

ContamiNATION

**How the US Nuclear Weapons Program Harmed Thousands
of Americans and Why Those Americans Had to Fight for
Decades to Receive Compensation for that Undue Harm**

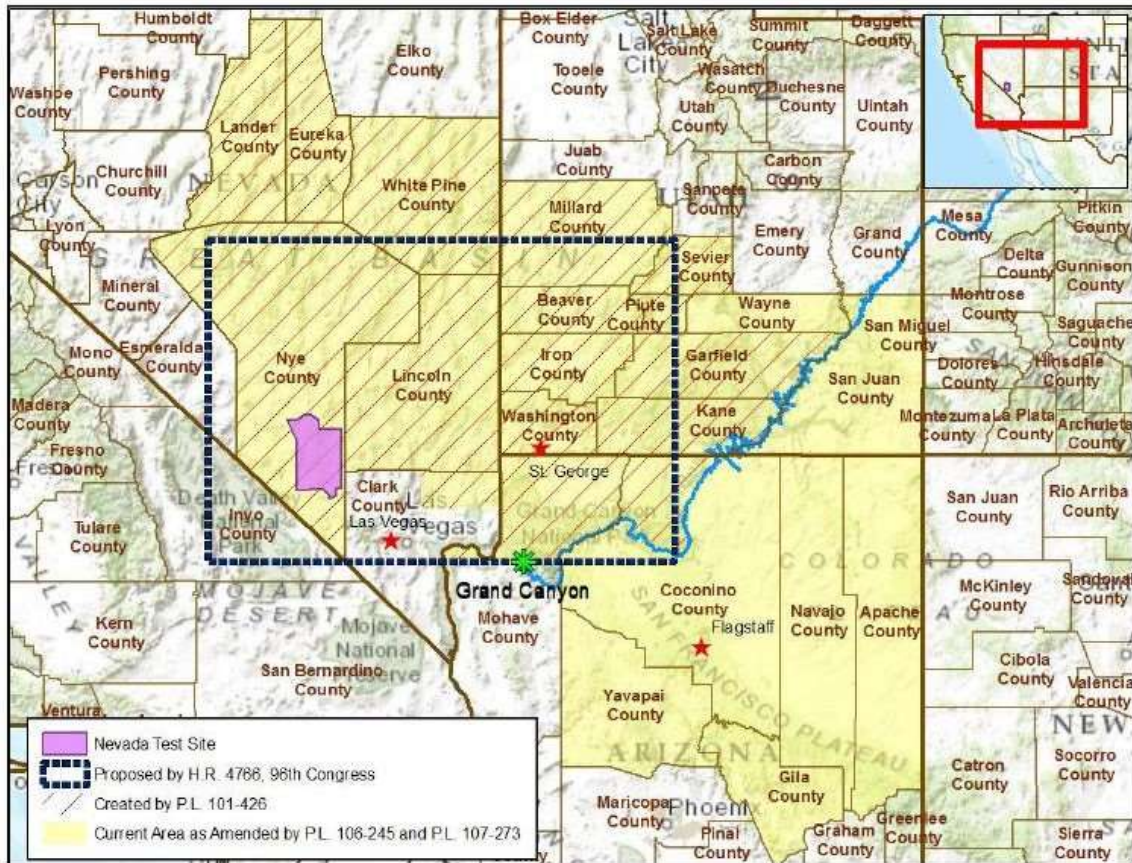
*“The greatest irony of our atmospheric nuclear testing program is that the only
victims of U.S. nuclear arms since World War II have been our own people.”*

**U.S. House of Representatives, Committee on Interstate and Foreign
Commerce, Subcommittee on Oversight and Investigations, August 1980 ⁱ**

**David Lochbaum
March 2024**

In August 1945, the United States detonated atomic bombs over the Japanese cities of Hiroshima and Nagasaki, killing between 129,000 and 226,000 people.ⁱⁱ The United States had exclusive use of this weapon, but only for less than half a decade. On August 29, 1949, the Soviet Union tested their first atomic bomb.ⁱⁱⁱ A nuclear arms race was underway.

The United States conducted 1,054 atomic weapons tests striving to win the arms race. The majority (928) of these tests were conducted at the Nevada Test Site (NTS), a 1,375 square-mile federal reservation located approximately 65 miles north of Las Vegas, Nevada and roughly 1,722 miles west of Chattanooga, Tennessee. Of the 928 tests conducted at NTS, 828 were underground tests and 100 were atmospheric tests in which the atomic weapons exploded at or above ground level.^{iv}



Byproducts of an atomic weapon explosion include radioactive materials; hence the transition from atmospheric tests (e.g., atomic bombs dropped from an aircraft or detonated from a tower) to underground tests in an effort to limit the spread of radioactive materials. The radioactive materials from both aboveground and underground tests were often – to quote Bob Dylan – blowing in the wind. Contamination is “*the process of making something dirty or poisonous, or the state of containing unwanted or dangerous substances.*”^{vi} The nuclear weapons testing released lots of dangerous radioactive materials that contaminated vast regions of the United States – **ContamiNATION**.

For example, the eleven atmospheric nuclear tests conducted between March 17 and June 4, 1953, at the Nevada Test Site, included the Nancy shot on March 24, 1953, and the Harry shot on May 19, 1953. At the time of these two detonations atop 300-foot tall towers, 11,710 sheep grazed in an area 40 miles north to 160 miles east of the site. Of these sheep, 1,420 ewes and 2,970 new lambs (37.5% of the herd) died during the spring and summer of 1953.^{vii}

Concerned about adverse public reaction to the deaths of so many sheep in southern Utah and Nevada, the Atomic Energy Commission (AEC) issued a press release attributing the deaths to “*unprecedented cold weather.*”^{viii} The AEC double-downed on January 6, 1954, by announcing that:

“On the basis of information now available, it is evident that radioactivity from atomic tests was not responsible for deaths and illness among sheep in areas adjacent to the Nevada Proving Grounds last Spring, the U.S. Atomic Energy Commission reported today.”^{ix}

The federal government then classified all evidence to the contrary. Consequently, the sheep ranchers’ attempt to litigate their claim for recovery of their losses was thwarted by these governmental actions.^x

Ranchers sued the AEC in Federal District Court in 1956, claiming that fallout killed their sheep. The government argued, in *Bulloch v. United States*, that other factors, including “*inadequate feeding, unfavorable winter range conditions, and infectious diseases,*” caused the deaths.^{xi}

During the Blanca 22-kiloton underground test on October 30, 1958, radioactivity escaped through the overburden at the edge of Rainier Mesa. The dust cloud containing highly radioactive material and drifted off to the west direction. Two months later, all the pinyon and juniper trees within 1,000 feet of the vent had died.^{xii} Maybe bad weather and disease killed all them trees instead of the AEC.



The underground Blanca nuclear weapons test resulted in the unexpected and unwanted release of highly radioactive materials in an airborne plume that killed a nearby forest.^{xiii}

And these tests were not the only ones that spread radioactive materials far and wide. **ContamiNATION.**

583 nuclear weapons were detonated at the Nevada Test Site (NTS) and other U.S. continental locations between September 15, 1961, and December 12, 1988.¹ Of these tests, 15 events, which were surface or near-surface tests, were not designed to be contained; therefore, radioactive effluents were expected to be released from these events. The other 568 tests were intended to be completely contained underground. Of these tests, 104 events (18.3%) involved containment failures and release of radioactive materials. Radioactive materials were also released from another 191 events (33.6%).^{xiv}

Radioactivity has been known to harm humans, too. The permissible – not safe, but permissible – radiation dose to workers has been steadily reduced over the years.^{xv}

Evolution of Radiation Protection Standards

Time Period	Maximum Permissible Dose (rem/year)
1925-1931	10% of skin erythema dose (SED ~ 600 rad)
1931-1936	50
1936-1948	30
1948-1958	15
1958-1994	External: 5 (actually 1¼ per quarter) 12 (if lifetime < 5(Age-18), 3 per quarter) Internal: 5
1994-Today	5 (total = external + internal)

H-201 - Health Physics Technology - Slide 5 -

The permissible dose to the public also stair-stepped down over the years. The more that is known about the health effects of radiation exposure, the lower the radiation dose that is permissible. This suggests that perfect knowledge might equate to a permissible dose of, at most, zero.

¹ Previously, 828 underground tests were reported. The difference is the time ranges for the tests. Suffice it to conclude that lots of nuclear weapons were tested over many years.

Fallout from nuclear weapons tests includes unstable atoms that emit radiation as a means to attain stability of the nucleus. Sometimes an atom emits radiation and transforms into a different unstable atom which in turn emits radiation – hence the so-called nuclear decay chain. Each emission is a decay event.

