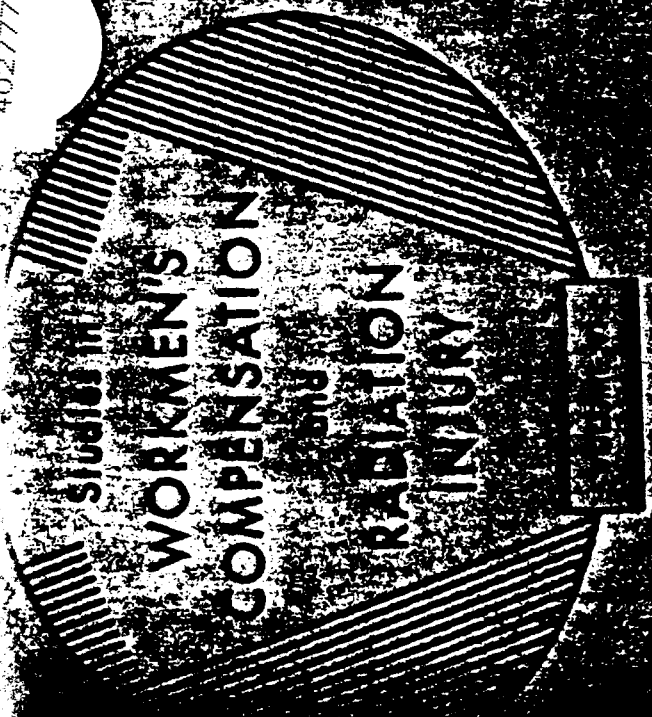


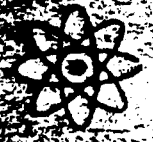
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1971 (S)

U.S. DEPARTMENT OF LABOR
 BUREAU OF OCCUPATIONAL SAFETY AND HEALTH
 DIVISION OF RADIATION PROTECTION



PRIVACY ACT MATERIAL REMOVED

Studies in
**WORKMEN'S COMPENSATION
AND
RADIATION INJURY**

VOLUME VI

**A DIGEST OF
WORKMEN'S COMPENSATION DECISIONS INVOLVING
DELAYED INJURY RESULTING FROM IONIZING
RADIATION EXPOSURE**

ISSUED 1972

Prepared by
THE UNITED STATES ATOMIC ENERGY COMMISSION

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PREFACE

Volume VI is the second of what is expected to be a series of compilations of digests of selected cases alleging injury, disability or death as the result of occupational exposure to ionizing radiation.

We wish to express our appreciation to the Bureau of Employees' Compensation and the Employees' Compensation Appeals Board, U.S. Department of Labor; the Veterans Administration, including the Board of Veterans Appeals for their advice and assistance in making information available for inclusion in this Volume. We also wish to express our appreciation to Harold Clark Thompson, Esq., Counsel for the Colorado State Compensation Insurance Fund, a Division of the Department of Labor and Employment of Colorado, who furnished the information necessary in preparing the uranium miner lung cancer cases and to the California Compensation Insurance Fund for their cooperation in furnishing material contained in this Volume.

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GLOSSARY OF NUCLEAR TERMS REFERRED TO IN CASE DIGESTS

1. Alpha radiation—A stream of positively charged alpha particles emitted by certain radioactive materials. It is the least penetrating of the three common types of radiation (alpha, beta, gamma). Alpha particles cannot penetrate the outer layers of human skin but if an element releasing them is deposited within the body, they may cause damage by destroying local tissue.
2. Beta radiation—A stream of negatively or positively charged particles emitted from the nucleus of certain radioactive materials.
3. Curie—(Symbols commonly used are C, c, and Ci)—The basic unit to describe the intensity of radioactivity in a sample of material. The curie is equal to 37 billion disintegrations per second, which is approximately the radioactivity of 1 gram of radium. A curie is also a quantity of any nuclide having 1 curie of radioactivity.
4. Dose—The amount of ionizing radiation energy absorbed per unit mass of irradiated material at a specific location, such as a part of the human body.
5. Dosimeter—A device that measures radiation dose, such as a film badge.
6. Fallout—Debris (radioactive material) that resettles to earth after a nuclear explosion.
7. Film badge—A package of photographic film worn like a badge by workers in the nuclear industry to measure exposure to ionizing radiation. The absorbed dose can be calculated by the degree of film darkening caused by the irradiation.
8. Fission Products—The nuclei formed by the fission of heavy elements, plus the nuclides formed by the fission fragments' radioactive decay.
9. Gamma Radiation—High-energy, short wavelength electromagnetic radiation emitted from the nuclei of many radioactive materials. Gamma radiation is very penetrating and is best shielded against by dense materials, such as concrete or lead.

10. **Ionizing Radiation**—(usually referred to as radiation in the case digests included herein) Any particulate or electromagnetic radiation capable of producing ions directly or indirectly in its passage through matter.
11. **Maximum Permissible Dose**—That dose of ionizing radiation established by competent authorities as the maximum that can be absorbed without undue risk to human health.
12. **Mega**—(abbreviated M) A prefix that multiplies a basic unit by one million.
13. **Milli**—(abbreviated m) A prefix that divides a basic unit by one thousand.
14. **Pico**—(abbreviated p) A prefix that divides a basic unit by one trillion.
15. **Rad**—(acronym for radiation absorbed dose) The basic unit of absorbed dose of ionizing radiation. A dose of one rad equals the absorption of 100 ergs of radiation per gram of absorbing material. (An erg is a very small unit of energy.)
16. **Radiation Dosimetry**—The procedure for estimating or measuring the amount of radiation delivered to a specific place or the amount of radiation that was absorbed there.
17. **Radiation Therapy**—Treatment of disease with any type of radiation. Often called radiotherapy.
18. **Radioisotope**—A radioactive isotope. An unstable isotope of an element that decays or disintegrates spontaneously, emitting radiation.
19. **Rem**—(acronym for roentgen equivalent man) A unit of absorbed radiation dose in biological matter. It is equal to the absorbed dose in rads multiplied by the relative biological effectiveness of the radiation. (One rem is equal to 1000 millirems.)
20. **Roentgen**—(abbreviated r or R) A unit of exposure dose of ionizing radiation. It is that amount of gamma or X-rays required to produce ions carrying 1 electrostatic unit of electrical charge in 1 cubic centimeter of dry air under standard conditions.
21. **X-ray**—A penetrating form of electromagnetic radiation emitted when the inner orbital electrons of an atom are excited and release energy. X-rays are always non-nuclear in origin.

**U.S. DEPARTMENT OF LABOR
BUREAU OF EMPLOYEES' COMPENSATION
INSTRUCTION-630, DATED JANUARY 1967**

Basic information to be secured on claims involving exposure to ionizing radiation:

1. Precise descriptions of employee's work assignments, including particularly, the equipment and appliances subjecting employee to radiation exposure and the length of time he worked with or was exposed to each, covering both his exposure in the employment here involved as **WELL AS ALL PRIOR EXPOSURES.**

2. Whether there were any uncontrolled exposure incidents and the extent of all radiation exposures. If feasible, submit scale drawings of the work areas showing ventilation system, storage facilities or sources of radiation, X-ray equipment, and the location of any radiation therapy areas. The shielding at the radiation sources and at the employee's work place should be described fully.

3. The standard operating procedures used for the storage, issuing, wearing, collection, developing, and recording of film badge records and breath samples, and specifying the calibrations of the instruments used. The same information should be furnished relating to any pocket ionization chamber records, if such records were maintained by the employing establishment. If specific data are not available, a summary of the results may be submitted.

4. Readings of any continuous monitoring equipment maintained in the employee's work area for the period of his employment, with a description of the equipment, its location, and its position in relation to the employee's work area for the period of his employment, and any other records of survey or tests of radiation made in the employee's work area. Please submit copies of reports showing film badge readings, and readings on dosimeters or pocket ionization chambers. If they have been retired to storage, please obtain their return as soon as possible and furnish full information. If no such records are now available please so state.

5. The identification of the persons who recorded and interpreted the data and their qualifications and training.

6. Complete hospital and/or medical records of all hospitalizations of the employee, either prior or current, not previously submitted to the Bureau, including any blood, urine, serological and radiological tests made. This should include any and all quantitative information relating to the level of excreted internally deposited isotopes, results of breath analysis for radon (where indicated), and whole body counts done during any period of such hospital or medical care.

7. Obtain from the employee a complete and comprehensive medical history covering all illnesses or injuries for which he has received medical care at any time. This history should be in chronological order and should bear the personal signature of the employee.

8. Furnish a full employment and occupational history on the employee. This should include that information which can be obtained from your records as well as that which can be obtained from the employee by personal contact or otherwise.

9. Furnish copies of all medical data included in the employee's personnel folder as well as copies of all dispensary records relating to the Federal Employee Health Program at the employing establishment.

10. Furnish from the employer's records, and from any personal information obtainable from the employee a complete history of his previous exposure to X-ray and/or radioisotopes, whether from medical or industrial sources. This history should be in chronological sequence and should identify those exposures which are a matter of written record as distinguished from those which are based on the employee's recollection or other indefinite information.

11. Furnish a list of X-ray equipment involved in this employee's exposure showing manufacturer, model, approximate normal power level, type of tube, and description of collimating devices used. State types of diagnostic X-rays taken (such as G.I. series, chest, etc.) and furnish quantitative data on numbers of each type involved. Describe location and form of safety device used such as aprons, screens, cubicles or others.

If employee was exposed to direct or stray radiation from industrial or therapeutic X-ray, furnish details on frequency, duration and extent of exposure, types of X-ray equipment and power level for normal operation.

CHAPTER I

DIGEST OF VETERANS ADMINISTRATION RADIATION CASES

PART A

VETERANS ADMINISTRATION CASE

CASE NO. 1

Type of Injury: Acute Lymphocytic Leukemia.

VA's Decision: Compensation Denied.

Date of Decision: 1969.

Claimant's Allegation: This veteran's duty assignment as an X-ray technician caused the disease which resulted in his death.

Facts: Veteran entered the U.S. Army in January 1953. Military records showed veteran was assigned to work as an X-ray technician from December 1953 until December 1954. He was separated from active duty in December 1954. His service records were essentially negative and his discharge examination was negative. The evidence of record indicated that the veteran did not at any time following discharge from service work around X-ray equipment or have any job that exposed him to any type of radiation. In 1969 the veteran developed acute lymphocytic leukemia and died. The death certificate indicated that his condition was only in existence for two weeks prior to his death. The widow filed a claim for death benefits.

It was alleged that the veteran wore no film badge and evidence of record did not contain any specific information concerning the veteran's work environment or the amount of radiation to which he was exposed.

Medical Evidence: In support of her claim the widow submitted statements from a medical radiologist and two physicians who attended the veteran prior to his death.

One of the medical doctors submitted the following opinion:

During my interview [the veteran] told me that he had worked as an X-ray technician for several years in the service and a legitimate question must be raised as to whether his exposure to radiation at that time

caused his death. There is no way of course in proving this but there is certainly adequate information in the literature to suggest a causal relationship. He did state to me that during his work as an X-ray technician he wore no protective badge which would have adequately monitored his X-ray exposure.

The other attending physician stated with respect to veteran's service occupation as an X-ray technician:

Exposure to X-ray nearly every day, may have contributed to the Leukemia which caused his death.

