.0668	0.5927
Ratio of Japanese to U.S. baseline cancer rates	1.0897	1.1392
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	2.1386	4.78512

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.096	0.479
Probability of Causation (PC)	8.79	32.39

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4529	0.6767
ERR/Sv with adjustments		
w/ age adjustment	1.0582	2.0694
w/ latency adjustment	1.0582	2.0694
w/ random errors in dosimetry adj	1.1557	2.2672
w/ systematic errors in dosimetry adj	0.8317	1.8948
adjusted for population transfer	0.9013	2.0022
multiplicative risk model	0.8317	1.8948
additive risk model	0.9063	2.1586
adjusted for smoking history	0.9013	2.0022
adjusted for DDREF	0.9013	2.0022
Final ERR/Sv	0.9013	2.0022
Organ equivalent dose (Sv)	0.10693	0.239256
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.096	0.479
Probability of Causation (PC)	8.79	32.39

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p2_6**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E=30-250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1156	798
Original ERR/Sv	0.8940	0.6767
Adjustment Factors		
Age at exposure, Attained age	2.7928	3.0582
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1013	0.0956
Systematic errors in gamma doses[b]	1.2140	1.1105
Systematic errors in neutron doses[b]	1.1691	1.1341
Systematic errors in RBE neutron doses[b]	1.0110	0.9501
Model Mixture factor for transfer to US pop	0.4678	0.5927
Ratio of Japanese to U.S. baseline cancer rates	1.1351	1.1392
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	4.78512

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.616	2.875
Probability of Causation (PC)	38.13	74.19

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.8940	0.6767
ERR/Sv with adjustments		
w/ age adjustment	2.4966	2.0694
w/ latency adjustment	2.4966	2.0694
w/ random errors in dosimetry adj	2.7495	2.2672
w/ systematic errors in dosimetry adj	1.9162	1.8948
adjusted for population transfer	2.0539	2.0022
multiplicative risk model	1.9162	1.8948
additive risk model	2.1751	2.1586
adjusted for smoking history	2.0539	2.0022
adjusted for DDREF	2.0539	2.0022
Final ERR/Sv	2.0539	2.0022
Organ equivalent dose (Sv)	0.3	1.435536
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.616	2.874
Probability of Causation (PC)	38.13	74.19

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p2_7**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E=30-250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	732	125
Original ERR/Sv	0.4447	1.0690
Adjustment Factors		
Age at exposure, Attained age	2.3892	3.1212
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0754	0.0787
Systematic errors in gamma doses[b]	1.0596	1.2258
Systematic errors in neutron doses[b]	1.2799	1.1103
Systematic errors in RBE neutron doses[b]	1.0272	0.9891
Model Mixture factor for transfer to US pop	0.1884	1.0301
Ratio of Japanese to U.S. baseline cancer rates	1.1271	1.1039
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	2	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	2.64536	3.17219

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.060	0.423
Probability of Causation (PC)	5.65	29.71

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4447	1.0690
ERR/Sv with adjustments		
w/ age adjustment	1.0625	3.3365
w/ latency adjustment	1.0625	3.3365
w/ random errors in dosimetry adj	1.1426	3.5989
w/ systematic errors in dosimetry adj	0.8203	2.6733
adjusted for population transfer	0.9049	2.6649
multiplicative risk model	0.8203	2.6733
additive risk model	0.9246	2.9511
adjusted for smoking history	0.9049	2.6649
adjusted for DDREF	0.4525	2.6649
Final ERR/Sv	0.4525	2.6649
Organ equivalent dose (Sv)	0.132268	0.15861
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.060	0.423
Probability of Causation (PC)	5.65	29.71

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p2_8**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E=30-250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	732	125
Original ERR/Sv	0.4447	1.0690
Adjustment Factors		
Age at exposure, Attained age	2.3892	3.1212
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0754	0.0787
Systematic errors in gamma doses[b]	1.0596	1.2258
Systematic errors in neutron doses[b]	1.2799	1.1103
Systematic errors in RBE neutron doses[b]	1.0272	0.9891
Model Mixture factor for transfer to US pop	0.1884	1.0301
Ratio of Japanese to U.S. baseline cancer rates	1.1271	1.1039
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	2	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	2.64536	3.17219

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.359	2.536
Probability of Causation (PC)	26.42	71.72

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4447	1.0690
ERR/Sv with adjustments		
w/ age adjustment	1.0625	3.3365
w/ latency adjustment	1.0625	3.3365
w/ random errors in dosimetry adj	1.1426	3.5989
w/ systematic errors in dosimetry adj	0.8203	2.6733
adjusted for population transfer	0.9049	2.6649
multiplicative risk model	0.8203	2.6733
additive risk model	0.9246	2.9511
adjusted for smoking history	0.9049	2.6649
adjusted for DDREF	0.4525	2.6649
Final ERR/Sv	0.4525	2.6649
Organ equivalent dose (Sv)	0.793608	0.951657
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.359	2.536
Probability of Causation (PC)	26.42	71.72

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p2_9**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E=30-250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	592	329
Original ERR/Sv	2.1697	4.3793
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0876	0.1061
Systematic errors in gamma doses[b]	1.1699	1.1850
Systematic errors in neutron doses[b]	1.1080	1.1734
Systematic errors in RBE neutron doses[b]	1.0159	0.9848
Model Mixture factor for transfer to US pop	0.2165	0.3925
Ratio of Japanese to U.S. baseline cancer rates	0.3320	0.3266
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1.83187	3.94574

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.078	0.412
Probability of Causation (PC)	7.25	29.20

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.1697	4.3793
ERR/Sv with adjustments		
w/ age adjustment	2.1697	4.3793
w/ latency adjustment	2.1697	4.3793
w/ random errors in dosimetry adj	2.3596	4.8439
w/ systematic errors in dosimetry adj	1.7920	3.5376
adjusted for population transfer	0.8540	2.0904
multiplicative risk model	1.7920	3.5376
additive risk model	0.5948	1.1554
adjusted for smoking history	0.8540	2.0904
adjusted for DDREF	0.8540	2.0904
Final ERR/Sv	0.8540	2.0904
Organ equivalent dose (Sv)	0.091594	0.197287
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.078	0.412
Probability of Causation (PC)	7.25	29.20

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p2_10**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E=30-250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	7	329
Original ERR/Sv	2.4729	4.3793
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0797	0.1061
Systematic errors in gamma doses[b]	1.1677	1.1850
Systematic errors in neutron doses[b]	1.0203	1.1734
Systematic errors in RBE neutron doses[b]	0.9851	0.9848
Model Mixture factor for transfer to US pop	0.0745	0.3925
Ratio of Japanese to U.S. baseline cancer rates	0.3459	0.3266
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1.79983	3.94574

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.485	2.474
Probability of Causation (PC)	32.65	71.22

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.4729	4.3793
ERR/Sv with adjustments		
w/ age adjustment	2.4729	4.3793
w/ latency adjustment	2.4729	4.3793
w/ random errors in dosimetry adj	2.6700	4.8439
w/ systematic errors in dosimetry adj	2.2749	3.5376
adjusted for population transfer	0.8978	2.0904
multiplicative risk model	2.2749	3.5376
additive risk model	0.7869	1.1554
adjusted for smoking history	0.8978	2.0904
adjusted for DDREF	0.8978	2.0904
Final ERR/Sv	0.8978	2.0904
Organ equivalent dose (Sv)	0.539949	1.183722
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.485	2.474
Probability of Causation (PC)	32.65	71.22

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p2_11**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E=30-250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	227	157
Original ERR/Sv	1.6410	2.2400
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0756	0.0869
Systematic errors in gamma doses[b]	1.3685	1.1435
Systematic errors in neutron doses[b]	1.0853	1.1834
Systematic errors in RBE neutron doses[b]	1.0566	0.9721
Model Mixture factor for transfer to US pop	0.2451	0.8715
Ratio of Japanese to U.S. baseline cancer rates	0.3296	0.3449
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	2	0.7
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	3.85604	3.22499

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.054	0.390
Probability of Causation (PC)	5.08	28.08

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.6410	2.2400
ERR/Sv with adjustments		
w/ age adjustment	1.6410	2.2400
w/ latency adjustment	1.6410	2.2400
w/ random errors in dosimetry adj	1.7651	2.4347
w/ systematic errors in dosimetry adj	1.1248	1.8509
adjusted for population transfer	0.5555	1.6951
multiplicative risk model	1.1248	1.8509
additive risk model	0.3707	0.6384
adjusted for smoking history	0.5555	1.6951
adjusted for DDREF	0.2778	2.4216
Final ERR/Sv	0.2778	2.4216
Organ equivalent dose (Sv)	0.192802	0.16125
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.054	0.390
Probability of Causation (PC)	5.08	28.08

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p2_12**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E=30-250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	227	157
Original ERR/Sv	1.6410	2.2400
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0756	0.0869
Systematic errors in gamma doses[b]	1.3685	1.1435
Systematic errors in neutron doses[b]	1.0853	1.1834
Systematic errors in RBE neutron doses[b]	1.0566	0.9721
Model Mixture factor for transfer to US pop	0.2451	0.8715
Ratio of Japanese to U.S. baseline cancer rates	0.3296	0.3449
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	2	0.7
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	3.85604	3.22499

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.321	2.344
Probability of Causation (PC)	24.32	70.09

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.6410	2.2400
ERR/Sv with adjustments		
w/ age adjustment	1.6410	2.2400
w/ latency adjustment	1.6410	2.2400
w/ random errors in dosimetry adj	1.7651	2.4347
w/ systematic errors in dosimetry adj	1.1248	1.8509
adjusted for population transfer	0.5555	1.6951
multiplicative risk model	1.1248	1.8509
additive risk model	0.3707	0.6384
adjusted for smoking history	0.5555	1.6951
adjusted for DDREF	0.2778	2.4216
Final ERR/Sv	0.2778	2.4216
Organ equivalent dose (Sv)	1.156812	0.967497
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.321	2.343
Probability of Causation (PC)	24.32	70.09

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p3_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	790	414
Original ERR/Sv	1.6054	11.6797
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0674	0.0824
Systematic errors in gamma doses[b]	1.0591	1.1505
Systematic errors in neutron doses[b]	1.0960	1.1152
Systematic errors in RBE neutron doses[b]	1.0738	1.0054
Model Mixture factor for transfer to US pop	0.8314	0.2115
Ratio of Japanese to U.S. baseline cancer rates	0.8237	0.9015
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.080	0.584
Probability of Causation (PC)	7.43	36.87

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.6054	11.6797
ERR/Sv with adjustments		
w/ age adjustment	1.6054	11.6797
w/ latency adjustment	1.6054	11.6797
w/ random errors in dosimetry adj	1.6054	11.6797
w/ systematic errors in dosimetry adj	1.6054	11.6797
adjusted for population transfer	1.6054	11.6797
multiplicative risk model	1.6054	11.6797
additive risk model	1.3225	10.5295
adjusted for smoking history	1.6054	11.6797
adjusted for DDREF	1.6054	11.6797
Final ERR/Sv	1.6054	11.6797
Organ equivalent dose (Sv)	0.05	0.05
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.080	0.584
Probability of Causation (PC)	7.43	36.87

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p3_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1102	679
Original ERR/Sv	1.8032	12.4338
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1219	0.1094
Systematic errors in gamma doses[b]	1.2233	1.2719
Systematic errors in neutron doses[b]	1.1344	1.1032
Systematic errors in RBE neutron doses[b]	0.9443	0.9593
Model Mixture factor for transfer to US pop	0.3182	0.9210
Ratio of Japanese to U.S. baseline cancer rates	0.8074	0.8568
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.541	3.730
Probability of Causation (PC)	35.11	78.86

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.8032	12.4338
ERR/Sv with adjustments		
w/ age adjustment	1.8032	12.4338
w/ latency adjustment	1.8032	12.4338
w/ random errors in dosimetry adj	1.8032	12.4338
w/ systematic errors in dosimetry adj	1.8032	12.4338
adjusted for population transfer	1.8032	12.4338
multiplicative risk model	1.8032	12.4338
additive risk model	1.4559	10.6529
adjusted for smoking history	1.8032	12.4338
adjusted for DDREF	1.8032	12.4338
Final ERR/Sv	1.8032	12.4338
Organ equivalent dose (Sv)	0.3	0.3
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.541	3.730
Probability of Causation (PC)	35.11	78.86

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p3_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	548	605
Original ERR/Sv	1.2206	10.6068
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0652	0.1271
Systematic errors in gamma doses[b]	1.0207	1.3331
Systematic errors in neutron doses[b]	1.2289	1.2075
Systematic errors in RBE neutron doses[b]	0.9508	1.0048
Model Mixture factor for transfer to US pop	0.8264	0.1246
Ratio of Japanese to U.S. baseline cancer rates	0.8425	0.9005
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.061	0.530
Probability of Causation (PC)	5.75	34.66

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.2206	10.6068
ERR/Sv with adjustments		
w/ age adjustment	1.2206	10.6068
w/ latency adjustment	1.2206	10.6068
w/ random errors in dosimetry adj	1.2206	10.6068
w/ systematic errors in dosimetry adj	1.2206	10.6068
adjusted for population transfer	1.2206	10.6068
multiplicative risk model	1.2206	10.6068
additive risk model	1.0283	9.5513
adjusted for smoking history	1.2206	10.6068
adjusted for DDREF	1.2206	10.6068
Final ERR/Sv	1.2206	10.6068
Organ equivalent dose (Sv)	0.05	0.05
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.061	0.530
Probability of Causation (PC)	5.75	34.66

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p3_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	548	605
Original ERR/Sv	1.2206	10.6068
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0652	0.1271
Systematic errors in gamma doses[b]	1.0207	1.3331
Systematic errors in neutron doses[b]	1.2289	1.2075
Systematic errors in RBE neutron doses[b]	0.9508	1.0048
Model Mixture factor for transfer to US pop	0.8264	0.1246
Ratio of Japanese to U.S. baseline cancer rates	0.8425	0.9005
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.366	3.183
Probability of Causation (PC)	26.80	76.09

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.2206	10.6068
ERR/Sv with adjustments		
w/ age adjustment	1.2206	10.6068
w/ latency adjustment	1.2206	10.6068
w/ random errors in dosimetry adj	1.2206	10.6068
w/ systematic errors in dosimetry adj	1.2206	10.6068
adjusted for population transfer	1.2206	10.6068
multiplicative risk model	1.2206	10.6068
additive risk model	1.0283	9.5513
adjusted for smoking history	1.2206	10.6068
adjusted for DDREF	1.2206	10.6068
Final ERR/Sv	1.2206	10.6068
Organ equivalent dose (Sv)	0.3	0.3
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.366	3.182
Probability of Causation (PC)	26.80	76.09

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p3_5**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	59	884
Original ERR/Sv	0.6618	0.7539
Adjustment Factors		
Age at exposure, Attained age	2.8088	2.8682
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0988	0.0948
Systematic errors in gamma doses[b]	1.1571	1.1472
Systematic errors in neutron doses[b]	1.2106	1.0827
Systematic errors in RBE neutron doses[b]	1.0112	0.9222
Model Mixture factor for transfer to US pop	0.8495	0.2940
Ratio of Japanese to U.S. baseline cancer rates	1.0934	1.1242
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1.45989	0.735022
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.050	0.153
Probability of Causation (PC)	4.77	13.26

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6618	0.7539
ERR/Sv with adjustments		
w/ age adjustment	1.8589	2.1622
w/ latency adjustment	1.8589	2.1622
w/ random errors in dosimetry adj	2.0426	2.3672
w/ systematic errors in dosimetry adj	1.4421	2.0667
adjusted for population transfer	1.4623	2.2479
multiplicative risk model	1.4421	2.0667
additive risk model	1.5768	2.3234
adjusted for smoking history	1.4623	2.2479
adjusted for DDREF	1.0017	3.0583
Final ERR/Sv	1.0017	3.0583
Organ equivalent dose (Sv)	0.05	0.05
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.050	0.153
Probability of Causation (PC)	4.77	13.26

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p3_6**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	9	696
Original ERR/Sv	0.3770	1.0795
Adjustment Factors		
Age at exposure, Attained age	3.1638	3.0345
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0940	0.1031
Systematic errors in gamma doses[b]	1.0880	1.1456
Systematic errors in neutron doses[b]	1.1132	1.0861
Systematic errors in RBE neutron doses[b]	0.9508	1.0640
Model Mixture factor for transfer to US pop	0.9232	-0.0929
Ratio of Japanese to U.S. baseline cancer rates	1.1143	1.1538
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.343	0.956
Probability of Causation (PC)	25.54	48.88

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.3770	1.0795
ERR/Sv with adjustments		
w/ age adjustment	1.1927	3.2757
w/ latency adjustment	1.1927	3.2757
w/ random errors in dosimetry adj	1.3049	3.6133
w/ systematic errors in dosimetry adj	1.1331	2.7292
adjusted for population transfer	1.1430	3.1879
multiplicative risk model	1.1331	2.7292
additive risk model	1.2626	3.1489
adjusted for smoking history	1.1430	3.1879
adjusted for DDREF	1.1430	3.1879
Final ERR/Sv	1.1430	3.1879
Organ equivalent dose (Sv)	0.3	0.3
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.343	0.956
Probability of Causation (PC)	25.54	48.88

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p3_7**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	965	170
Original ERR/Sv	0.5957	0.7732
Adjustment Factors		
Age at exposure, Attained age	2.5536	2.4700
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0882	0.0738
Systematic errors in gamma doses[b]	1.0737	1.2620
Systematic errors in neutron doses[b]	1.0794	1.1310
Systematic errors in RBE neutron doses[b]	1.0961	0.9808
Model Mixture factor for transfer to US pop	0.6108	0.4277
Ratio of Japanese to U.S. baseline cancer rates	1.1488	1.1088
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	2	0.5
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.034	0.156
Probability of Causation (PC)	3.33	13.47

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5957	0.7732
ERR/Sv with adjustments		
w/ age adjustment	1.5211	1.9099
w/ latency adjustment	1.5211	1.9099
w/ random errors in dosimetry adj	1.6552	2.0509
w/ systematic errors in dosimetry adj	1.3030	1.4652
adjusted for population transfer	1.3784	1.5564
multiplicative risk model	1.3030	1.4652
additive risk model	1.4969	1.6246
adjusted for smoking history	1.3784	1.5564
adjusted for DDREF	0.6892	3.1128
Final ERR/Sv	0.6892	3.1128
Organ equivalent dose (Sv)	0.05	0.05
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.034	0.156
Probability of Causation (PC)	3.33	13.47

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p3_8**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	965	170
Original ERR/Sv	0.5957	0.7732
Adjustment Factors		
Age at exposure, Attained age	2.5536	2.4700
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0882	0.0738
Systematic errors in gamma doses[b]	1.0737	1.2620
Systematic errors in neutron doses[b]	1.0794	1.1310
Systematic errors in RBE neutron doses[b]	1.0961	0.9808
Model Mixture factor for transfer to US pop	0.6108	0.4277
Ratio of Japanese to U.S. baseline cancer rates	1.1488	1.1088
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	2	0.5
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.207	0.934
Probability of Causation (PC)	17.13	48.29

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5957	0.7732
ERR/Sv with adjustments		
w/ age adjustment	1.5211	1.9099
w/ latency adjustment	1.5211	1.9099
w/ random errors in dosimetry adj	1.6552	2.0509
w/ systematic errors in dosimetry adj	1.3030	1.4652
adjusted for population transfer	1.3784	1.5564
multiplicative risk model	1.3030	1.4652
additive risk model	1.4969	1.6246
adjusted for smoking history	1.3784	1.5564
adjusted for DDREF	0.6892	3.1128
Final ERR/Sv	0.6892	3.1128
Organ equivalent dose (Sv)	0.3	0.3
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.207	0.934
Probability of Causation (PC)	17.13	48.29

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p3_9**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	788	231
Original ERR/Sv	2.4376	3.1266
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0993	0.0898
Systematic errors in gamma doses[b]	1.1376	1.3255
Systematic errors in neutron doses[b]	1.0768	1.0747
Systematic errors in RBE neutron doses[b]	1.0039	0.9074
Model Mixture factor for transfer to US pop	0.0000	0.9518
Ratio of Japanese to U.S. baseline cancer rates	0.3359	0.3294
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.037	0.128
Probability of Causation (PC)	3.53	11.31

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.4376	3.1266
ERR/Sv with adjustments		
w/ age adjustment	2.4376	3.1266
w/ latency adjustment	2.4376	3.1266
w/ random errors in dosimetry adj	2.6797	3.4074
w/ systematic errors in dosimetry adj	2.1791	2.6362
adjusted for population transfer	0.7320	2.5510
multiplicative risk model	2.1791	2.6362
additive risk model	0.7320	0.8684
adjusted for smoking history	0.7320	2.5510
adjusted for DDREF	0.7320	2.5510
Final ERR/Sv	0.7320	2.5510
Organ equivalent dose (Sv)	0.05	0.05
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.037	0.128
Probability of Causation (PC)	3.53	11.31

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p3_10**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	558	6
Original ERR/Sv	2.7245	2.9301
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0966	0.1071
Systematic errors in gamma doses[b]	1.2018	1.1609
Systematic errors in neutron doses[b]	1.1199	1.0821
Systematic errors in RBE neutron doses[b]	0.9459	1.0038
Model Mixture factor for transfer to US pop	0.0000	1.0587
Ratio of Japanese to U.S. baseline cancer rates	0.3413	0.3385
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.240	0.802
Probability of Causation (PC)	19.37	44.50

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.7245	2.9301
ERR/Sv with adjustments		
w/ age adjustment	2.7245	2.9301
w/ latency adjustment	2.7245	2.9301
w/ random errors in dosimetry adj	2.9878	3.2439
w/ systematic errors in dosimetry adj	2.3469	2.5724
adjusted for population transfer	0.8009	2.6724
multiplicative risk model	2.3469	2.5724
additive risk model	0.8009	0.8707
adjusted for smoking history	0.8009	2.6724
adjusted for DDREF	0.8009	2.6724
Final ERR/Sv	0.8009	2.6724
Organ equivalent dose (Sv)	0.3	0.3
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.240	0.802
Probability of Causation (PC)	19.37	44.50

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p3_11**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	259	273
Original ERR/Sv	1.7740	2.0978
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0806	0.0688
Systematic errors in gamma doses[b]	1.0444	1.0758
Systematic errors in neutron doses[b]	1.1114	1.1710
Systematic errors in RBE neutron doses[b]	0.9150	0.9779
Model Mixture factor for transfer to US pop	0.0000	1.0205
Ratio of Japanese to U.S. baseline cancer rates	0.3266	0.3388
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	0.7
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.029	0.132
Probability of Causation (PC)	2.86	11.64

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.7740	2.0978
ERR/Sv with adjustments		
w/ age adjustment	1.7740	2.0978
w/ latency adjustment	1.7740	2.0978
w/ random errors in dosimetry adj	1.9170	2.2421
w/ systematic errors in dosimetry adj	1.8050	1.8199
adjusted for population transfer	0.5895	1.8446
multiplicative risk model	1.8050	1.8199
additive risk model	0.5895	0.6166
adjusted for smoking history	0.5895	1.8446
adjusted for DDREF	0.5895	2.6351
Final ERR/Sv	0.5895	2.6351
Organ equivalent dose (Sv)	0.05	0.05
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.029	0.132
Probability of Causation (PC)	2.86	11.64

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_p3_12**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	259	273
Original ERR/Sv	1.7740	2.0978
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0806	0.0688
Systematic errors in gamma doses[b]	1.0444	1.0758
Systematic errors in neutron doses[b]	1.1114	1.1710
Systematic errors in RBE neutron doses[b]	0.9150	0.9779
Model Mixture factor for transfer to US pop	0.0000	1.0205
Ratio of Japanese to U.S. baseline cancer rates	0.3266	0.3388
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	0.7
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.177	0.791
Probability of Causation (PC)	15.03	44.15

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.7740	2.0978
ERR/Sv with adjustments		
w/ age adjustment	1.7740	2.0978
w/ latency adjustment	1.7740	2.0978
w/ random errors in dosimetry adj	1.9170	2.2421
w/ systematic errors in dosimetry adj	1.8050	1.8199
adjusted for population transfer	0.5895	1.8446
multiplicative risk model	1.8050	1.8199
additive risk model	0.5895	0.6166
adjusted for smoking history	0.5895	1.8446
adjusted for DDREF	0.5895	2.6351
Final ERR/Sv	0.5895	2.6351
Organ equivalent dose (Sv)	0.3	0.3
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.177	0.791
Probability of Causation (PC)	15.03	44.15

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n1_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E<10keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	394	958
Original ERR/Sv	1.8801	5.3485
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0741	0.1021
Systematic errors in gamma doses[b]	1.1734	1.1686
Systematic errors in neutron doses[b]	1.1538	1.1533
Systematic errors in RBE neutron doses[b]	1.0592	1.0643
Model Mixture factor for transfer to US pop	0.0564	0.2346
Ratio of Japanese to U.S. baseline cancer rates	0.8768	0.8952
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	1.9914	9.7896

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.037	0.524
Probability of Causation (PC)	3.61	34.37

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.8801	5.3485
ERR/Sv with adjustments		
w/ age adjustment	1.8801	5.3485
w/ latency adjustment	1.8801	5.3485
w/ random errors in dosimetry adj	1.8801	5.3485
w/ systematic errors in dosimetry adj	1.8801	5.3485
adjusted for population transfer	1.8801	5.3485
multiplicative risk model	1.8801	5.3485
additive risk model	1.6484	4.7882
adjusted for smoking history	1.8801	5.3485
adjusted for DDREF	1.8801	5.3485
Final ERR/Sv	1.8801	5.3485
Organ equivalent dose (Sv)	0.019914	0.097896
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.037	0.524
Probability of Causation (PC)	3.61	34.37

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n1_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E<10keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	394	958
Original ERR/Sv	1.8801	5.3485
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0741	0.1021
Systematic errors in gamma doses[b]	1.1734	1.1686
Systematic errors in neutron doses[b]	1.1538	1.1533
Systematic errors in RBE neutron doses[b]	1.0592	1.0643
Model Mixture factor for transfer to US pop	0.0564	0.2346
Ratio of Japanese to U.S. baseline cancer rates	0.8768	0.8952
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	1.9914	9.7896

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.225	3.142
Probability of Causation (PC)	18.34	75.85

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.8801	5.3485
ERR/Sv with adjustments		
w/ age adjustment	1.8801	5.3485
w/ latency adjustment	1.8801	5.3485
w/ random errors in dosimetry adj	1.8801	5.3485
w/ systematic errors in dosimetry adj	1.8801	5.3485
adjusted for population transfer	1.8801	5.3485
multiplicative risk model	1.8801	5.3485
additive risk model	1.6484	4.7882
adjusted for smoking history	1.8801	5.3485
adjusted for DDREF	1.8801	5.3485
Final ERR/Sv	1.8801	5.3485
Organ equivalent dose (Sv)	0.119484	0.587376
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.225	3.142
Probability of Causation (PC)	18.34	75.85

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n1_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E<10keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	508	1010
Original ERR/Sv	2.7489	16.8661
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0859	0.1109
Systematic errors in gamma doses[b]	1.1741	1.2603
Systematic errors in neutron doses[b]	1.1024	1.1297
Systematic errors in RBE neutron doses[b]	1.0473	1.0579
Model Mixture factor for transfer to US pop	0.4007	0.7406
Ratio of Japanese to U.S. baseline cancer rates	0.8833	0.8759
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	1.85573	5.2008

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.051	0.877
Probability of Causation (PC)	4.85	46.73

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.7489	16.8661
ERR/Sv with adjustments		
w/ age adjustment	2.7489	16.8661
w/ latency adjustment	2.7489	16.8661
w/ random errors in dosimetry adj	2.7489	16.8661
w/ systematic errors in dosimetry adj	2.7489	16.8661
adjusted for population transfer	2.7489	16.8661
multiplicative risk model	2.7489	16.8661
additive risk model	2.4281	14.7730
adjusted for smoking history	2.7489	16.8661
adjusted for DDREF	2.7489	16.8661
Final ERR/Sv	2.7489	16.8661
Organ equivalent dose (Sv)	0.018557	0.052008
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.051	0.877
Probability of Causation (PC)	4.85	46.73

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n1_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E<10keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	508	1010
Original ERR/Sv	2.7489	16.8661
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0859	0.1109
Systematic errors in gamma doses[b]	1.1741	1.2603
Systematic errors in neutron doses[b]	1.1024	1.1297
Systematic errors in RBE neutron doses[b]	1.0473	1.0579
Model Mixture factor for transfer to US pop	0.4007	0.7406
Ratio of Japanese to U.S. baseline cancer rates	0.8833	0.8759
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	1.85573	5.2008

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.306	5.263
Probability of Causation (PC)	23.43	84.03

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.7489	16.8661
ERR/Sv with adjustments		
w/ age adjustment	2.7489	16.8661
w/ latency adjustment	2.7489	16.8661
w/ random errors in dosimetry adj	2.7489	16.8661
w/ systematic errors in dosimetry adj	2.7489	16.8661
adjusted for population transfer	2.7489	16.8661
multiplicative risk model	2.7489	16.8661
additive risk model	2.4281	14.7730
adjusted for smoking history	2.7489	16.8661
adjusted for DDREF	2.7489	16.8661
Final ERR/Sv	2.7489	16.8661
Organ equivalent dose (Sv)	0.111344	0.312048
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.306	5.263
Probability of Causation (PC)	23.43	84.03

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n1_5**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E<10keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	598	1860
Original ERR/Sv	0.5684	0.9772
Adjustment Factors		
Age at exposure, Attained age	2.8842	2.8812
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0609	0.0708
Systematic errors in gamma doses[b]	1.0084	1.1318
Systematic errors in neutron doses[b]	1.2024	1.1584
Systematic errors in RBE neutron doses[b]	1.0384	1.0082
Model Mixture factor for transfer to US pop	0.9023	0.1087
Ratio of Japanese to U.S. baseline cancer rates	1.0547	1.1275
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	1.57945	7.5624

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.022	0.192
Probability of Causation (PC)	2.15	16.11

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5684	0.9772
ERR/Sv with adjustments		
w/ age adjustment	1.6394	2.8154
w/ latency adjustment	1.6394	2.8154
w/ random errors in dosimetry adj	1.7393	3.0149
w/ systematic errors in dosimetry adj	1.3815	2.2808
adjusted for population transfer	1.3889	2.5399
multiplicative risk model	1.3815	2.2808
additive risk model	1.4570	2.5715
adjusted for smoking history	1.3889	2.5399
adjusted for DDREF	1.3889	2.5399
Final ERR/Sv	1.3889	2.5399
Organ equivalent dose (Sv)	0.015795	0.075624
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.022	0.192
Probability of Causation (PC)	2.15	16.11

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n1_6**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E<10keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	598	1860
Original ERR/Sv	0.5684	0.9772
Adjustment Factors		
Age at exposure, Attained age	2.8842	2.8812
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0609	0.0708
Systematic errors in gamma doses[b]	1.0084	1.1318
Systematic errors in neutron doses[b]	1.2024	1.1584
Systematic errors in RBE neutron doses[b]	1.0384	1.0082
Model Mixture factor for transfer to US pop	0.9023	0.1087
Ratio of Japanese to U.S. baseline cancer rates	1.0547	1.1275
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	1.57945	7.5624

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.132	1.152
Probability of Causation (PC)	11.63	53.54

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5684	0.9772
ERR/Sv with adjustments		
w/ age adjustment	1.6394	2.8154
w/ latency adjustment	1.6394	2.8154
w/ random errors in dosimetry adj	1.7393	3.0149
w/ systematic errors in dosimetry adj	1.3815	2.2808
adjusted for population transfer	1.3889	2.5399
multiplicative risk model	1.3815	2.2808
additive risk model	1.4570	2.5715
adjusted for smoking history	1.3889	2.5399
adjusted for DDREF	1.3889	2.5399
Final ERR/Sv	1.3889	2.5399
Organ equivalent dose (Sv)	0.094767	0.453744
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.132	1.152
Probability of Causation (PC)	11.63	53.54

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n1_7**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E<10keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1841	695
Original ERR/Sv	1.0539	1.4381
Adjustment Factors		
Age at exposure, Attained age	2.5868	2.4267
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1036	0.0711
Systematic errors in gamma doses[b]	1.1265	1.1203
Systematic errors in neutron doses[b]	1.1562	1.1700
Systematic errors in RBE neutron doses[b]	0.9531	1.0036
Model Mixture factor for transfer to US pop	0.7082	0.4442
Ratio of Japanese to U.S. baseline cancer rates	1.1403	1.1330
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	1.17055	10.5672

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.030	0.322
Probability of Causation (PC)	2.87	24.38

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.0539	1.4381
ERR/Sv with adjustments		
w/ age adjustment	2.7262	3.4898
w/ latency adjustment	2.7262	3.4898
w/ random errors in dosimetry adj	3.0087	3.7378
w/ systematic errors in dosimetry adj	2.4238	2.8414
adjusted for population transfer	2.5230	3.0515
multiplicative risk model	2.4238	2.8414
additive risk model	2.7637	3.2194
adjusted for smoking history	2.5230	3.0515
adjusted for DDREF	2.5230	3.0515
Final ERR/Sv	2.5230	3.0515
Organ equivalent dose (Sv)	0.011706	0.105672
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.030	0.322
Probability of Causation (PC)	2.87	24.38

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n1_8**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E<10keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1841	695
Original ERR/Sv	1.0539	1.4381
Adjustment Factors		
Age at exposure, Attained age	2.5868	2.4267
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1036	0.0711
Systematic errors in gamma doses[b]	1.1265	1.1203
Systematic errors in neutron doses[b]	1.1562	1.1700
Systematic errors in RBE neutron doses[b]	0.9531	1.0036
Model Mixture factor for transfer to US pop	0.7082	0.4442
Ratio of Japanese to U.S. baseline cancer rates	1.1403	1.1330
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	1.17055	10.5672

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.177	1.935
Probability of Causation (PC)	15.05	65.93

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.0539	1.4381
ERR/Sv with adjustments		
w/ age adjustment	2.7262	3.4898
w/ latency adjustment	2.7262	3.4898
w/ random errors in dosimetry adj	3.0087	3.7378
w/ systematic errors in dosimetry adj	2.4238	2.8414
adjusted for population transfer	2.5230	3.0515
multiplicative risk model	2.4238	2.8414
additive risk model	2.7637	3.2194
adjusted for smoking history	2.5230	3.0515
adjusted for DDREF	2.5230	3.0515
Final ERR/Sv	2.5230	3.0515
Organ equivalent dose (Sv)	0.070233	0.634032
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.177	1.935
Probability of Causation (PC)	15.05	65.93

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n1_9**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E<10keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	989	734
Original ERR/Sv	1.6517	1.7153
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1043	0.1057
Systematic errors in gamma doses[b]	1.2034	1.0863
Systematic errors in neutron doses[b]	1.1274	1.1530
Systematic errors in RBE neutron doses[b]	1.0119	0.9371
Model Mixture factor for transfer to US pop	0.9216	1.0421
Ratio of Japanese to U.S. baseline cancer rates	0.3362	0.3230
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	1.34695	9.8568

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.017	0.164
Probability of Causation (PC)	1.67	14.08

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.6517	1.7153
ERR/Sv with adjustments		
w/ age adjustment	1.6517	1.7153
w/ latency adjustment	1.6517	1.7153
w/ random errors in dosimetry adj	1.8240	1.8966
w/ systematic errors in dosimetry adj	1.3287	1.6160
adjusted for population transfer	1.2596	1.6620
multiplicative risk model	1.3287	1.6160
additive risk model	0.4467	0.5219
adjusted for smoking history	1.2596	1.6620
adjusted for DDREF	1.2596	1.6620
Final ERR/Sv	1.2596	1.6620
Organ equivalent dose (Sv)	0.01347	0.098568
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.017	0.164
Probability of Causation (PC)	1.67	14.08