The harm from fallout can be direct exposure to the radioactive emissions. In addition, radioactivity can be inhaled or ingested in air or contaminated food and fluids. The hazard does not end when the radioactive cloud floats by. Particles settling onto the ground or falling in raindrops can contaminate water sources and foodstuffs. Different radioactive materials behave differently within the body. Iodine-131 can be absorbed by the thyroid. Strontium-90 can be absorbed into the teeth and bone. Some radioactive materials remain in the body until they are exhaled or excreted; however, some radioactive materials are absorbed into the body and never leave. Jane Smith and John Doe can live next door to one another for three decades and yet have different radiation doses due to differences in age, gender, diet, metabolism, house types (i.e., brick vs. wooden frame), hobbies (i.e., backyard gardening vs. basement video gaming), and many other factors.

Tennessee Senator Howard Baker famously asked during the Watergate hearings “*What did the President know and when did he know it?*” The federal government knew about fallout’s harm fairly early in the nuclear weapons testing program.

Like radioactive materials from underground tests, ample evidence was surfacing that the radioactive materials released in support of the nuclear weapons program harmed more than sheep and trees:

“The Public Health Service’s study of health problems in the uranium mining industry, beginning in 1949, in cooperation with other Federal and State agencies, shows that uranium miners are subject to higher mortality from lung diseases, such as cancer, than the general population. In fact, it is said that the rate is about 10 times higher.” ^{xvi}

“As early as 1953, the government was aware of the potential health hazards posed to humans by the internalization of radionuclides absorbed through the food chain system. Yet, the government failed to take measurements of milk contamination by radioisotopes, upon which to establish internal safety standards, until 1957. Moreover, the government refused to alter the levels subsequently set for internal radiation exposure even after a 1963 scientific report concluded that the government’s original assessment of the hazard was substantially underestimated.” ^{xvii}

A 1956 study by the World Federation of Scientific Workers reported: “*Many geneticists consider that a doubling of the mean natural radiation dose would have very serious consequences. The figures given above would indicate that a rate of testing of about thirty 10-megaton fission-fusion-fission bombs per annum would lead to such a doubling of the natural radiation dose per head throughout the world.*” ^{xviii}

“In 1965, Dr. Edward S. Weiss documented an unusual increase in leukemia deaths in southwestern Utah for the years 1959 through 1960. The Department of HEW investigated additional leukemia “hot spots” in Arizona and Utah for the years 1965 through 1970, but the Department failed to draw any final conclusions on causation. Then, in 1979, Dr. Joseph L. Lyon’s study in the New England Journal of Medicine provided further substantiation of the early Weiss study on the excess leukemia deaths that occurred in Utah for the years 1959 through 1967. Statistics from the Cancer Center in Reno, Nevada also revealed a higher incidence of leukemia deaths than the national average for the years 1959 through 1963.” ^{xix}

“MacMahon confirmed these general findings [as reported in 1971] from a prospective study based on the records of some 700,000 births, and indicated that the ratio of incidence in the

irradiated group to that in the unirradiated groups was approximately 1.4 for leukemia, 1.2 for cancer of the central nervous system and for other childhood malignancies. An increase of approximately 40% in both leukemia and other cancers following prenatal diagnostic examination was consistent, statistically, with the values found by other investigators.”^{xx}

Dr. Joseph L. Lyon, Associate Professor, Department of Family and Preventative Medicine, University of Utah: *“In 1977, a group at the University of Utah, of which I was a member, became interested in the issue because of a newspaper report of higher than expected leukemia death rates in Washington and Iron Counties in Utah between 1950-1969. We devised a study to address this problem. We chose to study childhood leukemia because children were known to be more sensitive to radiation than adults, and leukemia was known to increase shortly after radiation exposure. We included all leukemia deaths ages 0-14 in Utah between 1944-1975. We used this period before and after exposure (1944-1951 and 1959-1975) as a control period and compared this rate to what which occurred in children born during the exposure period of 1952-1958. No information was available on individual exposure to NTS fallout, so we divided the state into high exposure and low exposure areas. Northern Utah was classified as a low exposure area compared to southern Utah. We found the leukemia death rate to be 2.44 times higher for those dying from leukemia in the high exposure area, who were born during the exposure period, compared to those dying in the same area who were born before or after exposure. We further subdivided the high exposure area into those counties closest to the Nevada Test Site and those further away from the NTS. We found the leukemia death rate was 3.4 times higher for those dying in counties closest to the NTS, compared to the same areas before and after testing.”^{xxi}*

While these studies focused on leukemia as an indicator of adverse health consequences from radiation exposure, it is not the only health impact as shown by the following sections. Radiation can and does kill many different ways.

ContamiNATION without Compensation

Compensation is defined as *“Something, typically money, awarded to someone as a recompense for loss, injury, or suffering.”^{xxii}* Since it was known the radioactive materials released from hundreds of atmospheric and underground nuclear weapons tests at the Nevada Test Site could harm workers onsite and members of the public offsite, compensation seems attainable. But compensation proved elusive.

The Nevada Test Site (NTS) was a federal facility and nuclear weapons testing was conducted by the federal government. But federal workers’ compensation programs typically did not cover NTS workers. And due to long latency periods of the adverse health consequences for adults, the uniqueness of the hazards to which they were exposed, and inadequate radiation exposure data, many individuals were also unable to obtain compensation benefits at the state level.^{xxiii}

When compensation programs fall short, surely harmed workers and members of the public could win compensation via lawsuits against the liable party. But lawsuits proved elusive, too.

The Federal Tort Claims Act (FTCA) governs civil lawsuits against the federal government. But under the FTCA, the federal government enjoys sovereign immunity and thus *“the United States cannot be sued without its consent.”^{xxiv}*

Irene Allen et al v. United States of America was a lawsuit filed in the late 1970s on behalf of over 1,100 plaintiffs.^{xxv} Judge Bruce Jenkins heard the case and ruled in favor of nearly half of the individuals in a select group of 24 test cases:

“After careful examination of the factors discussed in detail above in all of the preceding sections, it appears that ten of the twenty-four bellwether cases merit compensation. Eight are wrongful death cases, 2 in Arizona and 6 in Utah. Heirs or survivors seek compensation for themselves for the wrongful deaths of their predecessors.”^{xxvi}

Judge Jenkins found numerous faults in the radiation protection provided for members of the public that factored in his favorable decision:

“Review of the radiation safety plans and reports as well as more recent analyses of NTS monitoring data and the testimony of witnesses at trial, however, discloses an astounding fact: at no time during the period 1951 through 1962 did the off-site radiation safety program make any concerted effort to directly monitor and record internal contamination or dosage in off-site residents on a comprehensive person-specific basis.”^{xxvii}

“No thyroid or whole-body counters were constructed for use in screening members of the community especially children who may have been exposed to more than was permissible even for radiation workers. In fact, in the aftermath of HARRY, the monitors decided not to take a number of milk samples in order to avoid arousing public concern.”^{xxviii}

“Even the efforts actually made to indirectly estimate internal dose risks through monitoring of milk or food stuffs were haphazard at best.”^{xxix}

“While onsite personnel were routinely monitored using instruments, film badges and pocket dosimeters, and continuing individual records were kept, no personal radiation exposure “diaries” were kept for the thousands of people living in neighboring communities.”^{xxx}

“[Two] minutes after fallout arrived in St. George that day, Frank Butrico’s instruments peaked off the scale at 350+ milliroentgens more exposure in an hour’s time than atomic workers were normally permitted in an entire week. The high readings in St. George continued for the hour or more that passed before the key radio announcement was made. By that time the hair, skin and clothing of Frank Butrico had become seriously contaminated with fallout, as undoubtedly had the hair, skin and clothing of a number of residents of the off-site communities. Butrico showered repeatedly and changed clothing. The off-site safety organization, with its almost obsessive concern for safety, (as implied by the film) neglected to advise the residents of those same simple precautions to avoid unnecessary exposure.”^{xxxi}

Table 16 from Judge Jenkins’s decision^{xxxii} listed the 24 bellwether individuals and highlighted several of his points. The third column provided the radiation exposures for the individuals estimated by Dr. John Gofman, the plaintiff’s expert witness. The fourth column provided the radiation exposures estimated for these individuals by the Off-site Radiation Exposure Review Project (ORERP) on behalf of the defense.

Judge Jenkins’s ruling explained why it was necessary to estimate the radiation exposures for these individuals – the testing protocols simply did very little to measure and document external and internal doses to the public from the fallout.