The radiologist submitted the following opinion concerning the veteran's case:

It is apparently well documented and also proven by his clinical course that this was a case of acute leukemia. It is well established in medical literature that people who have been exposed to radiation over a period of time have a much higher incidence of leukemia than a normal segment of population. As a radiologist, I am deeply conscious of this situation and everyone in our department who works with X-rays wears film badges, which are changed every week to record the amount of radiation which they have been exposed to and to prevent overexposure. In addition, the radiologists who fluoroscope wear their lead aprons and lead gloves.

It was my personal experience in residency that one of my teachers who was somewhat casual as to wearing particular attire developed acute leukemia in the same way and died very rapidly. I am convinced that it is very likely that [veteran's] fatal illness was related to inadequate protection and chronic exposure to radiation during his service years.

The claimant also submitted a statement from a health physicist, testifying as an expert, in which he said in pertinent part:

I am . . . particularly interested to note that [veteran] worked as an X-ray technologist for quite some time prior to his death.

During the past few years, I have . . . attempted in every way I know to point up the risks of leukemia and other forms of radiation damage . . . from exposure to X-rays. Reports of the United Nations Scientific Committee on the Effects of Atomic Radiation have indicated that on a linear hypothesis one would expect from 0.5 to 2×10^6 leukemia per year per rem. In the United States, there are on an average 14,000 new cases of leukemia each year, so the doubling rate for leukemia is between 35 and 140 rem. In other words, if a person dies of leukemia and has been exposed to X-rays between 35 and 140 rem, there is a 50% chance his death was due to radiation.

. . . The average X-ray technologist . . . receives far more than this exposure. In fact, there is good evidence that many are receiving a few hundred roentgens of occupational exposure per year. Thus, if in the course of his work [veteran] received, let us say, 400 roentgens of X-ray

exposure, there is then an 80% chance that his death is attributable to exposure from X-rays.

* * *

I am sorry I cannot be very quantitative expressing my opinion in this case. However, from the information I have on the average exposures received by X-ray technologists, I would say that in my own mind at least there is better than a 50% chance his death was caused by exposure to X-rays. It is very probable that there is more than an 80% chance that this death resulted from such occupational exposure.

Concerning the latent period between radiation exposure and the onset of the leukemia another expert who had done extensive research in the causes of cancer said:

Another point of possible pertinence is the question of the induction period intervening between irradiation and the onset of the disease . . . There is a great variation in induction period, depending upon age, amount of radiation received and other factors. The induction period for most types of leukemia reaches a peak at 10 to 15 years after irradiation. However, it should be pointed out that the disease may occur only a year or two after exposure or after a very long time. Recent reports point out that leukemia continues to develop in the bomb survivors of Hiroshima (after 23-24 years).

. . . authorities in this field of scientific investigation would strongly suggest a cause and effect relationship between radiation received during [veteran's] tenure in the service and the tragic case of leukemia which has just terminated his life.

VA's Decision: In rejecting the claim the Veterans Administration pointed out that the evidence of record did not indicate that the veteran received "excessive radiation" during his work and said:

It is held that it would be purely speculative to service connect cause of death in this case when no positive pathology has been shown between separation from service until just prior to veteran's death and it is not indicated from any source that the veteran received excessive doses of radiation during service. . . It is held that the cause of death is in no way related to the veteran's military service nor is it due to excessive radiation received by the veteran during service.

No appeal taken.

PART B
BOARD OF VETERANS APPEALS CASES
(Nos. 2-34)

CASE NO. 2

Type of Injury: Acute Lymphatic Leukemia.

BVA's Decision: Denial Affirmed.

Date of Decision: 1971.

Appellant's Allegation: That her husband's death due to leukemia was caused by his exposure to radiation at Nagasaki and Hiroshima, Japan, in 1945, following the explosion of atomic bombs there. She maintained that there is a far higher incidence among those with such radiation exposure and that there is a strong presumption that the veteran's leukemia was service connected.

Facts: The veteran had active service in the United States Marine Corps from December 1942 to November 1945. The official certificate of death shows that he died on December 23, 1969, at the age of 55 years. The immediate cause of his death was septicemia of a reported five days' duration and the underlying cause of his death was acute lymphatic leukemia of a reported 21 days' duration.

World War II service medical records, including reports of examination in December 1942 and November 1945, were negative for findings of leukemia or radiation exposure. The records disclose he was a member of the 2nd Marine Division in the occupation of Nagasaki and that on September 23, 1945, the 2nd Marine Division landed at the Harbor of Nagasaki and moved to occupy the city. He served as a pharmacist's mate who had been transferred to the 2nd Marine Division in June 1945. Before and during the occupation of Nagasaki he served at a regimental aid station of the 2nd Pioneer Battalion. He embarked for a return to the United States in October 1945 and was discharged in the following month.

Medical Evidence: In February 1970, a medical doctor who treated the veteran just prior to his death reported that there was clearcut evidence of a relationship between the effect of radiation and the increased incidence of leukemia. He said there was a definite increase in leukemia among people around the peripheral area of the atomic blast. He said it was possible that

[veteran] might have developed leukemia from his Hiroshima experience. He said that one could wonder about the incubation period and how long the disease might take to develop but that the onset of the illness would probably never be well decided. He doubted if the veteran carried the disease for years in the sense that he felt badly from it. The doctor reported that other than the most recent symptoms of infection, bleeding and anemia which occur, any earlier symptoms of leukemia would be purely speculative.

In July 1970, a medical doctor, Chairman of the Division of Medical Sciences, National Research Council, advised the Veterans Administration that six weeks had elapsed between the bombing of Nagasaki and the veteran's disembarkation there and that the chance he was exposed to prompt or induced radiation from the atomic bomb detonated over Nagasaki on August 9, 1945, was most unlikely.

On appeal, the appellant's representative suggested that the independent medical opinion obtained previously by the Board of Veterans Appeals is out-dated, is negatively speculative and does not resolve all reasonable doubt in the appellant's favor.

Findings of the BVA and Basis for Decision: The Board denied service connection for the reasons that (1) chronic leukemia was not incurred in or aggravated during active service (38 USC 310); (2) that chronic leukemia was not manifest to a compensable degree within one year following the termination of World War II service (38 USC 312, 313; 38 CFR 3.307); and (3) that a service-connected disability did not cause death or contribute substantially or materially to cause death (38 USC 410; 38 CFR 3.312, 3.102). In finding no probability that the veteran's leukemia was causally related to any exposure to radiation during military service the Board said:

In the past, the question of the possible relationship of lymphatic leukemia to alleged exposure to radiation after the atomic bomb blast in Nagasaki and Hiroshima has been the subject of submission to independent medical experts not associated with the Veterans Administration. One renowned specialist has been consulted on several occasions, including recently. He has been one of the medical directors of the Atomic Energy Commission, a member of the Committee on Atomic Casualties of the National Research Council and a representative of the United States on the United Nations Scientific Committee on Effects of Atomic Radiation.

The specialist has stated that fission products from the explosion at Nagasaki were carried over the hills and deposited to some extent in the area around the Nishiyama Reservoir. A rough fallout track could be followed for some 30 miles to the east but at barely measurable levels in September and October of 1945. At different times readings on the edge of the harbor in Nagasaki were barely elevated above background (0.05 micro-microrentgens/hr.). The specialist reported that the effective exposure time of one who worked in the area of highest exposure for 20 hours per day from mid-September to mid-December 1945 would be less than 5 r. The series of typhoons and heavy rains in the fall of 1945 reduced the levels still farther.

The specialist went on to say that no case of leukemia has been known to have developed with acute whole body doses of less than 100 r and that protracted radiation is even less effective than radiation given as an acute dose. It was concluded that there is an increased rate of leukemia at Hiroshima and Nagasaki among Japanese who were exposed to the gamma and neutron radiation received *at the time* of the bomb explosion. However, there is no excess of leukemia as compared with the rest of Japan among those living in Hiroshima or Nagasaki who did not receive *direct* radiation from the weapons explosions but who received slight exposure from residual radioactivity.

The independent medical expert has given the official measurements of radiation in Nagasaki which is the accepted basis for calculating dosage there and for determining whether or not the radiation could have been leukemogenic. This is, of course, as valid today as it was in 1945 after the explosion and in 1962 when presented to the Veterans Administration.

Returning to [veteran's] case, he did not arrive at Nagasaki until September 23, 1945, about one and one-half months after the atomic bomb explosion there. Therefore, he certainly received no direct radiation from the explosion. At the most he could have received only slight protracted radiation exposure. Inasmuch as there is no excess of leukemia among those persons living in Hiroshima and Nagasaki who did not receive *direct* radiation from the weapons explosion in August 1945 but who did receive extremely slight exposures from residual radiation comparable and probably in excess of those of the veteran, there is no reasonable probability that the veteran's leukemia was due to the effects of radiation exposure or was attributable to the period of military service. The disease was first shown about 24 years after the date of his discharge from service. This is too remote from the period of service to be significant in the present case.

CASE NO. 3

Type of Injury: Leukemia.

BVA's Decision: Denial Affirmed.

Date of Decision: 1970.

Appellant's Allegation: That the veteran was in Hiroshima, Japan, after the explosion of the atom bomb in World War II and the leukemia now present resulted from exposure to radiation.

Facts: The veteran's active service extended from August 1943 to January 1946. Evidence indicated that his ship was in Japanese waters after the atomic bomb was dropped; that he fell into the water while assisting in anchoring in Tokyo Bay; that he visited areas thought to be near Hiroshima and subsequently wandered around a demolished area for approximately 3 or 4 hours; and that he returned to his ship through Yokohama. The veteran stated that he was sterile on return to the United States but indicated that this had never been proven.

His service medical record did not reveal complaint or finding related to leukemia and no pertinent abnormality was noted at discharge.

Medical Evidence: Statements and reports from two hospitals and a medical doctor relate to medical studies from December 1968 and diagnosis of leukemia, most likely myelocytic. The clinical information did not indicate any significant illness in the past. Approximately two weeks previously he had flu-like symptoms and an abnormal blood count. The complaints included fatigue and weakness. His medical record also included information to the effect that he had discovered symptoms of gum bleeding approximately one year prior to diagnosis of leukemia and other symptoms approximately three months before the diagnosis.

Findings of the BVA and Basis for Decision: In finding that leukemia was not incurred in or aggravated during wartime service, the Board said:

The evidence in this case does not affirmatively show specific exposure to atomic radiation. It is recognized that the amount of radiation received by an individual is determined by the type of exposure and dosage rate. An acute dose is that received when the whole body is exposed for a short period of time, ranging up to about a week. It is also known that early fallout descends quickly and its radioactivity decreases rapidly at first and more slowly as time passes. The fallout which enveloped Hiroshima was not radioactive to any significant degree

after a few months . . . an analysis of the evidence in this case does not show exposure to radiation or at least not to an extent that can be considered the inception of the currently diagnosed leukemia.

Leukemia was not present during the veteran's World War II service terminating in January 1946.

The veteran served aboard a carrier during the period the ship visited Japanese waters in the latter part of 1945, approximately two months following the atomic bomb explosion at Hiroshima. There is considerable distance between the Tokyo area, where the [carrier] anchored and the veteran visited, and the area of the atomic explosion at Hiroshima.

There is no official record that the veteran was exposed to atomic radiation in Japan. An exposure to radioactive fallout or radiation occurring while in the area was negligible.

The initial symptoms of leukemia approximates 1968, with diagnosis of the disease in the latter part of the year.

A causal relationship is not shown between leukemia and any exposure to atomic radiation during World War II.

CASE NO. 4

Type of Injury: Metastatic Carcinoma.

BVA's Decision: Denial Affirmed.

Date of Decision: 1970.