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n1_10**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E<10keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1334	734
Original ERR/Sv	2.8504	1.7153
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0699	0.1057
Systematic errors in gamma doses[b]	1.1344	1.0863
Systematic errors in neutron doses[b]	1.1378	1.1530
Systematic errors in RBE neutron doses[b]	0.9920	0.9371
Model Mixture factor for transfer to US pop	0.3507	1.0421
Ratio of Japanese to U.S. baseline cancer rates	0.3517	0.3230
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	1.22995	9.8568

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.102	0.983
Probability of Causation (PC)	9.24	49.57

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.8504	1.7153
ERR/Sv with adjustments		
w/ age adjustment	2.8504	1.7153
w/ latency adjustment	2.8504	1.7153
w/ random errors in dosimetry adj	3.0495	1.8966
w/ systematic errors in dosimetry adj	2.3818	1.6160
adjusted for population transfer	1.3792	1.6620
multiplicative risk model	2.3818	1.6160
additive risk model	0.8377	0.5219
adjusted for smoking history	1.3792	1.6620
adjusted for DDREF	1.3792	1.6620
Final ERR/Sv	1.3792	1.6620
Organ equivalent dose (Sv)	0.073797	0.591408
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.102	0.983
Probability of Causation (PC)	9.24	49.57

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n1_11**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E<10keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	739	1670
Original ERR/Sv	2.7804	2.5360
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1015	0.0928
Systematic errors in gamma doses[b]	1.3019	1.1308
Systematic errors in neutron doses[b]	1.1329	1.0792
Systematic errors in RBE neutron doses[b]	0.9948	1.0382
Model Mixture factor for transfer to US pop	0.0000	0.3276
Ratio of Japanese to U.S. baseline cancer rates	0.3357	0.3204
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	3.3429	21.1536

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.023	0.251
Probability of Causation (PC)	2.29	20.08

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.7804	2.5360
ERR/Sv with adjustments		
w/ age adjustment	2.7804	2.5360
w/ latency adjustment	2.7804	2.5360
w/ random errors in dosimetry adj	3.0625	2.7713
w/ systematic errors in dosimetry adj	2.0872	2.1871
adjusted for population transfer	0.7007	1.1876
multiplicative risk model	2.0872	2.1871
additive risk model	0.7007	0.7007
adjusted for smoking history	0.7007	1.1876
adjusted for DDREF	0.7007	1.1876
Final ERR/Sv	0.7007	1.1876
Organ equivalent dose (Sv)	0.033429	0.211536
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.023	0.251
Probability of Causation (PC)	2.29	20.08

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n1_12**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E<10keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1677	1670
Original ERR/Sv	2.3761	2.5360
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0671	0.0928
Systematic errors in gamma doses[b]	1.3633	1.1308
Systematic errors in neutron doses[b]	1.1657	1.0792
Systematic errors in RBE neutron doses[b]	0.9583	1.0382
Model Mixture factor for transfer to US pop	0.0000	0.3276
Ratio of Japanese to U.S. baseline cancer rates	0.3421	0.3204
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	4.1124	21.1536

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.141	1.507
Probability of Causation (PC)	12.32	60.12

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.3761	2.5360
ERR/Sv with adjustments		
w/ age adjustment	2.3761	2.5360
w/ latency adjustment	2.3761	2.5360
w/ random errors in dosimetry adj	2.5356	2.7713
w/ systematic errors in dosimetry adj	1.6651	2.1871
adjusted for population transfer	0.5696	1.1876
multiplicative risk model	1.6651	2.1871
additive risk model	0.5696	0.7007
adjusted for smoking history	0.5696	1.1876
adjusted for DDREF	0.5696	1.1876
Final ERR/Sv	0.5696	1.1876
Organ equivalent dose (Sv)	0.246744	1.269216
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.141	1.507
Probability of Causation (PC)	12.32	60.12

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n2_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=10-100keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1196	305
Original ERR/Sv	1.6565	5.7326
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1043	0.0746
Systematic errors in gamma doses[b]	1.1498	1.0803
Systematic errors in neutron doses[b]	1.1741	1.1978
Systematic errors in RBE neutron doses[b]	1.0434	0.9420
Model Mixture factor for transfer to US pop	0.5465	0.3369
Ratio of Japanese to U.S. baseline cancer rates	1.0307	0.9900
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	4.2635	16.2687

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.035	0.466
Probability of Causation (PC)	3.41	31.80

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.6565	5.7326
ERR/Sv with adjustments		
w/ age adjustment	1.6565	5.7326
w/ latency adjustment	1.6565	5.7326
w/ random errors in dosimetry adj	1.6565	5.7326
w/ systematic errors in dosimetry adj	1.6565	5.7326
adjusted for population transfer	1.6565	5.7326
multiplicative risk model	1.6565	5.7326
additive risk model	1.7074	5.6752
adjusted for smoking history	1.6565	5.7326
adjusted for DDREF	1.6565	5.7326
Final ERR/Sv	1.6565	5.7326
Organ equivalent dose (Sv)	0.021318	0.081344
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.035	0.466
Probability of Causation (PC)	3.41	31.80

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n2_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=10-100keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1196	305
Original ERR/Sv	1.6565	5.7326
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1043	0.0746
Systematic errors in gamma doses[b]	1.1498	1.0803
Systematic errors in neutron doses[b]	1.1741	1.1978
Systematic errors in RBE neutron doses[b]	1.0434	0.9420
Model Mixture factor for transfer to US pop	0.5465	0.3369
Ratio of Japanese to U.S. baseline cancer rates	1.0307	0.9900
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	4.2635	16.2687

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.212	2.798
Probability of Causation (PC)	17.48	73.67

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.6565	5.7326
ERR/Sv with adjustments		
w/ age adjustment	1.6565	5.7326
w/ latency adjustment	1.6565	5.7326
w/ random errors in dosimetry adj	1.6565	5.7326
w/ systematic errors in dosimetry adj	1.6565	5.7326
adjusted for population transfer	1.6565	5.7326
multiplicative risk model	1.6565	5.7326
additive risk model	1.7074	5.6752
adjusted for smoking history	1.6565	5.7326
adjusted for DDREF	1.6565	5.7326
Final ERR/Sv	1.6565	5.7326
Organ equivalent dose (Sv)	0.127905	0.488061
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.212	2.798
Probability of Causation (PC)	17.48	73.67

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n2_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=10-100keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1118	455
Original ERR/Sv	4.4005	4.2668
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0836	0.0853
Systematic errors in gamma doses[b]	1.1436	1.3378
Systematic errors in neutron doses[b]	1.1787	1.0701
Systematic errors in RBE neutron doses[b]	0.9990	0.9984
Model Mixture factor for transfer to US pop	1.0002	0.7478
Ratio of Japanese to U.S. baseline cancer rates	0.8912	0.8499
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	2.067	33.4075

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.045	0.713
Probability of Causation (PC)	4.35	41.61

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	4.4005	4.2668
ERR/Sv with adjustments		
w/ age adjustment	4.4005	4.2668
w/ latency adjustment	4.4005	4.2668
w/ random errors in dosimetry adj	4.4005	4.2668
w/ systematic errors in dosimetry adj	4.4005	4.2668
adjusted for population transfer	4.4005	4.2668
multiplicative risk model	4.4005	4.2668
additive risk model	3.9219	3.6263
adjusted for smoking history	4.4005	4.2668
adjusted for DDREF	4.4005	4.2668
Final ERR/Sv	4.4005	4.2668
Organ equivalent dose (Sv)	0.010335	0.167038
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.045	0.713
Probability of Causation (PC)	4.35	41.61

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n2_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=10-100keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1118	455
Original ERR/Sv	4.4005	4.2668
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0836	0.0853
Systematic errors in gamma doses[b]	1.1436	1.3378
Systematic errors in neutron doses[b]	1.1787	1.0701
Systematic errors in RBE neutron doses[b]	0.9990	0.9984
Model Mixture factor for transfer to US pop	1.0002	0.7478
Ratio of Japanese to U.S. baseline cancer rates	0.8912	0.8499
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	2.067	33.4075

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.273	4.277
Probability of Causation (PC)	21.44	81.05

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	4.4005	4.2668
ERR/Sv with adjustments		
w/ age adjustment	4.4005	4.2668
w/ latency adjustment	4.4005	4.2668
w/ random errors in dosimetry adj	4.4005	4.2668
w/ systematic errors in dosimetry adj	4.4005	4.2668
adjusted for population transfer	4.4005	4.2668
multiplicative risk model	4.4005	4.2668
additive risk model	3.9219	3.6263
adjusted for smoking history	4.4005	4.2668
adjusted for DDREF	4.4005	4.2668
Final ERR/Sv	4.4005	4.2668
Organ equivalent dose (Sv)	0.06201	1.002225
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.273	4.276
Probability of Causation (PC)	21.44	81.05

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n2_5**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=10-100keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1544	1522
Original ERR/Sv	0.4755	0.9747
Adjustment Factors		
Age at exposure, Attained age	2.2541	3.0469
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1047	0.0859
Systematic errors in gamma doses[b]	1.1994	1.0911
Systematic errors in neutron doses[b]	1.0822	1.0725
Systematic errors in RBE neutron doses[b]	1.0532	0.9942
Model Mixture factor for transfer to US pop	0.4497	0.2467
Ratio of Japanese to U.S. baseline cancer rates	1.1004	1.0967
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	4.6205	12.6988

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.021	0.189
Probability of Causation (PC)	2.07	15.88

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4755	0.9747
ERR/Sv with adjustments		
w/ age adjustment	1.0718	2.9697
w/ latency adjustment	1.0718	2.9697
w/ random errors in dosimetry adj	1.1839	3.2247
w/ systematic errors in dosimetry adj	0.8661	2.7719
adjusted for population transfer	0.9139	2.9737
multiplicative risk model	0.8661	2.7719
additive risk model	0.9530	3.0398
adjusted for smoking history	0.9139	2.9737
adjusted for DDREF	0.9139	2.9737
Final ERR/Sv	0.9139	2.9737
Organ equivalent dose (Sv)	0.023103	0.063494
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.021	0.189
Probability of Causation (PC)	2.07	15.88

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n2_6**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=10-100keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1544	1522
Original ERR/Sv	0.4755	0.9747
Adjustment Factors		
Age at exposure, Attained age	2.2541	3.0469
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1047	0.0859
Systematic errors in gamma doses[b]	1.1994	1.0911
Systematic errors in neutron doses[b]	1.0822	1.0725
Systematic errors in RBE neutron doses[b]	1.0532	0.9942
Model Mixture factor for transfer to US pop	0.4497	0.2467
Ratio of Japanese to U.S. baseline cancer rates	1.1004	1.0967
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	4.6205	12.6988

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.127	1.133
Probability of Causation (PC)	11.24	53.11

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4755	0.9747
ERR/Sv with adjustments		
w/ age adjustment	1.0718	2.9697
w/ latency adjustment	1.0718	2.9697
w/ random errors in dosimetry adj	1.1839	3.2247
w/ systematic errors in dosimetry adj	0.8661	2.7719
adjusted for population transfer	0.9139	2.9737
multiplicative risk model	0.8661	2.7719
additive risk model	0.9530	3.0398
adjusted for smoking history	0.9139	2.9737
adjusted for DDREF	0.9139	2.9737
Final ERR/Sv	0.9139	2.9737
Organ equivalent dose (Sv)	0.138615	0.380964
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.127	1.133
Probability of Causation (PC)	11.24	53.11

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n2_7**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=10-100keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	836	1983
Original ERR/Sv	0.6472	0.6421
Adjustment Factors		
Age at exposure, Attained age	2.3423	2.2287
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1045	0.0785
Systematic errors in gamma doses[b]	1.0813	1.1324
Systematic errors in neutron doses[b]	1.0119	1.0973
Systematic errors in RBE neutron doses[b]	1.0015	1.0345
Model Mixture factor for transfer to US pop	0.0482	0.8187
Ratio of Japanese to U.S. baseline cancer rates	1.0916	1.1006
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	3.3185	45.2512

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.028	0.277
Probability of Causation (PC)	2.68	21.67

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6472	0.6421
ERR/Sv with adjustments		
w/ age adjustment	1.5159	1.4310
w/ latency adjustment	1.5159	1.4310
w/ random errors in dosimetry adj	1.6743	1.5433
w/ systematic errors in dosimetry adj	1.5278	1.2006
adjusted for population transfer	1.6611	1.2225
multiplicative risk model	1.5278	1.2006
additive risk model	1.6678	1.3215
adjusted for smoking history	1.6611	1.2225
adjusted for DDREF	1.6611	1.2225
Final ERR/Sv	1.6611	1.2225
Organ equivalent dose (Sv)	0.016593	0.226256
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.028	0.277
Probability of Causation (PC)	2.68	21.67

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n2_8**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=10-100keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	836	1983
Original ERR/Sv	0.6472	0.6421
Adjustment Factors		
Age at exposure, Attained age	2.3423	2.2287
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1045	0.0785
Systematic errors in gamma doses[b]	1.0813	1.1324
Systematic errors in neutron doses[b]	1.0119	1.0973
Systematic errors in RBE neutron doses[b]	1.0015	1.0345
Model Mixture factor for transfer to US pop	0.0482	0.8187
Ratio of Japanese to U.S. baseline cancer rates	1.0916	1.1006
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	3.3185	45.2512

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.165	1.660
Probability of Causation (PC)	14.19	62.40

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6472	0.6421
ERR/Sv with adjustments		
w/ age adjustment	1.5159	1.4310
w/ latency adjustment	1.5159	1.4310
w/ random errors in dosimetry adj	1.6743	1.5433
w/ systematic errors in dosimetry adj	1.5278	1.2006
adjusted for population transfer	1.6611	1.2225
multiplicative risk model	1.5278	1.2006
additive risk model	1.6678	1.3215
adjusted for smoking history	1.6611	1.2225
adjusted for DDREF	1.6611	1.2225
Final ERR/Sv	1.6611	1.2225
Organ equivalent dose (Sv)	0.099555	1.357536
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.165	1.660
Probability of Causation (PC)	14.19	62.40

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n2_9**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=10-100keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	554	61
Original ERR/Sv	2.1413	2.6722
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0922	0.1142
Systematic errors in gamma doses[b]	1.0404	1.1304
Systematic errors in neutron doses[b]	1.1168	1.1273
Systematic errors in RBE neutron doses[b]	0.9522	0.9921
Model Mixture factor for transfer to US pop	0.0000	0.9815
Ratio of Japanese to U.S. baseline cancer rates	0.3440	0.3285
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	4.3355	13.2088

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.016	0.154
Probability of Causation (PC)	1.55	13.32

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.1413	2.6722
ERR/Sv with adjustments		
w/ age adjustment	2.1413	2.6722
w/ latency adjustment	2.1413	2.6722
w/ random errors in dosimetry adj	2.3388	2.9774
w/ systematic errors in dosimetry adj	2.1139	2.3552
adjusted for population transfer	0.7271	2.3259
multiplicative risk model	2.1139	2.3552
additive risk model	0.7271	0.7737
adjusted for smoking history	0.7271	2.3259
adjusted for DDREF	0.7271	2.3259
Final ERR/Sv	0.7271	2.3259
Organ equivalent dose (Sv)	0.021678	0.066044
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.016	0.154
Probability of Causation (PC)	1.55	13.32

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n2_10**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=10-100keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	554	61
Original ERR/Sv	2.1413	2.6722
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0922	0.1142
Systematic errors in gamma doses[b]	1.0404	1.1304
Systematic errors in neutron doses[b]	1.1168	1.1273
Systematic errors in RBE neutron doses[b]	0.9522	0.9921
Model Mixture factor for transfer to US pop	0.0000	0.9815
Ratio of Japanese to U.S. baseline cancer rates	0.3440	0.3285
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	4.3355	13.2088

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.095	0.922
Probability of Causation (PC)	8.64	47.96

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.1413	2.6722
ERR/Sv with adjustments		
w/ age adjustment	2.1413	2.6722
w/ latency adjustment	2.1413	2.6722
w/ random errors in dosimetry adj	2.3388	2.9774
w/ systematic errors in dosimetry adj	2.1139	2.3552
adjusted for population transfer	0.7271	2.3259
multiplicative risk model	2.1139	2.3552
additive risk model	0.7271	0.7737
adjusted for smoking history	0.7271	2.3259
adjusted for DDREF	0.7271	2.3259
Final ERR/Sv	0.7271	2.3259
Organ equivalent dose (Sv)	0.130065	0.396264
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.095	0.922
Probability of Causation (PC)	8.64	47.96

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n2_11**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=10-100keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	438	1175
Original ERR/Sv	2.1238	2.1512
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0747	0.1042
Systematic errors in gamma doses[b]	1.0549	1.1171
Systematic errors in neutron doses[b]	1.2076	1.2374
Systematic errors in RBE neutron doses[b]	0.9823	1.0370
Model Mixture factor for transfer to US pop	0.0000	1.0145
Ratio of Japanese to U.S. baseline cancer rates	0.3367	0.3245
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	6.99125	27.6788

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.021	0.232
Probability of Causation (PC)	2.10	18.80

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.1238	2.1512
ERR/Sv with adjustments		
w/ age adjustment	2.1238	2.1512
w/ latency adjustment	2.1238	2.1512
w/ random errors in dosimetry adj	2.2824	2.3754
w/ systematic errors in dosimetry adj	1.8241	1.6571
adjusted for population transfer	0.6142	1.6733
multiplicative risk model	1.8241	1.6571
additive risk model	0.6142	0.5378
adjusted for smoking history	0.6142	1.6733
adjusted for DDREF	0.6142	1.6733
Final ERR/Sv	0.6142	1.6733
Organ equivalent dose (Sv)	0.034956	0.138394
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.021	0.232
Probability of Causation (PC)	2.10	18.80

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n2_12**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=10-100keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	438	1175
Original ERR/Sv	2.1238	2.1512
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0747	0.1042
Systematic errors in gamma doses[b]	1.0549	1.1171
Systematic errors in neutron doses[b]	1.2076	1.2374
Systematic errors in RBE neutron doses[b]	0.9823	1.0370
Model Mixture factor for transfer to US pop	0.0000	1.0145
Ratio of Japanese to U.S. baseline cancer rates	0.3367	0.3245
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	6.99125	27.6788

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.129	1.390
Probability of Causation (PC)	11.41	58.15

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.1238	2.1512
ERR/Sv with adjustments		
w/ age adjustment	2.1238	2.1512
w/ latency adjustment	2.1238	2.1512
w/ random errors in dosimetry adj	2.2824	2.3754
w/ systematic errors in dosimetry adj	1.8241	1.6571
adjusted for population transfer	0.6142	1.6733
multiplicative risk model	1.8241	1.6571
additive risk model	0.6142	0.5378
adjusted for smoking history	0.6142	1.6733
adjusted for DDREF	0.6142	1.6733
Final ERR/Sv	0.6142	1.6733
Organ equivalent dose (Sv)	0.209738	0.830364
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.129	1.389
Probability of Causation (PC)	11.41	58.15

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n3_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=100keV-2MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1008	119
Original ERR/Sv	1.2105	5.4016
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1147	0.0753
Systematic errors in gamma doses[b]	1.1031	1.1543
Systematic errors in neutron doses[b]	1.0937	1.0162
Systematic errors in RBE neutron doses[b]	0.9781	1.0738
Model Mixture factor for transfer to US pop	0.7753	0.7725
Ratio of Japanese to U.S. baseline cancer rates	1.0037	0.9566
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	11.6499	28.7627

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.035	0.388
Probability of Causation (PC)	3.41	27.98

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.2105	5.4016
ERR/Sv with adjustments		
w/ age adjustment	1.2105	5.4016
w/ latency adjustment	1.2105	5.4016
w/ random errors in dosimetry adj	1.2105	5.4016
w/ systematic errors in dosimetry adj	1.2105	5.4016
adjusted for population transfer	1.2105	5.4016
multiplicative risk model	1.2105	5.4016
additive risk model	1.2150	5.1671
adjusted for smoking history	1.2105	5.4016
adjusted for DDREF	1.2105	5.4016
Final ERR/Sv	1.2105	5.4016
Organ equivalent dose (Sv)	0.029125	0.071907
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.035	0.388
Probability of Causation (PC)	3.41	27.98

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n3_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=100keV-2MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1008	119
Original ERR/Sv	1.2105	5.4016
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1147	0.0753
Systematic errors in gamma doses[b]	1.1031	1.1543
Systematic errors in neutron doses[b]	1.0937	1.0162
Systematic errors in RBE neutron doses[b]	0.9781	1.0738
Model Mixture factor for transfer to US pop	0.7753	0.7725
Ratio of Japanese to U.S. baseline cancer rates	1.0037	0.9566
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	11.6499	28.7627

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.212	2.330
Probability of Causation (PC)	17.46	69.97

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.2105	5.4016
ERR/Sv with adjustments		
w/ age adjustment	1.2105	5.4016
w/ latency adjustment	1.2105	5.4016
w/ random errors in dosimetry adj	1.2105	5.4016
w/ systematic errors in dosimetry adj	1.2105	5.4016
adjusted for population transfer	1.2105	5.4016
multiplicative risk model	1.2105	5.4016
additive risk model	1.2150	5.1671
adjusted for smoking history	1.2105	5.4016
adjusted for DDREF	1.2105	5.4016
Final ERR/Sv	1.2105	5.4016
Organ equivalent dose (Sv)	0.174749	0.431441
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.212	2.330
Probability of Causation (PC)	17.46	69.97

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n3_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=100keV-2MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	108	1815
Original ERR/Sv	2.9132	10.4975
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1097	0.0844
Systematic errors in gamma doses[b]	1.2021	1.1996
Systematic errors in neutron doses[b]	1.0323	1.2298
Systematic errors in RBE neutron doses[b]	1.0042	1.0159
Model Mixture factor for transfer to US pop	0.0438	0.5267
Ratio of Japanese to U.S. baseline cancer rates	0.9577	0.7656
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	6.34842	23.801

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.046	0.625
Probability of Causation (PC)	4.42	38.45

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.9132	10.4975
ERR/Sv with adjustments		
w/ age adjustment	2.9132	10.4975
w/ latency adjustment	2.9132	10.4975
w/ random errors in dosimetry adj	2.9132	10.4975
w/ systematic errors in dosimetry adj	2.9132	10.4975
adjusted for population transfer	2.9132	10.4975
multiplicative risk model	2.9132	10.4975
additive risk model	2.7901	8.0367
adjusted for smoking history	2.9132	10.4975
adjusted for DDREF	2.9132	10.4975
Final ERR/Sv	2.9132	10.4975
Organ equivalent dose (Sv)	0.015871	0.059503
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.046	0.625
Probability of Causation (PC)	4.42	38.45

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n3_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=100keV-2MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	108	1815
Original ERR/Sv	2.9132	10.4975
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1097	0.0844
Systematic errors in gamma doses[b]	1.2021	1.1996
Systematic errors in neutron doses[b]	1.0323	1.2298
Systematic errors in RBE neutron doses[b]	1.0042	1.0159
Model Mixture factor for transfer to US pop	0.0438	0.5267
Ratio of Japanese to U.S. baseline cancer rates	0.9577	0.7656
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	6.34842	23.801

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.277	3.748
Probability of Causation (PC)	21.72	78.94

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.9132	10.4975
ERR/Sv with adjustments		
w/ age adjustment	2.9132	10.4975
w/ latency adjustment	2.9132	10.4975
w/ random errors in dosimetry adj	2.9132	10.4975
w/ systematic errors in dosimetry adj	2.9132	10.4975
adjusted for population transfer	2.9132	10.4975
multiplicative risk model	2.9132	10.4975
additive risk model	2.7901	8.0367
adjusted for smoking history	2.9132	10.4975
adjusted for DDREF	2.9132	10.4975
Final ERR/Sv	2.9132	10.4975
Organ equivalent dose (Sv)	0.095226	0.357015
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.277	3.748
Probability of Causation (PC)	21.72	78.94

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n3_5**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=100keV-2MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	84	1942
Original ERR/Sv	0.3028	0.7333
Adjustment Factors		
Age at exposure, Attained age	2.2976	3.4879
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0788	0.0840
Systematic errors in gamma doses[b]	1.1116	1.2736
Systematic errors in neutron doses[b]	1.1072	1.2174
Systematic errors in RBE neutron doses[b]	0.9297	1.0778
Model Mixture factor for transfer to US pop	0.0591	-0.0184
Ratio of Japanese to U.S. baseline cancer rates	1.1250	1.0689
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	11.5544	31.4083

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.021	0.139
Probability of Causation (PC)	2.07	12.24

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.3028	0.7333
ERR/Sv with adjustments		
w/ age adjustment	0.6956	2.5576
w/ latency adjustment	0.6956	2.5576
w/ random errors in dosimetry adj	0.7504	2.7724
w/ systematic errors in dosimetry adj	0.6557	1.6592
adjusted for population transfer	0.7329	1.7757
multiplicative risk model	0.6557	1.6592
additive risk model	0.7377	1.7735
adjusted for smoking history	0.7329	1.7757
adjusted for DDREF	0.7329	1.7757
Final ERR/Sv	0.7329	1.7757
Organ equivalent dose (Sv)	0.028886	0.078521
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.021	0.139
Probability of Causation (PC)	2.07	12.24

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n3_6**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=100keV-2MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	84	1942
Original ERR/Sv	0.3028	0.7333
Adjustment Factors		
Age at exposure, Attained age	2.2976	3.4879
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0788	0.0840
Systematic errors in gamma doses[b]	1.1116	1.2736
Systematic errors in neutron doses[b]	1.1072	1.2174
Systematic errors in RBE neutron doses[b]	0.9297	1.0778
Model Mixture factor for transfer to US pop	0.0591	-0.0184
Ratio of Japanese to U.S. baseline cancer rates	1.1250	1.0689
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	11.5544	31.4083

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.127	0.837
Probability of Causation (PC)	11.27	45.55

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.3028	0.7333
ERR/Sv with adjustments		
w/ age adjustment	0.6956	2.5576
w/ latency adjustment	0.6956	2.5576
w/ random errors in dosimetry adj	0.7504	2.7724
w/ systematic errors in dosimetry adj	0.6557	1.6592
adjusted for population transfer	0.7329	1.7757
multiplicative risk model	0.6557	1.6592
additive risk model	0.7377	1.7735
adjusted for smoking history	0.7329	1.7757
adjusted for DDREF	0.7329	1.7757
Final ERR/Sv	0.7329	1.7757
Organ equivalent dose (Sv)	0.173316	0.471125
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.127	0.837
Probability of Causation (PC)	11.27	45.55

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n3_7**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=100keV-2MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1342	1677
Original ERR/Sv	0.5755	0.5693
Adjustment Factors		
Age at exposure, Attained age	2.8218	2.5114
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0822	0.0640
Systematic errors in gamma doses[b]	1.0515	1.3633
Systematic errors in neutron doses[b]	1.1182	1.1657
Systematic errors in RBE neutron doses[b]	0.9619	0.9583
Model Mixture factor for transfer to US pop	1.0013	0.6983
Ratio of Japanese to U.S. baseline cancer rates	1.0458	1.1528
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	7.20048	84.3799

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.028	0.220
Probability of Causation (PC)	2.72	18.06

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5755	0.5693
ERR/Sv with adjustments		
w/ age adjustment	1.6240	1.4298
w/ latency adjustment	1.6240	1.4298
w/ random errors in dosimetry adj	1.7574	1.5213
w/ systematic errors in dosimetry adj	1.5538	0.9990
adjusted for population transfer	1.5537	1.0450
multiplicative risk model	1.5538	0.9990
additive risk model	1.6249	1.1516
adjusted for smoking history	1.5537	1.0450
adjusted for DDREF	1.5537	1.0450
Final ERR/Sv	1.5537	1.0450
Organ equivalent dose (Sv)	0.018001	0.21095
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.028	0.220
Probability of Causation (PC)	2.72	18.06

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n3_8**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=100keV-2MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1342	1677
Original ERR/Sv	0.5755	0.5693
Adjustment Factors		
Age at exposure, Attained age	2.8218	2.5114
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0822	0.0640
Systematic errors in gamma doses[b]	1.0515	1.3633
Systematic errors in neutron doses[b]	1.1182	1.1657
Systematic errors in RBE neutron doses[b]	0.9619	0.9583
Model Mixture factor for transfer to US pop	1.0013	0.6983
Ratio of Japanese to U.S. baseline cancer rates	1.0458	1.1528
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	7.20048	84.3799

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.168	1.323
Probability of Causation (PC)	14.37	56.95

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5755	0.5693
ERR/Sv with adjustments		
w/ age adjustment	1.6240	1.4298
w/ latency adjustment	1.6240	1.4298
w/ random errors in dosimetry adj	1.7574	1.5213
w/ systematic errors in dosimetry adj	1.5538	0.9990
adjusted for population transfer	1.5537	1.0450
multiplicative risk model	1.5538	0.9990
additive risk model	1.6249	1.1516
adjusted for smoking history	1.5537	1.0450
adjusted for DDREF	1.5537	1.0450
Final ERR/Sv	1.5537	1.0450
Organ equivalent dose (Sv)	0.108007	1.265699
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.168	1.323
Probability of Causation (PC)	14.37	56.95

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n3_9**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=100keV-2MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	144	31
Original ERR/Sv	2.2491	2.8302
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1001	0.1009
Systematic errors in gamma doses[b]	1.1065	1.2501
Systematic errors in neutron doses[b]	1.2635	1.2044
Systematic errors in RBE neutron doses[b]	0.9929	0.9850
Model Mixture factor for transfer to US pop	0.0267	0.9628
Ratio of Japanese to U.S. baseline cancer rates	0.3335	0.3463
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	10.9556	22.0455

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.017	0.113
Probability of Causation (PC)	1.69	10.15

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.2491	2.8302
ERR/Sv with adjustments		
w/ age adjustment	2.2491	2.8302
w/ latency adjustment	2.2491	2.8302
w/ random errors in dosimetry adj	2.4744	3.1158
w/ systematic errors in dosimetry adj	1.7826	2.1009
adjusted for population transfer	0.6263	2.0499
multiplicative risk model	1.7826	2.1009
additive risk model	0.5945	0.7276
adjusted for smoking history	0.6263	2.0499
adjusted for DDREF	0.6263	2.0499
Final ERR/Sv	0.6263	2.0499
Organ equivalent dose (Sv)	0.027389	0.055114
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.017	0.113
Probability of Causation (PC)	1.69	10.15

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n3_10**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=100keV-2MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	144	31
Original ERR/Sv	2.2491	2.8302
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1001	0.1009
Systematic errors in gamma doses[b]	1.1065	1.2501
Systematic errors in neutron doses[b]	1.2635	1.2044
Systematic errors in RBE neutron doses[b]	0.9929	0.9850
Model Mixture factor for transfer to US pop	0.0267	0.9628
Ratio of Japanese to U.S. baseline cancer rates	0.3335	0.3463
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	10.9556	22.0455

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.103	0.678
Probability of Causation (PC)	9.33	40.40

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.2491	2.8302
ERR/Sv with adjustments		
w/ age adjustment	2.2491	2.8302
w/ latency adjustment	2.2491	2.8302
w/ random errors in dosimetry adj	2.4744	3.1158
w/ systematic errors in dosimetry adj	1.7826	2.1009
adjusted for population transfer	0.6263	2.0499
multiplicative risk model	1.7826	2.1009
additive risk model	0.5945	0.7276
adjusted for smoking history	0.6263	2.0499
adjusted for DDREF	0.6263	2.0499
Final ERR/Sv	0.6263	2.0499
Organ equivalent dose (Sv)	0.164334	0.330683
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.103	0.678
Probability of Causation (PC)	9.33	40.40

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n3_11**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=100keV-2MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	917	1490
Original ERR/Sv	1.9716	2.5975
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1065	0.0707
Systematic errors in gamma doses[b]	1.0972	1.2860
Systematic errors in neutron doses[b]	1.1569	1.1519
Systematic errors in RBE neutron doses[b]	0.9861	0.9577
Model Mixture factor for transfer to US pop	0.0000	0.8380
Ratio of Japanese to U.S. baseline cancer rates	0.3412	0.3354
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	15.1504	43.5062

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.023	0.190
Probability of Causation (PC)	2.20	15.99

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.9716	2.5975
ERR/Sv with adjustments		
w/ age adjustment	1.9716	2.5975
w/ latency adjustment	1.9716	2.5975
w/ random errors in dosimetry adj	2.1816	2.7813
w/ systematic errors in dosimetry adj	1.7430	1.9606
adjusted for population transfer	0.5947	1.7495
multiplicative risk model	1.7430	1.9606
additive risk model	0.5947	0.6577
adjusted for smoking history	0.5947	1.7495
adjusted for DDREF	0.5947	1.7495
Final ERR/Sv	0.5947	1.7495
Organ equivalent dose (Sv)	0.037876	0.108766
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.023	0.190
Probability of Causation (PC)	2.20	15.99

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n3_12**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=100keV-2MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	917	1490
Original ERR/Sv	1.9716	2.5975
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1065	0.0707
Systematic errors in gamma doses[b]	1.0972	1.2860
Systematic errors in neutron doses[b]	1.1569	1.1519
Systematic errors in RBE neutron doses[b]	0.9861	0.9577
Model Mixture factor for transfer to US pop	0.0000	0.8380
Ratio of Japanese to U.S. baseline cancer rates	0.3412	0.3354
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	15.1504	43.5062

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.135	1.142
Probability of Causation (PC)	11.91	53.31

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.9716	2.5975
ERR/Sv with adjustments		
w/ age adjustment	1.9716	2.5975
w/ latency adjustment	1.9716	2.5975
w/ random errors in dosimetry adj	2.1816	2.7813
w/ systematic errors in dosimetry adj	1.7430	1.9606
adjusted for population transfer	0.5947	1.7495
multiplicative risk model	1.7430	1.9606
additive risk model	0.5947	0.6577
adjusted for smoking history	0.5947	1.7495
adjusted for DDREF	0.5947	1.7495
Final ERR/Sv	0.5947	1.7495
Organ equivalent dose (Sv)	0.227256	0.652593
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.135	1.142
Probability of Causation (PC)	11.91	53.31

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n4_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=2-20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1988	329
Original ERR/Sv	4.2366	20.9632
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0589	0.1096
Systematic errors in gamma doses[b]	1.0960	1.1227
Systematic errors in neutron doses[b]	1.1571	1.1734
Systematic errors in RBE neutron doses[b]	1.0008	0.9897
Model Mixture factor for transfer to US pop	0.4101	0.6873
Ratio of Japanese to U.S. baseline cancer rates	0.8280	0.7949
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	1.6335	4.6615

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.035	0.489
Probability of Causation (PC)	3.34	32.82

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	4.2366	20.9632
ERR/Sv with adjustments		
w/ age adjustment	4.2366	20.9632
w/ latency adjustment	4.2366	20.9632
w/ random errors in dosimetry adj	4.2366	20.9632
w/ systematic errors in dosimetry adj	4.2366	20.9632
adjusted for population transfer	4.2366	20.9632
multiplicative risk model	4.2366	20.9632
additive risk model	3.5079	16.6632
adjusted for smoking history	4.2366	20.9632
adjusted for DDREF	4.2366	20.9632
Final ERR/Sv	4.2366	20.9632
Organ equivalent dose (Sv)	0.008168	0.023308
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.035	0.489
Probability of Causation (PC)	3.34	32.82

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n4_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=2-20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1102	329
Original ERR/Sv	1.8032	20.9632
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0773	0.1096
Systematic errors in gamma doses[b]	1.0952	1.1227
Systematic errors in neutron doses[b]	1.1750	1.1734
Systematic errors in RBE neutron doses[b]	1.0044	0.9897
Model Mixture factor for transfer to US pop	0.0580	0.6873
Ratio of Japanese to U.S. baseline cancer rates	0.7727	0.7949
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	3.8375	4.6615

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.208	2.932
Probability of Causation (PC)	17.19	74.57