TABLE 16. [*]

PLAINTIFF	RELEVANT	GOFMAN (rads)	ORERP (rads)
	ORGAN		
Donna Berry	Ovaries	36.7	0.25
Willard Bowler	Skin	237.3	310
Delsa Bradshaw	Lung	36.7	0.47
Jeffery Bradshaw	Lymphatic S.	24.6	0.52
Arthur Bruhn	Bone Marrow	18.2	1.8
John Crabtree	Bone Marrow	18.2	0.36
Karlene Hafen	Bone Marrow	8.1	2.2
Glen Hunt	Pancreas	29.4	0.42
Sybil Johnson	Bone Marrow	18.2	0.45
Lenn McKinney	Bone Marrow	18.2	1.7
Sheldon Nisson	Bone Marrow	14.1	2.8
Melvin Orton	Stomach	36.7	0.39
Peggy Orton	Bone Marrow	14.1	0.50
Lisa Pectol	Brain	22.0	0.60
Daisey Prince	Lymphatic S.	36.7	0.44
Norma Pollitt	Breast	36.7	0.38
Jacquelynn Sanders	Thyroid	717.6	31
William Swapp	Kidney	20.0	3.7
LaVier Tait	Bone Marrow	20.2	2.0
Geraldine Thompson	Ovaries	29.4	0.28
Lionell Walker	Prostate	14.7	0.69
Kent Whipple	Thorax	36.7	0.69
Irma Wilson	Bladder	36.7	2.5
Catherine Wood	Colon	36.7	0.43

Table 16 further illuminated the problem facing both sides and the presiding judge in such cases – the lack of measured radiation exposures makes dose reconstruction necessary, and the numerous variables

involved permits a wide range of “answers” depending on what assumptions are made. Dr. Gofman made certain reasonable assumptions en route to his estimates while the ORERP made other reasonable assumptions on the pathway to their estimates.

Having a federal judge rule in one’s favor should result in compensation for the harm. But it didn’t.

The federal government appealed Judge Jenkins’ decision and won on grounds that the federal government cannot be sued unless it agrees to be sued:

“Our decision here adheres to the principle enunciated by the Supreme Court of broad sovereign immunity. An inevitable consequence of that sovereign immunity is that the United States may escape legal responsibility for injuries that would be compensable if caused by a private party.”
xxxiii

The federal government simply did not agree to compensate citizens of the United States harmed or killed by its nuclear weapons program.

The Table 16 data illustrate the challenge in estimating a member of the public’s radiation exposure when measured levels are unavailable. Without measurements, the amount of radioactivity released during a nuclear weapons test must then be evaluated to estimate the doses to members of the public from direct, external radiation, from inhalation of radioactive gases and particles, and from ingestion of radioactive material in food and drink. Making appropriate assumptions about parameters like diets, lifestyles, metabolisms, etc., in order to accurately estimate radiation doses is a daunting task fraught with uncertainties.

Ascribing radiation doses to workers at the Nevada Test Site wearing film badges that measure exposures must be a breeze by comparison. But determining workers’ radiation doses proved elusive, too.

A study into mortality rates among military participants in nuclear weapons testing sought to use the Nuclear Test Personnel Review (NTPR) database containing the radiation doses for each participant. But the radiation doses in most cases were estimated through reconstruction based on duty assignments. In less than half of cases, the assigned dose was based on one or more film badges worn by the participant or on a film badge worn by another participant in the same unit (i.e., cohort badging). The researchers felt that film badge measurements should be (1) individual-specific; (2) recorded by time, duration, and dose; (3) sensitive to different components of exposure (e.g., alpha, beta, or gamma radiation); (4) previously validated for use in similar situations; (5) quantitative and at least theoretically reproducible; (6) complete, in that they cover all exposures for all involved people; and (7) accepted by all interested parties. The researchers concluded that the NTPR dosimetry data was not “*appropriate for the individual-specific assignments necessary for the type of epidemiologic comparisons.*” xxxiv

Making matters worse, the recorded film badge doses might not be the actual dose measured by the film badges. For example, workers’ film badges at the Oak Ridge National Laboratory were read weekly from mid-1944 to mid-1956. If the film badge showed a dose below the permissible weekly exposure limit, the recorded value was typically set to zero. Thus, a worker receiving 90 percent of the permissible exposure each and every week for an entire year might have a recorded dose of 0 rem for that year when his or her actual dose was significantly higher. Furthermore, the policy at Oak Ridge’s Y-12 nuclear facility from 1948 to 1961 was to provide film badges to only those workers considered to be at risk for radiation exposure. xxxv

Further worsening matters, the U.S. General Accounting Office (GAO) investigated the radiation exposures to personnel during the Crossroads nuclear testing at the Bikini Atoll in mid-1946. GAO found the U.S. National Bureau of Standards in the mid-1950s determined that film badge readings were

inaccurate by up to 100 percent.^{xxxvi} Hence, a “measured” radiation dose of 5 rem could represent an actual dose of 10 rem, or an actual dose of 2.5 rem. GAO also found that personnel were assigned doses lower than measured by the film badges on the unsubstantiated belief the badges overestimated external beta radiation. GAO identified cases where the beta exposure may have been underestimated.^{xxxvii}

Worsening matters even further, records of separated nuclear facility workers pertaining to employment data (e.g., department and job titles and assignments, job descriptions, dates of job changes) were destroyed. In some facilities, the only data remaining for certain years of employment are the payroll numbers.^{xxxviii} Reconstructing radiation doses to workers from their payroll numbers cannot be done; at least not accurately. Ouija board any one? Be about as useful.

To be fair (or less unfair) to the federal government, determining liability for cancers, leukemia, and other adverse health consequences would be problematic even if individual radiation exposures were accurately known to five decimal precision (e.g., 10.41925 rem) because such illnesses can be caused by non-radiation causes:

“Nevertheless, if an individual claims that his or her cancer was caused by exposure to some environmental factor, such as ionizing radiation, it is not possible for medical science to confirm or deny that claim.”^{xxxix}

After the federal judges’ decisions awarding compensation to workers and members of the public from harm they experienced from radiation exposures were overturned, bipartisan efforts by the U.S. Congress resulted in the Radiation Exposure Compensation Act (RECA). Senator Orrin Hatch (R-UT) introduced the legislation while Senator Ted Kennedy (D-MA) was among many Senators on both sides of the aisle who co-sponsored the bill. RECA provided the means to compensate workers at the Nuclear Test Site, members of the public downwind of the site, and uranium miners for certain health impairments.

The path taken by Congress to RECA included several hearings conducted both at the U.S. Capitol and in affected locations. The hearings prompted the belated release of a fallout study:

“The scientist who oversaw a 14-year health study of radiation fallout from Cold War bomb tests apologized Wednesday for years of delay in making the findings public. ***“The sense was that nobody was really terribly interested in this,”*** Bruce Wachholz, chief of the radiation effects branch of the National Cancer Institute who coordinated the fallout study, told a Senate hearing. ... The study, which tracked fallout nationwide from 100 aboveground nuclear explosions in the Nevada desert during the early years of the Cold War, was released last October, nearly 15 years after Congress ordered it. Three months earlier, key findings were made public. **The study concluded that exposure to iodine-131 from the bomb test fallout may have caused 11,300 to 212,000 additional cases of cancer.”^{xl} [boldfacing added for emphasis]**

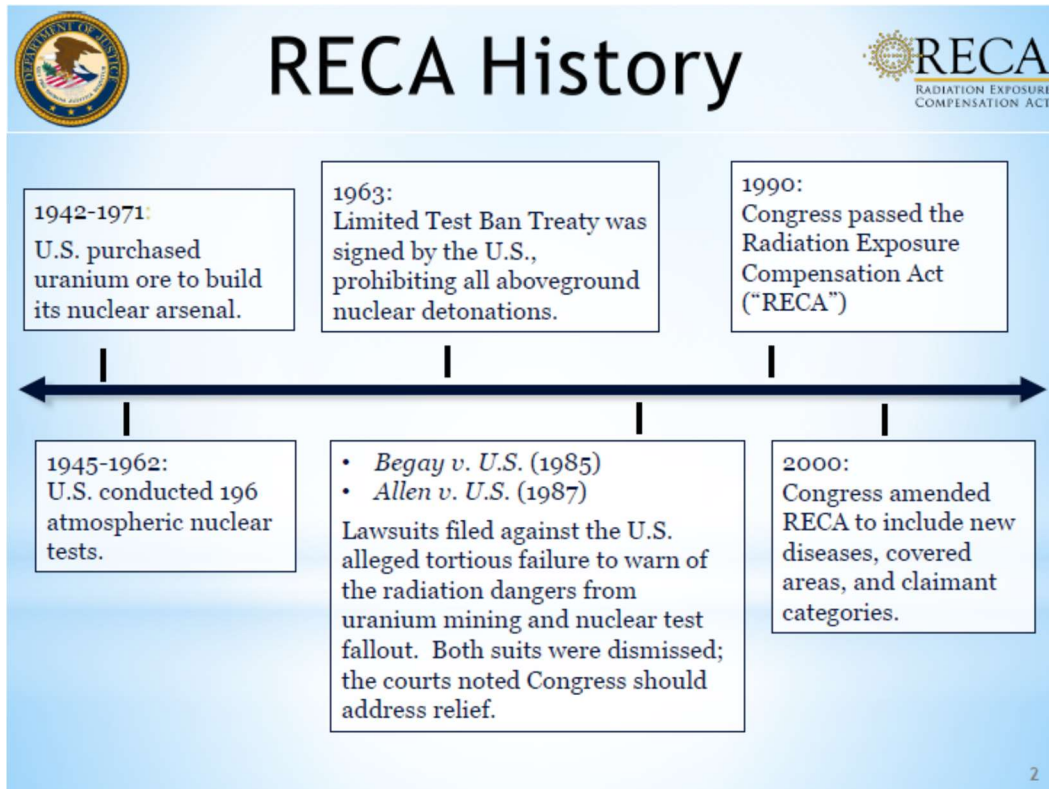
Kudos to Senator Collins for pointing out the utter lameness of this silly excuse.