Appellant's Allegation: That the veteran's death from diffuse metastatic carcinoma was due to exposure to excessive X-ray radiation sustained while he was an X-ray technician during his World War II service.

Facts: The veteran's active service extended from January 1942 to February 1946. No pertinent abnormality was reported on examination prior to his separation from active service.

The veteran was hospitalized in 1968. Hospital records showed that a biopsy specimen supplied from operative procedures and from bone marrow were reviewed by the pathology department of the hospital and it was felt that the specimen most likely represented a soft tissue sarcoma, possibly arising from skeletal muscle. The bone marrow aspiration showed the presence of a similar tumor. Following the above evaluation the patient was started on a course of chemotherapy.

The veteran died in February 1969 at the age of 49 from diffuse metastatic sarcoma. At the time of his death service connection was not in effect for any disability.

In a statement of March 1969, the appellant stated that her husband had been an X-ray technician while in service and during his training for this speciality he became violently ill and was hospitalized in Army Hospitals. She added that this was then thought to be due to overirradiation while training. She related that cancer was diagnosed in 1967 and his condition got continuously worse until his death. She said that while he was in X-ray school he was constantly being X-rayed and received excessive amounts of radiation. She stated in a subsequent communication that he had received a 12 weeks' X-ray technician's course in 1942 at the Army Medical Center, Washington, D.C.

Evidence indicated that after an extensive search of Army hospital records there was no record of the veteran ever having been hospitalized between January 1942 and December 1946 in Washington, D.C. Evidence further indicated that the veteran did have one hospitalization near Washington, D.C. for four days for an acute nasopharyngitis. Records of that hospitalization showed no evidence regarding radiation overexposure.

Medical Evidence: The BVA referred specimens from the veteran's bone

marrow biopsy to the Armed Forces Institute of Pathology with the claims folder for study and an opinion as to the correct diagnosis of the tumor and whether or not there was a reasonable probability that the tumor was related to X-ray exposure. Pertinent parts of the reply are as follows:

It was common in teaching the technicians to teach them positioning on each other. However, from personal experience during World War II, no single technician would have been used more than a very few times, fewer than the number of exposures that many patients received during the course of treatment under roentgenographic control. Sufficient radiation to produce a neoplasm from a diagnostic machine would produce a visible skin burn, visible at the time of physical discharge from the service, and constantly visible subsequently.

For the last fifty years, the only known association between the practice of radiology and neoplasms is the higher incidence of leukemia among radiologists, generally those that are doing a great deal of fluoroscopy. (Before that, skin cancers developed on the radiation burned hands of older radiologists.) Neither of these events occurred with this patient, nor does the patient have the appropriate type of malignancy

In view of these facts, the staff does not see how it is possible for radiation to have produced a malignant tumor in the scapular area over twenty years after discharge from the service, on the basis of four years as a radiologic technician who never had any evidence of a burn, was never hospitalized for radiation, and does not have the type of neoplasm that is known to be associated with radiation. If radiation had played a role, one would have to assume that he stood with his upper back to diagnostic equipment for great periods of time, since his neoplasm is stated to have arisen in the back.

With respect to a lack of evidence that the veteran had ever received an overexposure to radiation the report further stated:

If he had ever been overexposed to radiation, it is expected (from the manner in which the schools were run) that this would have been recorded, and that he would have been hospitalized and studied. The lack of any records speaks clearly against any such excessive exposure.

Findings of the BVA and Basis for Decision: In finding that the evidence did not establish a causal relationship between exposure to X-ray radiation during his active service and the development of a malignant tumor many years following his release from such service the Board said in pertinent part:

It is the defined and consistently applied policy of the Veterans Administration to administer the law under a broad interpretation, consistent, however, with the facts shown in every case. When, after careful consideration of all procurable and assembled data, a reasonable doubt arises regarding service origin, the degree of disability, or any other point, such doubt will be resolved in favor of the claimant. By reasonable doubt is meant one which exists by reason of the fact that

the evidence does not satisfactorily prove or disprove the claim, yet a substantial doubt and one within the range of probability as distinguished from pure speculation or remote possibility. (38 CFR 3.102)

The evidence does not establish that the veteran was exposed to excessive X-ray radiation during his active military service. In addition, the evidence has been carefully developed and to conclude that there was a causal relationship between exposure to X-ray radiation during his active service and the development of a malignant tumor originating in his scapular area many years following his release from such service would require resort to pure speculation or remote possibility, which is not permitted.

CASE NO. 5

Type of Injury: Adenocarcinoma of the Colon, Cataracts, Glaucoma and Detached Retina.

BVA's Decision: Denial Affirmed.

Date of Decision: 1970.

Appellant's Allegation: That the adenocarcinoma of the colon and eye abnormalities were the result of the appellant's exposure to radiation during World War II while serving with the Manhattan Engineer District.

Facts: The veteran entered on active duty from an inactive reserve status in June 1942 and served until June 1945. His discharge papers reflect that he was assigned to the Manhattan Engineer District prior to his release from active duty. His duty assignments during service were shown to be that of patent officer, legal officer and instructor. As a patent officer, he investigated inventions and prepared patent opinions and applications. As legal officer, he was adviser to the commanding officer and to the military and civilian personnel of his unit on all legal matters. His instructor duties consisted of instructing at an officer candidate school in matters of law, ordnance, drill, etc.

His army records did not indicate that he was involved either directly or indirectly with the handling of radioactive materials. However, the veteran alleged that he had been exposed to radioactivity during service in 1944 and 1945. A fellow serviceman who had served with the veteran on the Manhattan Project in 1944-1945 testified that it had been customary for them to visit the Cyclotron Building while the "calutron" (mass spectrometer uranium separator) was in operation. From time to time, they had looked through the observation window and observed the ion beam as well as the ion source. Although he did not know quantitatively the amount of radiation exposure at the locality and under those conditions, he did know that the veteran often took part in the described activities and was subjected to whatever radiation that might have been present.

The service medical records disclose that the veteran was found to have bilateral compound myopic astigmatism when he was examined for extended active duty purposes in February 1942. He was accepted for limited service as having uncorrected visual acuity of 20/200, bilaterally, correctable to 20/20 in the right eye and to 20/30 in the left eye. No complaints or treatment referable to his eyes were reported during the period of active duty, although the myopia was mentioned on one occasion while he was undergoing treatment for an unrelated disorder. Nothing concerning gastrointestinal trouble or radiation

exposure was recorded. Compound myopic astigmatism was noted on examination for his release from active duty.

Examinations by the service department for various purposes in December 1946, June 1956, May 1959 and January 1961 while the veteran continued as a Reserve Corps Officer were reported as showing no pertinent abnormalities other than the myopia. Examinations by this Administration in March 1946, May 1948, June 1950 and November 1954 also were negative for signs or symptoms of increased eye pathology and tumor.

The possibility of his having been exposed to radioactivity was first mentioned by the veteran in his application for service connection for the eye disorders in October 1966.

Medical Evidence: A statement from a medical doctor, in November 1966 revealed that he had attended the veteran from February 1959 to August 1963 for the eye defects. Surgery for cataract of the left eye had been performed in June 1960, and surgery for cataract of the right eye had been conducted in October 1960. In January 1961, the veteran had been involved in an automobile accident which resulted in a drop in his visual acuity of the right eye, detachment of the retina and surgical procedure. Bilateral cataract, retinal detachment of the right eye, and diplopia were diagnosed.

Reports on file from an Army Hospital reflected treatment for the disorders since 1967 and adenocarcinoma of the colon with metastasis to the mesocolic nodes since February 1969.

Information furnished by [another medical doctor] reveals that he had examined the veteran professionally since November 1969. He reported that during the 1950's the veteran's myopia had accelerated without apparent cause, and nuclear disintegration of the crystalline lens had been diagnosed by an ophthalmologist who expressed surprise at the finding in a patient of relatively young age; that cataract surgery had been performed in 1960 with unfortunate sequelae; that in 1968 the veteran had developed a gastric distress which led to the finding of adenocarcinoma of the ascending colon in 1969. In the opinion of this medical doctor the untimely optical involvement was indicative of radioactivity, for it was notorious that the crystalline lens were peculiarly susceptible. He said that the colon was another area sensitive to radiation and that the biological effects were usually delayed. He further said that the emergence of classic symptoms in two susceptible areas was clear evidence that the symptoms were the result of the patient's exposure.

Another medical doctor gave an opinion in May 1970 that, based on the veteran's history of exposure to radioactivity during 1945, the radiation might have contributed to the occurrence of cataracts.

Findings of the BVA and Basis for Decision: In finding that the veteran's cataracts, subsequent eye disorders and adenocarcinoma of the colon were not shown to have been due to overexposure to radioactivity during World War II service, the Board said:

Authorities have recognized that there is a minimum acceptable level of radiation which the body can absorb without producing harmful effects. In the veteran's case the Board has no idea of the dose received by him, if any at all. His Army records do not indicate he was involved

either directly or indirectly with the handling of radioactive materials. The statement of the [fellow serviceman] suggests they were only casual, occasional, distant spectators. Apparently, [this fellow serviceman] has suffered no deleterious effects from their curiosity. Accordingly, the Board is of the opinion that the association made between the disorder at issue and overexposure to radiation is purely speculative.

Overexposure of the veteran to radioactivity during World War II service is not demonstrated by the service and postservice evidence on file.

His cataracts and subsequent eye disorders and adenocarcinoma of the colon, all of which developed many years after service, are not shown to have been due to service injury or disease.

CASE NO. 6

Type of Injury: Arachnoiditis.

BVA's Decision: Denial Affirmed.

Date of Decision: 1971.

Appellant's Allegation: That as a crewman of the U.S.S. Sumner in July 1946, he was exposed to atomic radiation following two atomic bomb tests in the Marshall Islands and that this exposure was the cause of his present disability.

Facts: The veteran had active Naval service from December 1945 to October 1947 and served aboard the U.S.S. Allen M. Sumner. He filed an original claim for service connection for a spinal condition in August 1966, indicating that he had been treated during service for extreme high fever and headaches and believed there was a connection between his ship's presence in the atomic testing area in July 1946, his ship's contamination with radioactive materials, his becoming wet with rain while in the contaminated area and a spinal condition for which he alleged treatment from 1953 to 1966.

The veteran contended, at a hearing on appeal held October 8, 1970, that as a crewman of the U.S.S. Sumner in July 1946 he was exposed to atomic radiation following two atomic bomb tests in the Marshall Islands and that this exposure was the cause of his present disability. The veteran stated that to his knowledge only he and a shipmate who actually jumped into the ocean after contamination, were injured. The veteran contended that he was affected because his duties as the only man assigned to cook and clean for the ship's chief petty officers required that he keep his hands in the water at least five hours daily. He asserted that after the blasts he had a loss of hair, change of complexion and eye color, and aching or numbness of the hands and arms, and, several months after the blasts, a fever of undetermined origin. He also recalled receiving a round of shots after the exposure. He contended that he experienced, soon after separation from service, pain in the legs which moved to his back in 1950 and became continuously worse until the onset of arachnoiditis in 1966. He maintains that since he has had no injuries to or sicknesses involving the back that the condition could only have resulted from his exposure to atomic radiation.

The veteran also testified at the hearing that his ship was within .2 to 20 miles of the two tests at the time of the blasts and moved, on the day of the Baker blast, into immediate blast area for about 25 minutes and spent longer periods in the area after both blasts, though the latter periods were further removed from the time of the blast itself.