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.8032	20.9632
ERR/Sv with adjustments		
w/ age adjustment	1.8032	20.9632
w/ latency adjustment	1.8032	20.9632
w/ random errors in dosimetry adj	1.8032	20.9632
w/ systematic errors in dosimetry adj	1.8032	20.9632
adjusted for population transfer	1.8032	20.9632
multiplicative risk model	1.8032	20.9632
additive risk model	1.3934	16.6632
adjusted for smoking history	1.8032	20.9632
adjusted for DDREF	1.8032	20.9632
Final ERR/Sv	1.8032	20.9632
Organ equivalent dose (Sv)	0.115125	0.139845
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.208	2.932
Probability of Causation (PC)	17.19	74.57

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n4_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=2-20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	211	1108
Original ERR/Sv	2.0690	8.9471
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1235	0.0771
Systematic errors in gamma doses[b]	1.1421	1.2901
Systematic errors in neutron doses[b]	1.0907	1.2104
Systematic errors in RBE neutron doses[b]	1.0225	1.0015
Model Mixture factor for transfer to US pop	0.0894	0.0515
Ratio of Japanese to U.S. baseline cancer rates	0.7332	1.0148
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	4.4185	15.2787

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.046	0.684
Probability of Causation (PC)	4.37	40.60

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.0690	8.9471
ERR/Sv with adjustments		
w/ age adjustment	2.0690	8.9471
w/ latency adjustment	2.0690	8.9471
w/ random errors in dosimetry adj	2.0690	8.9471
w/ systematic errors in dosimetry adj	2.0690	8.9471
adjusted for population transfer	2.0690	8.9471
multiplicative risk model	2.0690	8.9471
additive risk model	1.5171	9.0792
adjusted for smoking history	2.0690	8.9471
adjusted for DDREF	2.0690	8.9471
Final ERR/Sv	2.0690	8.9471
Organ equivalent dose (Sv)	0.022093	0.076394
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.046	0.684
Probability of Causation (PC)	4.37	40.60

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n4_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=2-20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	211	1108
Original ERR/Sv	2.0690	8.9471
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1235	0.0771
Systematic errors in gamma doses[b]	1.1421	1.2901
Systematic errors in neutron doses[b]	1.0907	1.2104
Systematic errors in RBE neutron doses[b]	1.0225	1.0015
Model Mixture factor for transfer to US pop	0.0894	0.0515
Ratio of Japanese to U.S. baseline cancer rates	0.7332	1.0148
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	4.4185	15.2787

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.274	4.101
Probability of Causation (PC)	21.52	80.40

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.0690	8.9471
ERR/Sv with adjustments		
w/ age adjustment	2.0690	8.9471
w/ latency adjustment	2.0690	8.9471
w/ random errors in dosimetry adj	2.0690	8.9471
w/ systematic errors in dosimetry adj	2.0690	8.9471
adjusted for population transfer	2.0690	8.9471
multiplicative risk model	2.0690	8.9471
additive risk model	1.5171	9.0792
adjusted for smoking history	2.0690	8.9471
adjusted for DDREF	2.0690	8.9471
Final ERR/Sv	2.0690	8.9471
Organ equivalent dose (Sv)	0.132555	0.458361
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.274	4.101
Probability of Causation (PC)	21.52	80.40

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n4_5**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=2-20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1393	1859
Original ERR/Sv	1.3824	0.6075
Adjustment Factors		
Age at exposure, Attained age	3.0109	3.3570
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0782	0.0662
Systematic errors in gamma doses[b]	1.2436	1.0871
Systematic errors in neutron doses[b]	1.2485	1.2190
Systematic errors in RBE neutron doses[b]	0.9614	0.9553
Model Mixture factor for transfer to US pop	0.5701	0.2671
Ratio of Japanese to U.S. baseline cancer rates	1.1490	1.0708
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	1.3075	19.3287

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.021	0.175
Probability of Causation (PC)	2.05	14.86

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.3824	0.6075
ERR/Sv with adjustments		
w/ age adjustment	4.1621	2.0393
w/ latency adjustment	4.1621	2.0393
w/ random errors in dosimetry adj	4.4875	2.1742
w/ systematic errors in dosimetry adj	3.0064	1.7174
adjusted for population transfer	3.1990	1.8065
multiplicative risk model	3.0064	1.7174
additive risk model	3.4545	1.8390
adjusted for smoking history	3.1990	1.8065
adjusted for DDREF	3.1990	1.8065
Final ERR/Sv	3.1990	1.8065
Organ equivalent dose (Sv)	0.006538	0.096644
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.021	0.175
Probability of Causation (PC)	2.05	14.86

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n4_6**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=2-20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1393	1859
Original ERR/Sv	1.3824	0.6075
Adjustment Factors		
Age at exposure, Attained age	3.0109	3.3570
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0782	0.0662
Systematic errors in gamma doses[b]	1.2436	1.0871
Systematic errors in neutron doses[b]	1.2485	1.2190
Systematic errors in RBE neutron doses[b]	0.9614	0.9553
Model Mixture factor for transfer to US pop	0.5701	0.2671
Ratio of Japanese to U.S. baseline cancer rates	1.1490	1.0708
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	1.3075	19.3287

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.125	1.048
Probability of Causation (PC)	11.15	51.16

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.3824	0.6075
ERR/Sv with adjustments		
w/ age adjustment	4.1621	2.0393
w/ latency adjustment	4.1621	2.0393
w/ random errors in dosimetry adj	4.4875	2.1742
w/ systematic errors in dosimetry adj	3.0064	1.7174
adjusted for population transfer	3.1990	1.8065
multiplicative risk model	3.0064	1.7174
additive risk model	3.4545	1.8390
adjusted for smoking history	3.1990	1.8065
adjusted for DDREF	3.1990	1.8065
Final ERR/Sv	3.1990	1.8065
Organ equivalent dose (Sv)	0.039225	0.579861
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.125	1.048
Probability of Causation (PC)	11.15	51.16

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n4_7**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=2-20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	499	1616
Original ERR/Sv	1.0031	0.5636
Adjustment Factors		
Age at exposure, Attained age	2.0506	2.1769
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0876	0.0979
Systematic errors in gamma doses[b]	1.2327	1.1245
Systematic errors in neutron doses[b]	1.0945	1.1433
Systematic errors in RBE neutron doses[b]	1.0042	1.0494
Model Mixture factor for transfer to US pop	0.5091	0.0993
Ratio of Japanese to U.S. baseline cancer rates	1.1264	1.1090
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	3.0885	48.6938

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.027	0.267
Probability of Causation (PC)	2.64	21.07

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.0031	0.5636
ERR/Sv with adjustments		
w/ age adjustment	2.0570	1.2268
w/ latency adjustment	2.0570	1.2268
w/ random errors in dosimetry adj	2.2372	1.3469
w/ systematic errors in dosimetry adj	1.6512	0.9985
adjusted for population transfer	1.7537	1.0965
multiplicative risk model	1.6512	0.9985
additive risk model	1.8600	1.1073
adjusted for smoking history	1.7537	1.0965
adjusted for DDREF	1.7537	1.0965
Final ERR/Sv	1.7537	1.0965
Organ equivalent dose (Sv)	0.015443	0.243469
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.027	0.267
Probability of Causation (PC)	2.64	21.07

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n4_8**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=2-20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	499	1616
Original ERR/Sv	1.0031	0.5636
Adjustment Factors		
Age at exposure, Attained age	2.0506	2.1769
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0876	0.0979
Systematic errors in gamma doses[b]	1.2327	1.1245
Systematic errors in neutron doses[b]	1.0945	1.1433
Systematic errors in RBE neutron doses[b]	1.0042	1.0494
Model Mixture factor for transfer to US pop	0.5091	0.0993
Ratio of Japanese to U.S. baseline cancer rates	1.1264	1.1090
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	3.0885	48.6938

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.162	1.602
Probability of Causation (PC)	13.98	61.56

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.0031	0.5636
ERR/Sv with adjustments		
w/ age adjustment	2.0570	1.2268
w/ latency adjustment	2.0570	1.2268
w/ random errors in dosimetry adj	2.2372	1.3469
w/ systematic errors in dosimetry adj	1.6512	0.9985
adjusted for population transfer	1.7537	1.0965
multiplicative risk model	1.6512	0.9985
additive risk model	1.8600	1.1073
adjusted for smoking history	1.7537	1.0965
adjusted for DDREF	1.7537	1.0965
Final ERR/Sv	1.7537	1.0965
Organ equivalent dose (Sv)	0.092655	1.460814
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.162	1.602
Probability of Causation (PC)	13.98	61.56

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n4_9**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=2-20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1913	1322
Original ERR/Sv	2.2812	2.5727
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0891	0.0661
Systematic errors in gamma doses[b]	1.2809	1.1716
Systematic errors in neutron doses[b]	1.0717	1.1184
Systematic errors in RBE neutron doses[b]	1.0708	0.9972
Model Mixture factor for transfer to US pop	0.2308	0.7131
Ratio of Japanese to U.S. baseline cancer rates	0.3452	0.3411
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	3.7595	18.4663

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.016	0.157
Probability of Causation (PC)	1.55	13.58

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.2812	2.5727
ERR/Sv with adjustments		
w/ age adjustment	2.2812	2.5727
w/ latency adjustment	2.2812	2.5727
w/ random errors in dosimetry adj	2.4844	2.7427
w/ systematic errors in dosimetry adj	1.6903	2.0990
adjusted for population transfer	0.8389	1.7023
multiplicative risk model	1.6903	2.0990
additive risk model	0.5834	0.7160
adjusted for smoking history	0.8389	1.7023
adjusted for DDREF	0.8389	1.7023
Final ERR/Sv	0.8389	1.7023
Organ equivalent dose (Sv)	0.018798	0.092332
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.016	0.157
Probability of Causation (PC)	1.55	13.58

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n4_10**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E=2-20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	612	1322
Original ERR/Sv	1.7270	2.5727
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0598	0.0661
Systematic errors in gamma doses[b]	1.3726	1.1716
Systematic errors in neutron doses[b]	1.2627	1.1184
Systematic errors in RBE neutron doses[b]	0.9528	0.9972
Model Mixture factor for transfer to US pop	0.8512	0.7131
Ratio of Japanese to U.S. baseline cancer rates	0.3472	0.3411
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	3.1515	18.4663

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.095	0.943
Probability of Causation (PC)	8.64	48.53

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.7270	2.5727
ERR/Sv with adjustments		
w/ age adjustment	1.7270	2.5727
w/ latency adjustment	1.7270	2.5727
w/ random errors in dosimetry adj	1.8304	2.7427
w/ systematic errors in dosimetry adj	1.1084	2.0990
adjusted for population transfer	1.0008	1.7023
multiplicative risk model	1.1084	2.0990
additive risk model	0.3848	0.7160
adjusted for smoking history	1.0008	1.7023
adjusted for DDREF	1.0008	1.7023
Final ERR/Sv	1.0008	1.7023
Organ equivalent dose (Sv)	0.094545	0.553989
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.095	0.943
Probability of Causation (PC)	8.64	48.53

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n4_11**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=2-20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	80	372
Original ERR/Sv	2.6427	2.5303
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0913	0.1166
Systematic errors in gamma doses[b]	1.1041	1.0421
Systematic errors in neutron doses[b]	1.0954	1.1004
Systematic errors in RBE neutron doses[b]	0.9708	0.9972
Model Mixture factor for transfer to US pop	0.0000	0.9694
Ratio of Japanese to U.S. baseline cancer rates	0.3303	0.3444
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	5.34375	20.5331

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.022	0.249
Probability of Causation (PC)	2.12	19.91

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.6427	2.5303
ERR/Sv with adjustments		
w/ age adjustment	2.6427	2.5303
w/ latency adjustment	2.6427	2.5303
w/ random errors in dosimetry adj	2.8840	2.8255
w/ systematic errors in dosimetry adj	2.4563	2.4709
adjusted for population transfer	0.8113	2.4213
multiplicative risk model	2.4563	2.4709
additive risk model	0.8113	0.8510
adjusted for smoking history	0.8113	2.4213
adjusted for DDREF	0.8113	2.4213
Final ERR/Sv	0.8113	2.4213
Organ equivalent dose (Sv)	0.026719	0.102666
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.022	0.249
Probability of Causation (PC)	2.12	19.91

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n4_12**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E=2-20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	80	372
Original ERR/Sv	2.6427	2.5303
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0913	0.1166
Systematic errors in gamma doses[b]	1.1041	1.0421
Systematic errors in neutron doses[b]	1.0954	1.1004
Systematic errors in RBE neutron doses[b]	0.9708	0.9972
Model Mixture factor for transfer to US pop	0.0000	0.9694
Ratio of Japanese to U.S. baseline cancer rates	0.3303	0.3444
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	10	10
Radiation effectiveness factor (REF)	5.34375	20.5331

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.130	1.492
Probability of Causation (PC)	11.51	59.86

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.6427	2.5303
ERR/Sv with adjustments		
w/ age adjustment	2.6427	2.5303
w/ latency adjustment	2.6427	2.5303
w/ random errors in dosimetry adj	2.8840	2.8255
w/ systematic errors in dosimetry adj	2.4563	2.4709
adjusted for population transfer	0.8113	2.4213
multiplicative risk model	2.4563	2.4709
additive risk model	0.8113	0.8510
adjusted for smoking history	0.8113	2.4213
adjusted for DDREF	0.8113	2.4213
Final ERR/Sv	0.8113	2.4213
Organ equivalent dose (Sv)	0.160313	0.615993
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.130	1.492
Probability of Causation (PC)	11.51	59.86

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n5_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E>20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	135	1907
Original ERR/Sv	0.4749	6.8768
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1315	0.0665
Systematic errors in gamma doses[b]	1.0699	1.2111
Systematic errors in neutron doses[b]	1.1554	1.0841
Systematic errors in RBE neutron doses[b]	0.9553	0.9332
Model Mixture factor for transfer to US pop	0.9733	0.9793
Ratio of Japanese to U.S. baseline cancer rates	1.0083	0.8779
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	8.0568	7.0344

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.038	0.484
Probability of Causation (PC)	3.69	32.60

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4749	6.8768
ERR/Sv with adjustments		
w/ age adjustment	0.4749	6.8768
w/ latency adjustment	0.4749	6.8768
w/ random errors in dosimetry adj	0.4749	6.8768
w/ systematic errors in dosimetry adj	0.4749	6.8768
adjusted for population transfer	0.4749	6.8768
multiplicative risk model	0.4749	6.8768
additive risk model	0.4789	6.0373
adjusted for smoking history	0.4749	6.8768
adjusted for DDREF	0.4749	6.8768
Final ERR/Sv	0.4749	6.8768
Organ equivalent dose (Sv)	0.080568	0.070344
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.038	0.484
Probability of Causation (PC)	3.69	32.60

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n5_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E>20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	135	1907
Original ERR/Sv	0.4749	6.8768
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1315	0.0665
Systematic errors in gamma doses[b]	1.0699	1.2111
Systematic errors in neutron doses[b]	1.1554	1.0841
Systematic errors in RBE neutron doses[b]	0.9553	0.9332
Model Mixture factor for transfer to US pop	0.9733	0.9793
Ratio of Japanese to U.S. baseline cancer rates	1.0083	0.8779
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	8.0568	7.0344

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.230	2.902
Probability of Causation (PC)	18.67	74.38

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4749	6.8768
ERR/Sv with adjustments		
w/ age adjustment	0.4749	6.8768
w/ latency adjustment	0.4749	6.8768
w/ random errors in dosimetry adj	0.4749	6.8768
w/ systematic errors in dosimetry adj	0.4749	6.8768
adjusted for population transfer	0.4749	6.8768
multiplicative risk model	0.4749	6.8768
additive risk model	0.4789	6.0373
adjusted for smoking history	0.4749	6.8768
adjusted for DDREF	0.4749	6.8768
Final ERR/Sv	0.4749	6.8768
Organ equivalent dose (Sv)	0.483408	0.422064
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.230	2.902
Probability of Causation (PC)	18.67	74.38

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n5_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E>20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1250	134
Original ERR/Sv	2.3674	14.8539
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0883	0.0899
Systematic errors in gamma doses[b]	1.0670	1.0716
Systematic errors in neutron doses[b]	1.2543	1.0273
Systematic errors in RBE neutron doses[b]	0.9905	0.9517
Model Mixture factor for transfer to US pop	0.3974	0.3991
Ratio of Japanese to U.S. baseline cancer rates	1.0575	0.7354
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	2.15137	5.0472

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.051	0.750
Probability of Causation (PC)	4.85	42.85

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.3674	14.8539
ERR/Sv with adjustments		
w/ age adjustment	2.3674	14.8539
w/ latency adjustment	2.3674	14.8539
w/ random errors in dosimetry adj	2.3674	14.8539
w/ systematic errors in dosimetry adj	2.3674	14.8539
adjusted for population transfer	2.3674	14.8539
multiplicative risk model	2.3674	14.8539
additive risk model	2.5035	10.9238
adjusted for smoking history	2.3674	14.8539
adjusted for DDREF	2.3674	14.8539
Final ERR/Sv	2.3674	14.8539
Organ equivalent dose (Sv)	0.021514	0.050472
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.051	0.750
Probability of Causation (PC)	4.85	42.85

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n5_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E>20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1250	134
Original ERR/Sv	2.3674	14.8539
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0883	0.0899
Systematic errors in gamma doses[b]	1.0670	1.0716
Systematic errors in neutron doses[b]	1.2543	1.0273
Systematic errors in RBE neutron doses[b]	0.9905	0.9517
Model Mixture factor for transfer to US pop	0.3974	0.3991
Ratio of Japanese to U.S. baseline cancer rates	1.0575	0.7354
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	2.15137	5.0472

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.306	4.498
Probability of Causation (PC)	23.41	81.81

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.3674	14.8539
ERR/Sv with adjustments		
w/ age adjustment	2.3674	14.8539
w/ latency adjustment	2.3674	14.8539
w/ random errors in dosimetry adj	2.3674	14.8539
w/ systematic errors in dosimetry adj	2.3674	14.8539
adjusted for population transfer	2.3674	14.8539
multiplicative risk model	2.3674	14.8539
additive risk model	2.5035	10.9238
adjusted for smoking history	2.3674	14.8539
adjusted for DDREF	2.3674	14.8539
Final ERR/Sv	2.3674	14.8539
Organ equivalent dose (Sv)	0.129082	0.302832
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.306	4.498
Probability of Causation (PC)	23.41	81.81

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n5_5**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E>20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	351	724
Original ERR/Sv	0.5076	0.6082
Adjustment Factors		
Age at exposure, Attained age	2.2086	3.2598
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0830	0.1079
Systematic errors in gamma doses[b]	1.1474	1.2603
Systematic errors in neutron doses[b]	1.0988	1.1178
Systematic errors in RBE neutron doses[b]	0.9136	0.9834
Model Mixture factor for transfer to US pop	0.3820	0.1950
Ratio of Japanese to U.S. baseline cancer rates	1.1041	1.0805
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	2.0186	11.676

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.023	0.197
Probability of Causation (PC)	2.21	16.47

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5076	0.6082
ERR/Sv with adjustments		
w/ age adjustment	1.1211	1.9825
w/ latency adjustment	1.1211	1.9825
w/ random errors in dosimetry adj	1.2141	2.1964
w/ systematic errors in dosimetry adj	1.0540	1.5854
adjusted for population transfer	1.1219	1.6882
multiplicative risk model	1.0540	1.5854
additive risk model	1.1638	1.7131
adjusted for smoking history	1.1219	1.6882
adjusted for DDREF	1.1219	1.6882
Final ERR/Sv	1.1219	1.6882
Organ equivalent dose (Sv)	0.020186	0.11676
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.023	0.197
Probability of Causation (PC)	2.21	16.47

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n5_6**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E>20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	351	724
Original ERR/Sv	0.5076	0.6082
Adjustment Factors		
Age at exposure, Attained age	2.2086	3.2598
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0830	0.1079
Systematic errors in gamma doses[b]	1.1474	1.2603
Systematic errors in neutron doses[b]	1.0988	1.1178
Systematic errors in RBE neutron doses[b]	0.9136	0.9834
Model Mixture factor for transfer to US pop	0.3820	0.1950
Ratio of Japanese to U.S. baseline cancer rates	1.1041	1.0805
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	2.0186	11.676

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.136	1.183
Probability of Causation (PC)	11.96	54.18

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5076	0.6082
ERR/Sv with adjustments		
w/ age adjustment	1.1211	1.9825
w/ latency adjustment	1.1211	1.9825
w/ random errors in dosimetry adj	1.2141	2.1964
w/ systematic errors in dosimetry adj	1.0540	1.5854
adjusted for population transfer	1.1219	1.6882
multiplicative risk model	1.0540	1.5854
additive risk model	1.1638	1.7131
adjusted for smoking history	1.1219	1.6882
adjusted for DDREF	1.1219	1.6882
Final ERR/Sv	1.1219	1.6882
Organ equivalent dose (Sv)	0.121116	0.70056
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.136	1.183
Probability of Causation (PC)	11.96	54.18

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n5_7**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E>20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	432	1507
Original ERR/Sv	0.4875	0.5911
Adjustment Factors		
Age at exposure, Attained age	2.2446	2.3776
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0942	0.0824
Systematic errors in gamma doses[b]	1.0921	1.0788
Systematic errors in neutron doses[b]	1.1829	1.1847
Systematic errors in RBE neutron doses[b]	0.9534	0.9811
Model Mixture factor for transfer to US pop	0.7527	0.8814
Ratio of Japanese to U.S. baseline cancer rates	1.1555	1.1216
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	2.9871	23.148

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.030	0.285
Probability of Causation (PC)	2.93	22.17

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4875	0.5911
ERR/Sv with adjustments		
w/ age adjustment	1.0942	1.4054
w/ latency adjustment	1.0942	1.4054
w/ random errors in dosimetry adj	1.1973	1.5212
w/ systematic errors in dosimetry adj	0.9721	1.2132
adjusted for population transfer	1.0094	1.2307
multiplicative risk model	0.9721	1.2132
additive risk model	1.1232	1.3608
adjusted for smoking history	1.0094	1.2307
adjusted for DDREF	1.0094	1.2307
Final ERR/Sv	1.0094	1.2307
Organ equivalent dose (Sv)	0.029871	0.23148
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.030	0.285
Probability of Causation (PC)	2.93	22.17

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n5_8**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E>20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	432	1507
Original ERR/Sv	0.4875	0.5911
Adjustment Factors		
Age at exposure, Attained age	2.2446	2.3776
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0942	0.0824
Systematic errors in gamma doses[b]	1.0921	1.0788
Systematic errors in neutron doses[b]	1.1829	1.1847
Systematic errors in RBE neutron doses[b]	0.9534	0.9811
Model Mixture factor for transfer to US pop	0.7527	0.8814
Ratio of Japanese to U.S. baseline cancer rates	1.1555	1.1216
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	2.9871	23.148

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.181	1.709
Probability of Causation (PC)	15.32	63.09

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4875	0.5911
ERR/Sv with adjustments		
w/ age adjustment	1.0942	1.4054
w/ latency adjustment	1.0942	1.4054
w/ random errors in dosimetry adj	1.1973	1.5212
w/ systematic errors in dosimetry adj	0.9721	1.2132
adjusted for population transfer	1.0094	1.2307
multiplicative risk model	0.9721	1.2132
additive risk model	1.1232	1.3608
adjusted for smoking history	1.0094	1.2307
adjusted for DDREF	1.0094	1.2307
Final ERR/Sv	1.0094	1.2307
Organ equivalent dose (Sv)	0.179226	1.38888
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.181	1.709
Probability of Causation (PC)	15.32	63.09

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n5_9**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E>20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	120	734
Original ERR/Sv	2.2910	1.7153
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1148	0.1057
Systematic errors in gamma doses[b]	1.0868	1.0863
Systematic errors in neutron doses[b]	1.2422	1.1530
Systematic errors in RBE neutron doses[b]	0.9654	0.9371
Model Mixture factor for transfer to US pop	0.2324	1.0421
Ratio of Japanese to U.S. baseline cancer rates	0.3409	0.3230
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	1.7526	9.1656

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.017	0.152
Probability of Causation (PC)	1.67	13.22

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.2910	1.7153
ERR/Sv with adjustments		
w/ age adjustment	2.2910	1.7153
w/ latency adjustment	2.2910	1.7153
w/ random errors in dosimetry adj	2.5540	1.8966
w/ systematic errors in dosimetry adj	1.9597	1.6160
adjusted for population transfer	0.9683	1.6620
multiplicative risk model	1.9597	1.6160
additive risk model	0.6681	0.5219
adjusted for smoking history	0.9683	1.6620
adjusted for DDREF	0.9683	1.6620
Final ERR/Sv	0.9683	1.6620
Organ equivalent dose (Sv)	0.017526	0.091656
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.017	0.152
Probability of Causation (PC)	1.67	13.22

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Calculations using MS Excel

Verification Run Identifier	**DDREF_n5_10**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons E>20MeV

Personal Information	
Age at exposure	20
Attained age	40

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	120	734
Original ERR/Sv	2.2910	1.7153
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1148	0.1057
Systematic errors in gamma doses[b]	1.0868	1.0863
Systematic errors in neutron doses[b]	1.2422	1.1530
Systematic errors in RBE neutron doses[b]	0.9654	0.9371
Model Mixture factor for transfer to US pop	0.2324	1.0421
Ratio of Japanese to U.S. baseline cancer rates	0.3409	0.3230
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	1.7526	9.1656

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.2910	1.7153
ERR/Sv with adjustments		
w/ age adjustment	2.2910	1.7153
w/ latency adjustment	2.2910	1.7153
w/ random errors in dosimetry adj	2.5540	1.8966
w/ systematic errors in dosimetry adj	1.9597	1.6160
adjusted for population transfer	0.9683	1.6620
multiplicative risk model	1.9597	1.6160
additive risk model	0.6681	0.5219
adjusted for smoking history	0.9683	1.6620
adjusted for DDREF	0.9683	1.6620
Final ERR/Sv	0.9683	1.6620
Organ equivalent dose (Sv)	0.105156	0.549936
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.102	0.914
Probability of Causation (PC)	9.24	47.75

Final results calculated in Excel		
Excess relative risk (ERR)	0.102	0.914
Probability of Causation (PC)	9.24	47.75

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n5_11**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E>20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1522	213
Original ERR/Sv	3.0732	2.8221
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0877	0.1003
Systematic errors in gamma doses[b]	1.0911	1.0678
Systematic errors in neutron doses[b]	1.0725	1.0548
Systematic errors in RBE neutron doses[b]	0.9942	1.0118
Model Mixture factor for transfer to US pop	0.0000	0.8088
Ratio of Japanese to U.S. baseline cancer rates	0.3382	0.3381
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	2.3902	9.0612

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.023	0.216
Probability of Causation (PC)	2.27	17.74

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	3.0732	2.8221
ERR/Sv with adjustments		
w/ age adjustment	3.0732	2.8221
w/ latency adjustment	3.0732	2.8221
w/ random errors in dosimetry adj	3.3428	3.1051
w/ systematic errors in dosimetry adj	2.8733	2.7249
adjusted for population transfer	0.9716	2.3801
multiplicative risk model	2.8733	2.7249
additive risk model	0.9716	0.9213
adjusted for smoking history	0.9716	2.3801
adjusted for DDREF	0.9716	2.3801
Final ERR/Sv	0.9716	2.3801
Organ equivalent dose (Sv)	0.023902	0.090612
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.023	0.216
Probability of Causation (PC)	2.27	17.74

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n5_12**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons E>20MeV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1522	213
Original ERR/Sv	3.0732	2.8221
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0877	0.1003
Systematic errors in gamma doses[b]	1.0911	1.0678
Systematic errors in neutron doses[b]	1.0725	1.0548
Systematic errors in RBE neutron doses[b]	0.9942	1.0118
Model Mixture factor for transfer to US pop	0.0000	0.8088
Ratio of Japanese to U.S. baseline cancer rates	0.3382	0.3381
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	5	5
Radiation effectiveness factor (REF)	2.3902	9.0612

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.139	1.294
Probability of Causation (PC)	12.23	56.41

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	3.0732	2.8221
ERR/Sv with adjustments		
w/ age adjustment	3.0732	2.8221
w/ latency adjustment	3.0732	2.8221
w/ random errors in dosimetry adj	3.3428	3.1051
w/ systematic errors in dosimetry adj	2.8733	2.7249
adjusted for population transfer	0.9716	2.3801
multiplicative risk model	2.8733	2.7249
additive risk model	0.9716	0.9213
adjusted for smoking history	0.9716	2.3801
adjusted for DDREF	0.9716	2.3801
Final ERR/Sv	0.9716	2.3801
Organ equivalent dose (Sv)	0.143412	0.543672
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.139	1.294
Probability of Causation (PC)	12.23	56.41

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n6_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons (fission)

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1032	663
Original ERR/Sv	2.1918	7.4491
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0905	0.0843
Systematic errors in gamma doses[b]	1.2653	1.1689
Systematic errors in neutron doses[b]	1.1221	1.0864
Systematic errors in RBE neutron doses[b]	1.0117	1.0701
Model Mixture factor for transfer to US pop	1.0341	0.6917
Ratio of Japanese to U.S. baseline cancer rates	1.0259	1.0236
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	6.28537	20.1747

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.034	0.376
Probability of Causation (PC)	3.33	27.31

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.1918	7.4491
ERR/Sv with adjustments		
w/ age adjustment	2.1918	7.4491
w/ latency adjustment	2.1918	7.4491
w/ random errors in dosimetry adj	2.1918	7.4491
w/ systematic errors in dosimetry adj	2.1918	7.4491
adjusted for population transfer	2.1918	7.4491
multiplicative risk model	2.1918	7.4491
additive risk model	2.2485	7.6246
adjusted for smoking history	2.1918	7.4491
adjusted for DDREF	2.1918	7.4491
Final ERR/Sv	2.1918	7.4491
Organ equivalent dose (Sv)	0.015713	0.050437
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.034	0.376
Probability of Causation (PC)	3.33	27.31

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n6_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons (fission)

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1032	663
Original ERR/Sv	2.1918	7.4491
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0905	0.0843
Systematic errors in gamma doses[b]	1.2653	1.1689
Systematic errors in neutron doses[b]	1.1221	1.0864
Systematic errors in RBE neutron doses[b]	1.0117	1.0701
Model Mixture factor for transfer to US pop	1.0341	0.6917
Ratio of Japanese to U.S. baseline cancer rates	1.0259	1.0236
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	6.28537	20.1747

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.207	2.254
Probability of Causation (PC)	17.13	69.27

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.1918	7.4491
ERR/Sv with adjustments		
w/ age adjustment	2.1918	7.4491
w/ latency adjustment	2.1918	7.4491
w/ random errors in dosimetry adj	2.1918	7.4491
w/ systematic errors in dosimetry adj	2.1918	7.4491
adjusted for population transfer	2.1918	7.4491
multiplicative risk model	2.1918	7.4491
additive risk model	2.2485	7.6246
adjusted for smoking history	2.1918	7.4491
adjusted for DDREF	2.1918	7.4491
Final ERR/Sv	2.1918	7.4491
Organ equivalent dose (Sv)	0.094281	0.302621
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.207	2.254
Probability of Causation (PC)	17.13	69.27

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n6_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons (fission)

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	836	1626
Original ERR/Sv	2.5544	6.3428
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0757	0.0808
Systematic errors in gamma doses[b]	1.1588	1.0814
Systematic errors in neutron doses[b]	1.0119	1.1014
Systematic errors in RBE neutron doses[b]	0.9422	0.9921
Model Mixture factor for transfer to US pop	0.3507	0.1554
Ratio of Japanese to U.S. baseline cancer rates	0.9764	0.8376
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	7.04463	37.6875

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.045	0.598
Probability of Causation (PC)	4.30	37.41

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.5544	6.3428
ERR/Sv with adjustments		
w/ age adjustment	2.5544	6.3428
w/ latency adjustment	2.5544	6.3428
w/ random errors in dosimetry adj	2.5544	6.3428
w/ systematic errors in dosimetry adj	2.5544	6.3428
adjusted for population transfer	2.5544	6.3428
multiplicative risk model	2.5544	6.3428
additive risk model	2.4941	5.3129
adjusted for smoking history	2.5544	6.3428
adjusted for DDREF	2.5544	6.3428
Final ERR/Sv	2.5544	6.3428
Organ equivalent dose (Sv)	0.017612	0.094219
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.045	0.598
Probability of Causation (PC)	4.30	37.41

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n6_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons (fission)

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	836	1626
Original ERR/Sv	2.5544	6.3428
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0757	0.0808
Systematic errors in gamma doses[b]	1.1588	1.0814
Systematic errors in neutron doses[b]	1.0119	1.1014
Systematic errors in RBE neutron doses[b]	0.9422	0.9921
Model Mixture factor for transfer to US pop	0.3507	0.1554
Ratio of Japanese to U.S. baseline cancer rates	0.9764	0.8376
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	7.04463	37.6875

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.270	3.586
Probability of Causation (PC)	21.25	78.19

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.5544	6.3428
ERR/Sv with adjustments		
w/ age adjustment	2.5544	6.3428
w/ latency adjustment	2.5544	6.3428
w/ random errors in dosimetry adj	2.5544	6.3428
w/ systematic errors in dosimetry adj	2.5544	6.3428
adjusted for population transfer	2.5544	6.3428
multiplicative risk model	2.5544	6.3428
additive risk model	2.4941	5.3129
adjusted for smoking history	2.5544	6.3428
adjusted for DDREF	2.5544	6.3428
Final ERR/Sv	2.5544	6.3428
Organ equivalent dose (Sv)	0.105669	0.565313
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.270	3.586
Probability of Causation (PC)	21.25	78.19

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n6_5**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons (fission)

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	489	373
Original ERR/Sv	0.5552	0.6401
Adjustment Factors		
Age at exposure, Attained age	1.7826	3.4286
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0622	0.1128
Systematic errors in gamma doses[b]	1.1836	1.1025
Systematic errors in neutron doses[b]	1.2389	1.1238
Systematic errors in RBE neutron doses[b]	1.0387	0.9770
Model Mixture factor for transfer to US pop	0.0361	0.5190
Ratio of Japanese to U.S. baseline cancer rates	1.1376	1.1051
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	10.5991	27.15

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.021	0.144
Probability of Causation (PC)	2.03	12.58

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5552	0.6401
ERR/Sv with adjustments		
w/ age adjustment	0.9898	2.1947
w/ latency adjustment	0.9898	2.1947
w/ random errors in dosimetry adj	1.0513	2.4423
w/ systematic errors in dosimetry adj	0.6902	2.0176
adjusted for population transfer	0.7818	2.1196
multiplicative risk model	0.6902	2.0176
additive risk model	0.7852	2.2297
adjusted for smoking history	0.7818	2.1196
adjusted for DDREF	0.7818	2.1196
Final ERR/Sv	0.7818	2.1196
Organ equivalent dose (Sv)	0.026498	0.067875
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.021	0.144
Probability of Causation (PC)	2.03	12.58

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n6_6**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons (fission)

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	489	373
Original ERR/Sv	0.5552	0.6401
Adjustment Factors		
Age at exposure, Attained age	1.7826	3.4286
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0622	0.1128
Systematic errors in gamma doses[b]	1.1836	1.1025
Systematic errors in neutron doses[b]	1.2389	1.1238
Systematic errors in RBE neutron doses[b]	1.0387	0.9770
Model Mixture factor for transfer to US pop	0.0361	0.5190
Ratio of Japanese to U.S. baseline cancer rates	1.1376	1.1051
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	10.5991	27.15

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.124	0.863
Probability of Causation (PC)	11.06	46.33