Sen. Susan Collins, R-Maine, responded: *“The public couldn’t be interested in what the public didn’t know.”^{xli}*

Hard to fathom how any reasonable, responsible person would feel that Americans would not be interested in something perhaps resulting in 11,300 to 212,000 additional cancers.

To put the estimated excess cancers from atomic bomb test fallout in context, radioactivity released during the 1986 accident at Chernobyl was estimated to have caused 8,000 to 28,000 excess cancer deaths in the Soviet Union and western Europe.^{xlii}

The following slides from a presentation by the U.S. Department of Labor explain the who, what, why, where and when of RECA: ^{xliii}

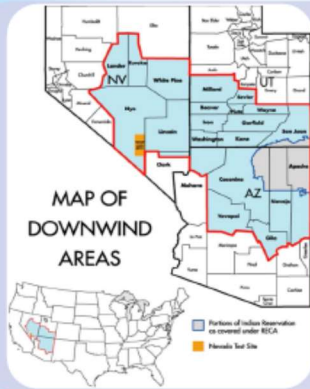


Claimants need not prove the amount of radiation exposure they received or prove that the radiation exposure caused their illnesses. Instead, they only had to prove they were in the danger zone for at least the minimum residence period and contracted a covered cancer to receive compensation.

The next slide describes the three classes of claimants eligible under RECA: downwinders, onsite participants, and uranium mine workers.



Claimants under RECA



Downwinders
 \$50,000 if develop a covered cancer after presence in covered areas downwind from the Nevada Test Site.

Onsite Participants
 \$75,000 if develop a covered cancer after participation in an above-ground nuclear test at designated sites.

Uranium Workers
 \$100,000 if develop a covered illness after working in a covered uranium mine, mill, or ore transport operation.

The next slides show which residents of Nevada, Utah, and Arizona are eligible for compensation under RECA and which diseases were covered.



Downwinders



Individuals who:

- Were physically present at any place within specified counties for at least two years (24 consecutive or cumulative months) during the period from January 21, 1951, to October 31, 1958; or
- Were physically present at any place within specified counties for the entire, continuous period from June 30, 1962, to July 31, 1962;

AND

subsequently contract a covered disease.



Covered Diseases for Downwinders and Onsite Participants



Leukemia (other than chronic lymphocytic leukemia)

Multiple myeloma

Non-Hodgkin's lymphoma

Primary cancers of the:

- thyroid
- male or female breast
- esophagus
- stomach
- pharynx
- small intestine
- pancreas
- bile ducts
- gall bladder
- salivary gland
- urinary bladder
- brain
- colon
- ovary
- liver (except if cirrhosis or hepatitis B is indicated)
- lung.

In addition to amending RECA in 2000, Congress passed Public Law 106-398, the Energy Employees Occupational Illness Compensation Program Act (EEOICPA). The EEOICPA provides compensation for workers and contractors or their survivors at nuclear weapons and defense facilities under certain conditions. ^{xliv}

Table 1: Comparison of EEOICPA Parts B and E Eligibility and Benefits

	Covered employees	Covered survivors	Covered illnesses	Compensation
Part B	<ul style="list-style-type: none"> Energy employees Energy contractor or subcontractor employees Employees of atomic weapons employers Employees of beryllium vendors Uranium miners, millers, and ore transporters awarded under Section 5 of the Radiation Exposure Compensation Act 	<ul style="list-style-type: none"> Next of kin (in order of precedence) -Spouse -Children -Parents -Grandchildren -Grandparents 	<ul style="list-style-type: none"> Cancer related to radiation Chronic beryllium disease^a Chronic silicosis^a Beryllium sensitivity^b 	<ul style="list-style-type: none"> \$150,000 lump sum (\$50,000 if awarded payment under Section 5 of the Radiation Exposure Compensation Act) Plus medical coverage for future medical expenses related to the illness
Part E	<ul style="list-style-type: none"> Energy contractor employees Uranium miners, millers, and ore transporters covered under Section 5 of the Radiation Exposure Compensation Act 	<ul style="list-style-type: none"> Spouse Children -Under 18 at time of death, -Under 23 and enrolled full-time in school, or -Incapable of self-support 	<ul style="list-style-type: none"> Illnesses related to exposure to toxic substances at Energy weapons facilities 	<ul style="list-style-type: none"> Wage loss and impairment up to \$250,000 Plus medical coverage for covered illnesses

Source: GAO analysis of the EEOICPA statute.

Similar to RECA, the EEOICPA was reactive to studies showing that these nuclear workers had an elevated risk of incurring certain health problems. Some studies indicated that 98 percent of radiation-

induced cancers of workers within the nuclear weapons complex occurred at radiation doses below existing permissible levels. ^{xlv} That statistic may not be as unsettling as it seems. As discussed above, recording-keeping of worker’s radiation doses was slipshod at best. Therefore, the true radiation dose levels to these victims could easily have been considerably higher than the scant, miniscule levels in the “official” records, many reconstructed and fabricated and conjured up.

The compensation programs did nothing to mandate improved radiation exposure records for ongoing employees, or to lower the permissible levels in light of the record-keeping deficiencies.

The probability of causation (PC) is a key factor in determining whether radiation exposure to an EEOICPA claimant warrants compensation:

$$PC = \frac{RadRisk}{RadRisk + BasRisk} \times 100\%$$

PC is the quantitative probability of causation, *RadRisk* is the risk that the cancer was caused by the radiation dose, and *BasRisk* is the risk of this cancer in the total population. ^{xlvi}

Even if he was alive, Thomas Jefferson would not call these cancer risk terms self-evident. The compensation data below demonstrates that the difficulties were nevertheless overcome.

Through January 15, 2024, RECA paid out over \$2.6 billion in compensation for more than 41,000 claims with nearly half of the compensation awarded to downwinders. Nearly 75 percent of the claims have been awarded: ^{xlvii}

Radiation Exposure Compensation System						
Claims to Date Summary of Claims Received by 01/15/2024 All Claims						
Claim Type Desc.	Pending	Approved	% Approved/of Disposed	\$ Approved	Denied	Total
Downwinder	124	26,433	84.1	\$1,321,620,000	5,003	31,560
Onsite Participant	40	5,562	58.9	\$406,586,952	3,875	9,477
Uranium Miner	35	6,959	62.6	\$695,174,560	4,162	11,156
Uranium Miller	6	1,945	74.4	\$194,500,000	671	2,622
Ore Transporter	4	416	71.0	\$41,600,000	170	590
Total:	209	41,315	74.9	\$2,659,481,512	13,881	55,405

Through January 7, 2024, EEOICPA paid out nearly \$25 billion in compensation and medical bills for claims by 141,006 individuals: ^{xlvi}

Data as of 01/07/2024 Statistical data updated weekly on Mondays		
Combined Part B and E Summary		
	CLAIMS	CASES
Applications Filed	349,741	236,197 *
Total Compensation Paid - Payments	143,850	107,604
Total Compensation Dollars Paid		\$14,572,470,871
Total Medical Bills Paid - Total Dollars		<u>\$10,400,795,934</u>
Total Compensation + Medical Bills Paid		\$24,973,266,805

* The above numbers of applications filed represent **141,006** unique individual workers.

CURIEosities

RECA compensated downwinders who developed a covered illness \$50,000, compensated Nevada Test Site participants who developed a covered cancer \$75,000, and compensated uranium workers who developed a covered illness \$100,000. ^{xlix} Since our Declaration of Independence stated that “... *all men are created equal*,”¹ unequal compensation provided for equal harm is **CURIEous**.

Utah Congressmen Wayne Owens explained during a hearing leading to the RECA legislation that higher compensation for uranium workers was warranted because the Public Health Service had warned the government by 1950 that “*unless those mines were properly ventilated at least three-fourths of those men would die from lung cancers. And the government allowed that abuse to happen knowingly.*”^{li}

The federal government knew in April 1953 from a research study it commissioned the Rand Corporation to conduct that each nuclear weapon detonation released 1 gram of Strontium-90 per kiloton of bomb yield,² that Strontium-90 had a long half-life, that the ingestion rate of Strontium-90 by the body is high, that Strontium-90 is a bone-seeker, and that Strontium-90 “*is the principal long-range, possibly worldwide, contaminant*” of nuclear weapons.^{lii}

That April 1953 study further reported that “*Young and growing tissue is most susceptible to radiation damage; bone formation in an individual is complete by the time he is 20 years of age... In our model, therefore, we have taken as the individual most at risk the one who accumulates Sr⁹⁰ from the age of 0 to 20 years.*”^{liii}

The federal government knew that thousands of sheep and an entire forest of trees died after being exposed to radioactive fallout, including plenty of Strontium-90, from nuclear weapons testing. That the federal government pretended not to know that Americans also downwind of the test site might also be harmed — and thus deserved equal compensation — is **CURIEous**.