At the hearing on appeal, the veteran's wife testified that since her marriage to the appellant in 1953, she had heard him complain periodically of soreness in his joints, leg muscles and back. His wife stated that the veteran had had such complaints since their marriage began and that she originally attributed them to his work as a brickmason. She questioned, however, why the pain should keep occurring and became concerned when the veteran, a few months before being stricken, continuously became nauseated during meals. She further stated that the veteran had had no back injury, growth, disease or bone disorder and she, therefore, felt that exposure to atomic radiation had contributed to his present illness.

The veteran's representative contends, in a letter dated April 1970, that the present case more strongly favors service connection than did the case of another veteran who, based on his exposure to radiation some 20 years previously, was granted service connection for leukemia by the Board of Veterans Appeals in 1968.

Medical Evidence: Service medical records reveal that the veteran was treated during service for mumps with acute parotitis in February 1946 and, in December 1946, for acute fever of undetermined origin but associated with cold and painful tooth. There is also a record of a normal blood count taken in June 1947 in connection with Operation Crossroads. The immunization record reveals that only routine vaccinations and booster shots were given the veteran both prior to and after July 1946. Separation examination states that the skin, hair and glands as well as the spine and extremities were normal.

Official hospital reports reveal that the veteran, while laying bricks on April 25, 1966, suddenly felt a sharp pain in his low back with radiation to the posterior aspect of the right thigh and calf, exacerbated by coughing, sneezing and any back motion. Several days later, following a nocturnal episode of numbness in the perianal area and weakness of the lower extremities, he was hospitalized at a private facility and improved markedly after traction, bed rest, and physiotherapy treatment for two weeks. When hospitalized by the Administration from July 12 to August 23, 1966, a tentative diagnosis was made of: Herniated nucleus pulposus, 5th lumbar-1st sacral segment, central. Myelographic study, bilateral laminectomy, 4th and 5th lumbar segments, and exploration of the subarachnoid space and spinal cord were accomplished. Many adhesions were found between the cauda equina roots. Postoperative diagnosis was: Arachnoiditis, cauda equina. Acute fibrinous pleurisy, mild, right, was also diagnosed during hospitalization.

Post-hospitalization examinations were accomplished on September 22 and November 3, 1966. He was hospitalized from January 5 to February 1, 1967, with complaints of perianal pressure and numbness. Physical examination was within normal limits and the type of discharge was: Maximum hospital benefits. Diagnosis was arachnoiditis, chronic, old, postoperative.

Findings of the BVA and Basis for Decision: In denying service connection the Board made the following findings of fact:

1. The veteran manifested no disabilities of the spine or extremities during his active service. Arachnoiditis, cauda equina, was initially manifested many years after termination of service.

2. There is no etiological relationship between the veteran's presence in the vicinity of two atomic bomb tests in July 1946 and the subsequent onset of arachnoiditis, cauda equina.

In support of its conclusion that veteran's disability was not incurred in or aggravated by military service, the Board said:

There is no support for the contention that since specific reasons for development of arachnoiditis by the appellant have not been isolated by physicians, there must be a causal relationship between the present condition and possible exposure to atomic radiation approximately 20 years earlier. The veteran has produced no medical support for his theory that overexposure to radiation could cause arachnoiditis. Independent research performed by the Board's staff has not produced such support.

Furthermore, the official report of Operation Crossroads, written by [the] official historian of Joint Task Force One, shows that film badges used to measure nuclear radiation following the blasts in question revealed no cases of overexposure to atomic radiation as a result of that operation.

The present case is not analogous to the Board's 1968 decision, the case of another veteran to which the veteran's representative refers. The veteran in that case developed granulocytic leukemia after direct exposure to radioactive materials, including actual entrance into the underground impact site of an explosion within a few days of the blast and after carrying, by hand, radioactive materials in addition to being present, apparently in the open air, at the time of nuclear explosions. Of primary importance in that case was the conclusion that he received radiation approximating 100 roentgens and medical evidence of a direct relationship between exposure to significant amounts of radiation and the subsequent development of leukemia. Present case presents no comparable basis for a favorable decision.

CASE NO. 7

Type of Injury: Bronchiolar Carcinoma of the Left Lung; Hypertrophy of the Prostate with Chronic Prostatitis; Fibrotic Contracture of the Bladder Outlet.

BVA's Decision: Denial Affirmed.

Date of Decision: 1968.

Appellant's Allegation: That his carcinoma of the left lung in 1961 (i) was etiologically related to carcinoma of the right testicle for which service connection is established; and (ii) the medical treatment which he received for his testicular tumor, especially the roentgen therapy to the left hilar region given in September 1946, contributed to the pulmonary carcinoma; and that his prostatic and renal conditions in 1965 and 1966 were caused by radiation therapy he received in June and August 1944.

Facts: Veteran served in military from August 1942 to July 1945. While in service he was treated for a malignant tumor of the right testicle. A right orchidectomy was performed. He was subsequently treated with X-ray therapy from June to August 1944. After service, he received other medical treatments including roentgen therapy to the left hilar region given in September 1946. In December 1961 he was again hospitalized. A tumor for which the lower lobe of the left lung was removed was diagnosed as a bronchiolar carcinoma. In November 1965 there was a clinical diagnosis of fibrous contracture of bladder outlet and pyelonephritis. In October 1966, there was also a diagnosis of prostatic hypertrophy, probably benign, of moderate degree and prostatitis.

Medical Evidence: In view of the specific allegations advanced, the Board submitted the clinical and other medical records to the Armed Forces Institute of Pathology for their examination, review and opinion. Three of the questions asked the Institute of Pathology were as follows:

Is there any relationship between the lung tumor and the treatment which the veteran received for possible residuals of the testicular tumor, especially the roentgen therapy to the left hilar region given in September 1946?

Is the [lung tumor] related to the testicular tumor for which right orchidectomy was performed in service in May 1944?

Is there any relationship between the radiation therapy of June to August 1944 to the back and abdomen and the genitourinary disorders reported in April and October 1966?

In response to the questions relating to the lung tumor, the Institute expressed the following opinion:

We can find no basis for relating the lung tumor to the treatment which the veteran received for possible residuals of the testicular tumor. Although roentgen radiation has been *directly* responsible for some tumors (e.g., skin cancer) we know of no evidence that roentgen therapy, even in large doses, has been a direct cause of carcinoma of lung. And, although it is theoretically possible that roentgen therapy involving the lungs may be *indirectly* responsible for the development of carcinoma of lung on the basis of radiation pneumonitis with fibrosis (in the nature of so-called scar cancer), there is no evidence of radiation changes in the slides of the resected lower lobe of the left lung or in the slides of the left hilar lymph nodes. Neither, according to the records submitted, were there at any time following the radiation to the chest the clinical symptoms or pulmonary roentgenographic findings associated with radiation pneumonitis.

The testicular tumor for which right orchidectomy was done in service (31 May 1944) (slides not submitted) is recorded in the records as "Embryonal carcinoma with lymphoid stroma (Seminoma)" and as "Seminoma (Malignant teratoma)." Although late metastasis is known to occur from seminoma, the tumor removed with the lower lobe of the left lung, 17-1/2 years after the orchidectomy bears no resemblance whatever to a seminoma and must be considered an independent primary tumor.

In response to the question relating to the genitourinary disorders, the Institute stated:

a. There is no known or proven relationship between radiation therapy and prostatic hypertrophy. No documented examples of radiation therapy causing hypertrophy have been reported.

b. Prostatitis, pyelonephritis and fibrous contracture of the bladder neck could conceivably result from radiation therapy, but:

1) Inflammation induced by radiation is generally acute, occurring at the time of administration of the radiation therapy. Chronic inflammation may occur in the healing stages following radiation therapy but it is unlikely that chronic inflammation, radiation induced, would persist for 20 years.

2) The chronic prostatitis diagnosed in October 1966 was considered by the examining physician to be secondary to prostate hypertrophy. In addition, no evidence of chronic prostatitis was found at the time of prior urologic examination in November 1965. The available evidence favors absence of correlation between radiation therapy and chronic prostatitis.

3) Pyelonephritis occurring this long after radiation would of necessity be associated with late radiation changes such as fibrosis

and atrophy or possibly hydronephrosis secondary to radiation-induced ureteral fibrosis. There is no evidence of any of these changes in the two urologic examinations performed, namely November 1965 and October 1966. The rapid clinical response to [the Doctor's] therapy and the later demonstration of normal kidney function (October 1966) rule out either radiation-induced fibrosis-atrophy or hydronephrosis secondary to ureteral obstruction.

4) Fibrosis of the bladder neck causing (fibrous contracture) could conceivably result from radiation therapy, but:

a. For fibrosis in this region to be secondary to the radiation therapy it would be necessary to prove the radiation therapy was indeed given to this region.

b. A clearer documentation of this clinical impression is necessary.

1. What were the cystoscopic findings at the time [Dr. . . .] made this diagnosis?

2. What were his impressions as to the etiology of the process?

3. What therapy was employed that would so relieve the contracture that no evidence of it existed at the subsequent examination in October 1966? Fibrous contracture implied fibrosis which could only be relieved by surgical delatation.

The Institute of Pathology, therefore, concluded that (1) there was no basis for relating the lung tumor to the roentgen therapy the veteran received for possible residuals to the testicular tumor; and (2) no cause and effect relationship between radiation therapy and the clinical diagnosis of pyelonephritis, prostatic hypertrophy or chronic prostatitis could be established in this case. And, although a cause and effect relationship between radiation therapy and fibrous contracture of the bladder neck (clinical diagnosis) was theoretically possible, it was unlikely in this case due to the long interval between the time the radiation therapy was given and the time the clinical symptoms said to be due to fibrous contracture of the bladder neck appeared.

Findings of the BVA and Basis for Decision: In denying service connection the Board said in pertinent part:

. . . The medical reasoning set forth in the report of the Armed Forces Institute of Pathology is lucid and unequivocal, and reflects the views of this Board. The Board, therefore, concurs in the medical findings and conclusions of the Institute of Pathology.

CASE NO. 8

Type of Injury: Chronic Lymphocytic Leukemia.

BVA's Decision: Denial Affirmed.

Date of Decision: 1962.

Appellant's Allegation: That veteran's leukemia was due to the effects of the atom bomb dropped at Nagasaki or to X-rays he received in the service or both.

Facts: Veteran had active duty from December 1920 to February 1951. Veteran was stationed in Nagasaki, Japan, from September 24, 1945 to July 7, 1946, where he was in charge of storage supplies in dumps or storage areas. In Nagasaki the supply dumps were located in the harbor area and some 1 to 1-1/2 miles southeast of Nishiyama reservoir. Also during his active service he received dental X-rays, routine chest X-rays and X-rays for injuries to his wrist and ankle and for intravenous pyelograms. His blood count was within normal limits when he completed his service.

Information introduced from the Armed Forces Institute of Pathology reflected that the first measurements of radiation were made in Nagasaki on October 2, 1945, by fanning out in four directions from ground zero and that an average of 1-1/2 milliroentgens an hour were measured in the Nishiyama area where fission products had been deposited. No other areas of such deposit were found.

A Government survey of June 30, 1946 reflected that the degree of activity in the area of detectable radiation activity at Nagasaki was insufficient to produce casualties.