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5552	0.6401
ERR/Sv with adjustments		
w/ age adjustment	0.9898	2.1947
w/ latency adjustment	0.9898	2.1947
w/ random errors in dosimetry adj	1.0513	2.4423
w/ systematic errors in dosimetry adj	0.6902	2.0176
adjusted for population transfer	0.7818	2.1196
multiplicative risk model	0.6902	2.0176
additive risk model	0.7852	2.2297
adjusted for smoking history	0.7818	2.1196
adjusted for DDREF	0.7818	2.1196
Final ERR/Sv	0.7818	2.1196
Organ equivalent dose (Sv)	0.158987	0.40725
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.124	0.863
Probability of Causation (PC)	11.06	46.33

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n6_7**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons (fission)

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	350	1056
Original ERR/Sv	0.4610	1.2579
Adjustment Factors		
Age at exposure, Attained age	2.8914	1.9648
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0721	0.1035
Systematic errors in gamma doses[b]	1.0859	1.0797
Systematic errors in neutron doses[b]	1.2557	1.0394
Systematic errors in RBE neutron doses[b]	0.9551	1.0406
Model Mixture factor for transfer to US pop	0.5228	0.8622
Ratio of Japanese to U.S. baseline cancer rates	1.0910	1.0618
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	9.49538	36.6631

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.027	0.216
Probability of Causation (PC)	2.65	17.75

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4610	1.2579
ERR/Sv with adjustments		
w/ age adjustment	1.3328	2.4715
w/ latency adjustment	1.3328	2.4715
w/ random errors in dosimetry adj	1.4289	2.7272
w/ systematic errors in dosimetry adj	1.0973	2.3353
adjusted for population transfer	1.1449	2.3552
multiplicative risk model	1.0973	2.3353
additive risk model	1.1971	2.4796
adjusted for smoking history	1.1449	2.3552
adjusted for DDREF	1.1449	2.3552
Final ERR/Sv	1.1449	2.3552
Organ equivalent dose (Sv)	0.023738	0.091658
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.027	0.216
Probability of Causation (PC)	2.65	17.75

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Calculations using MS Excel

Verification Run Identifier	**DDREF_n6_8**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons (fission)

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	350	1056
Original ERR/Sv	0.4610	1.2579
Adjustment Factors		
Age at exposure, Attained age	2.8914	1.9648
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0721	0.1035
Systematic errors in gamma doses[b]	1.0859	1.0797
Systematic errors in neutron doses[b]	1.2557	1.0394
Systematic errors in RBE neutron doses[b]	0.9551	1.0406
Model Mixture factor for transfer to US pop	0.5228	0.8622
Ratio of Japanese to U.S. baseline cancer rates	1.0910	1.0618
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	9.49538	36.6631

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.163	1.295
Probability of Causation (PC)	14.02	56.43

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4610	1.2579
ERR/Sv with adjustments		
w/ age adjustment	1.3328	2.4715
w/ latency adjustment	1.3328	2.4715
w/ random errors in dosimetry adj	1.4289	2.7272
w/ systematic errors in dosimetry adj	1.0973	2.3353
adjusted for population transfer	1.1449	2.3552
multiplicative risk model	1.0973	2.3353
additive risk model	1.1971	2.4796
adjusted for smoking history	1.1449	2.3552
adjusted for DDREF	1.1449	2.3552
Final ERR/Sv	1.1449	2.3552
Organ equivalent dose (Sv)	0.142431	0.549947
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.163	1.295
Probability of Causation (PC)	14.02	56.43

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n6_9**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons (fission)

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	205	740
Original ERR/Sv	1.9055	2.9033
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0706	0.1097
Systematic errors in gamma doses[b]	1.2542	1.1928
Systematic errors in neutron doses[b]	1.2060	1.2065
Systematic errors in RBE neutron doses[b]	0.9764	0.9599
Model Mixture factor for transfer to US pop	0.0000	0.8391
Ratio of Japanese to U.S. baseline cancer rates	0.3492	0.3399
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	14.054	23.3554

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.017	0.122
Probability of Causation (PC)	1.67	10.85

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.9055	2.9033
ERR/Sv with adjustments		
w/ age adjustment	1.9055	2.9033
w/ latency adjustment	1.9055	2.9033
w/ random errors in dosimetry adj	2.0400	3.2217
w/ systematic errors in dosimetry adj	1.3814	2.3323
adjusted for population transfer	0.4824	2.0845
multiplicative risk model	1.3814	2.3323
additive risk model	0.4824	0.7927
adjusted for smoking history	0.4824	2.0845
adjusted for DDREF	0.4824	2.0845
Final ERR/Sv	0.4824	2.0845
Organ equivalent dose (Sv)	0.035135	0.058389
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.017	0.122
Probability of Causation (PC)	1.67	10.85

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Calculations using MS Excel

Verification Run Identifier	**DDREF_n6_10**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	neutrons (fission)

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	205	740
Original ERR/Sv	1.9055	2.9033
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0706	0.1097
Systematic errors in gamma doses[b]	1.2542	1.1928
Systematic errors in neutron doses[b]	1.2060	1.2065
Systematic errors in RBE neutron doses[b]	0.9764	0.9599
Model Mixture factor for transfer to US pop	0.0000	0.8391
Ratio of Japanese to U.S. baseline cancer rates	0.3492	0.3399
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	14.054	23.3554

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.102	0.730
Probability of Causation (PC)	9.23	42.21

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.9055	2.9033
ERR/Sv with adjustments		
w/ age adjustment	1.9055	2.9033
w/ latency adjustment	1.9055	2.9033
w/ random errors in dosimetry adj	2.0400	3.2217
w/ systematic errors in dosimetry adj	1.3814	2.3323
adjusted for population transfer	0.4824	2.0845
multiplicative risk model	1.3814	2.3323
additive risk model	0.4824	0.7927
adjusted for smoking history	0.4824	2.0845
adjusted for DDREF	0.4824	2.0845
Final ERR/Sv	0.4824	2.0845
Organ equivalent dose (Sv)	0.21081	0.350331
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.102	0.730
Probability of Causation (PC)	9.23	42.21

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n6_11**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons (fission)

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	666	389
Original ERR/Sv	2.8030	3.5858
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1072	0.0661
Systematic errors in gamma doses[b]	1.0976	1.0389
Systematic errors in neutron doses[b]	1.1957	1.0720
Systematic errors in RBE neutron doses[b]	0.9651	1.0083
Model Mixture factor for transfer to US pop	0.0000	0.8781
Ratio of Japanese to U.S. baseline cancer rates	0.3507	0.3309
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	10.2037	23.7564

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.022	0.186
Probability of Causation (PC)	2.14	15.66

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.8030	3.5858
ERR/Sv with adjustments		
w/ age adjustment	2.8030	3.5858
w/ latency adjustment	2.8030	3.5858
w/ random errors in dosimetry adj	3.1035	3.8229
w/ systematic errors in dosimetry adj	2.4502	3.4044
adjusted for population transfer	0.8592	3.1268
multiplicative risk model	2.4502	3.4044
additive risk model	0.8592	1.1265
adjusted for smoking history	0.8592	3.1268
adjusted for DDREF	0.8592	3.1268
Final ERR/Sv	0.8592	3.1268
Organ equivalent dose (Sv)	0.025509	0.059391
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.022	0.186
Probability of Causation (PC)	2.14	15.66

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_n6_12**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	neutrons (fission)

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	666	389
Original ERR/Sv	2.8030	3.5858
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1072	0.0661
Systematic errors in gamma doses[b]	1.0976	1.0389
Systematic errors in neutron doses[b]	1.1957	1.0720
Systematic errors in RBE neutron doses[b]	0.9651	1.0083
Model Mixture factor for transfer to US pop	0.0000	0.8781
Ratio of Japanese to U.S. baseline cancer rates	0.3507	0.3309
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	10.2037	23.7564

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.132	1.114
Probability of Causation (PC)	11.62	52.70

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.8030	3.5858
ERR/Sv with adjustments		
w/ age adjustment	2.8030	3.5858
w/ latency adjustment	2.8030	3.5858
w/ random errors in dosimetry adj	3.1035	3.8229
w/ systematic errors in dosimetry adj	2.4502	3.4044
adjusted for population transfer	0.8592	3.1268
multiplicative risk model	2.4502	3.4044
additive risk model	0.8592	1.1265
adjusted for smoking history	0.8592	3.1268
adjusted for DDREF	0.8592	3.1268
Final ERR/Sv	0.8592	3.1268
Organ equivalent dose (Sv)	0.153056	0.356346
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.132	1.114
Probability of Causation (PC)	11.62	52.70

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_a_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	alpha

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	786	1061
Original ERR/Sv	1.6708	9.9749
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0999	0.1006
Systematic errors in gamma doses[b]	1.2358	1.3108
Systematic errors in neutron doses[b]	1.1451	1.1416
Systematic errors in RBE neutron doses[b]	0.9996	0.9563
Model Mixture factor for transfer to US pop	1.0293	0.5228
Ratio of Japanese to U.S. baseline cancer rates	0.8749	0.9554
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	2	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	27.0908	43.9488

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.057	1.096
Probability of Causation (PC)	5.35	52.29

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.6708	9.9749
ERR/Sv with adjustments		
w/ age adjustment	1.6708	9.9749
w/ latency adjustment	1.6708	9.9749
w/ random errors in dosimetry adj	1.6708	9.9749
w/ systematic errors in dosimetry adj	1.6708	9.9749
adjusted for population transfer	1.6708	9.9749
multiplicative risk model	1.6708	9.9749
additive risk model	1.4617	9.5297
adjusted for smoking history	1.6708	9.9749
adjusted for DDREF	0.8354	9.9749
Final ERR/Sv	0.8354	9.9749
Organ equivalent dose (Sv)	0.067727	0.109872
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.057	1.096
Probability of Causation (PC)	5.35	52.29

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_a_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	alpha

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	786	1061
Original ERR/Sv	1.6708	9.9749
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0999	0.1006
Systematic errors in gamma doses[b]	1.2358	1.3108
Systematic errors in neutron doses[b]	1.1451	1.1416
Systematic errors in RBE neutron doses[b]	0.9996	0.9563
Model Mixture factor for transfer to US pop	1.0293	0.5228
Ratio of Japanese to U.S. baseline cancer rates	0.8749	0.9554
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	2	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	27.0908	43.9488

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.339	6.576
Probability of Causation (PC)	25.34	86.80

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.6708	9.9749
ERR/Sv with adjustments		
w/ age adjustment	1.6708	9.9749
w/ latency adjustment	1.6708	9.9749
w/ random errors in dosimetry adj	1.6708	9.9749
w/ systematic errors in dosimetry adj	1.6708	9.9749
adjusted for population transfer	1.6708	9.9749
multiplicative risk model	1.6708	9.9749
additive risk model	1.4617	9.5297
adjusted for smoking history	1.6708	9.9749
adjusted for DDREF	0.8354	9.9749
Final ERR/Sv	0.8354	9.9749
Organ equivalent dose (Sv)	0.406362	0.659232
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.339	6.576
Probability of Causation (PC)	25.34	86.80

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_a_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	alpha

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	786	1061
Original ERR/Sv	1.6708	9.9749
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0999	0.1006
Systematic errors in gamma doses[b]	1.2358	1.3108
Systematic errors in neutron doses[b]	1.1451	1.1416
Systematic errors in RBE neutron doses[b]	0.9996	0.9563
Model Mixture factor for transfer to US pop	1.0293	0.5228
Ratio of Japanese to U.S. baseline cancer rates	0.8749	0.9554
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	2	1
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	27.0908	43.9488

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.057	1.096
Probability of Causation (PC)	5.35	52.29

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.6708	9.9749
ERR/Sv with adjustments		
w/ age adjustment	1.6708	9.9749
w/ latency adjustment	1.6708	9.9749
w/ random errors in dosimetry adj	1.6708	9.9749
w/ systematic errors in dosimetry adj	1.6708	9.9749
adjusted for population transfer	1.6708	9.9749
multiplicative risk model	1.6708	9.9749
additive risk model	1.4617	9.5297
adjusted for smoking history	1.6708	9.9749
adjusted for DDREF	0.8354	9.9749
Final ERR/Sv	0.8354	9.9749
Organ equivalent dose (Sv)	0.067727	0.109872
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.057	1.096
Probability of Causation (PC)	5.35	52.29

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_a_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Thyroid
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	alpha

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	786	1061
Original ERR/Sv	1.6708	9.9749
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0999	0.1006
Systematic errors in gamma doses[b]	1.2358	1.3108
Systematic errors in neutron doses[b]	1.1451	1.1416
Systematic errors in RBE neutron doses[b]	0.9996	0.9563
Model Mixture factor for transfer to US pop	1.0293	0.5228
Ratio of Japanese to U.S. baseline cancer rates	0.8749	0.9554
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	2	1
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	27.0908	43.9488

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.339	6.576
Probability of Causation (PC)	25.34	86.80

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.6708	9.9749
ERR/Sv with adjustments		
w/ age adjustment	1.6708	9.9749
w/ latency adjustment	1.6708	9.9749
w/ random errors in dosimetry adj	1.6708	9.9749
w/ systematic errors in dosimetry adj	1.6708	9.9749
adjusted for population transfer	1.6708	9.9749
multiplicative risk model	1.6708	9.9749
additive risk model	1.4617	9.5297
adjusted for smoking history	1.6708	9.9749
adjusted for DDREF	0.8354	9.9749
Final ERR/Sv	0.8354	9.9749
Organ equivalent dose (Sv)	0.406362	0.659232
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.339	6.576
Probability of Causation (PC)	25.34	86.80

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_a_5**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	alpha

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1340	1578
Original ERR/Sv	0.6137	0.1953
Adjustment Factors		
Age at exposure, Attained age	2.8105	2.3685
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0749	0.0894
Systematic errors in gamma doses[b]	1.2032	1.1181
Systematic errors in neutron doses[b]	1.1500	1.2571
Systematic errors in RBE neutron doses[b]	0.9499	1.0063
Model Mixture factor for transfer to US pop	1.0248	0.7791
Ratio of Japanese to U.S. baseline cancer rates	1.1054	1.1194
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	3	0.7
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	25.8258	285.559

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.030	0.373
Probability of Causation (PC)	2.94	27.16

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6137	0.1953
ERR/Sv with adjustments		
w/ age adjustment	1.7248	0.4625
w/ latency adjustment	1.7248	0.4625
w/ random errors in dosimetry adj	1.8541	0.5039
w/ systematic errors in dosimetry adj	1.4108	0.3562
adjusted for population transfer	1.4071	0.3656
multiplicative risk model	1.4108	0.3562
additive risk model	1.5595	0.3988
adjusted for smoking history	1.4071	0.3656
adjusted for DDREF	0.4690	0.5223
Final ERR/Sv	0.4690	0.5223
Organ equivalent dose (Sv)	0.064565	0.713898
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.030	0.373
Probability of Causation (PC)	2.94	27.16

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_a_6**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	alpha

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1340	1578
Original ERR/Sv	0.6137	0.1953
Adjustment Factors		
Age at exposure, Attained age	2.8105	2.3685
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0749	0.0894
Systematic errors in gamma doses[b]	1.2032	1.1181
Systematic errors in neutron doses[b]	1.1500	1.2571
Systematic errors in RBE neutron doses[b]	0.9499	1.0063
Model Mixture factor for transfer to US pop	1.0248	0.7791
Ratio of Japanese to U.S. baseline cancer rates	1.1054	1.1194
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	3	0.7
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	25.8258	285.559

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.182	2.238
Probability of Causation (PC)	15.38	69.11

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6137	0.1953
ERR/Sv with adjustments		
w/ age adjustment	1.7248	0.4625
w/ latency adjustment	1.7248	0.4625
w/ random errors in dosimetry adj	1.8541	0.5039
w/ systematic errors in dosimetry adj	1.4108	0.3562
adjusted for population transfer	1.4071	0.3656
multiplicative risk model	1.4108	0.3562
additive risk model	1.5595	0.3988
adjusted for smoking history	1.4071	0.3656
adjusted for DDREF	0.4690	0.5223
Final ERR/Sv	0.4690	0.5223
Organ equivalent dose (Sv)	0.387387	4.283385
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.182	2.237
Probability of Causation (PC)	15.38	69.11

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_a_7**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	alpha

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1340	1578
Original ERR/Sv	0.6137	0.1953
Adjustment Factors		
Age at exposure, Attained age	2.8105	2.3685
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0749	0.0894
Systematic errors in gamma doses[b]	1.2032	1.1181
Systematic errors in neutron doses[b]	1.1500	1.2571
Systematic errors in RBE neutron doses[b]	0.9499	1.0063
Model Mixture factor for transfer to US pop	1.0248	0.7791
Ratio of Japanese to U.S. baseline cancer rates	1.1054	1.1194
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	3	0.7
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	25.8258	285.559

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.030	0.373
Probability of Causation (PC)	2.94	27.16

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6137	0.1953
ERR/Sv with adjustments		
w/ age adjustment	1.7248	0.4625
w/ latency adjustment	1.7248	0.4625
w/ random errors in dosimetry adj	1.8541	0.5039
w/ systematic errors in dosimetry adj	1.4108	0.3562
adjusted for population transfer	1.4071	0.3656
multiplicative risk model	1.4108	0.3562
additive risk model	1.5595	0.3988
adjusted for smoking history	1.4071	0.3656
adjusted for DDREF	0.4690	0.5223
Final ERR/Sv	0.4690	0.5223
Organ equivalent dose (Sv)	0.064565	0.713898
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.030	0.373
Probability of Causation (PC)	2.94	27.16

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_a_8**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Colon
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	alpha

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1340	1578
Original ERR/Sv	0.6137	0.1953
Adjustment Factors		
Age at exposure, Attained age	2.8105	2.3685
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0749	0.0894
Systematic errors in gamma doses[b]	1.2032	1.1181
Systematic errors in neutron doses[b]	1.1500	1.2571
Systematic errors in RBE neutron doses[b]	0.9499	1.0063
Model Mixture factor for transfer to US pop	1.0248	0.7791
Ratio of Japanese to U.S. baseline cancer rates	1.1054	1.1194
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	3	0.7
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	25.8258	285.559

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.182	2.238
Probability of Causation (PC)	15.38	69.11

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6137	0.1953
ERR/Sv with adjustments		
w/ age adjustment	1.7248	0.4625
w/ latency adjustment	1.7248	0.4625
w/ random errors in dosimetry adj	1.8541	0.5039
w/ systematic errors in dosimetry adj	1.4108	0.3562
adjusted for population transfer	1.4071	0.3656
multiplicative risk model	1.4108	0.3562
additive risk model	1.5595	0.3988
adjusted for smoking history	1.4071	0.3656
adjusted for DDREF	0.4690	0.5223
Final ERR/Sv	0.4690	0.5223
Organ equivalent dose (Sv)	0.387387	4.283385
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.182	2.237
Probability of Causation (PC)	15.38	69.11

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_a_9**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	alpha

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	682	1506
Original ERR/Sv	2.0608	2.4894
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0847	0.0875
Systematic errors in gamma doses[b]	1.1582	1.2008
Systematic errors in neutron doses[b]	1.1570	1.1528
Systematic errors in RBE neutron doses[b]	1.0564	0.9323
Model Mixture factor for transfer to US pop	0.9337	0.9892
Ratio of Japanese to U.S. baseline cancer rates	0.3254	0.3376
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	4	1.5
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	29.3727	101.832

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.028	0.354
Probability of Causation (PC)	2.69	26.12

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.0608	2.4894
ERR/Sv with adjustments		
w/ age adjustment	2.0608	2.4894
w/ latency adjustment	2.0608	2.4894
w/ random errors in dosimetry adj	2.2354	2.7072
w/ systematic errors in dosimetry adj	1.5792	2.0977
adjusted for population transfer	1.5085	2.0828
multiplicative risk model	1.5792	2.0977
additive risk model	0.5139	0.7083
adjusted for smoking history	1.5085	2.0828
adjusted for DDREF	0.3771	1.3885
Final ERR/Sv	0.3771	1.3885
Organ equivalent dose (Sv)	0.073432	0.25458
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.028	0.353
Probability of Causation (PC)	2.69	26.12

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_a_10**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	alpha

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	682	1506
Original ERR/Sv	2.0608	2.4894
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0847	0.0875
Systematic errors in gamma doses[b]	1.1582	1.2008
Systematic errors in neutron doses[b]	1.1570	1.1528
Systematic errors in RBE neutron doses[b]	1.0564	0.9323
Model Mixture factor for transfer to US pop	0.9337	0.9892
Ratio of Japanese to U.S. baseline cancer rates	0.3254	0.3376
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	4	1.5
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	29.3727	101.832

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.166	2.121
Probability of Causation (PC)	14.25	67.96

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.0608	2.4894
ERR/Sv with adjustments		
w/ age adjustment	2.0608	2.4894
w/ latency adjustment	2.0608	2.4894
w/ random errors in dosimetry adj	2.2354	2.7072
w/ systematic errors in dosimetry adj	1.5792	2.0977
adjusted for population transfer	1.5085	2.0828
multiplicative risk model	1.5792	2.0977
additive risk model	0.5139	0.7083
adjusted for smoking history	1.5085	2.0828
adjusted for DDREF	0.3771	1.3885
Final ERR/Sv	0.3771	1.3885
Organ equivalent dose (Sv)	0.440591	1.52748
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.166	2.121
Probability of Causation (PC)	14.25	67.96

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_a_11**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	alpha

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	682	1506
Original ERR/Sv	2.0608	2.4894
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0847	0.0875
Systematic errors in gamma doses[b]	1.1582	1.2008
Systematic errors in neutron doses[b]	1.1570	1.1528
Systematic errors in RBE neutron doses[b]	1.0564	0.9323
Model Mixture factor for transfer to US pop	0.9337	0.9892
Ratio of Japanese to U.S. baseline cancer rates	0.3254	0.3376
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	4	1.5
Organ equivalent dose (cSv)[c]	5	5
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	29.3727	101.832

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.028	0.354
Probability of Causation (PC)	2.69	26.12

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.0608	2.4894
ERR/Sv with adjustments		
w/ age adjustment	2.0608	2.4894
w/ latency adjustment	2.0608	2.4894
w/ random errors in dosimetry adj	2.2354	2.7072
w/ systematic errors in dosimetry adj	1.5792	2.0977
adjusted for population transfer	1.5085	2.0828
multiplicative risk model	1.5792	2.0977
additive risk model	0.5139	0.7083
adjusted for smoking history	1.5085	2.0828
adjusted for DDREF	0.3771	1.3885
Final ERR/Sv	0.3771	1.3885
Organ equivalent dose (Sv)	0.073432	0.25458
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.028	0.353
Probability of Causation (PC)	2.69	26.12

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**DDREF_a_12**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Breast
Exposure Information	
Exposure year	1920
Exposure rate	chronic
Radiation type	alpha

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	682	1506
Original ERR/Sv	2.0608	2.4894
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0847	0.0875
Systematic errors in gamma doses[b]	1.1582	1.2008
Systematic errors in neutron doses[b]	1.1570	1.1528
Systematic errors in RBE neutron doses[b]	1.0564	0.9323
Model Mixture factor for transfer to US pop	0.9337	0.9892
Ratio of Japanese to U.S. baseline cancer rates	0.3254	0.3376
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	4	1.5
Organ equivalent dose (cSv)[c]	30	30
Radiation weighting factor (w_R - ICRP 60)	20	20
Radiation effectiveness factor (REF)	29.3727	101.832

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.166	2.121
Probability of Causation (PC)	14.25	67.96

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	2.0608	2.4894
ERR/Sv with adjustments		
w/ age adjustment	2.0608	2.4894
w/ latency adjustment	2.0608	2.4894
w/ random errors in dosimetry adj	2.2354	2.7072
w/ systematic errors in dosimetry adj	1.5792	2.0977
adjusted for population transfer	1.5085	2.0828
multiplicative risk model	1.5792	2.0977
additive risk model	0.5139	0.7083
adjusted for smoking history	1.5085	2.0828
adjusted for DDREF	0.3771	1.3885
Final ERR/Sv	0.3771	1.3885
Organ equivalent dose (Sv)	0.440591	1.52748
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.166	2.121
Probability of Causation (PC)	14.25	67.96

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Appendix F

Effect of Ethnic Origin on the ERR per Unit Dose for Skin Cancer

The calculations documented in this appendix were performed to verify that the adjustment accounting for the interaction between ionizing and UV radiation for individuals of different ethnic origins is implemented correctly in NIOSH-IREP. A total of 15 calculations was performed for this specific verification task.

The calculations performed for this exercise assume an acute exposure to high energy photons (E>250 keV), the age at exposure (AAE) was kept constant at 20 years, and the attained age (ATA) was kept constant at 40 years. The verification calculations were performed for males only under the assumption of a single acute exposure to a dose of 20 cSv.

Further details about this verification task can be found in Section 5.5 of the report. The results for ERR and PC obtained with MS Excel verify the mid and upper bound values of ERR and PC estimated using NIOSH-IREP v.5.5.3r, for all exposure scenarios considered.

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Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Ethnic_MM_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Malignant melanoma
Ethnic Origin	American Indian
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1765	1049
Original ERR/Sv	6.5583	7.7109
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0698	0.0898
Systematic errors in gamma doses[b]	1.0539	1.3507
Systematic errors in neutron doses[b]	1.1616	1.1749
Systematic errors in RBE neutron doses[b]	0.9546	0.9325
Model Mixture factor for transfer to US pop	0.3199	0.5910
Ratio of Japanese to U.S. baseline cancer rates	0.6958	8.3440
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.952	4.547
Probability of Causation (PC)	48.78	81.97

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	6.5583	7.7109
ERR/Sv with adjustments		
w/ age adjustment	6.5583	7.7109
w/ latency adjustment	6.5583	7.7109
w/ random errors in dosimetry adj	7.0160	8.4036
w/ systematic errors in dosimetry adj	6.0032	5.6788
adjusted for population transfer	4.7611	22.7350
multiplicative risk model	6.0032	5.6788
additive risk model	4.1770	47.3836
adjusted for smoking history	4.7611	22.7350
adjusted for DDREF	4.7611	22.7350
Final ERR/Sv	4.7611	22.7350
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.952	4.547
Probability of Causation (PC)	48.78	81.97

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Ethnic_MM_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Malignant melanoma
Ethnic Origin	Asian
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	98	1149
Original ERR/Sv	7.0486	14.5782
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0821	0.0902
Systematic errors in gamma doses[b]	1.1636	1.1357
Systematic errors in neutron doses[b]	1.0992	1.0782
Systematic errors in RBE neutron doses[b]	1.0096	1.0024
Model Mixture factor for transfer to US pop	0.5327	1.0293
Ratio of Japanese to U.S. baseline cancer rates	0.2600	0.3635
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.773	2.638
Probability of Causation (PC)	43.59	72.51

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	7.0486	14.5782
ERR/Sv with adjustments		
w/ age adjustment	7.0486	14.5782
w/ latency adjustment	7.0486	14.5782
w/ random errors in dosimetry adj	7.6273	15.8930
w/ systematic errors in dosimetry adj	5.9067	12.9492
adjusted for population transfer	3.8644	13.1904
multiplicative risk model	5.9067	12.9492
additive risk model	1.5360	4.7076
adjusted for smoking history	3.8644	13.1904
adjusted for DDREF	3.8644	13.1904
Final ERR/Sv	3.8644	13.1904
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.773	2.638
Probability of Causation (PC)	43.59	72.51

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Ethnic_MM_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Malignant melanoma
Ethnic Origin	Black
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1025	912
Original ERR/Sv	6.4498	16.6240
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1108	0.1214
Systematic errors in gamma doses[b]	1.0572	1.0955
Systematic errors in neutron doses[b]	1.1545	1.1504
Systematic errors in RBE neutron doses[b]	1.0036	1.0100
Model Mixture factor for transfer to US pop	0.5146	0.4920
Ratio of Japanese to U.S. baseline cancer rates	0.4303	0.8584
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.846	2.719
Probability of Causation (PC)	45.84	73.11

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	6.4498	16.6240
ERR/Sv with adjustments		
w/ age adjustment	6.4498	16.6240
w/ latency adjustment	6.4498	16.6240
w/ random errors in dosimetry adj	7.1645	18.6424
w/ systematic errors in dosimetry adj	5.8486	14.6478
adjusted for population transfer	4.2314	13.5941
multiplicative risk model	5.8486	14.6478
additive risk model	2.5170	12.5736
adjusted for smoking history	4.2314	13.5941
adjusted for DDREF	4.2314	13.5941
Final ERR/Sv	4.2314	13.5941
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.846	2.719
Probability of Causation (PC)	45.84	73.11

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Ethnic_MM_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Malignant melanoma
Ethcni Origin	Hispanic
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1291	409
Original ERR/Sv	6.4430	14.7888
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0673	0.0783
Systematic errors in gamma doses[b]	1.0263	1.1418
Systematic errors in neutron doses[b]	1.2047	1.1142
Systematic errors in RBE neutron doses[b]	0.9811	1.0277
Model Mixture factor for transfer to US pop	0.3787	1.0549
Ratio of Japanese to U.S. baseline cancer rates	0.2472	0.1370
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.604	2.555
Probability of Causation (PC)	37.64	71.87

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	6.4430	14.7888
ERR/Sv with adjustments		
w/ age adjustment	6.4430	14.7888
w/ latency adjustment	6.4430	14.7888
w/ random errors in dosimetry adj	6.8769	15.9473
w/ systematic errors in dosimetry adj	5.6690	12.1974
adjusted for population transfer	3.0177	12.7753
multiplicative risk model	5.6690	12.1974
additive risk model	1.4016	1.6715
adjusted for smoking history	3.0177	12.7753
adjusted for DDREF	3.0177	12.7753
Final ERR/Sv	3.0177	12.7753
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.604	2.555
Probability of Causation (PC)	37.64	71.87

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Ethnic_MM_5**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Malignant melanoma
Ethnic Origin	White non-Hispanic
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	423	1325
Original ERR/Sv	4.3731	16.1408
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0727	0.0817
Systematic errors in gamma doses[b]	1.0643	1.0561
Systematic errors in neutron doses[b]	1.1357	1.0828
Systematic errors in RBE neutron doses[b]	1.0143	0.9595
Model Mixture factor for transfer to US pop	0.6251	0.7731
Ratio of Japanese to U.S. baseline cancer rates	0.0328	0.0382
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.488	2.488
Probability of Causation (PC)	32.79	71.33

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	4.3731	16.1408
ERR/Sv with adjustments		
w/ age adjustment	4.3731	16.1408
w/ latency adjustment	4.3731	16.1408
w/ random errors in dosimetry adj	4.6909	17.4598
w/ systematic errors in dosimetry adj	3.8262	15.9123
adjusted for population transfer	2.4389	12.4392
multiplicative risk model	3.8262	15.9123
additive risk model	0.1254	0.6073
adjusted for smoking history	2.4389	12.4392
adjusted for DDREF	2.4389	12.4392
Final ERR/Sv	2.4389	12.4392
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.488	2.488
Probability of Causation (PC)	32.79	71.33

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Ethnic_BCC_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Non-melanoma (BCC)
Ethnic Origin	American Indian
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1342	695
Original ERR/Sv	6.8480	21.5451
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0936	0.1004
Systematic errors in gamma doses[b]	1.0515	1.1203
Systematic errors in neutron doses[b]	1.1182	1.1700
Systematic errors in RBE neutron doses[b]	0.9619	1.0036
Model Mixture factor for transfer to US pop	1.0013	0.4442
Ratio of Japanese to U.S. baseline cancer rates	1.7002	1.9241
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	1.323	5.457
Probability of Causation (PC)	56.95	84.51

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	6.8480	21.5451
ERR/Sv with adjustments		
w/ age adjustment	6.8480	21.5451
w/ latency adjustment	6.8479	21.5451
w/ random errors in dosimetry adj	7.4891	23.7088
w/ systematic errors in dosimetry adj	6.6215	18.0229
adjusted for population transfer	6.6153	27.2805
multiplicative risk model	6.6215	18.0229
additive risk model	11.2577	34.6784
adjusted for smoking history	6.6153	27.2805
adjusted for DDREF	6.6153	27.2805
Final ERR/Sv	6.6153	27.2805
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	1.323	5.456
Probability of Causation (PC)	56.95	84.51

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Ethnic_BCC_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Non-melanoma (BCC)
Ethnic Origin	Asian
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1342	695
Original ERR/Sv	6.8480	21.5451
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0936	0.1004
Systematic errors in gamma doses[b]	1.0515	1.1203
Systematic errors in neutron doses[b]	1.1182	1.1700
Systematic errors in RBE neutron doses[b]	0.9619	1.0036
Model Mixture factor for transfer to US pop	1.0013	0.4442
Ratio of Japanese to U.S. baseline cancer rates	1.7002	1.9241
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	1.323	5.457
Probability of Causation (PC)	56.95	84.51

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	6.8480	21.5451
ERR/Sv with adjustments		
w/ age adjustment	6.8480	21.5451
w/ latency adjustment	6.8479	21.5451
w/ random errors in dosimetry adj	7.4891	23.7088
w/ systematic errors in dosimetry adj	6.6215	18.0229
adjusted for population transfer	6.6153	27.2805
multiplicative risk model	6.6215	18.0229
additive risk model	11.2577	34.6784
adjusted for smoking history	6.6153	27.2805
adjusted for DDREF	6.6153	27.2805
Final ERR/Sv	6.6153	27.2805
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	1.323	5.456
Probability of Causation (PC)	56.95	84.51

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Ethnic_BCC_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Non-melanoma (BCC)
Ethnic Origin	Black
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1342	695
Original ERR/Sv	6.8480	21.5451
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0936	0.1004
Systematic errors in gamma doses[b]	1.0515	1.1203
Systematic errors in neutron doses[b]	1.1182	1.1700
Systematic errors in RBE neutron doses[b]	0.9619	1.0036
Model Mixture factor for transfer to US pop	1.0013	0.4442
Ratio of Japanese to U.S. baseline cancer rates	1.7002	1.9241
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	1.323	5.457
Probability of Causation (PC)	56.95	84.51

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	6.8480	21.5451
ERR/Sv with adjustments		
w/ age adjustment	6.8480	21.5451
w/ latency adjustment	6.8479	21.5451
w/ random errors in dosimetry adj	7.4891	23.7088
w/ systematic errors in dosimetry adj	6.6215	18.0229
adjusted for population transfer	6.6153	27.2805
multiplicative risk model	6.6215	18.0229
additive risk model	11.2577	34.6784
adjusted for smoking history	6.6153	27.2805
adjusted for DDREF	6.6153	27.2805
Final ERR/Sv	6.6153	27.2805
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	1.323	5.456
Probability of Causation (PC)	56.95	84.51

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Ethnic_BCC_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Non-melanoma (BCC)
Ethnic Origin	Hispanic
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1740	371
Original ERR/Sv	5.7313	13.2732
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0948	0.0947
Systematic errors in gamma doses[b]	1.1507	1.0902
Systematic errors in neutron doses[b]	1.1377	1.0519
Systematic errors in RBE neutron doses[b]	1.0181	0.9277
Model Mixture factor for transfer to US pop	0.5025	0.9100
Ratio of Japanese to U.S. baseline cancer rates	0.1204	0.1027
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.529	2.512
Probability of Causation (PC)	34.62	71.52

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	5.7313	13.2732
ERR/Sv with adjustments		
w/ age adjustment	5.7313	13.2732
w/ latency adjustment	5.7313	13.2732
w/ random errors in dosimetry adj	6.2745	14.5304
w/ systematic errors in dosimetry adj	4.7078	13.6592
adjusted for population transfer	2.6476	12.5564
multiplicative risk model	4.7078	13.6592
additive risk model	0.5669	1.4023
adjusted for smoking history	2.6476	12.5564
adjusted for DDREF	2.6476	12.5564
Final ERR/Sv	2.6476	12.5564
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.530	2.511
Probability of Causation (PC)	34.62	71.52

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Ethnic_BCC_5**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Non-melanoma (BCC)
Ethnic Origin	While non-Hispanic
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	15	1430
Original ERR/Sv	4.5614	13.4140
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0853	0.0587
Systematic errors in gamma doses[b]	1.1193	1.1511
Systematic errors in neutron doses[b]	1.2012	1.0334
Systematic errors in RBE neutron doses[b]	0.9865	0.9946
Model Mixture factor for transfer to US pop	0.6356	1.0471
Ratio of Japanese to U.S. baseline cancer rates	0.0215	0.0203
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.480	2.511
Probability of Causation (PC)	32.45	71.52