RECA compensated downwinders in designated areas who were present for at least 24 months between January 21, 1951, and October 31, 1958, or were continuously present between June 30, 1962, and July 31, 1962.^{liv} Eight nuclear weapons tests were conducted between June 30, 1962, and July 31, 1962. Three tests involved underground detonations, two tests involved crater detonations, two tests had surface detonations, and one test featured a tower detonation. The total radioactive released from these tests was 15,023,760 curies. Radiation levels of 324 millirem/hour were measured at Diablo, Nevada and 1,960 millirem per hour at Queen City Summit, Nevada during the SEDAN test on July 6, 1962, which was a detonation for Project PLOWSHARE.^{lv}

² For context, the yield of the bomb that devastated Hiroshima was approximately 15 kilotons, with subsequent weapons having significantly larger yields.

EVENT:	SEDAN		
DATE:	07/06/62	SPONSOR:	LRL
LOCATION:	NTS U10h	PURPOSE:	PLOWSHARE
TYPE:	CRATER	YIELD RANGE:	104 KT
RELEASE DETECTED:	OFFSITE	TYPE OF RELEASE:	EVENT
EVENT RELEASE AT R+12 HOURS, IN CURIES: 1.5×10^7			
ISOTOPES IDENTIFIED IN THE RELEASE: I-131, I-132, Te-132, W-187, Na-24, W-181, W-188, Be-7, Mn-56, Ba-La-140, and tracers			
CLOUD DIRECTION: Northeasterly			
MAXIMUM ACTIVITY DETECTED IN AIR OFFSITE: 13,000 picocuries of gross beta activity per cubic meter of air at Diablo, Nevada			
MAXIMUM GAMMA EXPOSURE RATE DETECTED OFFSITE: 324 mR/h at Diablo, Nevada and 1,960 mR/h near Queen City Summit, Nevada (an unpopulated area)			

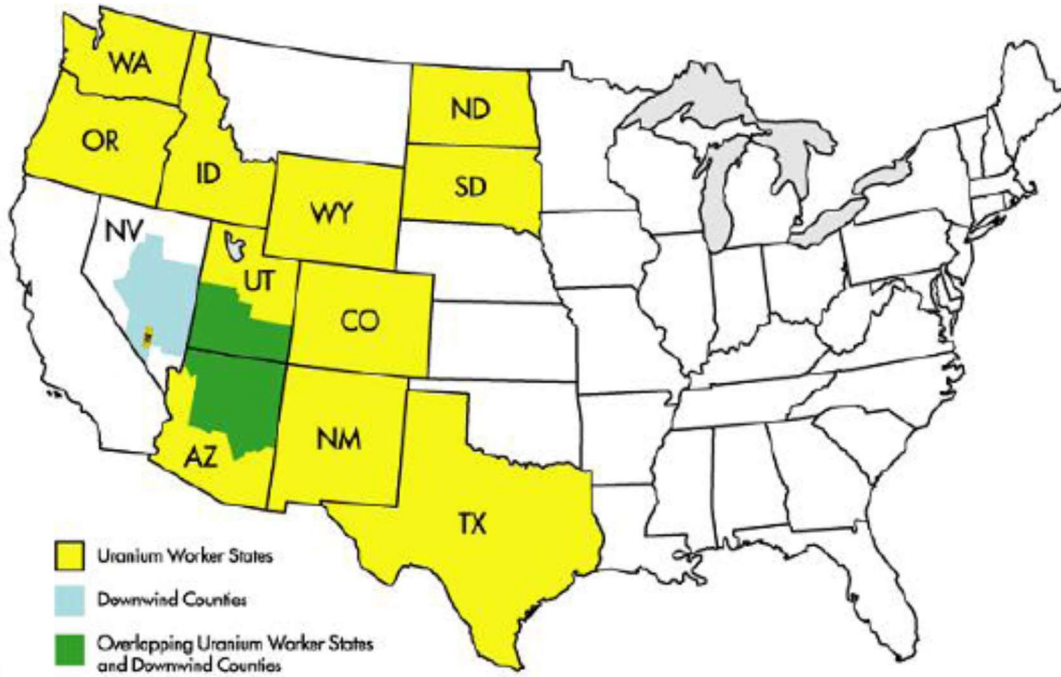
lvi

On March 5, 1962, the DANNY BOY test released 14,000,000,000 curies,^{lvii} or about 930 times the radioactivity released during the eight tests in RECA's second compensation window. But persons residing in the designated area continuously at the time of DANNY BOY and for 120 days afterwards but leaving the area on July 3, 1962, to attend the Fourth of July festivities in the nation's capitol would not be eligible for any compensation. **CURIEous.**

Likewise, nuclear weapons tests during 1965 released 11,152,062 curies. While that year's radioactivity release was "only" about 75% of the radioactivity released in the June/July 1962 period, harm caused by those later releases was literally compensation-free. **CURIEous.**

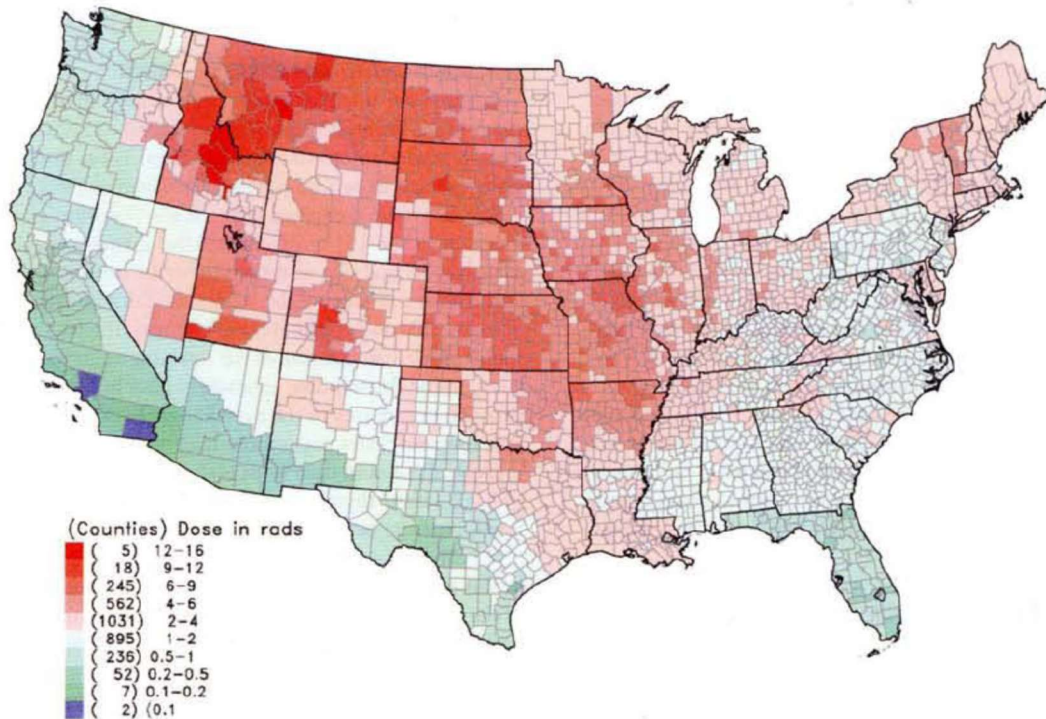
RECA provided compensation for uranium miners in eleven western states, workers at the testing site in Nevada, and downwinders in three western states (twelve western states in all):^{lviii}

RECA COVERED AREAS



The radioactive fallout from the nuclear weapons testing, however, did not confine itself to these twelve states: ^{lix}

Figure ES.1. Per capita thyroid doses resulting from all exposure routes from all tests



The radiation dose from fallout is significantly higher in many counties in Montana, Nebraska, Kansas, Missouri, Arkansas and Vermont than in Arizona’s counties. Yet individuals incurring covered illnesses in these select Arizona counties may be eligible for compensation while the public in the more heavily contaminated states are not eligible under any circumstances. **CURIEous.**

The average family size in 1955 was 3.59 persons slightly increasing to 3.67 persons in 1962. ^{lx} Consider an average family living in a designated area downwind of the Nevada Test Site in 1955. One spouse works at the Nevada Test Site. The other spouse and their child and a half live nearby. Suppose that all members of the family develop a disease covered by RECA. The working spouse would receive \$75,000. The non-working spouse would receive \$50,000. Their first child would also receive \$50,000 while the other child would receive \$29,500 (i.e., 59% of \$50,000). **CURIEous.**

Consider another family living in Utah in 1955. One spouse works as a uranium miner. The other spouse manages their household. Both develop a covered disease. The working spouse would receive \$100,000 while the non-working spouse would only get \$50,000. Talk about something non-working. **CURIEous.**

But consistency is vastly over-rated. Consistency incurs a risk of being wrong all the time. Inconsistency increases the chances of being right at least some of the time, even when no has zero clue about what time is the right time.