Medical Evidence: An independent medical expert on radiation effects was asked for an opinion and wrote as follows:

Since a survey party under my command had mapped out the fallout areas in Nagasaki, I am quite familiar with the entire region. Fission products from the explosion at Nagasaki were indeed carried over the hills and deposited to some extent in the area about the Nishiyama reservoir. This apparently was due to an eddy in the air just over the top of the hills, as a short distance out from Nishiyama the radiation was detected only with difficulty. A rough fallout track could be followed for some 30 miles to the east but at barely measurable levels in September and October of 1945. By December of 1945 the level at Nishiyama had fallen to 1.4 microroentgens/hr. At different times readings on the edge of the harbor in Nagasaki were barely elevated above background

We can say that his effective exposure time, assuming that he had worked in the area of highest exposure for 20 hours per day from September 15th for 90 days, which would carry him into December of 1945, would be 1800 hrs. His total dose extrapolating back to September 15th, assuming 20 hours exposure per day at the highest activity available, would have been less than 5 r. The series of typhoons and heavy rains in the fall of 1945 reduced the levels still farther and when I again visited the area in the spring of 1947 it was barely above background. The bulk of the fallout was washed into the reservoir and was largely absorbed in the sand at the bottom of the reservoir. The overlying water, of course, acted as an efficient shield. After December 1945, the accumulated dose would be negligible. No case of leukemia has been known to have developed with acute whole body doses of less than 100 r

* * *

There is an increased rate of leukemia at Hiroshima and Nagasaki among Japanese who had been exposed to the gamma and neutron radiation received at the time of the bomb explosion. There is no excess of leukemia as compared with the rest of Japan among those living in Hiroshima and Nagasaki who did not receive direct radiation from the weapons explosions and who did receive extremely slight exposures from residual radioactivity comparable to those of [veteran].

Findings of the BVA and Basis for Decision: In finding that veteran's leukemia was not related to radiation incurred while in service, the Board observed in pertinent part:

As to the incurrence of leukemia as the result of diagnostic X-rays, although cases of leukemia have been reported in persons such as radiologists, nurses, and technicians a review of such cases has shown that at present there are no grounds for making a determination that low level radiation such as that received from diagnostic X-rays has any leukemogenic effect.

* * *

[The medical expert] who was himself at Nagasaki shortly after the bombing conducting studies relative to the radiation effects of the bomb, has shown that the amount of radiation which was found in the area was very slight. The service files have shown that the veteran was in the area of the harbor and undoubtedly at some time in the area of the reservoir. How much time he may have spent in these areas is not known with any degree of accuracy. However, conceding as the medical expert did, that he worked in the area of highest exposure for 20 hours a day from September 15 to December 15, 1945, which is well in excess of any time indicated either by the veteran or the official records, his total dose of ionizing radiation would have been so small that no leukemogenic effect could be established. This, together with the

medical information with regard to the exposure to diagnostic X-rays, which is of small dosage and, over a period of many years, and thus producing no known leukemogenic effect, establishes that the veteran's leukemia cannot be ascribed to the radiation received in military service.

CASE NO. 9

Type of Injury: Acute Lymphatic Leukemia.

BVA's Decision: Denial Affirmed.

Date of Decision: 1970.

Appellant's Allegation: That the acute lymphatic leukemia which caused the veteran's death could have resulted from his being exposed to radiation sometime in November 1945 while he visited Hiroshima, and subsequently from souvenirs (glass) picked up at the time of this visit.

Facts: The veteran served from January 1945 to January 1946 when he was honorably discharged by reason of demobilization. Complaints of, treatment for, or a notation of symptoms characteristic of leukemia were not reported in service or at separation therefrom. Visual acuity at induction and at discharge was 20/20 bilaterally. He made a sightseeing trip in company with others to Hiroshima, apparently on November 6, 1945, although at various times in the claim this trip was stated to have been made in October.

On October 2, 1951, the veteran was examined at a Veterans Administration Center and found to have visual acuity of 20/40 in the right eye, 20/50 in the left eye with posterior subcapsular cataracts in both eyes, most marked on the left. In January of 1952 his vision was 20/200 in each eye with definite cataract. On April 2, 1952 the veteran was hospitalized and an intracapsular cataract extraction was performed on the left eye. On November 7, 1952 the veteran was rejected for employment because of poor to absent vision with a cataract present in the right eye and the left eye postoperative from removal of cataract. A February 12, 1953 report of a special eye examination at a [veteran's hospital], showed 20/200 in the right eye, 20/20 with correction in the left eye.

In April of 1946 the veteran was found to have secondary anemia with a hemoglobin of 70% and a red count of 3,850,000. His white cell count was 5,250 (within normal limits). The differential count showed polymorphonuclear leukocytes 54%, small lymphocytes 32%, large lymphocytes 16% and eosinophils 2%. In September 1951, the veteran applied for pension stating, among other things, that since 1951 he was totally disabled by reason of cataracts.

The veteran was seen several times by doctors between April 1946 and February of 1953. During this time there was no evidence of acute or other form of leukemia. On February 12, 1953, he was examined at a Veterans Administration Center with regard to defective vision and chronic lumbosacral strain. There was no evidence of leukemia at this time also.

On December 13, 1953, the veteran was again hospitalized at a V.A. Center with a diagnosis of acute lymphatic leukemia and was discharged January 5, 1954. The veteran died March 17, 1954. The death certificate listed the cause of death as acute lymphatic leukemia. An autopsy was not performed. The issue of service connection for the cause of the veteran's death was before the Board of Veterans Appeals in 1958 and again in 1965. On both occasions the Board held that the acute lymphatic leukemia which caused the veteran's death was not the result of exposure to atomic radiation and there otherwise was no basis for relating it to his service.

Medical Evidence. The appellant's claim for service connection for the cause of the veteran's death was reopened with the submission of the following statement from a medical doctor:

I certify that I have examined the file pertaining to the case of [veteran]. It is known that cataracts and/or leukemia are related to the history of exposure to ionizing radiation.

If exposure to radiation can be ascertained, it would appear that the aforementioned patient's diseases mentioned above could be related to such exposure. It would have been desirable to have had a total body count on the patient in order to rule out accidental ingestion of low energy material not ordinarily picked up by routine monitoring. Such material may remain in the endothelial system many years before causing damage.

Pursuant to the request of the appellant's service representative, an opinion, dated in June 1970, was obtained by the Board from an independent medical specialist who is an acknowledged authority on the effects of radiation exposure on whether there was an etiological relationship between the veteran's exposure to the after effects of the Hiroshima bombing and his development both of bilateral cataracts and acute lymphatic leukemia. The specialist stated, in pertinent part, as follows:

In considering the veteran's survivor's claim for compensation for the cataracts as related to the veteran's visit to Hiroshima in November of 1945 and possible exposure to radiation in the course of this visit and subsequently from souvenirs (glass) picked up at the time of this visit, I have reviewed the situation and the possible dose levels the veteran might have received.

... I was in Hiroshima both in October and in November 1945. Portions of glass found in the rubble at that time were not sufficiently radioactive to register on the radiation protection survey meters. Therefore, the glass can be ruled out as a source of radiation that might cause cataracts. A survey of radiation levels... demonstrates that the highest dose level found at Hiroshima as of October 3-7, 1945 was 0.4 milliroentgen/hr; most of Hiroshima was even less radioactive, and also caused no hazard.

If the veteran had remained for four hours early in October, the total dose which he could have received would have been 1.6 milliroentgen,

assuming that he spent the entire time at the point of highest activity. Had the visit been made in early November of 1945 as appeared most likely, the radiation levels would have been even less. Such a dose would be completely negligible and is approximately 1 millionth part of the development of cataracts. Hence, the claim for service connection of the cataracts is not valid.

There was no evidence of leukemia on discharge.

* * *

On November 30, 1953 [a medical doctor] reports that differential blood count was normal; his hemoglobin still 70% . . .

On December 13, 1953 the veteran was hospitalized at [a] V.A. Center with a diagnosis of acute lymphatic leukemia and was discharged January 5, 1954. The veteran died March 17, 1954 of acute lymphatic leukemia. This duration of acute lymphatic leukemia of approximately 3 - 4 months is fairly characteristic of the disease.

The dose of radiation that the veteran might have received during his visit to Hiroshima is at the very most 1.6 milliroentgens, and probably much less, a completely negligible amount . . .

Findings of the BVA and Basis for Decision: In finding that the additional evidence added to the record did not establish that there was a relationship between the veteran's service, including his exposure to atomic radiation at Hiroshima, and the cause of his death from acute leukemia, the Board pointed out:

Where a veteran served ninety (90) days or more during a period of war and leukemia becomes manifest to a degree of ten per cent (10%) within one year from date of termination of such service, such disease shall be presumed to have been incurred in service, even though there is no evidence of such disease during the period of service. This presumption is rebuttable by affirmative evidence to the contrary. (38 USC 312, 313; 38 CFR 3.307).

* * *

Where, after a claim is disallowed by the Board, a reopened claim is filed and evidence is submitted in support thereof which establishes a new factual basis, the reopened claim shall be adjudicated without regard to prior appellate decision on the issue. (38 CFR 19.155).

The opinion of the independent medical specialist, obtained pursuant to request confirms the correctness of the Board's two earlier decisions denying service connection for the cause of the veteran's death . . .

CASE NO. 10

Type of Injury: Leukemic Reticuloendotheliosis.

BVA's Decision: Denial Affirmed.

Date of Decision: 1969.

Appellant's Allegation: The veteran's death from leukemia was caused by exposure to radiation while in the service.

Facts: Veteran was in active service from September 1941 to September 1946. Veteran was commanding officer of a naval vessel from January 1945 to December 1945. Vessel was engaged in escort and patrol duties during air strikes against Japan. After the war the vessel was engaged in mine sweeping operations out of Sasebo, Kyusku, Japan. There was no evidence that there was any substantial radioactive fallout in the areas where the ship was operating. Veteran was hospitalized in early February 1951 and died on March 11, 1951 of leukemic reticuloendotheliosis (monocytic granulosus of schilling type).

Medical Evidence: The earliest relevant postservice medical evidence of record concerns treatment at a hospital in August 1949 for diagnosed acute aplastic anemia of unknown cause, granulocytopenia and thrombocytopenia, with clinical information that the veteran had unusual fatigue and malaise during the summer of 1949, becoming more severe prior to admission to the hospital. On examination in September 1950 for inactive reserve retention, there was recorded information that the veteran had jaundice due to a liver infection one year previously, when he had leukopenia following the use of sulfa drugs. He was treated at a hospital during February and March 1951, was transferred to another hospital in March 1951 and died about one week later, on March 11, 1951. During terminal hospitalization, there was recorded clinical information that he had been treated for a blood dyscrasia in the late summer of 1949, and that the symptoms which had occasioned his admission in February 1951 had been increasingly severe low back pain with radiation into the left lower extremity.

In view of the specific presentations advanced on the appeal, the Board obtained an advisory opinion from a specialist in nuclear medicine. In October 1969, the independent medical specialist furnished an opinion, relating in specific reference to this claim that he had studied in considerable detail in September 1945 the amounts and extent of radioactive fallout from both the Hiroshima and the Nagasaki bombs and was in command of the scientific group studying the pattern and amount of fallout from the Nagasaki bomb and that

there was no fallout outside either city in sufficient amount to have caused injurious exposure to anyone.

With respect to the level of radioactivity in Sasebo in late September 1945, the specialist said in pertinent part:

... there was no radioactivity above natural background at that time. Had there been increased radioactivity immediately following the bomb explosions, our instruments were sufficiently delicate and accurate to have detected the presence of residual radioactivity from it.

The specialist further stated that the radiation from fallout was "below any level that was biologically significant". He concluded:

It is my opinion that there is no evidence of ionizing radiation in any form having been a factor in the induction of leukemia in the case of [the veteran].