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	4.5614	13.4140
ERR/Sv with adjustments		
w/ age adjustment	4.5614	13.4140
w/ latency adjustment	4.5614	13.4140
w/ random errors in dosimetry adj	4.9504	14.2010
w/ systematic errors in dosimetry adj	3.7325	12.0023
adjusted for population transfer	2.4015	12.5555
multiplicative risk model	3.7325	12.0023
additive risk model	0.0802	0.2433
adjusted for smoking history	2.4015	12.5555
adjusted for DDREF	2.4015	12.5555
Final ERR/Sv	2.4015	12.5555
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.480	2.511
Probability of Causation (PC)	32.45	71.52

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Ethnic_SCC_1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Non-melanoma (SCC)
Ethnic Origin	American Indian
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1	124
Original ERR/Sv	-0.1915	0.8683
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0865	0.0894
Systematic errors in gamma doses[b]	1.1934	1.1452
Systematic errors in neutron doses[b]	1.0294	1.1605
Systematic errors in RBE neutron doses[b]	0.9363	0.9577
Model Mixture factor for transfer to US pop	0.7027	0.1378
Ratio of Japanese to U.S. baseline cancer rates	1.7100	0.9269
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.000	0.139
Probability of Causation (PC)	0.00	12.22

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0000	0.8683
ERR/Sv with adjustments		
w/ age adjustment	0.0000	0.8683
w/ latency adjustment	0.0000	0.8683
w/ random errors in dosimetry adj	0.0000	0.9459
w/ systematic errors in dosimetry adj	0.0000	0.7431
adjusted for population transfer	0.0000	0.6963
multiplicative risk model	0.0000	0.7431
additive risk model	0.0000	0.6888
adjusted for smoking history	0.0000	0.6963
adjusted for DDREF	0.0000	0.6963
Final ERR/Sv	0.0000	0.6963
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.000	0.139
Probability of Causation (PC)	0.00	12.22

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Ethnic_SCC_2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Non-melanoma (SCC)
Ethnic Origin	Asian
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1	124
Original ERR/Sv	-0.1915	0.8683
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0865	0.0894
Systematic errors in gamma doses[b]	1.1934	1.1452
Systematic errors in neutron doses[b]	1.0294	1.1605
Systematic errors in RBE neutron doses[b]	0.9363	0.9577
Model Mixture factor for transfer to US pop	0.7027	0.1378
Ratio of Japanese to U.S. baseline cancer rates	1.7100	0.9269
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.000	0.139
Probability of Causation (PC)	0.00	12.22

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0000	0.8683
ERR/Sv with adjustments		
w/ age adjustment	0.0000	0.8683
w/ latency adjustment	0.0000	0.8683
w/ random errors in dosimetry adj	0.0000	0.9459
w/ systematic errors in dosimetry adj	0.0000	0.7431
adjusted for population transfer	0.0000	0.6963
multiplicative risk model	0.0000	0.7431
additive risk model	0.0000	0.6888
adjusted for smoking history	0.0000	0.6963
adjusted for DDREF	0.0000	0.6963
Final ERR/Sv	0.0000	0.6963
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.000	0.139
Probability of Causation (PC)	0.00	12.22

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Ethnic_SCC_3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Non-melanoma (SCC)
Ethnic Origin	Black
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1	124
Original ERR/Sv	-0.1915	0.8683
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0865	0.0894
Systematic errors in gamma doses[b]	1.1934	1.1452
Systematic errors in neutron doses[b]	1.0294	1.1605
Systematic errors in RBE neutron doses[b]	0.9363	0.9577
Model Mixture factor for transfer to US pop	0.7027	0.1378
Ratio of Japanese to U.S. baseline cancer rates	1.7100	0.9269
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.000	0.139
Probability of Causation (PC)	0.00	12.22

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0000	0.8683
ERR/Sv with adjustments		
w/ age adjustment	0.0000	0.8683
w/ latency adjustment	0.0000	0.8683
w/ random errors in dosimetry adj	0.0000	0.9459
w/ systematic errors in dosimetry adj	0.0000	0.7431
adjusted for population transfer	0.0000	0.6963
multiplicative risk model	0.0000	0.7431
additive risk model	0.0000	0.6888
adjusted for smoking history	0.0000	0.6963
adjusted for DDREF	0.0000	0.6963
Final ERR/Sv	0.0000	0.6963
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.000	0.139
Probability of Causation (PC)	0.00	12.22

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Ethnic_SCC_4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Non-melanoma (SCC)
Ethnic Origin	Hispanic
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1	409
Original ERR/Sv	-0.1915	0.3996
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0865	0.0901
Systematic errors in gamma doses[b]	1.1934	1.1418
Systematic errors in neutron doses[b]	1.0294	1.1142
Systematic errors in RBE neutron doses[b]	0.9363	1.0277
Model Mixture factor for transfer to US pop	0.7027	1.0549
Ratio of Japanese to U.S. baseline cancer rates	0.0995	0.0799
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.000	0.070
Probability of Causation (PC)	0.00	6.54

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0000	0.3996
ERR/Sv with adjustments		
w/ age adjustment	0.0000	0.3996
w/ latency adjustment	0.0000	0.3996
w/ random errors in dosimetry adj	0.0000	0.4356
w/ systematic errors in dosimetry adj	0.0000	0.3332
adjusted for population transfer	0.0000	0.3500
multiplicative risk model	0.0000	0.3332
additive risk model	0.0000	0.0266
adjusted for smoking history	0.0000	0.3500
adjusted for DDREF	0.0000	0.3500
Final ERR/Sv	0.0000	0.3500
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.000	0.070
Probability of Causation (PC)	0.00	6.54

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Ethnic_SCC_5**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Non-melanoma (SCC)
Ethnic Origin	White non-Hispanic
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1	1945
Original ERR/Sv	-0.1915	0.4633
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0865	0.0821
Systematic errors in gamma doses[b]	1.1934	1.1230
Systematic errors in neutron doses[b]	1.0294	1.0286
Systematic errors in RBE neutron doses[b]	0.9363	0.9589
Model Mixture factor for transfer to US pop	0.7027	0.7560
Ratio of Japanese to U.S. baseline cancer rates	0.0189	0.0213
Smoking history	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.000	0.069
Probability of Causation (PC)	0.00	6.45

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.0000	0.4633
ERR/Sv with adjustments		
w/ age adjustment	0.0000	0.4633
w/ latency adjustment	0.0000	0.4633
w/ random errors in dosimetry adj	0.0000	0.5014
w/ systematic errors in dosimetry adj	0.0000	0.4526
adjusted for population transfer	0.0000	0.3446
multiplicative risk model	0.0000	0.4526
additive risk model	0.0000	0.0096
adjusted for smoking history	0.0000	0.3446
adjusted for DDREF	0.0000	0.3446
Final ERR/Sv	0.0000	0.3446
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0

Final results calculated in Excel		
Excess relative risk (ERR)	0.000	0.069
Probability of Causation (PC)	0.00	6.45

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Appendix G

Effect of Cigarette Smoking on the Risk of Lung Cancer (Non-radon Exposures)

The calculations documented in this appendix were performed to ensure that the interaction effect between smoking and radiation exposures (non-radon) has been properly programmed in NIOSH-IREP for estimating the risk of lung cancer. A total of 14 calculations was performed for this specific verification task.

Both models to estimate risk for lung cancer due to sources of exposure other than radon (the NIH lung model and the pre-2006 NIOSH lung model) take into account an interaction between radiation and smoking history. The calculations have been performed to test the combined lung model and report the 99^{th} percentile PC value that is the largest.

Calculations were performed separately for males and females and assume an acute exposure to 20 cSv of high energy photons, E > 250 keV. The age at exposure (AAE) was kept constant at 20 years of age, and the attained age (ATA) was kept constant at 40 years of age.

Further details about this verification task can be found in Section 5.6 of the report. The results for ERR and PC obtained with MS Excel verify the mid and upper bound values of ERR and PC estimated using NIOSH-IREP v.5.5.3r, for all exposure scenarios considered.

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Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_other_m1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	Never smoked
Lung model used for calculation	NIOSH-IREP
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	720	1305
Original ERR/Sv	0.6477	0.7451
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1168	0.0928
Systematic errors in gamma doses[b]	1.0722	1.1818
Systematic errors in neutron doses[b]	1.1975	1.0316
Systematic errors in RBE neutron doses[b]	1.0342	0.9563
Model Mixture factor for transfer to US pop	0.1956	0.7841
Ratio of Japanese to U.S. baseline cancer rates	0.7358	0.7121
Smoking history	1.475203	3.548618
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1
Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.127	0.465
Probability of Causation (PC)	11.24	31.74

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6477	0.7451
ERR/Sv with adjustments		
w/ age adjustment	0.6477	0.7451
w/ latency adjustment	0.6477	0.7451
w/ random errors in dosimetry adj	0.7233	0.8143
w/ systematic errors in dosimetry adj	0.5448	0.6984
adjusted for population transfer	0.4290	0.6550
multiplicative risk model	0.5448	0.6984
additive risk model	0.4009	0.4974
adjusted for smoking history	0.6329	2.3244
adjusted for DDREF	0.6329	2.3244
Final ERR/Sv	0.6329	2.3244
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0
Final results calculated in Excel		
Excess relative risk (ERR)	0.127	0.465
Probability of Causation (PC)	11.24	31.74

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_other_m2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	Former smoker
Lung model used for calculation	NIH-IREP
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	280	1591
Original ERR/Sv	1.3769	1.1800
Adjustment Factors		
Age at exposure, Attained age	1.7843	1.8577
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0929	0.1048
Systematic errors in gamma doses[b]	1.0611	1.2085
Systematic errors in neutron doses[b]	1.1830	1.0301
Systematic errors in RBE neutron doses[b]	1.0611	1.0390
Model Mixture factor for transfer to US pop	0.0000	1.0053
Ratio of Japanese to U.S. baseline cancer rates	0.7018	0.7208
Smoking history	0.2511	0.835326
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1
Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.071	0.313
Probability of Causation (PC)	6.63	23.85

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.3769	1.1800
ERR/Sv with adjustments		
w/ age adjustment	2.4567	2.1920
w/ latency adjustment	2.4567	2.1920
w/ random errors in dosimetry adj	2.6850	2.4216
w/ systematic errors in dosimetry adj	2.0159	1.8722
adjusted for population transfer	1.4148	1.8750
multiplicative risk model	2.0159	1.8722
additive risk model	1.4148	1.3494
adjusted for smoking history	0.3553	1.5662
adjusted for DDREF	0.3553	1.5662
Final ERR/Sv	0.3553	1.5662
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0
Final results calculated in Excel		
Excess relative risk (ERR)	0.071	0.313
Probability of Causation (PC)	6.63	23.85

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_other_m3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	Current smoker (? cig/day)
Lung model used for calculation	NIH-IREP
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1796	168
Original ERR/Sv	1.1319	1.4015
Adjustment Factors		
Age at exposure, Attained age	2.2554	1.6119
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1180	0.0944
Systematic errors in gamma doses[b]	1.2020	1.1366
Systematic errors in neutron doses[b]	1.1182	1.0434
Systematic errors in RBE neutron doses[b]	1.0387	1.0168
Model Mixture factor for transfer to US pop	0.7626	0.2720
Ratio of Japanese to U.S. baseline cancer rates	0.7000	0.7067
Smoking history	0.08861	0.944771
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1
Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.021	0.102
Probability of Causation (PC)	3.26	23.35

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.1319	1.4015
ERR/Sv with adjustments		
w/ age adjustment	2.5529	2.2591
w/ latency adjustment	2.5529	2.2591
w/ random errors in dosimetry adj	2.8541	2.4723
w/ systematic errors in dosimetry adj	2.0443	2.0504
adjusted for population transfer	1.8987	1.6126
multiplicative risk model	2.0443	2.0504
additive risk model	1.4311	1.4490
adjusted for smoking history	0.1682	1.5236
adjusted for DDREF	0.1682	1.5236
Final ERR/Sv	0.1682	1.5236
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0
Final results calculated in Excel		
Excess relative risk (ERR)	0.034	0.305
Probability of Causation (PC)	3.26	23.35

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_other_m4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	<10 cig/day (currently)
Lung model used for calculation	NIH-IREP
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	9	1591
Original ERR/Sv	1.1671	1.1800
Adjustment Factors		
Age at exposure, Attained age	0.8492	1.8577
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0691	0.1048
Systematic errors in gamma doses[b]	1.1168	1.2085
Systematic errors in neutron doses[b]	1.2330	1.0301
Systematic errors in RBE neutron doses[b]	1.0267	1.0390
Model Mixture factor for transfer to US pop	0.0000	1.0053
Ratio of Japanese to U.S. baseline cancer rates	0.7459	0.7208
Smoking history	0.643891	0.836711
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1
Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.074	0.087
Probability of Causation (PC)	6.72	23.88

Verification Calculations using MS Excel

Personal Information		
Age at exposure	20	
Attained age	40	

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.1671	1.1800
ERR/Sv with adjustments		
w/ age adjustment	0.9911	2.1920
w/ latency adjustment	0.9911	2.1920
w/ random errors in dosimetry adj	1.0596	2.4216
w/ systematic errors in dosimetry adj	0.7494	1.8722
adjusted for population transfer	0.5590	1.8750
multiplicative risk model	0.7494	1.8722
additive risk model	0.5590	1.3494
adjusted for smoking history	0.3599	1.5688
adjusted for DDREF	0.3599	1.5688
Final ERR/Sv	0.3599	1.5688
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0
Final results calculated in Excel		
Excess relative risk (ERR)	0.072	0.314
Probability of Causation (PC)	6.72	23.88

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_other_m5**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	10-19 cig/day (currently)
Lung model used for calculation	NIH-IREP
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	31	488
Original ERR/Sv	1.8611	1.4669
Adjustment Factors		
Age at exposure, Attained age	1.4695	1.7637
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1032	0.0922
Systematic errors in gamma doses[b]	1.1297	1.1780
Systematic errors in neutron doses[b]	1.2574	1.0604
Systematic errors in RBE neutron doses[b]	0.9979	1.0121
Model Mixture factor for transfer to US pop	0.4123	0.3067
Ratio of Japanese to U.S. baseline cancer rates	0.7368	0.7205
Smoking history	0.1034	0.847862
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1
Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.080	0.062
Probability of Causation (PC)	3.59	23.41

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.8611	1.4669
ERR/Sv with adjustments		
w/ age adjustment	2.7350	2.5872
w/ latency adjustment	2.7350	2.5872
w/ random errors in dosimetry adj	3.0173	2.8258
w/ systematic errors in dosimetry adj	2.1286	2.2352
adjusted for population transfer	1.7992	1.8020
multiplicative risk model	2.1286	2.2352
additive risk model	1.5682	1.6104
adjusted for smoking history	0.1860	1.5279
adjusted for DDREF	0.1860	1.5279
Final ERR/Sv	0.1860	1.5279
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0
Final results calculated in Excel		
Excess relative risk (ERR)	0.037	0.306
Probability of Causation (PC)	3.59	23.41

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_other_m6**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	20-39 cig/day (currently)
Lung model used for calculation	NIH-IREP
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1625	525
Original ERR/Sv	0.4357	1.3657
Adjustment Factors		
Age at exposure, Attained age	1.7414	2.2395
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0630	0.0687
Systematic errors in gamma doses[b]	1.0860	1.2143
Systematic errors in neutron doses[b]	1.2007	1.2437
Systematic errors in RBE neutron doses[b]	0.9875	1.0760
Model Mixture factor for transfer to US pop	0.0000	0.6840
Ratio of Japanese to U.S. baseline cancer rates	0.7318	0.6999
Smoking history	0.258283	0.83471
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1
Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.073	0.081
Probability of Causation (PC)	2.31	23.31

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.4357	1.3657
ERR/Sv with adjustments		
w/ age adjustment	0.7588	3.0586
w/ latency adjustment	0.7588	3.0586
w/ random errors in dosimetry adj	0.8065	3.2687
w/ systematic errors in dosimetry adj	0.6263	2.0113
adjusted for population transfer	0.4583	1.8206
multiplicative risk model	0.6263	2.0113
additive risk model	0.4583	1.4078
adjusted for smoking history	0.1184	1.5197
adjusted for DDREF	0.1184	1.5197
Final ERR/Sv	0.1184	1.5197
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0
Final results calculated in Excel		
Excess relative risk (ERR)	0.024	0.304
Probability of Causation (PC)	2.31	23.31

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_other_m7**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	>40 cig/day (currently)
Lung model used for calculation	NIH-IREP
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	346	525
Original ERR/Sv	1.2640	1.3657
Adjustment Factors		
Age at exposure, Attained age	1.4803	2.2395
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0994	0.0687
Systematic errors in gamma doses[b]	1.1566	1.2143
Systematic errors in neutron doses[b]	1.2016	1.2437
Systematic errors in RBE neutron doses[b]	1.0047	1.0760
Model Mixture factor for transfer to US pop	0.0000	0.6840
Ratio of Japanese to U.S. baseline cancer rates	0.6941	0.6999
Smoking history	0.08984	0.831744
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1
Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.049	0.303
Probability of Causation (PC)	1.80	23.25

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.2640	1.3657
ERR/Sv with adjustments		
w/ age adjustment	1.8711	3.0586
w/ latency adjustment	1.8711	3.0586
w/ random errors in dosimetry adj	2.0572	3.2687
w/ systematic errors in dosimetry adj	1.4732	2.0113
adjusted for population transfer	1.0225	1.8206
multiplicative risk model	1.4732	2.0113
additive risk model	1.0225	1.4078
adjusted for smoking history	0.0919	1.5143
adjusted for DDREF	0.0919	1.5143
Final ERR/Sv	0.0919	1.5143
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0
Final results calculated in Excel		
Excess relative risk (ERR)	0.018	0.303
Probability of Causation (PC)	1.80	23.25

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_other_f1**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	Never smoked
Lung model used for calculation	NIOSH-IREP
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	485	132
Original ERR/Sv	1.6814	2.7666
Adjustment Factors		
Age at exposure, Attained age	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0923	0.0715
Systematic errors in gamma doses[b]	1.1067	1.0356
Systematic errors in neutron doses[b]	1.1249	1.1335
Systematic errors in RBE neutron doses[b]	0.9881	0.9714
Model Mixture factor for transfer to US pop	0.5503	1.0184
Ratio of Japanese to U.S. baseline cancer rates	0.3777	0.3659
Smoking history	1.710404	2.426341
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1
Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.368	1.276
Probability of Causation (PC)	26.89	56.07

Verification Calculations using MS Excel

Personal Information		
Age at exposure	20	
Attained age	40	

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.6814	2.7666
ERR/Sv with adjustments		
w/ age adjustment	1.6814	2.7666
w/ latency adjustment	1.6814	2.7666
w/ random errors in dosimetry adj	1.8365	2.9645
w/ systematic errors in dosimetry adj	1.4930	2.5998
adjusted for population transfer	1.0752	2.6302
multiplicative risk model	1.4930	2.5998
additive risk model	0.5639	0.9514
adjusted for smoking history	1.8390	6.3818
adjusted for DDREF	1.8390	6.3818
Final ERR/Sv	1.8390	6.3818
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0
Final results calculated in Excel		
Excess relative risk (ERR)	0.368	1.276
Probability of Causation (PC)	26.89	56.07

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_other_f2**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	Former smoker
Lung model used for calculation	NIH-IREP
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	270	42
Original ERR/Sv	0.5407	0.8124
Adjustment Factors		
Age at exposure, Attained age	4.4025	4.9982
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1325	0.0791
Systematic errors in gamma doses[b]	1.2626	1.2347
Systematic errors in neutron doses[b]	1.2389	1.0653
Systematic errors in RBE neutron doses[b]	0.9486	1.0468
Model Mixture factor for transfer to US pop	0.0000	0.9568
Ratio of Japanese to U.S. baseline cancer rates	0.3638	0.3714
Smoking history	0.785756	1.063091
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1
Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.185	0.369
Probability of Causation (PC)	9.41	39.69

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.5407	0.8124
ERR/Sv with adjustments		
w/ age adjustment	2.3804	4.0607
w/ latency adjustment	2.3804	4.0607
w/ random errors in dosimetry adj	2.6958	4.3819
w/ systematic errors in dosimetry adj	1.8167	3.1823
adjusted for population transfer	0.6609	3.0958
multiplicative risk model	1.8167	3.1823
additive risk model	0.6609	1.1820
adjusted for smoking history	0.5193	3.2911
adjusted for DDREF	0.5193	3.2911
Final ERR/Sv	0.5193	3.2911
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0
Final results calculated in Excel		
Excess relative risk (ERR)	0.104	0.658
Probability of Causation (PC)	9.41	39.69

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_other_f3**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	Current smoker (? cig/day)
Lung model used for calculation	NIH-IREP
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	360	521
Original ERR/Sv	0.3161	1.0684
Adjustment Factors		
Age at exposure, Attained age	3.9253	6.3926
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0973	0.1061
Systematic errors in gamma doses[b]	1.0898	1.3439
Systematic errors in neutron doses[b]	1.0529	1.0717
Systematic errors in RBE neutron doses[b]	1.0342	0.9618
Model Mixture factor for transfer to US pop	0.0000	1.0071
Ratio of Japanese to U.S. baseline cancer rates	0.3610	0.3656
Smoking history	0.657158	0.5805
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1
Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.167	0.636
Probability of Causation (PC)	5.16	38.88

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.3161	1.0684
ERR/Sv with adjustments		
w/ age adjustment	1.2407	6.8297
w/ latency adjustment	1.2407	6.8297
w/ random errors in dosimetry adj	1.3614	7.5544
w/ systematic errors in dosimetry adj	1.1472	5.4535
adjusted for population transfer	0.4141	5.4780
multiplicative risk model	1.1472	5.4535
additive risk model	0.4141	1.9937
adjusted for smoking history	0.2721	3.1800
adjusted for DDREF	0.2721	3.1800
Final ERR/Sv	0.2721	3.1800
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0
Final results calculated in Excel		
Excess relative risk (ERR)	0.054	0.636
Probability of Causation (PC)	5.16	38.88

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_other_f4**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	<10 cig/day (currently)
Lung model used for calculation	NIH-IREP
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	55	42
Original ERR/Sv	0.6129	0.8124
Adjustment Factors		
Age at exposure, Attained age	3.7965	4.9982
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1112	0.0791
Systematic errors in gamma doses[b]	1.1558	1.2347
Systematic errors in neutron doses[b]	1.0572	1.0653
Systematic errors in RBE neutron doses[b]	0.9282	1.0468
Model Mixture factor for transfer to US pop	0.8556	0.9568
Ratio of Japanese to U.S. baseline cancer rates	0.3506	0.3714
Smoking history	0.2564	1.062662
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1
Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.214	0.658
Probability of Causation (PC)	9.58	39.68

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.6129	0.8124
ERR/Sv with adjustments		
w/ age adjustment	2.3270	4.0607
w/ latency adjustment	2.3270	4.0607
w/ random errors in dosimetry adj	2.5857	4.3819
w/ systematic errors in dosimetry adj	2.2796	3.1823
adjusted for population transfer	2.0658	3.0958
multiplicative risk model	2.2796	3.1823
additive risk model	0.7991	1.1820
adjusted for smoking history	0.5297	3.2898
adjusted for DDREF	0.5297	3.2898
Final ERR/Sv	0.5297	3.2898
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0
Final results calculated in Excel		
Excess relative risk (ERR)	0.106	0.658
Probability of Causation (PC)	9.58	39.68

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_other_f5**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	10-19 cig/day (currently)
Lung model used for calculation	NIH-IREP
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	1003	521
Original ERR/Sv	0.7013	1.0684
Adjustment Factors		
Age at exposure, Attained age	2.9582	6.3926
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.1264	0.1061
Systematic errors in gamma doses[b]	1.2365	1.3439
Systematic errors in neutron doses[b]	1.0555	1.0717
Systematic errors in RBE neutron doses[b]	1.0428	0.9618
Model Mixture factor for transfer to US pop	0.0000	1.0071
Ratio of Japanese to U.S. baseline cancer rates	0.3311	0.3656
Smoking history	0.538526	0.587579
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1
Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.070	0.145
Probability of Causation (PC)	5.77	39.16

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	0.7013	1.0684
ERR/Sv with adjustments		
w/ age adjustment	2.0745	6.8297
w/ latency adjustment	2.0745	6.8297
w/ random errors in dosimetry adj	2.3367	7.5544
w/ systematic errors in dosimetry adj	1.7169	5.4535
adjusted for population transfer	0.5685	5.4780
multiplicative risk model	1.7169	5.4535
additive risk model	0.5685	1.9937
adjusted for smoking history	0.3061	3.2188
adjusted for DDREF	0.3061	3.2188
Final ERR/Sv	0.3061	3.2188
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0
Final results calculated in Excel		
Excess relative risk (ERR)	0.061	0.644
Probability of Causation (PC)	5.77	39.16

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_other_f6**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	20-39 cig/day (currently)
Lung model used for calculation	NIH-IREP
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	896	525
Original ERR/Sv	1.1974	1.3657
Adjustment Factors		
Age at exposure, Attained age	3.5961	5.2653
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0720	0.0687
Systematic errors in gamma doses[b]	1.1483	1.2143
Systematic errors in neutron doses[b]	1.0825	1.2437
Systematic errors in RBE neutron doses[b]	0.9921	1.0760
Model Mixture factor for transfer to US pop	0.9502	0.6840
Ratio of Japanese to U.S. baseline cancer rates	0.3373	0.3648
Smoking history	0.05897	0.834692
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1
Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.157	0.631
Probability of Causation (PC)	4.09	38.69

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.1974	1.3657
ERR/Sv with adjustments		
w/ age adjustment	4.3061	7.1910
w/ latency adjustment	4.3061	7.1910
w/ random errors in dosimetry adj	4.6162	7.6851
w/ systematic errors in dosimetry adj	3.7433	4.7289
adjusted for population transfer	3.6197	3.7796
multiplicative risk model	3.7433	4.7289
additive risk model	1.2625	1.7252
adjusted for smoking history	0.2135	3.1548
adjusted for DDREF	0.2135	3.1548
Final ERR/Sv	0.2135	3.1548
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0
Final results calculated in Excel		
Excess relative risk (ERR)	0.043	0.631
Probability of Causation (PC)	4.09	38.69

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_other_f7**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	>40 cig/day (currently)
Lung model used for calculation	NIH-IREP
Exposure Information	
Exposure year	1920
Exposure rate	acute
Radiation type	photons E>250keV

Parameter[a]	**Mid**[d]	**Upper**[d]
Monte Carlo iteration number	761	525
Original ERR/Sv	1.0654	1.3657
Adjustment Factors		
Age at exposure, Attained age	4.6183	5.2653
Minimum latency for cancer induction	1.0000	1.0000
Random errors in doses[b]	0.0935	0.0687
Systematic errors in gamma doses[b]	1.1760	1.2143
Systematic errors in neutron doses[b]	1.1878	1.2437
Systematic errors in RBE neutron doses[b]	0.9682	1.0760
Model Mixture factor for transfer to US pop	0.9986	0.6840
Ratio of Japanese to U.S. baseline cancer rates	0.3607	0.3648
Smoking history	0.04103	0.831541
Dose and dose rate effectiveness factor (DDREF)	1	1
Organ equivalent dose (cSv)[c]	20	20
Radiation weighting factor (w_R - ICRP 60)	1	1
Radiation effectiveness factor (REF)	1	1
Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.109	0.328
Probability of Causation (PC)	3.16	38.60

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[d]	**Upper**[d]
Original ERR/Sv	1.0654	1.3657
ERR/Sv with adjustments		
w/ age adjustment	4.9205	7.1910
w/ latency adjustment	4.9205	7.1910
w/ random errors in dosimetry adj	5.3803	7.6851
w/ systematic errors in dosimetry adj	3.9782	4.7289
adjusted for population transfer	3.9746	3.7796
multiplicative risk model	3.9782	4.7289
additive risk model	1.4349	1.7252
adjusted for smoking history	0.1631	3.1429
adjusted for DDREF	0.1631	3.1429
Final ERR/Sv	0.1631	3.1429
Organ equivalent dose (Sv)	0.2	0.2
Linear Quadratic (1=Yes, 0=No)	0	0
Final results calculated in Excel		
Excess relative risk (ERR)	0.033	0.629
Probability of Causation (PC)	3.16	38.60

[a] Listed values that produce the 50th and 99th percentiles of PC reported by NIOSH-IREP, respectively

[b] Doses to the Japanese atomic bomb survivors

[c] Dose assigned to the claimant

[d] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Appendix H

Effect of Cigarette Smoking on the Risk of Lung Cancer from Radon Exposures

The calculations documented in this appendix were performed to ensure that the interaction effect between smoking and radon exposures has been properly programmed in NIOSH-IREP for estimating the risk of lung cancer. A total of 36 calculations was performed for this specific verification task.

Although the radon risk model used in NIOSH-IREP is assumed to be independent of gender, calculations were performed separately for males and females, for purposes of verification.

Smoking history was defined as “never smoked” (to represent a nonsmoker) or having a smoking history of between 20 and 39 cigarettes per day (to represent a smoker). The age at exposure (AAE) was varied between 20 and 75 years, while the attained age (ATA) was varied between 40 and 80 years. All calculations assume a radon exposure of 1 Working Level Month (WLM).

Further details about this verification task can be found in Section 5.7 of the report. The results for ERR and PC obtained with MS Excel verify the mid and upper bound values of ERR and PC estimated using NIOSH-IREP v.5.5.3r, for all exposure scenarios considered.

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Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_radon_ns_m1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	Never smoked
Exposure Information	
Exposure year	1920

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	336	1591
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0723	0.6827
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.3241	1.3760

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.287	2.818
Probability of Causation (PC)	22.32	73.81

Verification Calculations using MS Excel

Personal Information	
Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0579	0.5461
ERR - nonsmoker	0.2170	2.0480

Final results calculated in Excel		
Excess relative risk (ERR)	0.287	2.818
Probability of Causation (PC)	22.32	73.81

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_radon_ns_m2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	Never smoked
Exposure Information	
Exposure year	1935

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	213	244
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.5800	2.5024
Adjustment Factors		
Minimum latency for cancer induction	0.0246	0.1744
Random errors in dosimetry	1.1765	1.2502

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.098	2.244
Probability of Causation (PC)	8.95	69.17

Verification Calculations using MS Excel

Personal Information	
Age at exposure	35
Attained age	40

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	0.0246	0.1744
ERR - smoker	0.0223	0.4787
ERR - nonsmoker	0.0835	1.7950

Final results calculated in Excel		
Excess relative risk (ERR)	0.098	2.244
Probability of Causation (PC)	8.95	69.17

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_radon_ns_m3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Lung
Smoking History	Never smoked
Exposure Information	
Exposure year	1920

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	1688	623
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0095	0.0655
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.1607	1.1750

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.033	0.231
Probability of Causation (PC)	3.21	18.75

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0076	0.0524
ERR - nonsmoker	0.0286	0.1964

Final results calculated in Excel		
Excess relative risk (ERR)	0.033	0.231
Probability of Causation (PC)	3.21	18.75

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_radon_ns_m4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Lung
Smoking History	Never smoked
Exposure Information	
Exposure year	1940

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	362	623
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0141	0.1113
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.3703	1.1750

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.058	0.392
Probability of Causation (PC)	5.47	28.18

Verification Calculations using MS Excel

Personal Information	
Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0113	0.0891
ERR - nonsmoker	0.0422	0.3340

Final results calculated in Excel		
Excess relative risk (ERR)	0.058	0.392
Probability of Causation (PC)	5.47	28.18

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_radon_ns_m5**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Lung
Smoking History	Never smoked
Exposure Information	
Exposure year	1955

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	943	244
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0781	0.3884
Adjustment Factors		
Minimum latency for cancer induction	0.0344	0.1744
Random errors in dosimetry	1.3381	1.2502

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.020	0.348
Probability of Causation (PC)	1.94	25.83

Verification Calculations using MS Excel

Personal Information

Age at exposure	55
Attained age	60

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	0.0344	0.1744
ERR - smoker	0.0040	0.0743
ERR - nonsmoker	0.0148	0.2786

Final results calculated in Excel		
Excess relative risk (ERR)	0.020	0.348
Probability of Causation (PC)	1.94	25.83

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_radon_ns_m6**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1980
Cancer	Lung
Smoking History	Never smoked
Exposure Information	
Exposure year	1920

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	5	1591
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0018	0.0126
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.2676	1.3760

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.007	0.052
Probability of Causation (PC)	0.67	4.93

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	80

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0014	0.0101
ERR - nonsmoker	0.0053	0.0377

Final results calculated in Excel		
Excess relative risk (ERR)	0.007	0.052
Probability of Causation (PC)	0.67	4.93

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_radon_ns_m7**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1980
Cancer	Lung
Smoking History	Never smoked
Exposure Information	
Exposure year	1940

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	5	1591
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0018	0.0126
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.2676	1.3760

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.007	0.052
Probability of Causation (PC)	0.67	4.93

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	80

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0014	0.0101
ERR - nonsmoker	0.0053	0.0377

Final results calculated in Excel		
Excess relative risk (ERR)	0.007	0.052
Probability of Causation (PC)	0.67	4.93

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_radon_ns_m8**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1980
Cancer	Lung
Smoking History	Never smoked
Exposure Information	
Exposure year	1960

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	698	1591
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0038	0.0217
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.0267	1.3760

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.012	0.090
Probability of Causation (PC)	1.16	8.23

Verification Calculations using MS Excel

Personal Information

Age at exposure	60
Attained age	80

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0030	0.0174
ERR - nonsmoker	0.0114	0.0652

Final results calculated in Excel		
Excess relative risk (ERR)	0.012	0.090
Probability of Causation (PC)	1.16	8.23

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_radon_ns_m9**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1980
Cancer	Lung
Smoking History	Never smoked
Exposure Information	
Exposure year	1975

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	779	1948
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0197	0.0447
Adjustment Factors		
Minimum latency for cancer induction	0.0249	0.4385
Random errors in dosimetry	1.3574	1.1934

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.004	0.081
Probability of Causation (PC)	0.39	7.53

Verification Calculations using MS Excel

Personal Information

Age at exposure	75
Attained age	80

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	0.0249	0.4385
ERR - smoker	0.0008	0.0182
ERR - nonsmoker	0.0029	0.0682

Final results calculated in Excel		
Excess relative risk (ERR)	0.004	0.081
Probability of Causation (PC)	0.39	7.53

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Lung_radon_sm_m1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	20-39 cig/day (currently)
Exposure Information	
Exposure year	1920

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	336	1591
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0723	0.6827
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.3241	1.3760

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.077	0.751
Probability of Causation (PC)	7.12	42.91

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0579	0.5461
ERR - nonsmoker	0.2170	2.0480

Final results calculated in Excel		
Excess relative risk (ERR)	0.077	0.751
Probability of Causation (PC)	7.12	42.91

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_sm_m2**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	20-39 cig/day (currently)
Exposure Information	
Exposure year	1935

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	213	244
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.5800	2.5024
Adjustment Factors		
Minimum latency for cancer induction	0.0246	0.1744
Random errors in dosimetry	1.1765	1.2502

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.026	0.598
Probability of Causation (PC)	2.55	37.44

Verification Calculations using MS Excel

Personal Information	
Age at exposure	35
Attained age	40

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	0.0246	0.1744
ERR - smoker	0.0223	0.4787
ERR - nonsmoker	0.0835	1.7950

Final results calculated in Excel		
Excess relative risk (ERR)	0.026	0.598
Probability of Causation (PC)	2.55	37.44

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_sm_m3**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Lung
Smoking History	20-39 cig/day (currently)
Exposure Information	
Exposure year	1920

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	1688	623
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0095	0.0655
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.1607	1.1750