DecontamiNATION?

Lots of nuclear weapons testing at the Nevada Test Site released lots of radioactive materials that have harmed lots of people in lots of places – **ContamiNATION.**

RECA sought to compensate individuals harmed by the nuclear weapons program. RECA, at best, compensated some of the individuals in designated contaminated places for their pain and suffering. All of the individuals in non-designated contaminated places received nothing for comparable pain and suffering.

Compensation discriminated helping some people in some places. **ContamiNATION** did not discriminate harming people in many more places.

For example, here are the radioactivity releases to the environment estimated from various atomic bomb tests at the Nevada Test Site: ^{lxi}

Test Shot	Date	Bomb Size ³	Radioactivity Released
Aardvark	05/12/1962	40 kilotons	10 curies
Haymaker	06/27/1962	67 kilotons	150 curies
Marshmallow	06/28/1962	<20 kilotons	35,000 curies
Sedan	07/06/1962	104 kilotons	15,000,000 curies
Mississippi	10/05/1962	115 kilotons	4,900 curies
Stones	05/22/1963	20 to 200 kilotons	5,800 curies
Bilby	09/13/1963	249 kilotons	1 curie
Clearwater	10/16/1963	20 to 200 kilotons	4,600 curies
Greys	11/22/1963	20 to 200 kilotons	<460 curies
Fore	01/16/1964	20 to 200 kilotons	1,200 curies

³ The atomic bomb dropped on Hiroshima had a yield of approximately 15 kilotons.

U.S. nuclear power plants have released lots and lots of radioactivity for years and years. For example: ^{lxii}

Plant	Noble Gas Releases 1974	Noble Gas Releases 1975	Noble Gas Releases 1976
Big Rock Point	188,000 curies	50,600 curies	15,200 curies
Browns Ferry	64,000 curies	92,400 curies	80,500 curies
Dresden	98,000 curies	520,000 curies	452,000 curies
Millstone	912,000 curies	2,970,000 curies	507,000 curies
Monticello	1,480,000 curies	155,000 curies	11,400 curies
Nine Mile Point	558,000 curies	1,300,000 curies	176,000 curies
Oyster Creek	279,000 curies	206,000 curies	167,000 curies
Pilgrim	546,000 curies	46,000 curies	183,000 curies

U.S. nuclear power plants routinely release as much if not more radioactivity to the environment than was released from atomic bomb tests at the Nevada Test Site. Workers at NTS and downwinders received compensation. Workers and downwinders from nuclear power plants received nothing, except perhaps harm, or death, from radiation exposure. **CURIEous**.

Consider the sad case of Gary Michael Whiting, who died on December 2, 1983, from acute lymphocytic leukemia. Mr. Whiting worked at the Pilgrim nuclear plant in Massachusetts between August 7, 1977 and May 5, 1980, and received a measured radiation exposure during that period of 6.249 rem, below federal exposure limits. The administratrix of Mr. Whiting's estate filed a lawsuit against Pilgrim's owner seeking compensation for his death due to alleged radiation exposure. While irrefutable that Mr. Whiting worked in a nuclear power plant, received radiation exposure, and died from an illness sometimes caused by radiation, the United States District Court ruled against the plaintiffs on grounds that it failed to prove that his acute lymphocytic leukemia was caused only by exposure to radiation received at Pilgrim and not from any other possible cause. ^{lxiii}

Had Mr. Whiting worked at a nuclear weapons facility at the right time and received the same radiation exposure, his survivors might have been awarded compensation for his death from a covered illness. But because he did not, they did not.

Fairness dictates an overdue need for CSI Nuclear – **ContamiNATION** Scene Investigation Nuclear.

Popular television shows like CSI Las Vegas, CSI Miami, CSI New York, and CSI New Orleans did not identify crime victims and their perpetrators based on who lived where when. Instead, they used forensics (i.e., fingerprints, stomach contents analysis, DNA testing, fiber analysis, etc.) to figure out who did what to whom.

CSI Nuclear would invest in the forensic technologies needed to:

- determine the actual, not guesstimated or conjectured, radiation doses of individuals,
- establish how radiation doses, even at low levels, affect the human body, and
- distinguish between harm caused by radiation and harm caused by other factors.

Knowing so little, almost nothing, with certainty about these areas that have harmed tens of thousands of Americans more than seven decades after Hiroshima and Nagasaki is **CURIEous**:

“In 2015, DOE directed its Biological and Environmental Research Advisory Committee to provide advice on defining a research program that could lead to conclusive results on whether low-dose radiation causes cancer in humans. In 2016, the committee issued a report stating that further research on the cancer risk from low-dose radiation could decrease uncertainty in cancer risk estimates. For example, according to the report, new tools for conducting biological research could advance the understanding of connections between radiation exposure, DNA damage, tissue responses, and cancer development.”^{lxiv}

“...we have no reasonable method to explain the complexity of the mechanism of radiation-induced cancer and the probability of injury to an individual exposed in the past to ionizing radiation...”^{lxv}

“What is currently lacking is a systematic approach to quantifying the nature and extent of these uncertainties, such as sites of cancer and cell types, source tables of cancer incidence, latent period, radiation dose and dose-rate effects, dose-response models, sampling errors in epidemiologic data, radiation risk coefficients, influence of age and sex, time-response models, other cancer risk factors and interaction effects, transfer of risk coefficients from one population to another, etc. and their influence on the reliability of the computation of PC estimates.”^{lxvi}

“Calculation of internal radiation exposure from these various sources is a complicated process that is fraught with tremendous uncertainty. Overlooking a single pathway can easily render analysis of internal exposure largely ineffective.”^{lxvii}

“Dose calculations for both licensing and compliance are based on computer models that have been and continue to be the subject of study. The most obvious shortcoming is the continued reliance on the internal dose models of 1959, but a change to more recent models (ICRP, 1969) would not materially change the results. The meteorology model may entail the greatest uncertainty. Unfortunately, means for improving confidence have not been readily available. The liquid pathway dose calculations also are uncertain but again opportunities for improvement are limited.”^{lxviii}

“The model of the gastrointestinal (GI) tract used in this study is essentially the GI tract model of the ICRP, which was developed for a reference adult. It appears that variation with age in transit times through the GI tract, although not well characterized at this time, may be within the limits of uncertainty of the parameter values in the ICRP model for adults, except possibly for a portion of the large intestine.”^{lxix}

The title page of this report contains the following quote from a U.S. House of Representatives report titled “The Forgotten Guinea Pigs”:^{lxx}

“The greatest irony of our atmospheric nuclear testing program is that the only victims of U.S. nuclear arms since World War II have been our own people.”

Contemplate the history of American victims from attacks by our enemies:

- The December 7, 1941, attack on Pearl Harbor by Japanese forces killed 2,403 persons and injured 1,178 others for a total of 3,581 victims.^{lxxi} A mere fraction of the Americans injured or killed by the atomic bomb testing at the Nevada Test Site.

- The September 11, 2001, attacks on New York City and Washington, DC killed 2,977 persons and injured 6,000 to 25,000 others for a total of 8,977 to 27,977 victims.^{lxxii} A mere fraction of the Americans injured or killed by the atomic bomb testing at the Nevada Test Site.

Taking the high end of the casualty estimates, 31,558 victims from the Pearl Harbor and September 11th attacks combined is but 17.3 percent of the 182,321 RECA and EEOICPA victims to date. Even tossing in some home-grown casualties doesn't approach the nuclear arms testing program casualty numbers:

- The April 15, 2013, bombing during the Boston Marathon killed 3 persons and injured 264 others for a total of 267 victims.^{lxxiii}
- The April 19, 1995, Oklahoma City bombing killed 168 persons and injured 680 others for a total of 848 victims.^{lxxiv}
- The September 8, 1900, hurricane that blew through Galveston, Texas killed an estimated 6,000 to 12,000 persons, with 8,000 fatalities being cited most often in official reports.^{lxxv}
- The May 31, 1889, failure of the South Fork Dam upriver of Johnstown, Pennsylvania killed 2,208 person.^{lxxvi}
- The April 27, 1865, explosion of the steamboat *Sultana* in the Mississippi River about 11 miles north of Memphis, Tennessee, killed an estimated 1,547 persons of the 2,148 persons aboard.^{lxxvii}

So, radioactive materials released by nuclear weapons testing resulted in far more victims than from numerous other external, internal, and natural causes.