Findings of the BVA and Basis for Decision: In finding that veteran's death from leukemia was not related to radioactivity sustained during service, the Board observed:

The evidence discloses that the earliest symptoms of a blood dyscrasia were when the veteran experienced undue fatigue and malaise in 1949, about 2-1/2 years after service. Findings later revealed a leukemia which resulted in his death. The claim is based on contentions that exposure to radiation between August and December 1945, as the result of the atomic bombing of Japan in August 1945, insidiously caused the leukemia which produced death. In consideration of this claim, the Board obtained an opinion from an independent medical specialist, a leading authority on atomic radiation and its effects. This specialist in nuclear medicine gave a detailed refutation of specific contentions advanced on the appeal, concluding that there was no evidence of ionizing radiation in any form having been a factor in the induction of leukemia in the case of this veteran.

CASE NO. 11

Type of Injury: Acute Myelogenous Leukemia.

BVA's Decision: Denial Affirmed.

Date of Decision: 1971.

Appellant's Allegation: That the veteran's service-connected chronic infection of his left leg and/or treatment for such disability was the cause of his leukemia. It is suggested that, since the role of radiation cannot be excluded, a reasonable doubt exists and should be resolved in favor of the appellant.

Facts: The veteran was born in September 1919 and had active service from March 1942 to June 1946. He was in apparent good health at age 22 when he entered the service. Service medical records disclosed that the veteran sustained a compound comminuted fracture of the left tibia when hit by flak during combat in September 1943.

Despite appropriate therapy, non-union of the left tibial fracture occurred, with granulating skin wound; seven months following the injury a successful skin graft to the area of the fracture site was applied without evidence of subsequent skin infection. During this period the patient developed serum hepatitis secondary to transfusions, which remitted spontaneously. Seventeen months after the injury, the patient continued to have leg pain and X-rays showed persistent non-union. Because of suspected osteomyelitis, penicillin therapy was given.

The veteran was discharged from military service on June 14, 1946. After discharge, the veteran was followed in Veterans Administration Hospitals where three additional X-ray diagnostic studies of the involved left lower extremity were done over a fourteen year period. Clinical and radiologic evaluation of the left leg in 1960 indicated no evidence of active osteomyelitis but marked osteosclerosis at the previous fracture site. There was shortening of the left lower extremity with secondary residual weakness and loss of muscle bulk, associated with dysesthesias.

On April 9, 1962, he was admitted to the hospital with severe anemia. In February of 1962 he had pneumonia treated with Declomycin and Achromycin. After that time he had had repeated bouts of pharyngitis and sinusitis and noted increasing fatigability. A review of a bone marrow aspiration done at the time of this admission by a consultant confirmed the diagnosis of acute myeloblastic leukemia. The patient was subsequently treated with whole blood transfusions and (presumptively) intravenous chemotherapy (although not clear from the record). On August 14, 1962, the patient was again admitted to the hospital acutely ill with weakness, high fever, dyspnea.

Death occurred on August 16, 1962. Autopsy confirmed the diagnosis of acute myelogenous leukemia with generalized leukemic infiltration of parenchymal organs. There was an acute hemorrhagic bronchopneumonia as the primary cause of death. The bone marrow showed complete replacement by immature cells of the granulocytic series. The left lower extremity, particularly the tibia previously involved with trauma and subsequent presumptive chronic osteomyelitis was not examined.

The question raised by this case was whether the exposure to diagnostic X-ray and the chronic infection and inflammatory state (which existed for an indeterminate period of time following the injury) played a significant etiologic role in the eventual acute leukemia.

Medical Evidence: One medical doctor stated that chronic infection and exposure to X-ray cause some blood dyscrasia and "wondered" if the veteran's leukemia had been related to his service-connected infection. Another medical doctor expressed the opinion that the veteran's "chronic infection and repeated X-ray exposure very definitely could have been a contributing factor toward the development of an acute leukemia".

The records were then submitted to a medical officer of the Veterans Administration for an opinion regarding the relationship of the leukemia to the radiation exposure to which the veteran had been subjected because of his service-connected disabilities. It was the medical officer's opinion that the radiation exposure "would be only a speculative possibility as a cause of the veteran's leukemia".

The veteran's family physician stated in a letter submitted to the Board that there might be a connection between the veteran's repeated X-ray exposure and final development of leukemia and that it was possible that the chronic osteomyelitis could have been a contributing factor in the development of the leukemia.

The records were forwarded to a leading medical school for the opinion of an independent specialist, not employed by the Veterans Administration. The opinion furnished is, in pertinent part, as follows:

Studies of atomic bomb survivors¹, American radiologists², British radiologists³, patients with ankylosing spondylitis^{4,5} treated with X-ray and patients treated with radium I^{3,1}, thorotrast and phosphorus 32^{6,7}, all indicated that sufficient dosage of irradiation given to hematopoietic bone marrow is associated with an increase in the incidence of myeloproliferative disorders, including acute leukemias in these individuals. In the Japanese bomb casualties, the incidence of leukemia was increased ten fold, whereas in American and British radiologists prior to 1963, acute leukemia occurred with twice the frequency seen in non-radiologist physicians. Common to all of these cases, however, was a high dose of irradiation given over a variable period of time, in excess of 100 R (total body radiation), and permitting the exposure of proliferating hematopoietic bone marrow to ionizing radiation either external or internal. A study of the relation of diagnostic and therapeutic X-rays to the incidence of leukemia and lymphoma published in 1962, showed that radiogenic leukemia occurred only in association with X-rays to the chest or abdomen taken within ten years

of the onset of leukemia.⁸ In this patient, however, the total dose of irradiation given in a series of some 15 to 20 diagnostic procedures is in all likelihood much less than 100 R.

Figures on the irradiation dosage generated by the old Picker portable units employed by the Army during World War II may be available from the Atomic Energy Commission or the Armed Forces Institute of Pathology. Although these instruments were poorly columnated and permitted scatter to unshielded portions of the anatomy, the estimated dose or irradiation per fluoroscopic study (which provided a much higher tissue dose than the diagnostic X-ray) is approximately 0.25 R. A rough estimate then of this patient's total radiation exposure stemming from the initial treatment and follow-up of his tibial fracture was in the neighborhood of 5 R, certainly not exceeding 20 R. Secondly, the tibia in an adult man is not a site of proliferative hematopoietic marrow. If adequate shielding of the axial skeleton was provided during the diagnostic X-ray procedures, the patient should have received no exposure of hematopoietic bone marrow.

From these considerations, therefore, this reviewer concludes that the patient had insufficient radiation exposure to proliferative hematopoietic marrow to increase his probability of radiation leukemogenesis on the basis of the diagnostic X-ray procedures required by the treatment of his combat injury and its follow-up. The role of chronic osteomyelitis and the genesis of acute leukemia is more obscure than that of irradiation. The patient's record, however, did not substantiate chronicity of the patient's osteomyelitis for more than three years following his initial injury. There is, finally, no conclusive evidence that a localized chronic osteomyelitis increases the probability of acute leukemia. I would conclude, therefore, that though one, on theoretical grounds, cannot exclude the possible etiologic role of radiation exposure and chronic infection in the genesis of acute leukemia after a latent period of some 19 years, there is no definite evidence either from this patient's military medical record or from available medical knowledge that this patient's war wound with resultant osteomyelitis and necessary diagnostic X-ray exposure played any etiologic role in the genesis of his terminal leukemia.

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8. Stewart, A., Pennybacher, W., and Barber, R., *Adult Leukemias and Diagnostic X-Rays*, *Brit. Med. J.*, 2: 882-890 (1962).

Findings of the BVA and Basis for Decision: In finding that the service-connected disability did not cause or contribute substantially or materially to the veteran's death the Board said:

The opinions expressed by physicians on behalf of the appellant and those obtained by this Administration are essentially the same. The possibility of an etiological relationship between the veteran's service-connected disabilities with treatment for such conditions and his leukemia is conceded. The probability of such relationship, however, is shown to be remote or speculative, rather than reasonable. The fact that radiation cannot be "excluded" as a factor does not satisfactorily demonstrate the existence of a substantial doubt. Recourse to speculation or conjecture is prohibited.

CASE NO. 12

Type of Injury: Sexual Disability (sterility and/or impotence) and Skin Condition.

BVA's Decision: Denial Affirmed.

Date of Decision: 1971.

Appellant's Allegation: That his sexual disability and the peeling of the skin of his hands was due to service exposure to radioactive material.

Facts: The veteran served from February 1965 to January 1967. In May 1965 it was recorded that he was medically qualified for duties involving nuclear weapons systems, at Sandia Base, New Mexico.

Veteran contended that during a session of the "Army Nuclear Weapons Basic Maintenance Specialist Course," he used his bare hands to pick up a piece of radioactive material; that as a result, the skin peeled off his hands after a few days and his hair started to thin; that after he met his future wife, he discovered his sexual disability which he variously referred to as impotence.

The evidence of record showed that in June 1965, he was seen for a peeling of the skin of his hands. He was referred to dermatology clinic where in July 1965, it was noted that he had peeling of the skin on the palms of the hands and the palmar surfaces of the fingers for about a month. It was noted that he was in nuclear weapons school for about six weeks. The impression was dyshidrosis, and medication was prescribed. No further skin manifestations were reported during the balance of his term of service. The separation examination showed no pertinent disease or abnormalities. The service records contain no reference to exposure to or contact with radioactive material.

Medical Evidence: In July 1970, a medical doctor stated, in pertinent part, that he treated the veteran in July 1968 for complaints of impotency. Medication was prescribed and on a visit in September 1968, improvement was noted. His pertinent diagnoses were impotency, helped with medication, possibly all psychological, and tinea cruris, treated and cured.

On special urology examination, the veteran gave a history of having put his hand on radioactive material for a few seconds on one occasion. Genitalia appeared normal, and prostate was normal in size and consistency. The examiner questioned whether the veteran had sufficient exposure to radiation to account for any of his symptoms. On special dermatology examination he related incidents relative to an eruption on his hands and in his groin, loss of hair, and impotency, all of which he attributed to nuclear radiation exposure at Sandia Base in 1965. The eruption on his hands cleared up after treatment in

service and his hair grew back. The veteran stated that after he was married in 1968, he was able to have satisfactory sexual relations with his wife about 2 to 3 times a week only if he took certain pills. He stated that his wife had been examined by a physician and their childless state "may be because of her." He gave a history of a skin disorder in his groin which developed in 1969 and cleared up after a few months and has not bothered him since the spring of 1969. Physical examination of the skin revealed normal skin on his hands. There was no evidence of telangiectasia, atrophy, pigmentary changes, etc., which would be expected following excessive radiation exposure. His scalp hair was normal in density and distribution and well rooted. No eruption was evident in the genito-anal area. There was no evidence of any active eruption and no residuals of excessive irradiation exposure. Diagnosis was: Allegation of radiation damage to skin and sex organs: no evidence noted.

Findings of the BVA and Basis for Decision: In denying service connection for the reason that the veteran's sterility, impotency or skin condition was not incurred in or aggravated by active service the Board found:

1. Service medical records reveal an episode of dyshidrosis during service, which was acute and transitory, left no residuals, and was not manifest on examination prior to separation in December 1966, or on official examination in 1970.
2. Service medical records reveal no evidence of exposure to nuclear radiation during service.
3. The evidence of record does not establish that the veteran is suffering from sterility or impotency due to nuclear radiation in service.

In support of its decision the Board pointed out:

Entitlement to service connection implies not only that there was injury or disease manifested in service, but also that the injury or disease resulted in residual disability.