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.009	0.062
Probability of Causation (PC)	0.88	5.80

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0076	0.0524
ERR - nonsmoker	0.0286	0.1964

Final results calculated in Excel		
Excess relative risk (ERR)	0.009	0.062
Probability of Causation (PC)	0.88	5.80

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_sm_m4**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Lung
Smoking History	20-39 cig/day (currently)
Exposure Information	
Exposure year	1940

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	362	623
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0141	0.1113
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.3703	1.1750

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.015	0.105
Probability of Causation (PC)	1.52	9.47

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0113	0.0891
ERR - nonsmoker	0.0422	0.3340

Final results calculated in Excel		
Excess relative risk (ERR)	0.015	0.105
Probability of Causation (PC)	1.52	9.47

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_sm_m5**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Lung
Smoking History	20-39 cig/day (currently)
Exposure Information	
Exposure year	1955

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	943	244
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0781	0.3884
Adjustment Factors		
Minimum latency for cancer induction	0.0344	0.1744
Random errors in dosimetry	1.3381	1.2502

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.005	0.093
Probability of Causation (PC)	0.53	8.50

Verification Calculations using MS Excel

Personal Information

Age at exposure	55
Attained age	60

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	0.0344	0.1744
ERR - smoker	0.0040	0.0743
ERR - nonsmoker	0.0148	0.2786

Final results calculated in Excel		
Excess relative risk (ERR)	0.005	0.093
Probability of Causation (PC)	0.53	8.50

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_sm_m6**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1980
Cancer	Lung
Smoking History	20-39 cig/day (currently)
Exposure Information	
Exposure year	1920

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	5	1591
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0018	0.0126
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.2676	1.3760

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.002	0.014
Probability of Causation (PC)	0.18	1.36

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	80

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0014	0.0101
ERR - nonsmoker	0.0053	0.0377

Final results calculated in Excel		
Excess relative risk (ERR)	0.002	0.014
Probability of Causation (PC)	0.18	1.36

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_sm_m7**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1980
Cancer	Lung
Smoking History	20-39 cig/day (currently)
Exposure Information	
Exposure year	1940

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	5	1591
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0018	0.0126
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.2676	1.3760

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.002	0.014
Probability of Causation (PC)	0.18	1.36

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	80

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0014	0.0101
ERR - nonsmoker	0.0053	0.0377

Final results calculated in Excel		
Excess relative risk (ERR)	0.002	0.014
Probability of Causation (PC)	0.18	1.36

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_sm_m8**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1980
Cancer	Lung
Smoking History	20-39 cig/day (currently)
Exposure Information	
Exposure year	1960

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	698	1591
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0038	0.0217
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.0267	1.3760

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.003	0.024
Probability of Causation (PC)	0.31	2.34

Verification Calculations using MS Excel

Personal Information

Age at exposure	60
Attained age	80

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0030	0.0174
ERR - nonsmoker	0.0114	0.0652

Final results calculated in Excel		
Excess relative risk (ERR)	0.003	0.024
Probability of Causation (PC)	0.31	2.34

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_sm_m9**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1980
Cancer	Lung
Smoking History	20-39 cig/day (currently)
Exposure Information	
Exposure year	1975

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	779	1948
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0197	0.0447
Adjustment Factors		
Minimum latency for cancer induction	0.0249	0.4385
Random errors in dosimetry	1.3574	1.1934

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.001	0.022
Probability of Causation (PC)	0.10	2.12

Verification Calculations using MS Excel

Personal Information

Age at exposure	75
Attained age	80

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	0.0249	0.4385
ERR - smoker	0.0008	0.0182
ERR - nonsmoker	0.0029	0.0682

Final results calculated in Excel		
Excess relative risk (ERR)	0.001	0.022
Probability of Causation (PC)	0.10	2.12

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_ns_f1**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	Never smoked
Exposure Information	
Exposure year	1920

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	336	1591
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0723	0.6827
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.3241	1.3760

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.287	2.818
Probability of Causation (PC)	22.32	73.81

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0579	0.5461
ERR - nonsmoker	0.2170	2.0480

Final results calculated in Excel		
Excess relative risk (ERR)	0.287	2.818
Probability of Causation (PC)	22.32	73.81

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_ns_f2**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	Never smoked
Exposure Information	
Exposure year	1935

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	213	244
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.5800	2.5024
Adjustment Factors		
Minimum latency for cancer induction	0.0246	0.1744
Random errors in dosimetry	1.1765	1.2502

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.098	2.244
Probability of Causation (PC)	8.95	69.17

Verification Calculations using MS Excel

Personal Information	
Age at exposure	35
Attained age	40

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	0.0246	0.1744
ERR - smoker	0.0223	0.4787
ERR - nonsmoker	0.0835	1.7950

Final results calculated in Excel		
Excess relative risk (ERR)	0.098	2.244
Probability of Causation (PC)	8.95	69.17

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_ns_f3**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Lung
Smoking History	Never smoked
Exposure Information	
Exposure year	1920

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	1688	623
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0095	0.0655
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.1607	1.1750

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.033	0.231
Probability of Causation (PC)	3.21	18.75

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0076	0.0524
ERR - nonsmoker	0.0286	0.1964

Final results calculated in Excel		
Excess relative risk (ERR)	0.033	0.231
Probability of Causation (PC)	3.21	18.75

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_ns_f4**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Lung
Smoking History	Never smoked
Exposure Information	
Exposure year	1940

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	362	623
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0141	0.1113
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.3703	1.1750

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.058	0.392
Probability of Causation (PC)	5.47	28.18

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0113	0.0891
ERR - nonsmoker	0.0422	0.3340

Final results calculated in Excel		
Excess relative risk (ERR)	0.058	0.392
Probability of Causation (PC)	5.47	28.18

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_ns_f5**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Lung
Smoking History	Never smoked
Exposure Information	
Exposure year	1955

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	943	244
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0781	0.3884
Adjustment Factors		
Minimum latency for cancer induction	0.0344	0.1744
Random errors in dosimetry	1.3381	1.2502

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.020	0.348
Probability of Causation (PC)	1.94	25.83

Verification Calculations using MS Excel

Personal Information	
Age at exposure	55
Attained age	60

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	0.0344	0.1744
ERR - smoker	0.0040	0.0743
ERR - nonsmoker	0.0148	0.2786

Final results calculated in Excel		
Excess relative risk (ERR)	0.020	0.348
Probability of Causation (PC)	1.94	25.83

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_ns_f6**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1980
Cancer	Lung
Smoking History	Never smoked
Exposure Information	
Exposure year	1920

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	5	1591
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0018	0.0126
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.2676	1.3760

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.007	0.052
Probability of Causation (PC)	0.67	4.93

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	80

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0014	0.0101
ERR - nonsmoker	0.0053	0.0377

Final results calculated in Excel		
Excess relative risk (ERR)	0.007	0.052
Probability of Causation (PC)	0.67	4.93

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_ns_f7**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1980
Cancer	Lung
Smoking History	Never smoked
Exposure Information	
Exposure year	1940

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	5	1591
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0018	0.0126
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.2676	1.3760

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.007	0.052
Probability of Causation (PC)	0.67	4.93

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	80

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0014	0.0101
ERR - nonsmoker	0.0053	0.0377

Final results calculated in Excel		
Excess relative risk (ERR)	0.007	0.052
Probability of Causation (PC)	0.67	4.93

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_ns_f8**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1980
Cancer	Lung
Smoking History	Never smoked
Exposure Information	
Exposure year	1960

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	698	1591
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0038	0.0217
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.0267	1.3760

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.012	0.090
Probability of Causation (PC)	1.16	8.23

Verification Calculations using MS Excel

Personal Information	
Age at exposure	60
Attained age	80

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0030	0.0174
ERR - nonsmoker	0.0114	0.0652

Final results calculated in Excel		
Excess relative risk (ERR)	0.012	0.090
Probability of Causation (PC)	1.16	8.23

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_ns_f9**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1980
Cancer	Lung
Smoking History	Never smoked
Exposure Information	
Exposure year	1975

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	779	1948
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0197	0.0447
Adjustment Factors		
Minimum latency for cancer induction	0.0249	0.4385
Random errors in dosimetry	1.3574	1.1934

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.004	0.081
Probability of Causation (PC)	0.39	7.53

Verification Calculations using MS Excel

Personal Information

Age at exposure	75
Attained age	80

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	0.0249	0.4385
ERR - smoker	0.0008	0.0182
ERR - nonsmoker	0.0029	0.0682

Final results calculated in Excel		
Excess relative risk (ERR)	0.004	0.081
Probability of Causation (PC)	0.39	7.53

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_sm_f1**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	20-39 cig/day (currently)
Exposure Information	
Exposure year	1920

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	336	1591
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0723	0.6827
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.3241	1.3760

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.077	0.751
Probability of Causation (PC)	7.12	42.91

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	40

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0579	0.5461
ERR - nonsmoker	0.2170	2.0480

Final results calculated in Excel		
Excess relative risk (ERR)	0.077	0.751
Probability of Causation (PC)	7.12	42.91

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_sm_f2**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1940
Cancer	Lung
Smoking History	20-39 cig/day (currently)
Exposure Information	
Exposure year	1935

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	213	244
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.5800	2.5024
Adjustment Factors		
Minimum latency for cancer induction	0.0246	0.1744
Random errors in dosimetry	1.1765	1.2502

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.026	0.598
Probability of Causation (PC)	2.55	37.44

Verification Calculations using MS Excel

Personal Information

Age at exposure	35
Attained age	40

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	0.0246	0.1744
ERR - smoker	0.0223	0.4787
ERR - nonsmoker	0.0835	1.7950

Final results calculated in Excel		
Excess relative risk (ERR)	0.026	0.598
Probability of Causation (PC)	2.55	37.44

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_sm_f3**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Lung
Smoking History	20-39 cig/day (currently)
Exposure Information	
Exposure year	1920

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	1688	623
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0095	0.0655
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.1607	1.1750

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.009	0.062
Probability of Causation (PC)	0.88	5.80

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	60

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0076	0.0524
ERR - nonsmoker	0.0286	0.1964

Final results calculated in Excel		
Excess relative risk (ERR)	0.009	0.062
Probability of Causation (PC)	0.88	5.80

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_sm_f4**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Lung
Smoking History	20-39 cig/day (currently)
Exposure Information	
Exposure year	1940

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	362	623
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0141	0.1113
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.3703	1.1750

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.015	0.105
Probability of Causation (PC)	1.52	9.47

Verification Calculations using MS Excel

Personal Information	
Age at exposure	40
Attained age	60

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0113	0.0891
ERR - nonsmoker	0.0422	0.3340

Final results calculated in Excel		
Excess relative risk (ERR)	0.015	0.105
Probability of Causation (PC)	1.52	9.47

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_sm_f5**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1960
Cancer	Lung
Smoking History	20-39 cig/day (currently)
Exposure Information	
Exposure year	1955

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	943	244
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0781	0.3884
Adjustment Factors		
Minimum latency for cancer induction	0.0344	0.1744
Random errors in dosimetry	1.3381	1.2502

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.005	0.093
Probability of Causation (PC)	0.53	8.50

Verification Calculations using MS Excel

Personal Information

Age at exposure	55
Attained age	60

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	0.0344	0.1744
ERR - smoker	0.0040	0.0743
ERR - nonsmoker	0.0148	0.2786

Final results calculated in Excel		
Excess relative risk (ERR)	0.005	0.093
Probability of Causation (PC)	0.53	8.50

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_sm_f6**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1980
Cancer	Lung
Smoking History	20-39 cig/day (currently)
Exposure Information	
Exposure year	1920

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	5	1591
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0018	0.0126
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.2676	1.3760

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.002	0.014
Probability of Causation (PC)	0.18	1.36

Verification Calculations using MS Excel

Personal Information

Age at exposure	20
Attained age	80

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0014	0.0101
ERR - nonsmoker	0.0053	0.0377

Final results calculated in Excel		
Excess relative risk (ERR)	0.002	0.014
Probability of Causation (PC)	0.18	1.36

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_sm_f7**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1980
Cancer	Lung
Smoking History	20-39 cig/day (currently)
Exposure Information	
Exposure year	1940

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	5	1591
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0018	0.0126
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.2676	1.3760

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.002	0.014
Probability of Causation (PC)	0.18	1.36

Verification Calculations using MS Excel

Personal Information

Age at exposure	40
Attained age	80

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0014	0.0101
ERR - nonsmoker	0.0053	0.0377

Final results calculated in Excel		
Excess relative risk (ERR)	0.002	0.014
Probability of Causation (PC)	0.18	1.36

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_sm_f8**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1980
Cancer	Lung
Smoking History	20-39 cig/day (currently)
Exposure Information	
Exposure year	1960

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	698	1591
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0038	0.0217
Adjustment Factors		
Minimum latency for cancer induction	1.0000	1.0000
Random errors in dosimetry	1.0267	1.3760

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.003	0.024
Probability of Causation (PC)	0.31	2.34

Verification Calculations using MS Excel

Personal Information

Age at exposure	60
Attained age	80

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	1.0000	1.0000
ERR - smoker	0.0030	0.0174
ERR - nonsmoker	0.0114	0.0652

Final results calculated in Excel		
Excess relative risk (ERR)	0.003	0.024
Probability of Causation (PC)	0.31	2.34

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**lung_radon_sm_f9**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1980
Cancer	Lung
Smoking History	20-39 cig/day (currently)
Exposure Information	
Exposure year	1975

Parameter[a]	**Mid**[b]	**Upper**[b]
Monte Carlo iteration number	779	1948
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
ERR at 1 WLM	0.0197	0.0447
Adjustment Factors		
Minimum latency for cancer induction	0.0249	0.4385
Random errors in dosimetry	1.3574	1.1934

Final results calculated by NIOSH-IREP		
Excess relative risk (ERR)	0.001	0.022
Probability of Causation (PC)	0.10	2.12

Verification Calculations using MS Excel

Personal Information

Age at exposure	75
Attained age	80

Intermediate results calculated in Excel	**Mid**[b]	**Upper**[b]
Unadjusted Radon Exposure (WLM)	1.0000	1.0000
WLM with latency adjustment	0.0249	0.4385
ERR - smoker	0.0008	0.0182
ERR - nonsmoker	0.0029	0.0682

Final results calculated in Excel		
Excess relative risk (ERR)	0.001	0.022
Probability of Causation (PC)	0.10	2.12

[a] Listed values of each parameter are for the iteration that is the closest to the 50th and 99th percentiles of PC reported by NIOSH-IREP

[b] Mid and upper values are representative of the iteration closest to the 50th and 99th percentile, respectively

Appendix I

Verification of the Implementation of Multiple Exposures Algorithms

A series of 5 calculations has been performed to ensure that NIOSH-IREP properly estimates PC in cases involving multiple radiation exposures.

Various combinations of gender, cancer type, age at time of exposure, time exposure and diagnosis, organ dose, exposure rate, and radiation type were chosen. Five exposures were assumed for the first 4 scenarios and three exposures were assumed for the 5^{th} scenario.

The results for ERR and PC obtained with MS Excel verify the mid and upper bound values of ERR and PC estimated using NIOSH-IREP v.5.5.3r, for all exposure scenarios considered.

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Midpoint Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Mult Exp 1**				
Personal Information					
Gender	Male				
Birth year	1900				
Diagnosis year	1960				
Cancer	Colon				
Attained age	60				
Exposure Information	**Exposure 1**	**Exposure 2**	**Exposure 3**	**Exposure 4**	**Exposure 5**
Exposure year	1920	1921	1922	1923	1924
Age at exposure	20	21	22	23	24
Exposure rate	acute	chronic	acute	chronic	chronic
Radiation type	photons E<30keV	photons E=30-250keV	electrons E<15keV	neutrons E<10keV	alpha

Parameter	**Exposure # 1**	**2**	**3**	**4**	**5**
Monte Carlo iteration number for 50th percentile	320	320	320	320	320
Original ERR/Sv, correlated w/ age adjustment	0.8082	0.7563	0.7352	0.6965	0.6571
Adjustment Factors					
Age at exposure, Attained age	1.8147	1.5180	1.6626	1.2128	1.4129
Minimum latency for cancer induction	1.0000	1.0000	1.0000	1.0000	1.0000
Random errors in doses[a]	0.0712	0.0712	0.0712	0.0712	0.0712
Systematic errors in gamma doses[a]	1.3201	1.3201	1.3201	1.3201	1.3201
Systematic errors in neutron doses[a]	1.1150	1.1150	1.1150	1.1150	1.1150
Systematic errors in RBE neutron doses[a]	1.0064	1.0064	1.0064	1.0064	1.0064
Model Mixture factor for transfer to US pop	0.1345	0.1345	0.1345	0.1345	0.1345
Ratio of Japanese to U.S. baseline cancer rates	1.0996	1.0996	1.0996	1.0996	1.0996
Smoking history	1	1	1	1	1
Dose and dose rate effectiveness factor (DDREF)	1	2	1.01633	1	2
Organ equivalent dose (cSv)[b]	5	5	5	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1	1	5	20
Radiation effectiveness factor (REF)	4.48112	3.19825	2.10526	2.14823	31.984

Final results calculated by NIOSH-IREP	**Midpoint[c]**
Excess relative risk (ERR)	0.282
Probability of Causation (PC)	21.99

[a] Doses to the Japanese atomic bomb survivors

[b] Dose assigned to the claimant

[c] Midpoint values are representative of the iteration closest to the 50th percentile

Verification of Midpoint Values using MS Excel

Verification Run Identifier	**Mult Exp 1**				
Personal Information					
Gender	Male				
Birth year	1900				
Diagnosis year	1960				
Cancer	Colon				
Attained age	60				
Exposure Information	**Exposure 1**	**Exposure 2**	**Exposure 3**	**Exposure 4**	**Exposure 5**
Exposure year	1920	1921	1922	1923	1924
Age at exposure	20	21	22	23	24
Exposure rate	acute	chronic	acute	chronic	chronic
Radiation type	photons E<30keV	photons E=30-250keV	electrons E<15keV	neutrons E<10keV	alpha

Intermediate results calculated in Excel	**Exposure # 1**	**2**	**3**	**4**	**5**
ERR/Sv correlated w/ age adjustment	0.8082	0.7563	0.7352	0.6965	0.6571
w/ latency adjustment	0.8082	0.7563	0.7352	0.6965	0.6571
w/ random errors in dosimetry adj	0.8657	0.8102	0.7876	0.7461	0.7039
w/ systematic errors in dosimetry adj	0.5845	0.5470	0.5317	0.5037	0.4752
adjusted for population transfer	0.6349	0.5941	0.5776	0.5471	0.5162
multiplicative risk model	0.5845	0.5470	0.5317	0.5037	0.4752
additive risk model	0.6427	0.6015	0.5847	0.5539	0.5225
adjusted for smoking history	0.6349	0.5941	0.5776	0.5471	0.5162
adjusted for DDREF	0.6349	0.2971	0.5683	0.5471	0.2581
ERR/Sv	0.6349	0.2971	0.5683	0.5471	0.2581
Organ equivalent dose (Sv)	0.224056	0.1599125	0.105263	0.0214823	0.07996
Linear Quadratic (1=Yes, 0=No)	0	0	0	0	0
Excess relative risk (ERR)	0.142	0.048	0.060	0.012	0.021

Final results calculated in Excel	**Midpoint[c]**
Total Excess relative risk (ERR)	0.282
Probability of Causation (PC)	21.99

[c] Midpoint values are representative of the iteration closest to the 50th percentile

Upper Bound Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Mult Exp 1**
Personal Information	
Gender	Male
Birth year	1900
Diagnosis year	1960
Cancer	Colon
Attained age	60

Exposure Information	**Exposure 1**	**Exposure 2**	**Exposure 3**	**Exposure 4**	**Exposure 5**
Exposure year	1920	1921	1922	1923	1924
Age at exposure	20	21	22	23	24
Exposure rate	acute	chronic	acute	chronic	chronic
Radiation type	photons E<30keV	photons E=30-250keV	electrons E<15keV	neutrons E<10keV	alpha

	Exposure #				
Parameter	**1**	**2**	**3**	**4**	**5**
Monte Carlo iteration number for 99th percentile	1393	1393	1393	1393	1393
Original ERR/Sv, correlated w/ age adjustment	2.0772	1.9272	1.7939	1.7047	1.5604
Adjustment Factors					
Age at exposure, Attained age	1.5027	1.4570	1.2892	1.5483	1.4639
Minimum latency for cancer induction	1.0000	1.0000	1.0000	1.0000	1.0000
Random errors in doses[a]	0.1161	0.1161	0.1161	0.1161	0.1161
Systematic errors in gamma doses[a]	1.2939	1.2939	1.2939	1.2939	1.2939
Systematic errors in neutron doses[a]	1.1460	1.1460	1.1460	1.1460	1.1460
Systematic errors in RBE neutron doses[a]	0.9256	0.9256	0.9256	0.9256	0.9256
Model Mixture factor for transfer to US pop	0.0058	0.0058	0.0058	0.0058	0.0058
Ratio of Japanese to U.S. baseline cancer rates	1.1628	1.1628	1.1628	1.1628	1.1628
Smoking history	1	1	1	1	1
Dose and dose rate effectiveness factor (DDREF)	1	2	1	1	2
Organ equivalent dose (cSv)[b]	5	5	5	5	5
Radiation weighting factor (w_R - ICRP 60)	1	1	1	5	20
Radiation effectiveness factor (REF)	5.06452	3.71541	2.75385	6.8652	20.2596

Final results calculated by NIOSH-IREP	**Upper[c]**
Excess relative risk (ERR)	1.047
Probability of Causation (PC)	51.16

[a] Doses to the Japanese atomic bomb survivors

[b] Dose assigned to the claimant

[c] Upper values are representative of the iteration closest to the 99th percentile

Verification of Upper Bound Values using MS Excel

Verification Run Identifier	**Mult Exp 1**				
Personal Information					
Gender	Male				
Birth year	1900				
Diagnosis year	1960				
Cancer	Colon				
Attained age	60				
Exposure Information	**Exposure 1**	**Exposure 2**	**Exposure 3**	**Exposure 4**	**Exposure 5**
Exposure year	1920	1921	1922	1923	1924
Age at exposure	20	21	22	23	24
Exposure rate	acute	chronic	acute	chronic	chronic
Radiation type	photons E<30keV	photons E=30-250keV	electrons E<15keV	neutrons E<10keV	alpha

	Exposure #				
Intermediate results calculated in Excel	**1**	**2**	**3**	**4**	**5**
ERR/Sv correlated w/ age adjustment	2.0772	1.9272	1.7939	1.7047	1.5604
w/ latency adjustment	2.0772	1.9272	1.7939	1.7047	1.5604
w/ random errors in dosimetry adj	2.3183	2.1509	2.0022	1.9026	1.7415
w/ systematic errors in dosimetry adj	1.6891	1.5671	1.4588	1.3862	1.2689
adjusted for population transfer	1.9624	1.8207	1.6948	1.6105	1.4742
multiplicative risk model	1.6891	1.5671	1.4588	1.3862	1.2689
additive risk model	1.9640	1.8222	1.6962	1.6118	1.4754
adjusted for smoking history	1.9624	1.8207	1.6948	1.6105	1.4742
adjusted for DDREF	1.9624	0.9103	1.6948	1.6105	0.7371
ERR/Sv	1.9624	0.9103	1.6948	1.6105	0.7371
Organ equivalent dose (Sv)	0.253226	0.1857705	0.1376925	0.068652	0.050649
Linear Quadratic (1=Yes, 0=No)	0	0	0	0	0
Excess relative risk (ERR)	0.497	0.169	0.233	0.111	0.037

Final results calculated in Excel	**Upper[c]**
Total Excess relative risk (ERR)	1.047
Probability of Causation (PC)	51.16

[c] Upper values are representative of the iteration closest to the 99th percentile

Midpoint Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Mult Exp 2**				
Personal Information					
Gender	Female				
Birth year	1900				
Diagnosis year	1945				
Cancer	Breast				
Attained age	45				
Exposure Information	**Exposure 1**	**Exposure 2**	**Exposure 3**	**Exposure 4**	**Exposure 5**
Exposure year	1920	1925	1930	1935	1940
Age at exposure	20	25	30	35	40
Exposure rate	chronic	acute	chronic	chronic	acute
Radiation type	photons E>250keV	electrons E>15keV	alpha	neutrons E=10-100keV	neutrons E=0.1 2MeV

	Exposure #				
Parameter	**1**	**2**	**3**	**4**	**5**
Monte Carlo iteration number for 50th percentile	551	551	551	551	551
Original ERR/Sv, correlated w/ age adjustment	1.9495	1.6302	1.3803	1.3803	1.3803
Adjustment Factors					
Age at exposure, Attained age	1.0000	1.0000	1.0000	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000	0.9999	0.9211	0.0146
Random errors in doses[a]	0.0910	0.0910	0.0910	0.0910	0.0910
Systematic errors in gamma doses[a]	1.2837	1.2837	1.2837	1.2837	1.2837
Systematic errors in neutron doses[a]	1.1098	1.1098	1.1098	1.1098	1.1098
Systematic errors in RBE neutron doses[a]	0.9846	0.9846	0.9846	0.9846	0.9846
Model Mixture factor for transfer to US pop	0.0476	0.0476	0.0476	0.0476	0.0476
Ratio of Japanese to U.S. baseline cancer rates	0.3378	0.3378	0.3378	0.3378	0.3378
Smoking history	1	1	1	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1	1	1	1
Organ equivalent dose (cSv)[b]	5	2	10	3	1
Radiation weighting factor (w_R - ICRP 60)	1	1	20	10	20
Radiation effectiveness factor (REF)	1	1	17.1051	2.24925	6.95244

Final results calculated by NIOSH-IREP	**Midpoint[c]**
Excess relative risk (ERR)	0.074
Probability of Causation (PC)	6.87

[a] Doses to the Japanese atomic bomb survivors

[b] Dose assigned to the claimant

[c] Midpoint values are representative of the iteration closest to the 50th percentile

Verification of Midpoint Values using MS Excel

Verification Run Identifier	**Mult Exp 2**				
Personal Information					
Gender	Female				
Birth year	1900				
Diagnosis year	1945				
Cancer	Breast				
Attained age	45				
Exposure Information	**Exposure 1**	**Exposure 2**	**Exposure 3**	**Exposure 4**	**Exposure 5**
Exposure year	1920	1925	1930	1935	1940
Age at exposure	20	25	30	35	40
Exposure rate	chronic	acute	chronic	chronic	acute
Radiation type	photons E>250keV	electrons E>15keV	alpha	neutrons E=10-100keV	neutrons E=0.1-2MeV

Intermediate results calculated in Excel	**Exposure # 1**	**2**	**3**	**4**	**5**
ERR/Sv correlated w/ age adjustment	1.9495	1.6302	1.3803	1.3803	1.3803
w/ latency adjustment	1.9495	1.6302	1.3802	1.2714	0.0202
w/ random errors in dosimetry adj	2.1269	1.7785	1.5058	1.3871	0.0220
w/ systematic errors in dosimetry adj	1.5163	1.2679	1.0735	0.9889	0.0157
adjusted for population transfer	0.5600	0.4683	0.3964	0.3652	0.0058
multiplicative risk model	1.5163	1.2679	1.0735	0.9889	0.0157
additive risk model	0.5122	0.4283	0.3626	0.3340	0.0053
adjusted for smoking history	0.5600	0.4683	0.3964	0.3652	0.0058
adjusted for DDREF	0.5600	0.4683	0.3964	0.3652	0.0058
ERR/Sv	0.5600	0.4683	0.3964	0.3652	0.0058
Organ equivalent dose (Sv)	0.05	0.02	0.0855255	0.00674775	0.00347622
Linear Quadratic (1=Yes, 0=No)	0	0	0	0	0
Excess relative risk (ERR)	0.028	0.009	0.034	0.002	0.000

Final results calculated in Excel	**Midpoint[c]**
Total Excess relative risk (ERR)	0.074
Probability of Causation (PC)	6.87

[c] Midpoint values are representative of the iteration closest to the 50th percentile

Upper Bound Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Mult Exp 2**
Personal Information	
Gender	Female
Birth year	1900
Diagnosis year	1945
Cancer	Breast
Attained age	45

Exposure Information	**Exposure 1**	**Exposure 2**	**Exposure 3**	**Exposure 4**	**Exposure 5**
Exposure year	1920	1925	1930	1935	1940
Age at exposure	20	25	30	35	40
Exposure rate	chronic	acute	chronic	chronic	acute
Radiation type	photons E>250keV	electrons E>15keV	alpha	neutrons E=10-100keV	neutrons E=0.1 2MeV

	Exposure #				
Parameter	**1**	**2**	**3**	**4**	**5**
Monte Carlo iteration number for 99th percentile	1837	1837	1837	1837	1837
Original ERR/Sv, correlated w/ age adjustment	2.2782	1.9395	1.7244	1.7244	1.7244
Adjustment Factors					
Age at exposure, Attained age	1.0000	1.0000	1.0000	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000	1.0000	0.9642	0.0332
Random errors in doses[a]	0.0943	0.0943	0.0943	0.0943	0.0943
Systematic errors in gamma doses[a]	1.1082	1.1082	1.1082	1.1082	1.1082
Systematic errors in neutron doses[a]	1.0990	1.0990	1.0990	1.0990	1.0990
Systematic errors in RBE neutron doses[a]	0.9332	0.9332	0.9332	0.9332	0.9332
Model Mixture factor for transfer to US pop	0.5943	0.5943	0.5943	0.5943	0.5943
Ratio of Japanese to U.S. baseline cancer rates	0.3482	0.3482	0.3482	0.3482	0.3482
Smoking history	1	1	1	1	1
Dose and dose rate effectiveness factor (DDREF)	1	1	1	1	1
Organ equivalent dose (cSv)[b]	5	2	10	3	1
Radiation weighting factor (w_R - ICRP 60)	1	1	20	10	20
Radiation effectiveness factor (REF)	1	1	54.2287	4.9275	4.35405

Final results calculated by NIOSH-IREP	**Upper[c]**
Excess relative risk (ERR)	0.457
Probability of Causation (PC)	31.35

[a] Doses to the Japanese atomic bomb survivors

[b] Dose assigned to the claimant

[c] Upper values are representative of the iteration closest to the 99th percentile

Verification of Upper Bound Values using MS Excel

Verification Run Identifier	**Mult Exp 2**				
Personal Information					
Gender	Female				
Birth year	1900				
Diagnosis year	1945				
Cancer	Breast				
Attained age	45				
Exposure Information	**Exposure 1**	**Exposure 2**	**Exposure 3**	**Exposure 4**	**Exposure 5**
Exposure year	1920	1925	1930	1935	1940
Age at exposure	20	25	30	35	40
Exposure rate	chronic	acute	chronic	chronic	acute
Radiation type	photons E>250keV	electrons E>15keV	alpha	neutrons E=10-100keV	neutrons E=0.1-2MeV

Intermediate results calculated in Excel	**Exposure # 1**	**2**	**3**	**4**	**5**
ERR/Sv correlated w/ age adjustment	2.2782	1.9395	1.7244	1.7244	1.7244
w/ latency adjustment	2.2782	1.9395	1.7243	1.6627	0.0572
w/ random errors in dosimetry adj	2.4931	2.1224	1.8869	1.8194	0.0626
w/ systematic errors in dosimetry adj	2.1935	1.8673	1.6601	1.6008	0.0551
adjusted for population transfer	1.6135	1.3736	1.2211	1.1775	0.0405
multiplicative risk model	2.1935	1.8673	1.6601	1.6008	0.0551
additive risk model	0.7637	0.6502	0.5780	0.5574	0.0192
adjusted for smoking history	1.6135	1.3736	1.2211	1.1775	0.0405
adjusted for DDREF	1.6135	1.3736	1.2211	1.1775	0.0405
ERR/Sv	1.6135	1.3736	1.2211	1.1775	0.0405
Organ equivalent dose (Sv)	0.05	0.02	0.2711435	0.0147825	0.002177025
Linear Quadratic (1=Yes, 0=No)	0	0	0	0	0
Excess relative risk (ERR)	0.081	0.027	0.331	0.017	0.000

Final results calculated in Excel	**Upper[c]**
Total Excess relative risk (ERR)	0.457
Probability of Causation (PC)	31.35

[c] Upper values are representative of the iteration closest to the 99th percentile

Midpoint Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Mult Exp 3**				
Personal Information					
Gender	Female				
Birth year	1900				
Diagnosis year	1950				
Cancer	Thyroid				
Attained age	50				
Exposure Information	**Exposure 1**	**Exposure 2**	**Exposure 3**	**Exposure 4**	**Exposure 5**
Exposure year	1920	1922	1924	1926	1928
Age at exposure	20	22	24	26	28
Exposure rate	chronic	acute	chronic	chronic	acute
Radiation type	photons E>250keV	neutrons E=2-20MeV	neutrons E>20MeV	photons E<30keV	photons E=30-250keV

	Exposure #				
Parameter	**1**	**2**	**3**	**4**	**5**
Monte Carlo iteration number for 50th percentile	331	331	331	331	331
Original ERR/Sv, correlated w/ age adjustment	1.6726	1.4161	1.1989	1.0155	0.8605
Adjustment Factors					
Age at exposure, Attained age	1.0000	1.0000	1.0000	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000	1.0000	1.0000	1.0000
Random errors in doses[a]	0.0805	0.0805	0.0805	0.0805	0.0805
Systematic errors in gamma doses[a]	1.1863	1.1863	1.1863	1.1863	1.1863
Systematic errors in neutron doses[a]	1.0890	1.0890	1.0890	1.0890	1.0890
Systematic errors in RBE neutron doses[a]	1.0209	1.0209	1.0209	1.0209	1.0209
Model Mixture factor for transfer to US pop	0.9210	0.9210	0.9210	0.9210	0.9210
Ratio of Japanese to U.S. baseline cancer rates	1.3271	1.3271	1.3271	1.3271	1.3271
Smoking history	1	1	1	1	1
Dose and dose rate effectiveness factor (DDREF)	2	1	1	2	1.5406
Organ equivalent dose (cSv)[b]	5	6	8	4	2
Radiation weighting factor (w_R - ICRP 60)	1	10	5	1	1
Radiation effectiveness factor (REF)	1	17.5362	3.1565	1.27585	1

Final results calculated by NIOSH-IREP	**Midpoint[c]**
Excess relative risk (ERR)	0.288
Probability of Causation (PC)	22.39

[a] Doses to the Japanese atomic bomb survivors

[b] Dose assigned to the claimant

[c] Midpoint values are representative of the iteration closest to the 50th percentile

Verification of Midpoint Values using MS Excel

Verification Run Identifier	**Mult Exp 3**				
Personal Information					
Gender	Female				
Birth year	1900				
Diagnosis year	1950				
Cancer	Thyroid				
Attained age	50				
Exposure Information	**Exposure 1**	**Exposure 2**	**Exposure 3**	**Exposure 4**	**Exposure 5**
Exposure year	1920	1922	1924	1926	1928
Age at exposure	20	22	24	26	28
Exposure rate	chronic	acute	chronic	chronic	acute
Radiation type	photons E>250keV	neutrons E=2-20MeV	neutrons E>20MeV	photons E<30keV	photons E=30-250keV

Intermediate results calculated in Excel	**Exposure # 1**	**2**	**3**	**4**	**5**
ERR/Sv correlated w/ age adjustment	1.6726	1.4161	1.1989	1.0155	0.8605
w/ latency adjustment	1.6726	1.4161	1.1989	1.0155	0.8605
w/ random errors in dosimetry adj	1.6726	1.4161	1.1989	1.0155	0.8605
w/ systematic errors in dosimetry adj	1.6726	1.4161	1.1989	1.0155	0.8605
adjusted for population transfer	1.6726	1.4161	1.1989	1.0155	0.8605
multiplicative risk model	1.6726	1.4161	1.1989	1.0155	0.8605
additive risk model	2.2197	1.8793	1.5912	1.3477	1.1420
adjusted for smoking history	1.6726	1.4161	1.1989	1.0155	0.8605
adjusted for DDREF	0.8363	1.4161	1.1989	0.5078	0.5585
ERR/Sv	0.8363	1.4161	1.1989	0.5078	0.5585
Organ equivalent dose (Sv)	0.05	0.1052172	0.050504	0.051034	0.02
Linear Quadratic (1=Yes, 0=No)	0	0	0	0	0
Excess relative risk (ERR)	0.042	0.149	0.061	0.026	0.011