Winston Churchill said: “*You can always count on Americans to do the right thing — after they’ve tried everything else.*”^{lxxviii} If nothing else, Americans have tried many things over many years. Maybe, just maybe, Americans are close to finally doing the right thing for ALL individuals harmed by radioactive material releases and not just some victims in some places.

The right thing would determine whether individuals were harmed by fallout that came down in Montana, Nebraska, Kansas, Missouri, Arkansas, Vermont and other states/counties not within RECA’s umbrella and warrant compensation.

The right thing would also permit informed decisions about whether routine releases of radioactivity to the air and water from dozens of nuclear power reactors across the country are, or are not, harming individuals. And with nuclear power reactors operating in Nebraska, Kansas, Missouri and Arkansas releasing radioactive materials to supplement the radioactive materials delivered by fallout, the right thing would determine whether the synergistic effect of the **contamiNATION** has adverse health implications.

If ignorance is bliss, a bliss reduction program for the health effects of radioactive materials released to the environment from all sources, not just a handful of them, is long overdue.

Cited Sources:

- ⁱ Subcommittee on Oversight and Investigations, Committee on Interstate and Foreign Commerce, U.S. House of Representatives, “The Forgotten Guinea Pigs – A Report on Health Effects of Low-Level Radiation Sustained as a Result of the Nuclear Weapons Testing Program Conducted by the United States Government,” August 1980, page 37.
- ⁱⁱ https://en.m.wikipedia.org/wiki/Atomic_bombings_of_Hiroshima_and_Nagasaki
- ⁱⁱⁱ https://en.wikipedia.org/wiki/Soviet_atomic_bomb_project
- ^{iv} Scott D. Szymendera, Analyst in Disability Policy, Congressional Research Service, Testimony before the Committee on the Judiciary, Subcommittee on the Constitution, Civil Rights, and Civil Liberties, U.S. House of Representatives in a Hearing on “Examining the Need to Expand Eligibility Under the Radiation Exposure Compensation Act,” March 24, 2021, pages 1-2.
- ^v Congressional Research Service, “The Radiation Exposure Compensation Act (RECA): Compensation Related to Exposure to Radiation from Atomic Weapons Testing and Uranium Mining,” June 14, 2022, Figure A-1.
- ^{vi} <https://dictionary.cambridge.org/us/dictionary/english/contamination#>
- ^{vii} Subcommittee on Oversight and Investigations, Committee on Interstate and Foreign Commerce, U.S. House of Representatives, “The Forgotten Guinea Pigs – A Report on Health Effects of Low-Level Radiation Sustained as a Result of the Nuclear Weapons Testing Program Conducted by the United States Government,” August 1980, page 3.
- ^{viii} Howard Ball, *The New York Times Magazine*, “Downwind from the Bomb,” February 9, 1986.
- ^{ix} Subcommittee on Oversight and Investigations, Committee on Interstate and Foreign Commerce, U.S. House of Representatives, “The Forgotten Guinea Pigs – A Report on Health Effects of Low-Level Radiation Sustained as a Result of the Nuclear Weapons Testing Program Conducted by the United States Government,” August 1980, page 4.
- ^x Subcommittee on Oversight and Investigations, Committee on Interstate and Foreign Commerce, U.S. House of Representatives, “The Forgotten Guinea Pigs – A Report on Health Effects of Low-Level Radiation Sustained as a Result of the Nuclear Weapons Testing Program Conducted by the United States Government,” August 1980, page 8.
- ^{xi} Howard Ball, *The New York Times Magazine*, “Downwind from the Bomb,” February 9, 1986.
- ^{xii} Peter W. Merlin, “Images of America: NEVADA TEST SITE,” Arcadia Publishing, Charleston, South Carolina, 2016, page 193. (ISBN 978-1-4671-1744-9)
- ^{xiii} Peter W. Merlin, “Images of America: NEVADA TEST SITE,” Arcadia Publishing, Charleston, South Carolina, 2016, page 193. (ISBN 978-1-4671-1744-9)
- ^{xiv} Nevada Operations Office, U.S. Department of Energy, “Radiological Effluents Released from Announced U.S. Continental Tests 1961 Through 1988,” DOE/NV-317, UC-702, May 1990, page 1.
- ^{xv} U.S. Nuclear Regulatory Commission, “H-201 – Health Physics Technology, Chapter 2, Radiation Protection Philosophy,” 2011. (ADAMS ML11262A155)
- ^{xvi} U.S. Congress, “Hearings before the Select Subcommittee on Labor of the Committee on Education and Labor House of Representatives, Ninetieth Congress Second Session on H.R. 14558 and H.R. 16302,” 1968, page 11.
- ^{xvii} Subcommittee on Oversight and Investigations, Committee on Interstate and Foreign Commerce, U.S. House of Representatives, “The Forgotten Guinea Pigs – A Report on Health Effects of Low-Level Radiation Sustained as a Result of the Nuclear Weapons Testing Program Conducted by the United States Government,” August 1980, page 17.
- ^{xviii} World Federal of Scientific Workers, “Unmeasured Hazards: An Analysis of the Effects of Tests of Atomic and Thermonuclear Weapons,” London, 1956, page 16.
- ^{xix} Subcommittee on Oversight and Investigations, Committee on Interstate and Foreign Commerce, U.S. House of Representatives, “The Forgotten Guinea Pigs – A Report on Health Effects of Low-Level Radiation Sustained as a Result of the Nuclear Weapons Testing Program Conducted by the United States Government,” August 1980, page 14.
- ^{xx} Jacob I. Fabrikant, Professor and Head, Department of Radiology, University of Connecticut School of Medicine, “Biological Effects of Small Doses of Radiation,” July 1971, pages 23-24.
- ^{xxi} U.S. Senate, “Hearing before the Committee on Labor and Human Resources United States Senate One Hundred First Congress First Congress Second Session on Examining the Health Effects of Radiation Exposure Caused by Open Air Atomic Testing and Uranium Mining,” February 8, 1990, pages 20-21.
- ^{xxii} <https://www.google.com/search?q=compensation%20definition&tbm=&source=sh/x/g/m2/5>

-
- ^{xxiii} William J. Clinton, President, United States of America, “Providing Compensation to America’s Nuclear Weapons Workers,” Executive Order 13179, *Federal Register*, Vol. 65, No. 238, pp. 77487-77490, December 11, 2000.
- ^{xxiv} Scott D. Szymendera, Analyst in Disability Policy, Congressional Research Service, Testimony before the Committee on the Judiciary, Subcommittee on the Constitution, Civil Rights, and Civil Liberties, U.S. House of Representatives in a Hearing on “Examining the Need to Expand Eligibility Under the Radiation Exposure Compensation Act,” March 24, 2021, page 4.
- ^{xxv} <https://www.intermountainhistories.org/items/show/165> accessed January 16, 2024.
- ^{xxvi} U.S. District Court for the District of Utah, “Irene Allen et al v. United States of America,” Civ. No. C-79-0515J, 588 F. Supp. 247, May 10, 1984.
- ^{xxvii} U.S. District Court for the District of Utah, “Irene Allen et al v. United States of America,” Civ. No. C-79-0515J, 588 F. Supp. 247, May 10, 1984.
- ^{xxviii} U.S. District Court for the District of Utah, “Irene Allen et al v. United States of America,” Civ. No. C-79-0515J, 588 F. Supp. 247, May 10, 1984.
- ^{xxix} U.S. District Court for the District of Utah, “Irene Allen et al v. United States of America,” Civ. No. C-79-0515J, 588 F. Supp. 247, May 10, 1984.
- ^{xxx} U.S. District Court for the District of Utah, “Irene Allen et al v. United States of America,” Civ. No. C-79-0515J, 588 F. Supp. 247, May 10, 1984.
- ^{xxxi} U.S. District Court for the District of Utah, “Irene Allen et al v. United States of America,” Civ. No. C-79-0515J, 588 F. Supp. 247, May 10, 1984.
- ^{xxxii} U.S. District Court for the District of Utah, “Irene Allen et al v. United States of America,” Civ. No. C-79-0515J, 588 F. Supp. 247, May 10, 1984.
- ^{xxxiii} United States Court of Appeals for the Tenth Circuit, “Allen v. United States, 816 F.2d 1417,” No. 84-2126, April 20, 1987.
- ^{xxxiv} Institute of Medicine, 2000, *The Five Series Study: Mortality of Military Participants in U.S. Nuclear Weapons Tests*, Washington, DC: The National Academies Press. <https://doi.org/10.17226/9697>, page 37.
- ^{xxxv} J. P. Watkins, J. L. Reagan, D. L. Cragle, E. L. Frome, C. M. West, D. J. Crawford-Brown, and W. G. Tankerley, Oak Ridge Institute for Science and Education, “Data Collection, Validation, and Description for the Oak Ridge Nuclear Facilities Mortality Study,” 1985, page 3.
- ^{xxxvi} United States General Accounting Office, “OPERATION CROSSROADS: Personnel Radiation Exposure Estimates Should Be Improved,” GAO/RCED-86-15, November 1985, page 3.
- ^{xxxvii} United States General Accounting Office, “OPERATION CROSSROADS: Personnel Radiation Exposure Estimates Should Be Improved,” GAO/RCED-86-15, November 1985, page 3.
- ^{xxxviii} Thomas F. Mancuso, Barkey S. Sanders, and Allen Brodsky, Department of Occupational Health, Graduate School of Public Health, University of Pittsburgh, “Feasibility Study of the Correlation of Lifetime Health and Mortality Experience of AEC and AEC Contractor Employees with Occupational Radiation Exposure,” April 1965, page 5-1.
- ^{xxxix} Jacob I. Frabrikant, Department of Radiology, Department of Biophysics and Medical Physics, University of California, “Probability of Causation: Implications for Radiological Protection and Dose Limitation,” May 1987, page 2.
- ^{xl} Press-Republican, “Scientist apologizes for delay in fallout study,” September 17, 1989, page 2.
- ^{xli} Press-Republican, “Scientist apologizes for delay in fallout study,” September 17, 1989, page 2.
- ^{xlii} U.S. Senate, “Hearing before the Committee on Labor and Human Resources United States Senate One Hundred First Congress First Congress Second Session on Examining the Health Effects of Radiation Exposure Caused by Open Air Atomic Testing and Uranium Mining,” February 8, 1990, page 3.
- ^{xliii} Jason C. Bougere, Senior Trial Attorney, Torts Branch, Civil Division, U.S. Department of Labor, “The Radiation Exposure Compensation Program: A Doorway to the EEOICP,” EEOICP Webinar, December 9, 2020.
- ^{xliv} U.S. Government Accountability Office, “ENERGY EMPLOYEES COMPENSATION: Additional Independent Oversight and Transparency Would Improve Program’s Credibility,” GAO-10-302, March 2010, Table 1.
- ^{xlv} Title 42 – The Public Health and Welfare, Chapter 84 – Department of Energy, Subchapter XVI – Energy Employees Occupational Illness Compensation Program, Part A – Establishment of Compensation Program and Compensation Fund §7384 (a)(6).
- ^{xlvi} Congressional Research Service, “The Energy Employees Occupational Illness Compensation Program Act (EEOICPA),” February 10, 2022.
- ^{xlvii} U.S. Department of Labor website accessed January 16, 2024.