In this case, the evidence of record shows a service episode of peeling of the skin of the hands and the examiner's impression was dyshidrosis. The disorder cleared immediately and no further manifestations were reported for the balance of his service or at examination for separation in December 1966 or on Veterans Administration examination in 1970. He had an episode of tinea cruris, treated and cured by his physician, subsequent to service. No evidence of exposure to radiation was reported in the service records. Medical evidence since service does not establish that the veteran has a sexual disability due to nuclear radiation.

CASE NO. 13

Type of Injury: Myeloid Leukemia.

BVA's Decision: Denial Affirmed.

Date of Decision: 1969.

Appellant's Allegation: Veteran claims he received bodily damage from radiation received in a service X-ray school.

Facts: Veteran served from February 1946 to August 1947. During this period he attended a 16-week X-ray technicians' school and was assigned as an X-ray technician at a general hospital. After his discharge from the Army the veteran served as an X-ray technician for most of the period before he became ill in 1966. In June 1966 he had a white blood count of 18,000 per cubic Millimeter. He was treated with antibiotics and the WBC decreased to 11,000. In August 1966 the WBC was again found to be elevated. In November and December 1966 he showed persistent leukocytosis and a final diagnosis of chronic myeloid leukemia was reported.

Medical Evidence: An independent medical expert stated:

The veteran claims that he received bodily injury from ionizing radiation while in the Army X-ray School at the age of 18 years, which injury led to chronic myelogenous leukemia about 20 years later. He contends that at least 50 per cent of the damage he received was aggravated by his exposures while in the service. However, he worked for 20 years as a civilian X-ray technician. There are no records available of the exposures to radiation received by the veteran while in the service nor are there records of blood counts done on him at that time. Hence one must rely on estimates of dose. Firm data are missing. He was apparently healthy and without evidence of damage on discharge.

Both in civilian and in military installations less protection against radiation was used prior to 1954-1955 than after that period. The possibility exists that while serving as a subject for the taking of films while in the X-ray Technicians School as well as in the regular work the veteran had received some radiation. Assuming 80 kV, X-ray appliances, as were then used, the dose measured in air might have approximated one R per exposure, about 30 percent of which might have reached some bone marrow cells. Moreover, this would have been partial-body exposure, which is less effective than whole-body radiation in inducing leukemia. A good part of his exposure would have been of the long

bones and extremities which contain little functioning hematopoietic bone marrow and, hence, this portion of the radiation would not be pertinent to the question of leukemia. The total effective dose to his hematopoietic tissue was probably less than 25 Rem.

In light of this estimate and knowledge of the experience of others who received comparable training in the Army, I doubt strongly that sufficient radiation would have been received by functioning hematopoietic bone marrow of the veteran while he was in the service to cause leukemia of any type.

The assumption is reasonable that the veteran's chronic myelogenous leukemia might have been incurred as a result of damage to his bone marrow from radiation received in the course of his work as a civilian X-ray technician for 20 years. It would be sheer speculation to attempt to say, as the veteran does, that any definite percentage could be ascribed to his work while in the service as compared to that received as a civilian.

Even though a reasonable doubt as to the service origin of the leukemia should be resolved in favor of the claimant, there is not in this instance such a doubt. In view of his 20 years spent as an X-ray technician following his Army service the additive exposures during this long period were much more probably the cause. It will be noted that the veteran reports that the Ohio State Industrial Commission has approved his claim for leukemia as an occupational disease attributable to his civilian employment of 20 years' duration.¹ My opinion concurs with this, and I believe only on a basis of speculation could one assume the exposures received during his military service to be causative.

Findings of the BVA and Basis for Decision: In finding that service connection for chronic myeloid leukemia is not warranted the Board said:

Although a relationship between excessive X-radiation exposure and leukemia is known, it has not been established, with any known degree of certainty, that the exposure to X-radiation in service was a significant causative factor in the development of leukemia.

In addition the Board noted:

It is conceded that there is a relationship between radiation exposure and myeloid leukemia. However, the X-radiation exposure of over 20 years' duration cannot be disregarded. The Board is mindful of the principle of reasonable doubt, but a careful review of the evidence and the opinions set forth by the independent medical specialist and the veteran's personal physician do not afford a basis to conclude that the exposure to radiation in service was a significantly causative factor in the development of leukemia. To so conclude would be purely speculative.

¹ The Ohio Industrial Commission allowed his claim for total permanent disability; and upon his death in 1971 approved a death claim of his widow due to X-ray exposure attributable to his civilian employment of 20 years duration.

CASE NO. 14

Type of Injury: Bronchogenic Carcinoma of the Lung.

BVA's Decision: Denial Affirmed.

Date of Decision: 1970.

Appellant's Allegation: That radiation to which her husband was exposed while stationed in Japan caused an eye disorder and the lung cancer which resulted in his death.

Facts: The veteran served on active duty from June 1942 to January 1946, and from March 1949 to March 1961. During his first period of service the veteran served on active duty within the United States. Service records further showed that the veteran served in Japan and Korea from April 1953 to April 1954. There was no record that the veteran was exposed to radiation during service. Service medical records for this period of one year show that the veteran was treated briefly for pleurisy. On an examination in August 1954 for the purpose of discharge and reenlistment, physical examination was essentially normal. The lungs and chest reported normal, and a chest X-ray was reported negative. Visual acuity was noted to be 20/50, bilaterally, when corrected.

His death in December 1968 at the age of 56 was certified as immediately caused by bronchogenic carcinoma, oat cell type, left lobe, with wide-spread metastasis. In 1969 the widow filed a claim for service connection for the cause of the veteran's death.

Medical Evidence: In December 1954, the veteran was examined for complaints of poor visual acuity since July 1954. Diagnostic studies resulted in a diagnosis of macular degeneration, bilaterally, cause undetermined. Physical and X-ray examination of the chest performed at that time was negative. During the remainder of his service the veteran was examined periodically for his eye disorder. No complaints or abnormalities of the chest or lungs were noted during this period, and chest X-rays were normal. The veteran was discharged from service in 1961 for macular degeneration, bilaterally; and for blindness, bilaterally, secondary to the macular degeneration. On examination at discharge, the chest X-ray was reported normal.

In 1961, after discharge from service, the veteran was granted service connection for macular degeneration in both eyes. This was evaluated as ninety per cent (90%) disabling from 1962.

In September 1968 he was admitted to surgical service and examination revealed a carcinoma of the lung which had metastasized. After the veteran's death, an autopsy was performed. Pathological diagnoses included

bronchogenic carcinoma, oat cell type, left lobe; diffuse metastases; and hemorrhage into left lower space. The autopsy did not include an examination of the veteran's eyes.

A medical doctor reported that during the period that the veteran was under his care he did not know that the veteran had been diagnosed as having macular degeneration. The doctor noted that during his last few weeks the veteran exhibited mental confusion and deterioration. A pathologist noted that the appellant claimed that the veteran was exposed to radiation during service. He expressed the opinion that in view of the nature of the carcinoma, that if the veteran were exposed to ionizing radiation in an unusual amount, it would appear a distinct possibility that the radiation exposure constituted an additional factor which could well have been the basis for the later development of bronchogenic carcinoma and the death of the veteran from this malignancy.

Findings of the BVA and Basis for Decision: In finding that the record did not warrant a grant of service connection for the cause of the veteran's death the Board stated in pertinent part:

The Board has carefully reviewed all the evidence of record in this case. We have specifically searched for evidence to determine whether the veteran was exposed to ionizing radiation during his second period of service. From our review of the record, it appears that the veteran was stationed in Korea and Japan between April 1953 and April 1954. However, the service records do not indicate that he was exposed to radiation during this period. A record of exposure to ionizing radiation does not show that the veteran was ever exposed to radiation, and service medical records are negative for any complaints or abnormalities indicative of exposure to radiation. It is noted that atomic weapons testing did occur during this period, but that the site of such testing was far removed from Japan or Asia.

A further review of the service medical records show several physical and X-ray examinations of the veteran's chest during service, which were reported normal. On discharge from service, his chest was also normal. A carcinoma of the lung was first found in 1968, approximately 7½ years after discharge from service. In the absence of any clinical manifestations of such disability during service and in view of the fact that the veteran was not exposed to radiation during service, the evidence does not establish that the carcinoma which caused the veteran's death was of service origin. During service the veteran did incur macular degeneration in both eyes, and when he was discharged from service he was granted service connection for this disability. However, the autopsy, although it did not contain an examination of the veteran's eyes, did conclusively establish that the cause of the veteran's death was the carcinoma of the lung. The macular degeneration of the eyes is not etiologically related to the carcinoma of the lung which caused the veteran's death, and did not substantially or materially contribute to cause his death.

CASE NO. 15

Type of Injury: Sycosis Vulgaris Including Residual Radiation Burns.

BVA's Decision: Denial Reversed.

Date of Decision: 1970.

Appellant's Allegation: That sycosis vulgaris was aggravated by service including extensive treatment therefor.

Facts: The veteran had active service from July 1943 to December 1944 when he was discharged on report of medical survey by reason of sycosis vulgaris. No pertinent defects were noted on examination for service at which time the skin was referred to as normal or negative.

Service medical records show that the veteran was hospitalized in August 1943 complaining of pustular eruption of the beard present for approximately two years. There had been prior treatment, but no X-ray therapy. Physical examination disclosed discrete follicular pustulous eruption of the beard area of the cheeks and chin. The neck was very slightly affected. Medication was prescribed and improvement was noted. He was discharged to duty in September 1943 described as apparently well. The diagnosis was sycosis vulgaris.

He reported to sick bay in May 1944 for the same complaint and was ultimately transferred through channels to a fleet hospital in June 1944. At that time it was reported that there had been eruption of the beard area of the face for the preceding five years, usually fairly well under control. It was further reported that when the ship entered the tropics, pustules began to erupt. Physical examination disclosed severe follicular pustular eruption of the beard area of the face and neck. Medication was prescribed with no definite improvement. Moderate anemia was noted. Subsequently he received 10 X-ray treatments which markedly improved the disorder, but never entirely cleared it up. The notation was made that in the tropics the disorder became markedly worse. Ultraviolet ray therapy was prescribed. He was assigned to limited duty within the continental United States pursuant to the action of a survey board which determined that sycosis vulgaris preexisted active service and had been aggravated thereby. Subsequently, another survey board determined that aggravation had not occurred as the condition was much improved. It was further determined that he was not fit for further duty because of the chronic dermatitis which would be aggravated by tropical service. It was stated that the veteran was desirous of remaining in service and his record was good. However, he was discharged from the hospital in October 1944 to limited duty and from the service in December 1944.

On Veterans Administration examination in February 1969 the veteran complained of "burns of throat". Examination disclosed a 3-inch by 3-inch area of scarred skin involving the neck. The skin over the lower part of the nose, upper lip and chin was described as dry, thin and smooth and there was superficial atrophic scarring. There was no sign of sycosis vulgaris. The diagnosis was radiodermatitis, mild, on the nose, upper lip and chin (not disfiguring); radiodermatitis, moderately severe, anterior portion of the neck (disfiguring).

Medical Evidence: A report from the outpatient department of the agency of original jurisdiction contained an expression of medical opinion that skin changes disclosed on Veterans Administration examination in February 1969 were compatible with late effects of radiation therapy and could have been the result of X-ray treatment dosage rendered the veteran during service. It was further stated that therapy rendered was acceptable treatment at the time and there was no negligence or lack of skill apparent.