Final results calculated in Excel	**Midpoint[c]**
Total Excess relative risk (ERR)	0.288
Probability of Causation (PC)	22.39

[c] Midpoint values are representative of the iteration closest to the 50th percentile

Upper Bound Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Mult Exp 3**				
Personal Information					
Gender	Female				
Birth year	1900				
Diagnosis year	1950				
Cancer	Thyroid				
Attained age	50				
Exposure Information	**Exposure 1**	**Exposure 2**	**Exposure 3**	**Exposure 4**	**Exposure 5**
Exposure year	1920	1922	1924	1926	1928
Age at exposure	20	22	24	26	28
Exposure rate	chronic	acute	chronic	chronic	acute
Radiation type	photons E>250keV	neutrons E=2-20MeV	neutrons E>20MeV	photons E<30keV	photons E=30-250keV

	Exposure #				
Parameter	**1**	**2**	**3**	**4**	**5**
Monte Carlo iteration number for 99th percentile	414	414	414	414	414
Original ERR/Sv, correlated w/ age adjustment	11.6797	10.1482	8.8169	7.5643	6.4079
Adjustment Factors					
Age at exposure, Attained age	1.0000	1.0000	1.0000	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000	1.0000	1.0000	1.0000
Random errors in doses[a]	0.0872	0.0872	0.0872	0.0872	0.0872
Systematic errors in gamma doses[a]	1.0633	1.0633	1.0633	1.0633	1.0633
Systematic errors in neutron doses[a]	1.0795	1.0795	1.0795	1.0795	1.0795
Systematic errors in RBE neutron doses[a]	0.9626	0.9626	0.9626	0.9626	0.9626
Model Mixture factor for transfer to US pop	0.4398	0.4398	0.4398	0.4398	0.4398
Ratio of Japanese to U.S. baseline cancer rates	1.1651	1.1651	1.1651	1.1651	1.1651
Smoking history	1	1	1	1	1
Dose and dose rate effectiveness factor (DDREF)	1.5	1	1	1.5	1.1761
Organ equivalent dose (cSv)[b]	5	6	8	4	2
Radiation weighting factor (w_R - ICRP 60)	1	10	5	1	1
Radiation effectiveness factor (REF)	1	4.2935	4.51	3.9791	2.63209

Final results calculated by NIOSH-IREP	**Upper[c]**
Excess relative risk (ERR)	2.376
Probability of Causation (PC)	70.38

[a] Doses to the Japanese atomic bomb survivors

[b] Dose assigned to the claimant

[c] Upper values are representative of the iteration closest to the 99th percentile

Verification of Upper Bound Values using MS Excel

Verification Run Identifier	**Mult Exp 3**				
Personal Information					
Gender	Female				
Birth year	1900				
Diagnosis year	1950				
Cancer	Thyroid				
Attained age	50				
Exposure Information	**Exposure 1**	**Exposure 2**	**Exposure 3**	**Exposure 4**	**Exposure 5**
Exposure year	1920	1922	1924	1926	1928
Age at exposure	20	22	24	26	28
Exposure rate	chronic	acute	chronic	chronic	acute
Radiation type	photons E>250keV	neutrons E=2-20MeV	neutrons E>20MeV	photons E<30keV	photons E=30-250keV

Intermediate results calculated in Excel	**Exposure # 1**	**2**	**3**	**4**	**5**
ERR/Sv correlated w/ age adjustment	11.6797	10.1482	8.8169	7.5643	6.4079
w/ latency adjustment	11.6797	10.1482	8.8169	7.5643	6.4079
w/ random errors in dosimetry adj	11.6797	10.1482	8.8169	7.5643	6.4079
w/ systematic errors in dosimetry adj	11.6797	10.1482	8.8169	7.5643	6.4079
adjusted for population transfer	11.6797	10.1482	8.8169	7.5643	6.4079
multiplicative risk model	11.6797	10.1482	8.8169	7.5643	6.4079
additive risk model	13.6076	11.8233	10.2722	8.8129	7.4656
adjusted for smoking history	11.6797	10.1482	8.8169	7.5643	6.4079
adjusted for DDREF	7.7865	10.1482	8.8169	5.0429	5.4484
ERR/Sv	7.7865	10.1482	8.8169	5.0429	5.4484
Organ equivalent dose (Sv)	0.05	0.025761	0.07216	0.159164	0.0526418
Linear Quadratic (1=Yes, 0=No)	0	0	0	0	0
Excess relative risk (ERR)	0.389	0.261	0.636	0.803	0.287

Final results calculated in Excel	**Upper[c]**
Total Excess relative risk (ERR)	2.376
Probability of Causation (PC)	70.38

[c] Upper values are representative of the iteration closest to the 99th percentile

Midpoint Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier **Mult Exp 4**

Personal Information

Gender	Male	
Birth year	1900	
Diagnosis year	1970	
Cancer	Non-melanoma (BCC)	Ethnic Origin: White-non-Hispanic
Attained age	70	

Exposure Information	**Exposure 1**	**Exposure 2**	**Exposure 3**	**Exposure 4**	**Exposure 5**
Exposure year	1930	1931	1932	1933	1934
Age at exposure	30	31	32	33	34
Exposure rate	chronic	acute	chronic	chronic	acute
Radiation type	photons E>250keV	neutrons E=2-20MeV	neutrons E>20MeV	photons E<30keV	photons E=30-250keV

Parameter	**Exposure # 1**	**2**	**3**	**4**	**5**
Monte Carlo iteration number for 50th percentile	89	89	89	89	89
Original ERR/Sv, correlated w/ age adjustment	1.7710	1.5503	1.3571	1.1880	1.0400
Adjustment Factors					
Age at exposure, Attained age	1.0000	1.0000	1.0000	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000	1.0000	1.0000	1.0000
Random errors in doses[a]	0.0816	0.0816	0.0816	0.0816	0.0816
Systematic errors in gamma doses[a]	1.2892	1.2892	1.2892	1.2892	1.2892
Systematic errors in neutron doses[a]	1.1145	1.1145	1.1145	1.1145	1.1145
Systematic errors in RBE neutron doses[a]	0.9545	0.9545	0.9545	0.9545	0.9545
Model Mixture factor for transfer to US pop	0.5800	0.5800	0.5800	0.5800	0.5800
Ratio of Japanese to U.S. baseline cancer rates	0.0179	0.0179	0.0179	0.0179	0.0179
Smoking history	1	1	1	1	1
Dose and dose rate effectiveness factor (DDREF)	2	1	1	2	1.74683
Organ equivalent dose (cSv)[b]	5	6	8	4	2
Radiation weighting factor (w_R - ICRP 60)	1	10	5	1	1
Radiation effectiveness factor (REF)	1	4.2425	1.6106	2.36288	1.71012

Final results calculated by NIOSH-IREP	**Midpoint[c]**
Excess relative risk (ERR)	0.090
Probability of Causation (PC)	8.29

[a] Doses to the Japanese atomic bomb survivors

[b] Dose assigned to the claimant

[c] Midpoint values are representative of the iteration closest to the 50th percentile

Verification of Midpoint Values using MS Excel

Verification Run Identifier	**Mult Exp 4**				
Personal Information					
Gender	Male				
Birth year	1900				
Diagnosis year	1970				
Cancer	Non-melanoma (BCC)		Ethnic Origin: White-non-Hispanic		
Attained age	70				
Exposure Information	**Exposure 1**	**Exposure 2**	**Exposure 3**	**Exposure 4**	**Exposure 5**
Exposure year	1930	1931	1932	1933	1934
Age at exposure	30	31	32	33	34
Exposure rate	chronic	acute	chronic	chronic	acute
Radiation type	photons E>250keV	neutrons E=2-20MeV	neutrons E>20MeV	photons E<30keV	photons E=30-250keV

Intermediate results calculated in Excel	**Exposure # 1**	**2**	**3**	**4**	**5**
ERR/Sv correlated w/ age adjustment	1.7710	1.5503	1.3571	1.1880	1.0400
w/ latency adjustment	1.7710	1.5503	1.3571	1.1880	1.0400
w/ random errors in dosimetry adj	1.9154	1.6767	1.4678	1.2849	1.1248
w/ systematic errors in dosimetry adj	1.3966	1.2226	1.0702	0.9369	0.8201
adjusted for population transfer	0.8206	0.7183	0.6288	0.5504	0.4818
multiplicative risk model	1.3966	1.2226	1.0702	0.9369	0.8201
additive risk model	0.0250	0.0218	0.0191	0.0167	0.0147
adjusted for smoking history	0.8206	0.7183	0.6288	0.5504	0.4818
adjusted for DDREF	0.4103	0.7183	0.6288	0.2752	0.2758
ERR/Sv	0.4103	0.7183	0.6288	0.2752	0.2758
Organ equivalent dose (Sv)	0.05	0.025455	0.0257696	0.0945152	0.0342024
Linear Quadratic (1=Yes, 0=No)	0	0	0	0	0
Excess relative risk (ERR)	0.021	0.018	0.016	0.026	0.009

Final results calculated in Excel	**Midpoint[c]**
Total Excess relative risk (ERR)	0.090
Probability of Causation (PC)	8.29

[c] Midpoint values are representative of the iteration closest to the 50th percentile

Upper Bound Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier **Mult Exp 4**

Personal Information

Gender	Male	
Birth year	1900	
Diagnosis year	1970	
Cancer	Non-melanoma (BCC)	Ethnic Origin: White-non-Hispanic
Attained age	70	

Exposure Information	**Exposure 1**	**Exposure 2**	**Exposure 3**	**Exposure 4**	**Exposure 5**
Exposure year	1930	1931	1932	1933	1934
Age at exposure	30	31	32	33	34
Exposure rate	chronic	acute	chronic	chronic	acute
Radiation type	photons E>250keV	neutrons E=2-20MeV	neutrons E>20MeV	photons E<30keV	photons E=30-250keV

Parameter	**Exposure # 1**	**2**	**3**	**4**	**5**
Monte Carlo iteration number for 99th percentile	127	127	127	127	127
Original ERR/Sv, correlated w/ age adjustment	3.0756	2.7551	2.4680	2.2109	1.9805
Adjustment Factors					
Age at exposure, Attained age	1.0000	1.0000	1.0000	1.0000	1.0000
Minimum latency for cancer induction	1.0000	1.0000	1.0000	1.0000	1.0000
Random errors in doses[a]	0.0835	0.0835	0.0835	0.0835	0.0835
Systematic errors in gamma doses[a]	1.2728	1.2728	1.2728	1.2728	1.2728
Systematic errors in neutron doses[a]	1.0606	1.0606	1.0606	1.0606	1.0606
Systematic errors in RBE neutron doses[a]	1.0136	1.0136	1.0136	1.0136	1.0136
Model Mixture factor for transfer to US pop	1.0178	1.0178	1.0178	1.0178	1.0178
Ratio of Japanese to U.S. baseline cancer rates	0.0225	0.0225	0.0225	0.0225	0.0225
Smoking history	1	1	1	1	1
Dose and dose rate effectiveness factor (DDREF)	1.5	1	1	1.5	1.04524
Organ equivalent dose (cSv)[b]	5	6	8	4	2
Radiation weighting factor (w_R - ICRP 60)	1	10	5	1	1
Radiation effectiveness factor (REF)	1	18.5112	4.815	3.43121	2.33891

Final results calculated by NIOSH-IREP	**Upper[c]**
Excess relative risk (ERR)	0.717
Probability of Causation (PC)	41.75

[a] Doses to the Japanese atomic bomb survivors

[b] Dose assigned to the claimant

[c] Upper values are representative of the iteration closest to the 99th percentile

Verification of Upper Bound Values using MS Excel

Verification Run Identifier	**Mult Exp 4**				
Personal Information					
Gender	Male				
Birth year	1900				
Diagnosis year	1970				
Cancer	Non-melanoma (BCC)		Ethnic Origin: White-non-Hispanic		
Attained age	70				
Exposure Information	**Exposure 1**	**Exposure 2**	**Exposure 3**	**Exposure 4**	**Exposure 5**
Exposure year	1930	1931	1932	1933	1934
Age at exposure	30	31	32	33	34
Exposure rate	chronic	acute	chronic	chronic	acute
Radiation type	photons E>250keV	neutrons E=2-20MeV	neutrons E>20MeV	photons E<30keV	photons E=30-250keV

Intermediate results calculated in Excel	**Exposure # 1**	**2**	**3**	**4**	**5**
ERR/Sv correlated w/ age adjustment	3.0756	2.7551	2.4680	2.2109	1.9805
w/ latency adjustment	3.0756	2.7551	2.4680	2.2109	1.9805
w/ random errors in dosimetry adj	3.3326	2.9853	2.6742	2.3956	2.1459
w/ systematic errors in dosimetry adj	2.4356	2.1818	1.9544	1.7508	1.5683
adjusted for population transfer	2.4779	2.2196	1.9883	1.7812	1.5956
multiplicative risk model	2.4356	2.1818	1.9544	1.7508	1.5683
additive risk model	0.0549	0.0492	0.0440	0.0395	0.0353
adjusted for smoking history	2.4779	2.2196	1.9883	1.7812	1.5956
adjusted for DDREF	1.6519	2.2196	1.9883	1.1874	1.5265
ERR/Sv	1.6519	2.2196	1.9883	1.1874	1.5265
Organ equivalent dose (Sv)	0.05	0.1110672	0.07704	0.1372484	0.0467782
Linear Quadratic (1=Yes, 0=No)	0	0	0	0	0
Excess relative risk (ERR)	0.083	0.247	0.153	0.163	0.071

Final results calculated in Excel	**Upper[c]**
Total Excess relative risk (ERR)	0.717
Probability of Causation (PC)	41.75

[c] Upper values are representative of the iteration closest to the 99th percentile

Midpoint Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Mult Exp 5**				
Personal Information					
Gender	Male				
Birth year	1900				
Diagnosis year	1960				
Cancer	Liver				
Attained age	60				
Exposure Information	**Exposure 1**	**Exposure 2**	**Exposure 3**	**Exposure 4**	**Exposure 5**
Exposure year	1925	1930	1935	---	---
Age at exposure	25	30	35	---	---
Exposure rate	chronic	acute	chronic	---	---
Radiation type	photons E<30keV	photons E=30-250keV	photons E>250keV	---	---

Parameter	**Exposure # 1**	**2**	**3**	**4**	**5**
Monte Carlo iteration number for 50th percentile	152	152	152	---	---
Original ERR/Sv, correlated w/ age adjustment	0.4900	0.3791	0.3791	---	---
Adjustment Factors					
Age at exposure, Attained age	1.0000	1.0000	1.0000	---	---
Minimum latency for cancer induction	1.0000	1.0000	1.0000	---	---
Random errors in doses[a]	0.0850	0.0850	0.0850	---	---
Systematic errors in gamma doses[a]	1.2421	1.2421	1.2421	---	---
Systematic errors in neutron doses[a]	1.1237	1.1237	1.1237	---	---
Systematic errors in RBE neutron doses[a]	1.0297	1.0297	1.0297	---	---
Model Mixture factor for transfer to US pop	0.2764	0.2764	0.2764	---	---
Ratio of Japanese to U.S. baseline cancer rates	8.2964	8.2964	8.2964	---	---
Smoking history	1	1	1	---	---
Dose and dose rate effectiveness factor (DDREF)	2	1	2	---	---
Organ equivalent dose (cSv)[b]	5	6	8	---	---
Radiation weighting factor (w_R - ICRP 60)	1	1	1	---	---
Radiation effectiveness factor (REF)	1.63787	1.35786	1	---	---

Final results calculated by NIOSH-IREP	**Midpoint[c]**
Excess relative risk (ERR)	0.313
Probability of Causation (PC)	23.86

[a] Doses to the Japanese atomic bomb survivors

[b] Dose assigned to the claimant

[c] Midpoint values are representative of the iteration closest to the 50th percentile

Verification of Midpoint Values using MS Excel

Verification Run Identifier	**Mult Exp 5**				
Personal Information					
Gender	Male				
Birth year	1900				
Diagnosis year	1960				
Cancer	Liver				
Attained age	60				
Exposure Information	**Exposure 1**	**Exposure 2**	**Exposure 3**	**Exposure 4**	**Exposure 5**
Exposure year	1925	1930	1935	---	---
Age at exposure	25	30	35	---	---
Exposure rate	chronic	acute	chronic	---	---
Radiation type	photons E<30keV	photons E=30-250keV	photons E>250keV	---	---

Intermediate results calculated in Excel	**Exposure # 1**	**2**	**3**	**4**	**5**
ERR/Sv correlated w/ age adjustment	0.4900	0.3791	0.3791	---	---
w/ latency adjustment	0.4900	0.3791	0.3791		
w/ random errors in dosimetry adj	0.5317	0.4113	0.4113	---	---
w/ systematic errors in dosimetry adj	0.3700	0.2862	0.2862	---	---
adjusted for population transfer	2.3232	1.7972	1.7972	---	---
multiplicative risk model	0.3700	0.2862	0.2862	---	---
additive risk model	3.0694	2.3745	2.3745	---	---
adjusted for smoking history	2.3232	1.7972	1.7972	---	---
adjusted for DDREF	1.1616	1.7972	0.8986	---	---
ERR/Sv	1.1616	1.7972	0.8986	---	---
Organ equivalent dose (Sv)	0.0818935	0.0814716	0.08	---	---
Linear Quadratic (1=Yes, 0=No)	0	0	0	---	---
Excess relative risk (ERR)	0.095	0.146	0.072	---	---

Final results calculated in Excel	**Midpoint[c]**
Total Excess relative risk (ERR)	0.313
Probability of Causation (PC)	23.86

[c] Midpoint values are representative of the iteration closest to the 50th percentile

Upper Bound Values Reported by NIOSH-IREP v.5.5.3r

Verification Run Identifier	**Mult Exp 5**				
Personal Information					
Gender	Male				
Birth year	1900				
Diagnosis year	1960				
Cancer	Liver				
Attained age	60				
Exposure Information	**Exposure 1**	**Exposure 2**	**Exposure 3**	**Exposure 4**	**Exposure 5**
Exposure year	1925	1930	1935	---	---
Age at exposure	25	30	35	---	---
Exposure rate	chronic	acute	chronic	---	---
Radiation type	photons E<30keV	photons E=30-250keV	photons E>250keV	---	---

	Exposure #				
Parameter	**1**	**2**	**3**	**4**	**5**
Monte Carlo iteration number for 99th percentile	1301	1301	1301	---	---
Original ERR/Sv, correlated w/ age adjustment	0.8327	0.6601	0.6601	---	---
Adjustment Factors					
Age at exposure, Attained age	1.0000	1.0000	1.0000	---	---
Minimum latency for cancer induction	1.0000	1.0000	1.0000	---	---
Random errors in doses[a]	0.1199	0.1199	0.1199	---	---
Systematic errors in gamma doses[a]	1.2456	1.2456	1.2456	---	---
Systematic errors in neutron doses[a]	1.0099	1.0099	1.0099	---	---
Systematic errors in RBE neutron doses[a]	0.9819	0.9819	0.9819	---	---
Model Mixture factor for transfer to US pop	0.0515	0.0515	0.0515	---	---
Ratio of Japanese to U.S. baseline cancer rates	7.8980	7.8980	7.8980	---	---
Smoking history	1	1	1	---	---
Dose and dose rate effectiveness factor (DDREF)	0.7	1	0.7	---	---
Organ equivalent dose (cSv)[b]	5	6	8	---	---
Radiation weighting factor (w_R - ICRP 60)	1	1	1	---	---
Radiation effectiveness factor (REF)	2.52989	1.7265	1	---	---

Final results calculated by NIOSH-IREP	**Upper[c]**
Excess relative risk (ERR)	2.013
Probability of Causation (PC)	66.81

[a] Doses to the Japanese atomic bomb survivors

[b] Dose assigned to the claimant

[c] Upper values are representative of the iteration closest to the 99th percentile

Verification of Upper Bound Values using MS Excel

Verification Run Identifier	**Mult Exp 5**				
Personal Information					
Gender	Male				
Birth year	1900				
Diagnosis year	1960				
Cancer	Liver				
Attained age	60				
Exposure Information	**Exposure 1**	**Exposure 2**	**Exposure 3**	**Exposure 4**	**Exposure 5**
Exposure year	1925	1930	1935	---	---
Age at exposure	25	30	35	---	---
Exposure rate	chronic	acute	chronic	---	---
Radiation type	photons E<30keV	photons E=30-250keV	photons E>250keV	---	---

Intermediate results calculated in Excel	**Exposure # 1**	**2**	**3**	**4**	**5**
ERR/Sv correlated w/ age adjustment	0.8327	0.6601	0.6601	---	---
w/ latency adjustment	0.8327	0.6601	0.6601		
w/ random errors in dosimetry adj	0.9326	0.7393	0.7393	---	---
w/ systematic errors in dosimetry adj	0.7551	0.5986	0.5986	---	---
adjusted for population transfer	5.6955	4.5152	4.5152	---	---
multiplicative risk model	0.7551	0.5986	0.5986	---	---
additive risk model	5.9636	4.7277	4.7277	---	---
adjusted for smoking history	5.6955	4.5152	4.5152	---	---
adjusted for DDREF	8.1365	4.5152	6.4503	---	---
ERR/Sv	8.1365	4.5152	6.4503	---	---
Organ equivalent dose (Sv)	0.1264945	0.10359	0.08	---	---
Linear Quadratic (1=Yes, 0=No)	0	0	0	---	---
Excess relative risk (ERR)	1.029	0.468	0.516	---	---

Final results calculated in Excel	**Upper[c]**
Total Excess relative risk (ERR)	2.013
Probability of Causation (PC)	66.81

[c] Upper values are representative of the iteration closest to the 99th percentile

Appendix J

Results of Testing the Monte Carlo Uncertainty Propagation Algorithms

The calculations presented in this appendix verify that the Monte-Carlo uncertainty propagation algorithm used in NIOSH-IREP operates properly. In these verification calculations, probability distribution functions for ERR and PC produced by NIOSH-IREP are compared to probability distribution functions for ERR and PC obtained from the independent programming of the risk models into Microsoft Excel® combined with Crystal Ball®. The risk models programmed in MS Excel/Crystal Ball contain all parameters defined using the probability distributions listed in the technical documentation of NIOSH-IREP. Although the two Monte-Carlo calculations, one in NIOSH-IREP and one in MS Excel/Crystal Ball, are not identical, they do not differ by more than the margin of error for a Monte-Carlo operation (as discussed in Section 6 of this report).

Verification calculations for this section were performed first using a LHS sample size of 2,000 followed by 30 individual runs of 10,000 iterations each. Comparisons based on the 30 runs of 10,000 iterations minimize the differences in ERR and PC due to differences in the random number generator used by the Analytica® and Crystal Ball® software packages. Verification calculations were performed for oral cavity, colon, bladder, and nervous system and for two combinations of ages at exposure and ages at diagnosis. All scenarios considered for this set of verification calculations represent males exposed to an acute dose of 20 cSv of high energy photons (E > 250 keV).

The results of the Monte-Carlo calculations are presented in this appendix both in tabular and graphical form. The tables of results show the 1^{st}, 5^{th}, 50^{th}, 95^{th} and 99^{th} percentiles of the probability distributions obtained by Monte-Carlo methods in NIOSH-IREP and in MS Excel/Crystal Ball for each of the 30 runs of 10,000 iterations and show the average of the 30 runs at each of the five percentiles selected for verification testing. The graphs included in this appendix are probability plots comparing the entire probability distributions for ERR and PC produced by NIOSH-IREP and by MS Excel/Crystal Ball using a Monte-Carlo LHS sample size of 2,000.

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Table J-1. **ERR values** for a male exposed to high-energy gamma rays[a] at age 40; diagnosed with an **oral cavity cancer** at age 60.

		ERR values reported by NIOSH-IREP EE (v.5.5.3r)					**ERR values reported by Excel/Crystal Ball**				
	Random seed	Percentile					Percentile				
Run	value	1st	5th	50th	95th	99th	1st	5th	50th	95th	99th
1	181256	0.00	0.0041	0.028	0.071	0.098	0.00	0.0040	0.028	0.072	0.097
2	98396	0.00	0.0042	0.028	0.070	0.097	0.00	0.0042	0.028	0.070	0.098
3	878134	0.00	0.0042	0.028	0.071	0.096	0.00	0.0042	0.028	0.071	0.096
4	273343	0.00	0.0042	0.028	0.071	0.098	0.00	0.0041	0.028	0.072	0.099
5	87715	0.00	0.0042	0.028	0.071	0.097	0.00	0.0042	0.028	0.071	0.097
6	910178	0.00	0.0041	0.028	0.071	0.096	0.00	0.0042	0.028	0.071	0.097
7	177211	0.00	0.0041	0.028	0.071	0.097	0.00	0.0041	0.028	0.071	0.098
8	376111	0.00	0.0041	0.028	0.072	0.097	0.00	0.0041	0.028	0.071	0.098
9	44990	0.00	0.0042	0.028	0.072	0.097	0.00	0.0042	0.028	0.071	0.098
10	38354	0.00	0.0041	0.028	0.071	0.096	0.00	0.0042	0.028	0.071	0.096
11	792683	0.00	0.0041	0.028	0.071	0.097	0.00	0.0042	0.028	0.070	0.097
12	529695	0.00	0.0041	0.028	0.071	0.097	0.00	0.0041	0.028	0.071	0.097
13	53080	0.00	0.0041	0.028	0.071	0.098	0.00	0.0041	0.028	0.071	0.097
14	482924	0.00	0.0041	0.028	0.070	0.097	0.00	0.0042	0.028	0.071	0.098
15	724550	0.00	0.0040	0.028	0.070	0.096	0.00	0.0041	0.028	0.071	0.096
16	999673	0.00	0.0041	0.028	0.071	0.098	0.00	0.0041	0.028	0.072	0.096
17	643144	0.00	0.0041	0.028	0.071	0.098	0.00	0.0041	0.028	0.071	0.096
18	978311	0.00	0.0042	0.028	0.071	0.097	0.00	0.0042	0.028	0.071	0.097
19	707232	0.00	0.0041	0.028	0.072	0.095	0.00	0.0041	0.028	0.072	0.097
20	786047	0.00	0.0041	0.028	0.071	0.098	0.00	0.0041	0.028	0.072	0.097
21	284024	0.00	0.0043	0.028	0.071	0.098	0.00	0.0041	0.028	0.070	0.098
22	55671	0.00	0.0042	0.028	0.071	0.099	0.00	0.0041	0.028	0.071	0.099
23	6310	0.00	0.0041	0.028	0.071	0.097	0.00	0.0042	0.028	0.071	0.097
24	888815	0.00	0.0043	0.028	0.071	0.098	0.00	0.0042	0.028	0.072	0.097
25	241299	0.00	0.0040	0.028	0.071	0.096	0.00	0.0042	0.028	0.070	0.097
26	183847	0.00	0.0041	0.028	0.072	0.097	0.00	0.0041	0.028	0.071	0.097
27	621782	0.00	0.0041	0.028	0.071	0.096	0.00	0.0041	0.028	0.071	0.097
28	42399	0.00	0.0041	0.028	0.071	0.100	0.00	0.0041	0.028	0.071	0.097
29	514968	0.00	0.0041	0.028	0.071	0.097	0.00	0.0042	0.028	0.071	0.095
30	628418	0.00	0.0042	0.028	0.072	0.095	0.00	0.0040	0.028	0.071	0.097
Average of 30 runs[b]		0.00	0.0042	0.0281	0.0711	0.0970	0.000	0.0041	0.0281	0.0711	0.0972

[a] Organ dose = 20 cSv (constant)

[b] Each run consists of 10,000 Monte Carlo Iterations

Table J-2. **PC results** for a male exposed to high-energy gamma rays[a] at age 40; diagnosed with an **oral cavity cancer** at age 60.

		PC values (%) reported by NIOSH-IREP EE (v.5.5.3r)					**PC values (%) reported by Excel/Crystal Ball**				
	Random seed	Percentile					Percentile				
Run	value	1st	5th	50th	95th	99th	1st	5th	50th	95th	99th
1	181256	0.00	0.41	2.73	6.61	8.90	0.00	0.40	2.74	6.68	8.88
2	98396	0.00	0.42	2.73	6.57	8.86	0.00	0.42	2.73	6.57	8.93
3	878134	0.00	0.42	2.73	6.61	8.76	0.00	0.42	2.72	6.67	8.77
4	273343	0.00	0.42	2.74	6.67	8.90	0.00	0.41	2.73	6.69	9.00
5	87715	0.00	0.42	2.73	6.64	8.85	0.00	0.41	2.72	6.61	8.88
6	910178	0.00	0.41	2.74	6.65	8.75	0.00	0.42	2.73	6.64	8.86
7	177211	0.00	0.41	2.74	6.63	8.84	0.00	0.41	2.73	6.63	8.90
8	376111	0.00	0.41	2.73	6.68	8.87	0.00	0.41	2.73	6.61	8.93
9	44990	0.00	0.42	2.75	6.70	8.81	0.00	0.42	2.75	6.64	8.89
10	38354	0.00	0.41	2.74	6.66	8.77	0.00	0.41	2.73	6.64	8.79
11	792683	0.00	0.41	2.73	6.66	8.87	0.00	0.42	2.72	6.58	8.82
12	529695	0.00	0.41	2.75	6.66	8.82	0.00	0.41	2.74	6.65	8.85
13	53080	0.00	0.41	2.73	6.64	8.90	0.00	0.41	2.74	6.64	8.84
14	482924	0.00	0.41	2.75	6.58	8.87	0.00	0.42	2.73	6.65	8.91
15	724550	0.00	0.40	2.73	6.58	8.74	0.00	0.41	2.73	6.66	8.78
16	999673	0.00	0.41	2.73	6.62	8.93	0.00	0.41	2.74	6.67	8.80
17	643144	0.00	0.41	2.75	6.62	8.92	0.00	0.41	2.73	6.61	8.77
18	978311	0.00	0.42	2.73	6.62	8.86	0.00	0.42	2.75	6.61	8.87
19	707232	0.00	0.41	2.73	6.68	8.67	0.00	0.41	2.72	6.70	8.81
20	786047	0.00	0.41	2.74	6.66	8.90	0.00	0.41	2.73	6.70	8.86
21	284024	0.00	0.43	2.73	6.66	8.92	0.00	0.41	2.74	6.58	8.90
22	55671	0.00	0.42	2.72	6.62	8.99	0.00	0.41	2.74	6.65	9.04
23	6310	0.00	0.41	2.74	6.59	8.86	0.00	0.42	2.74	6.60	8.81
24	888815	0.00	0.43	2.73	6.64	8.89	0.00	0.42	2.73	6.70	8.80
25	241299	0.00	0.40	2.73	6.64	8.72	0.00	0.42	2.73	6.59	8.87
26	183847	0.00	0.41	2.73	6.74	8.82	0.00	0.41	2.74	6.66	8.84
27	621782	0.00	0.41	2.74	6.63	8.74	0.00	0.41	2.75	6.61	8.87
28	42399	0.00	0.41	2.73	6.60	9.05	0.00	0.41	2.72	6.64	8.85
29	514968	0.00	0.41	2.74	6.67	8.82	0.00	0.42	2.73	6.67	8.71
30	628418	0.00	0.42	2.72	6.68	8.68	0.00	0.40	2.73	6.62	8.86
Average of 30 runs[b]		0.00	0.413	2.73	6.64	8.84	0.000	0.413	2.73	6.64	8.86

[a] Organ dose = 20 cSv (constant)

[b] Each run consists of 10,000 Monte Carlo Iterations

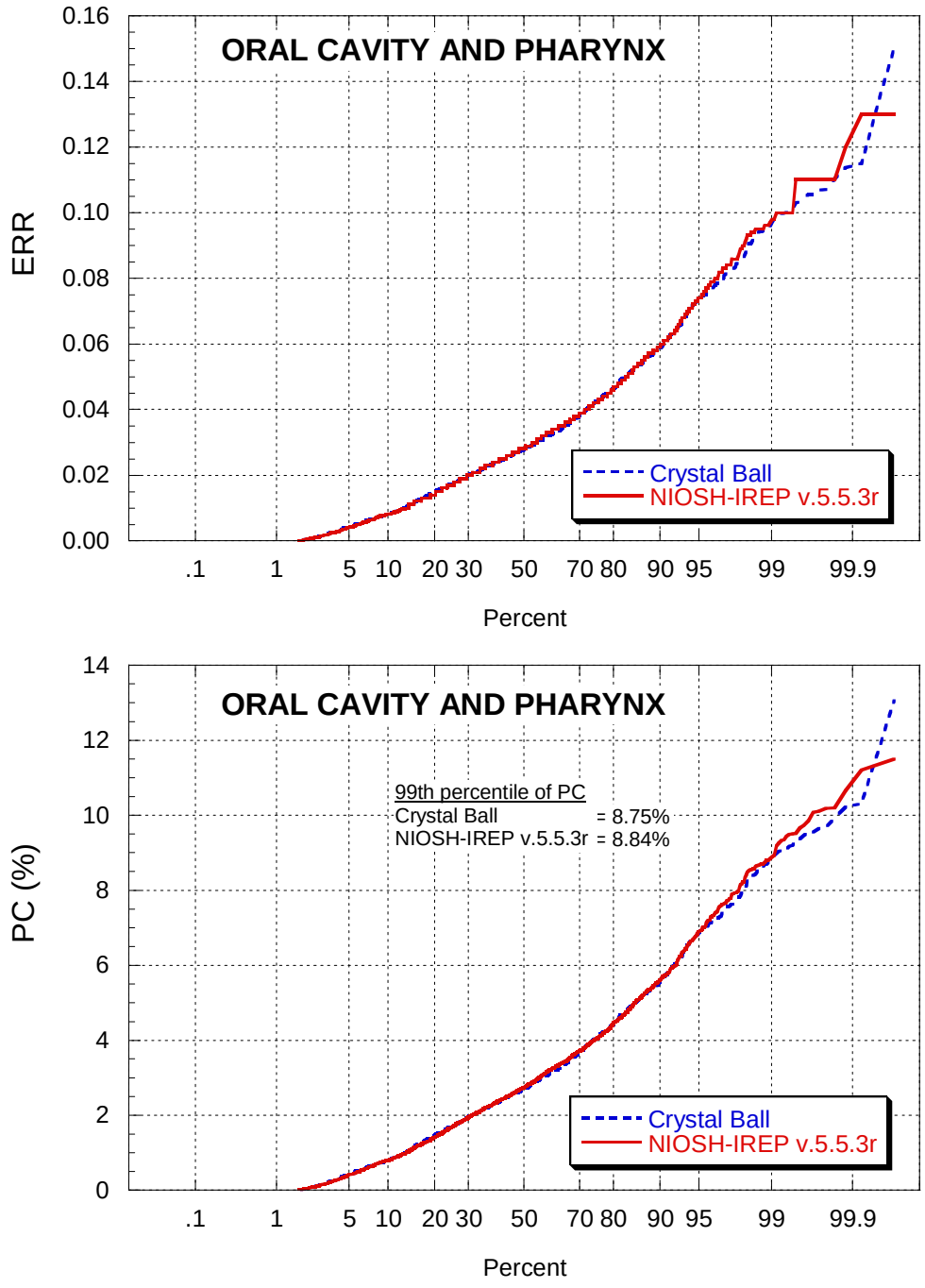

Fig. J-1 Comparison of the probability distribution functions for ERR and PC based on a single run of 2,000 iterations with NIOSH-IREP and MS Excel/Crystal Ball. The scenario represents a male with an oral cavity and pharynx cancer diagnosed at age 60, and who was exposed at age 40 to an acute dose of 20 cSv of high energy photons (E > 250 keV).