-
- ^{xlvi} U.S. Department of Labor, Office of Workers' Compensation Programs webpage, accessed January 7, 2024. Online at <https://www.dol.gov/owcp/energy/regs/compliance/weeklstats.htm>
- ^{xlvi} Jason C. Bougere, Senior Trial Attorney, Torts Branch, Civil Division, U.S. Department of Labor, "The Radiation Exposure Compensation Program: A Doorway to the EEOICP," EEOICP Webinar, December 9, 2020.
- ^l U.S. National Archives website <https://www.archives.gov/founding-docs/declaration#:~:text=We%20hold%20these%20truths%20to,and%20the%20pursuit%20of%20Happiness.> accessed January 20, 2024.
- ^{li} U.S. Senate, "Hearing before the Committee on Labor and Human Resources United States Senate One Hundred First Congress First Congress Second Session on Examining the Health Effects of Radiation Exposure Caused by Open Air Atomic Testing and Uranium Mining," February 8, 1990, page 5.
- ^{lii} Rand Corporation, "Worldwide Effects of Atomic Weapons – Project Sunshine," R-251-AEC, August 6, 1953.
- ^{liii} Rand Corporation, "Worldwide Effects of Atomic Weapons – Project Sunshine," R-251-AEC, August 6, 1953, page 4.
- ^{liv} Jason C. Bougere, Senior Trial Attorney, Torts Branch, Civil Division, U.S. Department of Labor, "The Radiation Exposure Compensation Program: A Doorway to the EEOICP," EEOICP Webinar, December 9, 2020, slide 5.
- ^{lv} Nevada Operations Office, U.S. Department of Energy, "Radiological Effluents Released from Announced U.S. Continental Tests 1961 Through 1988," DOE/NV-317, UC-702, May 1990.
- ^{lvi} Nevada Operations Office, U.S. Department of Energy, "Radiological Effluents Released from Announced U.S. Continental Tests 1961 Through 1988," DOE/NV-317, UC-702, May 1990, page 28.
- ^{lvii} Nevada Operations Office, U.S. Department of Energy, "Radiological Effluents Released from Announced U.S. Continental Tests 1961 Through 1988," DOE/NV-317, UC-702, May 1990.
- ^{lviii} U.S. Department of Justice, "Radiation Exposure Compensation Act," webpage accessed March 27, 2023.
- ^{lix} National Cancer Institute, National Institutes of Health, U.S. Department of Health and Human Services, "Estimated Exposures and Thyroid Doses Received by the American People from Iodine-131 in Fallout Following Nevada Atmospheric Nuclear Bomb Tests," October 1997, page ES.2.
- ^{lx} USA FACTS website <https://usafacts.org/data/topics/people-society/population-and-demographics/population-data/average-family-size/> accessed January 20, 2024.
- ^{lxi} U.S. Department of Energy, "Radiological Effluents Released from Announced U.S. Continental Tests 1961 Through 1988," DOE/NV-317, May 1990.
- ^{lxii} U.S. Nuclear Regulatory Commission, "Radioactive Materials Released from Nuclear Power Plants (1976)," NUREG-0367, March 1978. (ADAMS ML19269E969)
- ^{lxiii} *Whiting v. Boston Edison Co.*, 891 F. Supp. 12, U.S. District four for the District of Massachusetts, February 17, 1995.
- ^{lxiv} U.S. Government Accountability Office, "Low-Dose Radiation: Interagency Collaboration on Planning Research Could Improve Information on Health Effects," GAO-17-546," September 2017, page 3.
- ^{lxv} Jacob I. Frabrikant, Department of Radiology, Department of Biophysics and Medical Physics, University of California, "Probability of Causation: Implications for Radiological Protection and Dose Limitation," May 1987, page 2.
- ^{lxvi} Jacob I. Frabrikant, Department of Radiology, Department of Biophysics and Medical Physics, University of California, "Probability of Causation: Implications for Radiological Protection and Dose Limitation," May 1987, pages 8-9.
- ^{lxvii} U.S. District Court for the District of Utah, "Irene Allen et al v. United States of America," Civ. No. C-79-0515J, 588 F. Supp. 247, May 10, 1984.
- ^{lxviii} National Council on Radiation Protection and Measurements, "Public Radiation Exposure from Nuclear Power Generation in the United States," NCRP Report No. 92, December 30, 1987, page 109.
- ^{lix} M. Cristy, R. W. Leggett, D. E. Dunning, Jr., and K. F. Eckerman, Maxima Corporation, "Relative Age-Specific Radiation Dose Commitment Factors for Major Radionuclides Released from Nuclear Fuel Facilities," NUREG/CR-4628, August 1986, Oak Ridge, Tennessee, page 9. (ADAMS ML20203M991)
- ^{lxx} Subcommittee on Oversight and Investigations, Committee on Interstate and Foreign Commerce, U.S. House of Representatives, "The Forgotten Guinea Pigs – A Report on Health Effects of Low-Level Radiation Sustained as a Result of the Nuclear Weapons Testing Program Conducted by the United States Government," August 1980, page 37.
- ^{lxxi} U.S. Census Bureau, "Remembering Pearl Harbor: A Pearl Harbor Fact Sheet," website <https://www.census.gov/history/pdf/pearl-harbor-fact-sheet-1.pdf> accessed February 5, 2024.

-
- ^{lxxii} Wikipedia, “Casualties of the September 11 attacks,” website https://en.wikipedia.org/wiki/Casualties_of_the_September_11_attacks#:~:text=The%20September%2011%20attacks%20of,a%20consequence%20of%20the%20attacks. accessed February 5, 2024.
- ^{lxxiii} Wikipedia, “Boston Marathon bombing,” website https://en.wikipedia.org/wiki/Boston_Marathon_bombing accessed February 5, 2024.
- ^{lxxiv} Wikipedia, “Oklahoma City bombing,” website https://en.wikipedia.org/wiki/Oklahoma_City_bombing accessed February 5, 2024.
- ^{lxxv} Wikipedia, “1900 Galveston hurricane,” website https://en.wikipedia.org/wiki/1900_Galveston_hurricane accessed February 5, 2024.
- ^{lxxvi} Wikipedia, “Johnstown Flood,” website https://en.wikipedia.org/wiki/Johnstown_Flood accessed February 5, 2024.
- ^{lxxvii} Wikipedia, “Sultana (steamboat),” website [https://en.wikipedia.org/wiki/Sultana_\(steamboat\)](https://en.wikipedia.org/wiki/Sultana_(steamboat)) accessed February 5, 2024.
- ^{lxxviii} Brainy Quote webpage https://www.brainyquote.com/quotes/winston_churchill_135259 accessed January 31, 2024.