Table J-3. **ERR values** for a male exposed to high-energy gamma rays[a] at age 20; diagnosed with a **colon cancer** at age 60.

		ERR values reported by NIOSH-IREP EE (v.5.5.3r)					**ERR values reported by Excel/Crystal Ball**				
	Random seed	Percentile					Percentile				
Run	value	1st	5th	50th	95th	99th	1st	5th	50th	95th	99th
1	181256	0.02	0.05	0.16	0.34	0.45	0.015	0.047	0.158	0.338	0.444
2	98396	0.01	0.05	0.16	0.34	0.44	0.015	0.048	0.158	0.339	0.454
3	878134	0.01	0.05	0.16	0.34	0.45	0.014	0.048	0.158	0.343	0.448
4	273343	0.02	0.05	0.16	0.34	0.45	0.015	0.048	0.158	0.342	0.457
5	87715	0.01	0.05	0.16	0.34	0.46	0.015	0.047	0.158	0.339	0.446
6	910178	0.01	0.05	0.16	0.34	0.45	0.015	0.048	0.159	0.339	0.439
7	177211	0.02	0.05	0.16	0.34	0.44	0.015	0.048	0.157	0.342	0.452
8	376111	0.01	0.05	0.16	0.34	0.46	0.015	0.047	0.159	0.339	0.441
9	44990	0.01	0.05	0.16	0.34	0.45	0.015	0.048	0.159	0.339	0.449
10	38354	0.01	0.05	0.16	0.34	0.45	0.015	0.048	0.158	0.344	0.442
11	792683	0.02	0.05	0.16	0.34	0.44	0.015	0.047	0.159	0.337	0.443
12	529695	0.02	0.05	0.16	0.34	0.45	0.015	0.048	0.158	0.341	0.452
13	53080	0.01	0.05	0.16	0.34	0.45	0.015	0.048	0.158	0.343	0.447
14	482924	0.01	0.05	0.16	0.34	0.44	0.014	0.047	0.159	0.338	0.438
15	724550	0.02	0.05	0.16	0.34	0.45	0.016	0.047	0.158	0.342	0.452
16	999673	0.01	0.05	0.16	0.34	0.44	0.016	0.048	0.158	0.339	0.439
17	643144	0.01	0.05	0.16	0.34	0.44	0.015	0.048	0.158	0.343	0.456
18	978311	0.02	0.05	0.16	0.34	0.44	0.016	0.048	0.158	0.337	0.445
19	707232	0.02	0.05	0.16	0.34	0.46	0.016	0.047	0.158	0.336	0.451
20	786047	0.02	0.05	0.16	0.34	0.44	0.016	0.047	0.159	0.340	0.445
21	284024	0.02	0.05	0.16	0.34	0.45	0.015	0.047	0.159	0.339	0.441
22	55671	0.01	0.05	0.16	0.34	0.44	0.015	0.047	0.157	0.343	0.455
23	6310	0.02	0.05	0.16	0.34	0.45	0.015	0.048	0.159	0.343	0.452
24	888815	0.02	0.05	0.16	0.34	0.45	0.015	0.048	0.159	0.338	0.448
25	241299	0.02	0.05	0.16	0.34	0.44	0.015	0.048	0.158	0.338	0.443
26	183847	0.01	0.05	0.16	0.34	0.44	0.016	0.048	0.158	0.342	0.442
27	621782	0.01	0.05	0.16	0.34	0.45	0.013	0.048	0.159	0.341	0.445
28	42399	0.02	0.05	0.16	0.34	0.45	0.015	0.048	0.159	0.340	0.444
29	514968	0.02	0.05	0.16	0.34	0.45	0.015	0.047	0.159	0.341	0.453
30	628418	0.02	0.05	0.16	0.34	0.45	0.015	0.047	0.158	0.339	0.450
Average of 30 runs[b]		0.01	0.0476	0.158	0.341	0.447	0.015	0.048	0.158	0.340	0.447

[a] Organ dose = 20 cSv (constant)

[b] Each run consists of 10,000 Monte Carlo Iterations

Table J-4. **PC results** for a male exposed to high-energy gamma rays[a] at age 20; diagnosed with a **colon cancer** at age 60.

		PC values (%) reported by NIOSH-IREP EE (v.5.5.3r)					**PC values (%) reported by Excel/Crystal Ball**				
	Random seed	Percentile					Percentile				
Run	value	1st	5th	50th	95th	99th	1st	5th	50th	95th	99th
1	181256	1.50	4.54	13.65	25.55	30.95	1.45	4.52	13.64	25.25	30.74
2	98396	1.45	4.58	13.68	25.31	30.56	1.44	4.56	13.67	25.34	31.21
3	878134	1.44	4.52	13.64	25.41	31.11	1.42	4.61	13.68	25.53	30.94
4	273343	1.52	4.56	13.66	25.43	31.01	1.45	4.59	13.67	25.47	31.38
5	87715	1.47	4.58	13.61	25.54	31.35	1.45	4.45	13.66	25.31	30.86
6	910178	1.46	4.53	13.72	25.59	31.08	1.46	4.61	13.70	25.30	30.51
7	177211	1.49	4.50	13.65	25.28	30.46	1.52	4.54	13.56	25.47	31.15
8	376111	1.46	4.51	13.67	25.34	31.29	1.51	4.52	13.69	25.30	30.62
9	44990	1.44	4.54	13.67	25.55	30.92	1.52	4.54	13.70	25.29	30.98
10	38354	1.37	4.58	13.58	25.37	31.00	1.50	4.57	13.65	25.57	30.66
11	792683	1.51	4.50	13.68	25.25	30.78	1.50	4.53	13.69	25.23	30.71
12	529695	1.48	4.59	13.66	25.32	31.09	1.47	4.56	13.65	25.42	31.13
13	53080	1.46	4.52	13.64	25.47	30.92	1.49	4.54	13.67	25.55	30.88
14	482924	1.47	4.52	13.70	25.46	30.76	1.38	4.50	13.69	25.27	30.44
15	724550	1.53	4.51	13.62	25.28	30.84	1.55	4.53	13.63	25.49	31.14
16	999673	1.42	4.49	13.69	25.47	30.72	1.54	4.56	13.62	25.31	30.48
17	643144	1.44	4.55	13.63	25.60	30.53	1.48	4.55	13.65	25.54	31.32
18	978311	1.48	4.57	13.59	25.46	30.61	1.53	4.55	13.65	25.20	30.81
19	707232	1.53	4.58	13.71	25.42	31.32	1.53	4.49	13.68	25.12	31.08
20	786047	1.51	4.49	13.70	25.58	30.67	1.55	4.47	13.71	25.35	30.80
21	284024	1.49	4.57	13.59	25.55	31.01	1.51	4.53	13.69	25.32	30.61
22	55671	1.37	4.57	13.62	25.42	30.70	1.49	4.49	13.60	25.55	31.29
23	6310	1.49	4.53	13.63	25.65	31.05	1.46	4.55	13.69	25.53	31.14
24	888815	1.50	4.52	13.65	25.48	31.22	1.46	4.56	13.69	25.26	30.93
25	241299	1.49	4.47	13.70	25.40	30.56	1.50	4.56	13.65	25.28	30.70
26	183847	1.44	4.58	13.63	25.38	30.68	1.53	4.54	13.64	25.50	30.67
27	621782	1.41	4.61	13.63	25.40	30.90	1.31	4.54	13.72	25.41	30.81
28	42399	1.51	4.54	13.66	25.44	31.05	1.50	4.58	13.71	25.39	30.77
29	514968	1.53	4.56	13.68	25.31	31.05	1.48	4.49	13.68	25.43	31.17
30	628418	1.51	4.57	13.60	25.37	31.04	1.44	4.53	13.63	25.31	31.04
Average of 30 runs		1.47	4.54	13.65	25.44	30.91	1.48	4.54	13.67	25.38	30.90

[a] Organ dose = 20 cSv (constant)

[b] Each run consists of 10,000 Monte Carlo Iterations

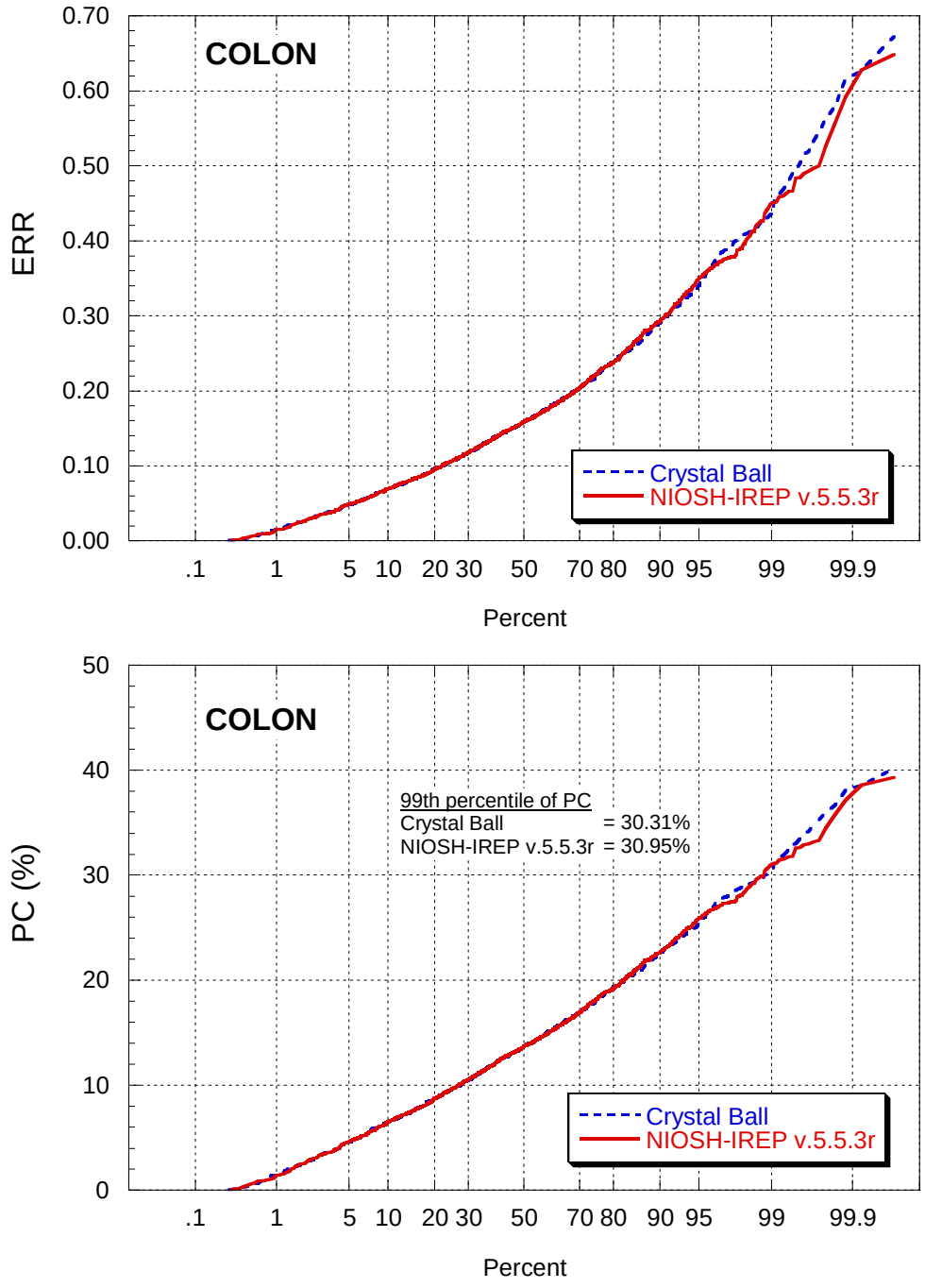

Fig. J-2 Comparison of the probability distribution functions for ERR and PC based on a single run of 2,000 iterations with NIOSH-IREP and MS Excel/Crystal Ball. The scenario represents a male with a colon cancer diagnosed at age 60, and who was exposed at age 20 to an acute dose of 20 cSv of high energy photons (E > 250 keV).

Table J-5. **ERR values** for a male exposed to high-energy gamma rays[a] at age 40; diagnosed with a **bladder cancer** at age 60.

		ERR values reported by NIOSH-IREP EE (v.5.5.3r)					**ERR values reported by Excel/Crystal Ball**				
	Random seed	Percentile					Percentile				
Run	value	1st	5th	50th	95th	99th	1st	5th	50th	95th	99th
1	181256	0.01	0.02	0.07	0.15	0.19	0.010	0.023	0.068	0.150	0.193
2	98396	0.01	0.02	0.07	0.15	0.19	0.010	0.023	0.069	0.149	0.194
3	878134	0.01	0.02	0.07	0.15	0.19	0.009	0.023	0.069	0.150	0.194
4	273343	0.01	0.02	0.07	0.15	0.19	0.010	0.023	0.069	0.147	0.192
5	87715	0.01	0.02	0.07	0.15	0.19	0.010	0.023	0.069	0.148	0.196
6	910178	0.01	0.02	0.07	0.15	0.19	0.010	0.023	0.069	0.147	0.196
7	177211	0.01	0.02	0.07	0.15	0.19	0.010	0.023	0.069	0.147	0.191
8	376111	0.01	0.02	0.07	0.15	0.20	0.010	0.023	0.069	0.148	0.191
9	44990	0.01	0.02	0.07	0.15	0.20	0.010	0.023	0.069	0.149	0.193
10	38354	0.01	0.02	0.07	0.15	0.19	0.010	0.023	0.069	0.148	0.194
11	792683	0.01	0.02	0.07	0.15	0.20	0.010	0.023	0.069	0.148	0.196
12	529695	0.01	0.02	0.07	0.15	0.19	0.010	0.023	0.069	0.148	0.194
13	53080	0.01	0.02	0.07	0.15	0.20	0.010	0.023	0.069	0.148	0.194
14	482924	0.01	0.02	0.07	0.15	0.20	0.010	0.023	0.068	0.148	0.192
15	724550	0.01	0.02	0.07	0.15	0.19	0.010	0.023	0.069	0.147	0.198
16	999673	0.01	0.02	0.07	0.15	0.20	0.010	0.023	0.069	0.148	0.191
17	643144	0.01	0.02	0.07	0.15	0.20	0.010	0.023	0.069	0.148	0.195
18	978311	0.01	0.02	0.07	0.15	0.19	0.010	0.023	0.069	0.149	0.196
19	707232	0.01	0.02	0.07	0.15	0.19	0.010	0.023	0.069	0.148	0.196
20	786047	0.01	0.02	0.07	0.15	0.19	0.010	0.023	0.069	0.147	0.195
21	284024	0.01	0.02	0.07	0.15	0.20	0.010	0.023	0.070	0.149	0.196
22	55671	0.01	0.02	0.07	0.15	0.20	0.010	0.023	0.069	0.148	0.191
23	6310	0.01	0.02	0.07	0.15	0.19	0.010	0.023	0.069	0.149	0.196
24	888815	0.01	0.02	0.07	0.15	0.20	0.010	0.023	0.069	0.148	0.196
25	241299	0.01	0.02	0.07	0.15	0.19	0.010	0.023	0.069	0.148	0.193
26	183847	0.01	0.02	0.07	0.15	0.19	0.010	0.023	0.069	0.149	0.195
27	621782	0.01	0.02	0.07	0.15	0.19	0.010	0.023	0.069	0.147	0.189
28	42399	0.01	0.02	0.07	0.15	0.20	0.010	0.023	0.069	0.149	0.197
29	514968	0.01	0.02	0.07	0.15	0.20	0.010	0.024	0.069	0.147	0.192
30	628418	0.01	0.02	0.07	0.15	0.19	0.010	0.023	0.069	0.148	0.193
Average of 30 runs[b]		0.01	0.0230	0.069	0.148	0.194	0.010	0.023	0.069	0.148	0.194

[a] Organ dose = 20 cSv (constant)

[b] Each run consists of 10,000 Monte Carlo Iterations

Table J-6. **PC results** for a male exposed to high-energy gamma rays[a] at age 40; diagnosed with a **bladder cancer** at age 60.

		PC values (%) reported by NIOSH-IREP EE (v.5.5.3r)					**PC values (%) reported by Excel/Crystal Ball**				
	Random seed	Percentile					Percentile				
Run	value	1st	5th	50th	95th	99th	1st	5th	50th	95th	99th
1	181256	0.98	2.25	6.45	12.86	16.30	0.98	2.25	6.40	13.05	16.17
2	98396	0.94	2.25	6.45	12.79	16.27	0.95	2.23	6.44	12.93	16.23
3	878134	0.94	2.30	6.44	12.82	16.13	0.93	2.23	6.47	13.08	16.24
4	273343	0.97	2.30	6.47	12.95	16.28	0.95	2.23	6.46	12.85	16.12
5	87715	0.97	2.24	6.46	12.99	16.28	0.98	2.24	6.45	12.92	16.42
6	910178	0.99	2.24	6.42	12.98	16.09	1.01	2.25	6.44	12.82	16.37
7	177211	0.96	2.23	6.45	12.95	16.20	0.97	2.21	6.45	12.83	16.03
8	376111	0.99	2.23	6.43	12.94	16.34	1.02	2.27	6.45	12.89	16.06
9	44990	0.92	2.26	6.46	12.87	16.41	0.99	2.22	6.44	12.97	16.18
10	38354	0.97	2.23	6.46	12.96	16.17	0.98	2.25	6.44	12.89	16.25
11	792683	0.95	2.25	6.44	12.93	16.43	0.95	2.24	6.46	12.91	16.41
12	529695	0.96	2.26	6.50	12.98	16.21	1.01	2.24	6.44	12.92	16.28
13	53080	1.01	2.22	6.42	12.87	16.35	0.96	2.22	6.45	12.91	16.22
14	482924	0.99	2.24	6.46	12.81	16.34	0.95	2.27	6.41	12.88	16.13
15	724550	0.94	2.22	6.46	12.85	16.07	0.97	2.24	6.50	12.83	16.50
16	999673	0.97	2.24	6.44	12.87	16.53	0.98	2.24	6.45	12.88	16.03
17	643144	1.01	2.25	6.48	12.88	16.41	0.97	2.23	6.48	12.91	16.32
18	978311	1.01	2.26	6.48	12.82	16.29	0.96	2.26	6.45	12.94	16.35
19	707232	1.04	2.24	6.46	12.90	16.09	0.96	2.27	6.46	12.93	16.39
20	786047	0.97	2.26	6.47	12.87	16.10	0.96	2.29	6.44	12.83	16.33
21	284024	1.02	2.27	6.44	12.94	16.34	1.01	2.23	6.51	13.00	16.35
22	55671	0.97	2.23	6.43	12.84	16.53	1.03	2.23	6.45	12.88	16.07
23	6310	1.01	2.23	6.47	12.85	16.30	0.99	2.27	6.46	12.94	16.35
24	888815	0.95	2.27	6.43	12.97	16.40	0.99	2.21	6.47	12.92	16.42
25	241299	0.96	2.22	6.45	12.89	16.28	0.99	2.23	6.46	12.88	16.15
26	183847	0.97	2.21	6.46	13.09	16.17	0.97	2.22	6.46	12.96	16.31
27	621782	1.01	2.23	6.43	12.86	16.06	0.99	2.24	6.47	12.85	15.90
28	42399	0.99	2.25	6.46	12.90	16.52	0.99	2.24	6.45	12.93	16.47
29	514968	0.99	2.23	6.46	12.91	16.39	0.98	2.30	6.44	12.80	16.11
30	628418	0.99	2.27	6.46	12.93	15.88	0.99	2.24	6.44	12.86	16.20
Average of 30 runs		0.98	2.25	6.45	12.90	16.27	0.98	2.24	6.45	12.91	16.25

[a] Organ dose = 20 cSv (constant)

[b] Each run consists of 10,000 Monte Carlo Iterations

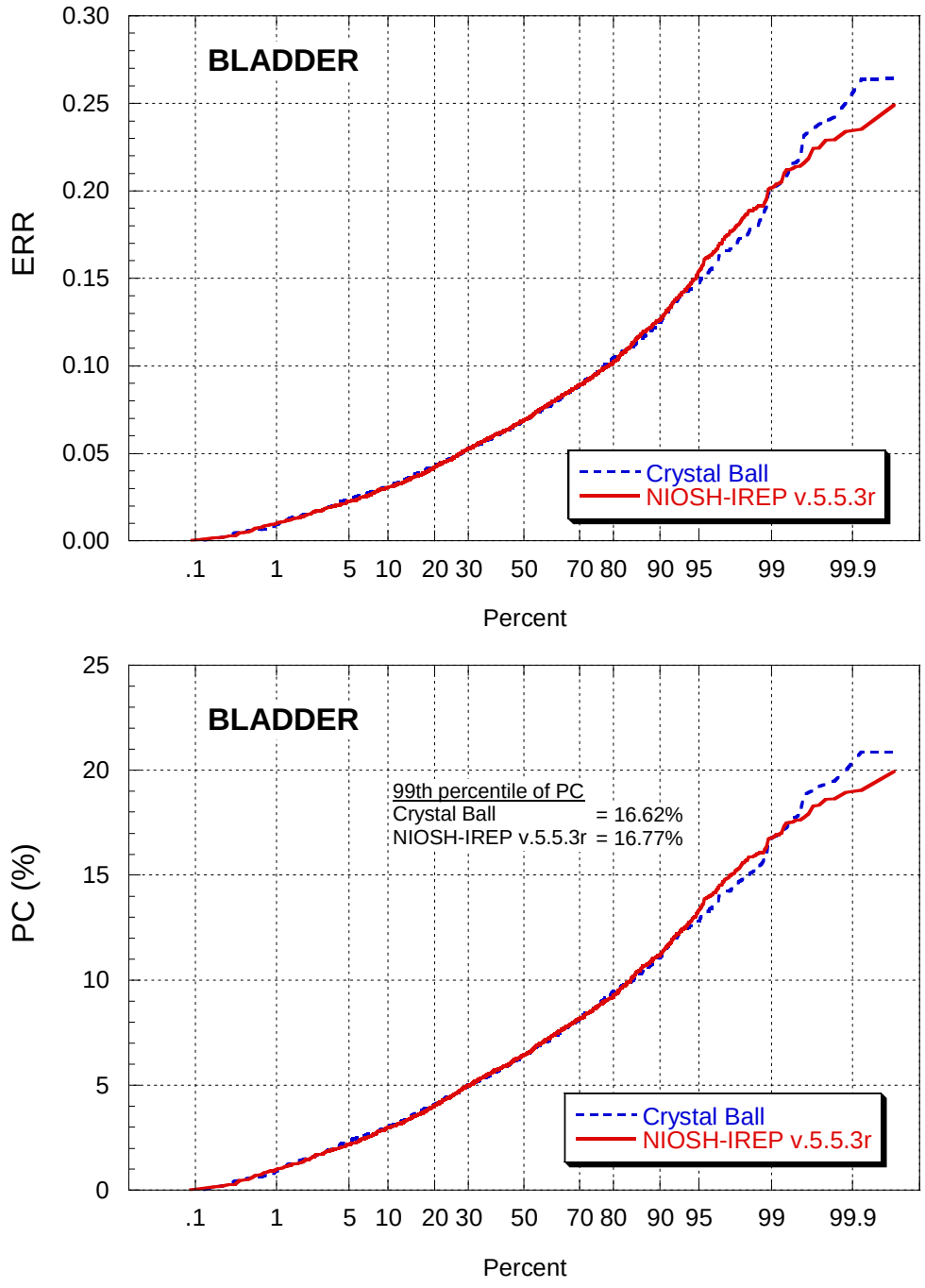

Fig. J-3 Comparison of the probability distribution functions for ERR and PC based on a single run of 2,000 iterations with NIOSH-IREP and MS Excel/Crystal Ball. The scenario represents a male with a bladder cancer diagnosed at age 60, and who was exposed at age 40 to an acute dose of 20 cSv of high energy photons (E > 250 keV).

Table J-7. **ERR values** for a male exposed to high-energy gamma rays[a] at age 20; diagnosed with a **cancer of the nervous system** at age 60.

		ERR values reported by NIOSH-IREP EE (v.5.5.3r)					**ERR values reported by Excel/Crystal Ball**				
	Random seed	Percentile					Percentile				
Run	value	1st	5th	50th	95th	99th	1st	5th	50th	95th	99th
1	181256	0.00	0.003	0.038	0.123	0.184	0.000	0.003	0.037	0.123	0.184
2	98396	0.00	0.003	0.038	0.122	0.185	0.000	0.003	0.037	0.122	0.180
3	878134	0.00	0.003	0.037	0.123	0.183	0.000	0.003	0.038	0.126	0.192
4	273343	0.00	0.003	0.037	0.122	0.183	0.000	0.003	0.037	0.122	0.180
5	87715	0.00	0.003	0.037	0.123	0.188	0.000	0.003	0.037	0.121	0.186
6	910178	0.00	0.003	0.037	0.123	0.188	0.000	0.003	0.037	0.121	0.182
7	177211	0.00	0.003	0.037	0.122	0.184	0.000	0.003	0.037	0.121	0.185
8	376111	0.00	0.003	0.037	0.124	0.186	0.000	0.003	0.037	0.123	0.178
9	44990	0.00	0.003	0.038	0.125	0.188	0.000	0.003	0.037	0.121	0.181
10	38354	0.00	0.003	0.037	0.122	0.187	0.000	0.003	0.037	0.122	0.188
11	792683	0.00	0.003	0.037	0.123	0.182	0.000	0.003	0.037	0.121	0.185
12	529695	0.00	0.003	0.038	0.123	0.185	0.000	0.003	0.037	0.122	0.188
13	53080	0.00	0.003	0.037	0.120	0.186	0.000	0.003	0.037	0.123	0.179
14	482924	0.00	0.003	0.037	0.122	0.181	0.000	0.003	0.037	0.122	0.181
15	724550	0.00	0.003	0.038	0.123	0.180	0.000	0.003	0.038	0.122	0.189
16	999673	0.00	0.003	0.038	0.122	0.184	0.000	0.003	0.037	0.121	0.180
17	643144	0.00	0.003	0.038	0.123	0.182	0.000	0.003	0.038	0.122	0.183
18	978311	0.00	0.003	0.037	0.123	0.183	0.000	0.003	0.037	0.122	0.186
19	707232	0.00	0.003	0.037	0.122	0.186	0.000	0.003	0.037	0.121	0.186
20	786047	0.00	0.003	0.037	0.121	0.185	0.000	0.003	0.038	0.121	0.186
21	284024	0.00	0.003	0.037	0.124	0.183	0.000	0.003	0.038	0.122	0.182
22	55671	0.00	0.003	0.037	0.122	0.183	0.000	0.003	0.037	0.123	0.179
23	6310	0.00	0.003	0.037	0.124	0.186	0.000	0.003	0.037	0.124	0.186
24	888815	0.00	0.004	0.037	0.124	0.184	0.000	0.003	0.038	0.122	0.187
25	241299	0.00	0.003	0.038	0.121	0.178	0.000	0.003	0.038	0.122	0.183
26	183847	0.00	0.003	0.037	0.124	0.184	0.000	0.003	0.038	0.123	0.184
27	621782	0.00	0.003	0.037	0.121	0.183	0.000	0.003	0.037	0.121	0.179
28	42399	0.00	0.003	0.038	0.123	0.189	0.000	0.003	0.037	0.123	0.186
29	514968	0.00	0.003	0.037	0.123	0.187	0.000	0.003	0.037	0.119	0.180
30	628418	0.00	0.003	0.037	0.121	0.183	0.000	0.003	0.037	0.122	0.183
Average of 30 runs[b]		0.00	0.0033	0.037	0.123	0.184	0.000	0.003	0.037	0.122	0.184

[a] Organ dose = 20 cSv (constant)

[b] Each run consists of 10,000 Monte Carlo Iterations

Table J-8. **PC results** for a male exposed to high-energy gamma rays[a] at age 20; diagnosed with a **cancer of the nervous system** at age 60.

		PC values (%) reported by NIOSH-IREP EE (v.5.5.3r)					**PC values (%) reported by Excel/Crystal Ball**				
	Random seed	Percentile					Percentile				
Run	value	1st	5th	50th	95th	99th	1st	5th	50th	95th	99th
1	181256	0.00	0.33	3.63	10.94	15.56	0.00	0.33	3.59	10.99	15.55
2	98396	0.00	0.33	3.62	10.89	15.62	0.00	0.34	3.60	10.87	15.22
3	878134	0.00	0.34	3.58	10.96	15.45	0.00	0.33	3.63	11.17	16.12
4	273343	0.00	0.34	3.59	10.91	15.45	0.00	0.32	3.60	10.88	15.25
5	87715	0.00	0.33	3.58	10.99	15.80	0.00	0.33	3.60	10.83	15.69
6	910178	0.00	0.33	3.60	10.92	15.81	0.00	0.33	3.58	10.79	15.40
7	177211	0.00	0.33	3.59	10.91	15.52	0.00	0.32	3.60	10.78	15.59
8	376111	0.00	0.32	3.58	11.03	15.66	0.00	0.33	3.59	10.97	15.12
9	44990	0.00	0.32	3.63	11.09	15.85	0.00	0.34	3.61	10.82	15.35
10	38354	0.00	0.32	3.61	10.90	15.77	0.00	0.34	3.59	10.85	15.83
11	792683	0.00	0.33	3.59	10.92	15.37	0.00	0.33	3.61	10.81	15.64
12	529695	0.00	0.34	3.62	10.97	15.60	0.00	0.33	3.59	10.85	15.82
13	53080	0.00	0.32	3.61	10.75	15.67	0.00	0.32	3.60	10.98	15.19
14	482924	0.00	0.32	3.61	10.84	15.34	0.00	0.33	3.59	10.89	15.31
15	724550	0.00	0.33	3.65	10.96	15.24	0.00	0.35	3.65	10.88	15.88
16	999673	0.00	0.32	3.64	10.90	15.54	0.00	0.32	3.60	10.81	15.23
17	643144	0.00	0.33	3.62	10.93	15.41	0.00	0.33	3.62	10.89	15.44
18	978311	0.00	0.33	3.61	10.94	15.47	0.00	0.33	3.58	10.91	15.67
19	707232	0.00	0.33	3.57	10.85	15.71	0.00	0.34	3.61	10.83	15.67
20	786047	0.00	0.33	3.61	10.77	15.58	0.00	0.32	3.63	10.82	15.68
21	284024	0.00	0.33	3.58	11.04	15.50	0.00	0.32	3.64	10.88	15.41
22	55671	0.00	0.33	3.61	10.91	15.47	0.00	0.33	3.61	10.94	15.20
23	6310	0.00	0.32	3.59	11.03	15.69	0.00	0.33	3.61	11.06	15.70
24	888815	0.00	0.35	3.60	11.06	15.56	0.00	0.31	3.62	10.88	15.73
25	241299	0.00	0.32	3.62	10.81	15.14	0.00	0.32	3.62	10.91	15.47
26	183847	0.00	0.34	3.61	11.05	15.54	0.00	0.31	3.62	10.96	15.54
27	621782	0.00	0.33	3.58	10.78	15.48	0.00	0.33	3.61	10.80	15.20
28	42399	0.00	0.33	3.62	10.97	15.91	0.00	0.33	3.61	10.96	15.70
29	514968	0.00	0.33	3.61	10.97	15.73	0.00	0.34	3.59	10.67	15.23
30	628418	0.00	0.33	3.59	10.81	15.44	0.00	0.33	3.60	10.86	15.46
Average of 30 runs		0.00	0.33	3.61	10.93	15.56	0.00	0.33	3.61	10.88	15.51

[a] Organ dose = 20 cSv (constant)

[b] Each run consists of 10,000 Monte Carlo Iterations

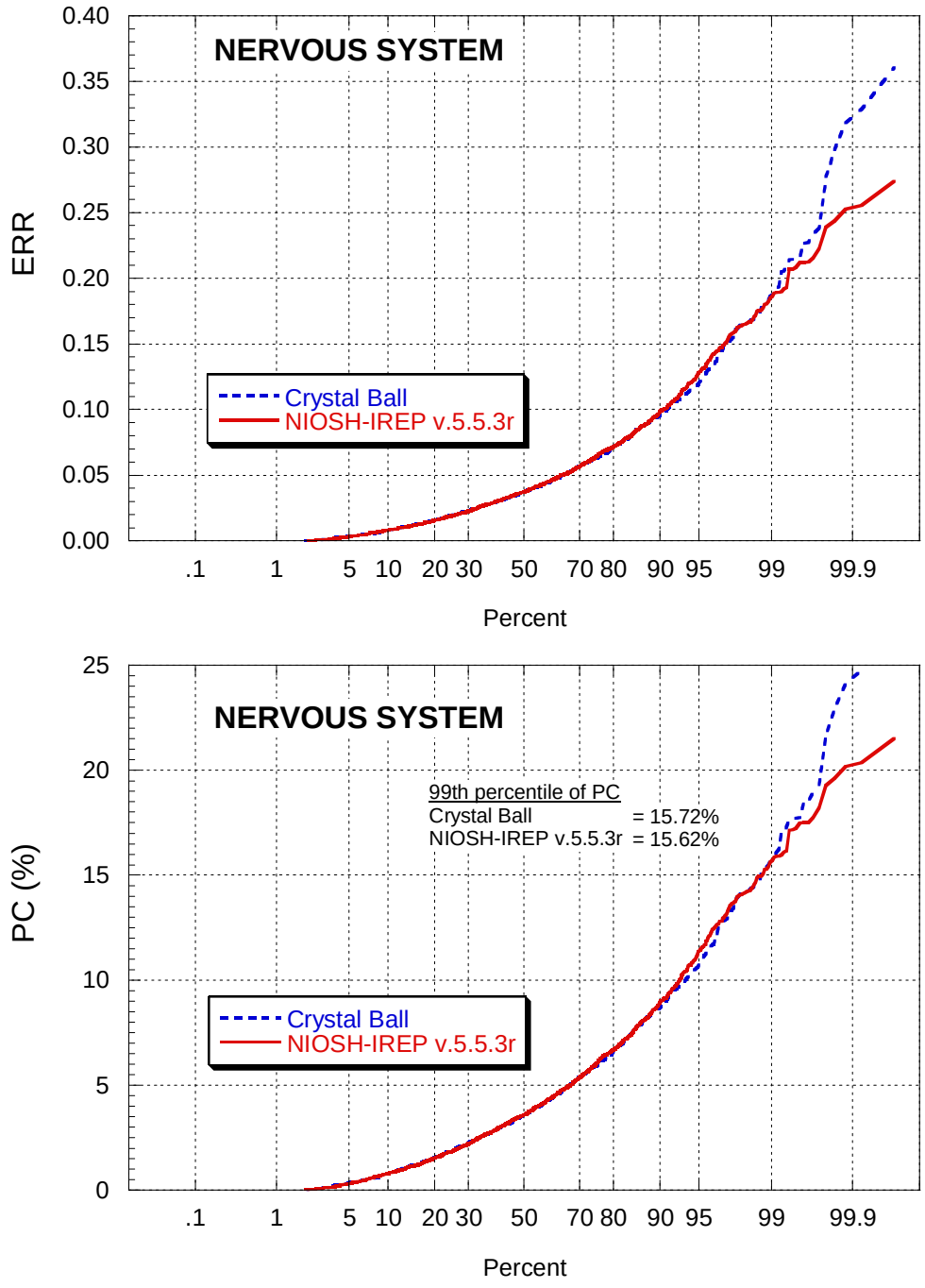

Fig. J-4 Comparison of the probability distribution functions for ERR and PC based on a single run of 2,000 iterations with NIOSH-IREP and MS Excel/Crystal Ball. The scenario represents a male with a nervous system cancer diagnosed at age 60, and who was exposed at age 20 to an acute dose of 20 cSv of high energy photons (E > 250 keV).