Findings of the BVA and Basis for Decision: In resolving reasonable doubt in favor of the veteran, the Board concluded that sycosis vulgaris which was present before service was aggravated by service, and it said:

The evidence, including statements recorded for clinical purposes, shows that sycosis vulgaris preexisted active service and it is not otherwise contended. The only question for consideration by the Board is whether the preservice skin disorder was aggravated by service.

Aggravation arises where, during service, a preexisting disease or disability undergoes increase in severity not accounted for by natural progress. Usually, an increase not due to natural progress, would be conceded where additional disease or injury was superimposed upon the preexisting condition while the veteran was in service, constituting a greater disability than that which existed at the time he entered service. The question of aggravation is determined by a preponderance of the evidence. Where a preexisting disease or injury was manifested during service only by its usual or expected characteristics, aggravation is not demonstrated. It may be stated that the usual effects of medical treatment during service, having the effect of ameliorating disease or other conditions incurred before service, will not be considered service connected, unless the disease or injury was aggravated by service other than by the usual effects of treatment.

In this case the skin was described as negative or normal at the time the veteran entered active service. Symptoms of the preservice skin disorder were manifested approximately one month later. After approximately a month of treatment there was apparent subsidence of the disorder and he was returned to duty. However, he reentered the hospital in May 1944 and remained hospitalized or under medical supervision practically continuously until the time of his discharge from service in December 1944. During this interval it was reported that after the ship on which he was stationed entered tropical waters there was a recurrence of the skin disorder and the condition was markedly worse.

Despite local treatment, including X-rays and ultraviolet light therapy, results were inconclusive and he was surveyed initially to limited duty and later from service because of the chronicity of the disorder and its relative recalcitrance to treatment.

It has been medically determined that the radiation therapy during service was consistent with the standards of treatment at the time and there was no apparent negligence or lack of professional skill involved. Aggravation by reason of the treatment effects per se is not demonstrated. However, it is the determination of the Board that the evidence is such as to present sufficient latitude for finding that there was an increase in the basic skin disorder incidental to the veteran's service apart from the treatment effects. It follows that any residuals as the result of treatment may not properly be separated from the disability. It is the determination of the Board that there was an increase in the basic disorder attributable to the veteran's service and that any residuals caused by treatment of the disorder are a component of the residual disability.

CASE NO. 16

Type of Injury: Metastatic Bronchogenic Carcinoma.

BVA's Decision: Denial Affirmed.

Date of Decision: 1971.

Appellant's Allegation: That carcinoma of the brain and carcinoma metastatic of the lungs resulted from his exposure to radiation during service in August 1945 after the bombing of Nagasaki.

Facts: The veteran served from June 1939 to June 1959. Service medical records show that in September 1958 full mouth X-rays during dental examination showed a cystic-type lesion, midline of maxilla. There was no evidence of a neoplasm. The diagnosis was nasopalatine duct cyst, maxilla. Service records are negative for any evidence of malignancy. Numerous examinations during service, including chest X-rays, disclosed an abnormality of the respiratory system.

The veteran died on May 16, 1969. The certificate of death on file shows the cause of death was metastatic brain tumor due to bronchogenic carcinoma. At the time of the veteran's death, service connection was not in effect for any disability.

Evidence indicated that during service, in August 1945, after the bombing of Nagasaki, the veteran spent a night going through the posted "hot" area due to the error of a boat coxswain in landing them on the wrong side of the bay; that he remained in the area for another three months; that he attended atomic tests at Camp Desert Rock, Indian Springs, Nevada, in 1951, for approximately one week.

Medical Evidence: Included in the evidence of record are clinical records of terminal hospitalization at Madigan General Hospital in May 1969. These records show that the veteran was admitted because of headaches, agitation, and paralysis of the left side. It was reported that he had been previously hospitalized from September to November 1968, after an abnormal chest X-ray in August 1968, showing a 3.5-centimeter, well-defined mass in the apical portion of the right lung, adjacent to the mediastinum. It was noted that a chest X-ray two years previously had been negative. After initial evaluation for possible infectious etiology for the right upper lobe mass, he underwent a right upper lobectomy in October 1968, revealing a primary tumor of the lung of bronchiolar epithelium.

A regional lymph node was negative for tumor. Following discharge from the hospital, he had an evaluation for possible carcinoma elsewhere, and this was nonrevealing. He did relatively well following discharge until March 1969, when he was seen in the clinic with complaint of a lump in the region of the right trapezius muscle. He was hospitalized in March 1969 for evaluation of this mass. At this time, a chest X-ray showed multiple bilateral pulmonary nodules consistent with metastatic carcinoma. A brain scan showed a lesion in the right parieto-occipital area adjacent to the midline. During the period of hospitalization in May 1969, physical examination revealed a hard, firm mass beneath the right trapezius muscle. Chest X-ray disclosed multiple metastatic lesions, with areas of pneumonitis. During hospitalization his mental status and overall condition progressively and quickly deteriorated. His downhill course continued and he expired. Final diagnoses were carcinoma, metastatic, brain; carcinoma, metastatic, multiple, both lung fields, with probably primary site lung; and pneumonitis, superimposed.

Findings of the BVA and Basis for Decision: In finding that the veteran's carcinoma was not incurred in or aggravated in service the Board said in pertinent part:

... It is not shown that the carcinoma, diagnosed many years after discharge from service, was present in service or manifested itself within one year following wartime service for the purposes of presumptive service connection. The many studies made as to causes of bronchogenic carcinoma have not identified any specific agent, bacterial, chemical, or other factors. Under known medical principles on the present facts, it would be entirely speculative to hold that exposure to radiation in service had a direct causal relationship to the malignant disease of the lungs.

CASE NO. 17

Type of Injury: Acute Myelocytic Leukemia

BVA's Decision: Denial Affirmed.

Date of Decision: 1968.

Appellant's Allegation: That the leukemia which resulted in veteran's death was caused by excessive radiation to which he was exposed while participating in atomic tests.

Facts: In July 1946 veteran was a member of a submarine crew which participated in atomic tests at Bikini Atoll on July 1 and July 25. He was sent to San Diego Naval Station on September 13, 1946 for an examination. The examination reflected that available records failed to reveal any dosage received by veteran other than that incident to medical or diagnostic procedures. Veteran retired in 1953 and died June 8, 1966 from bronchopneumonia due to acute myelocytic leukemia of 3-4 months duration.

The appellant stated that following veteran's return from service, the veteran had no desire for sex, complained constantly about being tired, suffered with severe hoarseness of throat, and had "aching bones" complaints which he thought was arthritis. She said he saw Navy doctors many times but was always given vitamins. She submitted a copy of a newspaper item to the effect that lung cancer among miners exposed to uranium radiation takes 20 years to develop. She cited a Department of Defense textbook to the effect that, "There are a number of consequences of nuclear radiation which may not appear for some years after exposure. Among them, apart from genetic effects, are the formation of cataracts, nonspecific life-shortening, leukemia, and other forms of malignant disease . . ."

Medical Evidence: The report of terminal hospitalization from April 21, to June 8, 1966 contains the following information:

System Review: The patient complained of intermittent epigastric distress described as a burning sensation and relieved with antacids and meals. Ten months prior to admission he had an episode of bright red bleeding, rectally. Upper GI series and proctosigmoidoscopy were reportedly negative. The patient was treated with Maalox and told he had bleeding hemorrhoids and gastritis.

Present Illness: The patient was in good health until 2 months prior to admission, when he noted gradual onset of progressive fatigue, lack of

energy, increased irritability, generalized pruritis, progressive dyspnea causing shortness of breath, intermittent episodes of dizziness and palpitations. During the 2 weeks prior to admission he lost 4 lbs. but attributed this to a weight reduction diet. He also noted the onset of nocturnal chills which lasted 5-10 minutes then subsided. He had spontaneous epistaxis during the past 3-4 days and complained of a sore throat on admission.

In addition, the hospital report stated that the claimant and other members of the crew consumed some ship's water that was accidentally contaminated with radioactive material; that repeated physical and blood count examinations for a number of years were all negative, and "Apparently the patient suffered no acute effects from the over-exposure to radioactivity."

The report further stated in pertinent part:

Approximately 4-5 months prior to admission the patient accidentally inhaled some burning chemical compounds . . . The fumes caused chest congestion and nausea which persisted for 2 days, then subsided . . . When his symptoms progressed in severity he . . . was found to have a WBC of 800, with a hematocrit of 15.5 and hemoglobin of 5.5.

Detailed clinical, laboratory and X-ray studies, including bone marrow aspiration, resulted in a pertinent diagnosis of acute myelocytic leukemia, subsequently confirmed by autopsy. During hospitalization, the veteran remained febrile. At the time of his death, service connection was not in effect for any disability.

Findings of the BVA and Basis for Decision: In finding that the acute myelocytic leukemia was not incurred in or aggravated by service and was not manifested to the degree of ten percent (10%) within the presumptive period following termination of active wartime periods of service, the Board said:

It is the defined and consistently applied policy of the Veterans Administration to administer the law under a broad interpretation, consistent, however, with the facts shown in every case, and without recourse to speculation or remote possibility. The records clearly establish that the veteran was physically present at the site of atomic bomb tests in July 1946. Whether he was, in fact, directly exposed to radiation to any appreciable degree is not reflected by the records furnished by the service department. Assuming, however, that he and others did consume some ship's water that had been accidentally contaminated with radioactive material, it is well established that no case of leukemia has been known to have developed with acute whole-bodied doses of less than 100 roentgens. It is extremely unlikely that the consumption of such contaminated water could involve such proportions. It is generally accepted that a latent period of two or more years commonly intervenes between exposure and the appearance of leukemia. In acute myelocytic leukemia, aside from bone marrow aspiration, an abnormal total white blood cell count is the significant

factor. Normal values range from 4,500,000 to 5,000,000 red blood cells; 5,000 to 10,000 white blood cells; and hemoglobin from 85 to 100 percent. In this case, the white blood cell count was well within the normal range in 1947 and 1954, but was extremely low when taken shortly before his hospitalization in 1966. The onset of acute myelocytic leukemia is sudden and its course rapidly progressive and short. The median survival time is measured in months. A determination, therefore, that, in this case, the acute myelocytic leukemia first demonstrated approximately 20 years after exposure to radioactive material is causally related to such exposure would involve prohibited recourse to conjecture or speculation.

CASE NO. 18

Type of Injury: Carcinoma of the Left Arm and Face.

BVA's Decision: Denial Reversed. Claim could not be supported on basis the carcinoma was caused by X-ray radiation but compensation granted on other grounds.

Date of Decision: 1967.

Appellant's Allegation: That basal cell carcinoma of the face and left arm were due to either exposure to sun in service and/or post service X-ray therapy.

Facts: Veteran's active military service was from March 1941 to December 1945 including overseas duty in the Asiatic-Pacific Theater from February 1944 to September 1945. After basic training, specific assignments were a year as a light truck driver, 5 months as a lineman, 1½ years as a light artillery gun crewman, and 15 months as a tank commander. Veteran served with a cannon company of an infantry regiment during the Solomon Island and Philippine campaigns. In June 1945 he developed infectious hepatitis and was hospitalized until evacuation to the United States in November 1945. Following his return to the United States he was treated for pain in the region of his left shoulder. He was discharged from the service in 1945 because of an arthritis involving the 4th and 5th lumbar vertebrae which was thought to be traumatic, resulting from a fall in March 1944. The lumbosacral spine was X-rayed in June, July, August and October 1945. No other X-rays in service are of record, and no skin lesions were found at any time. Post-service treatment of service-connected bursitis of the left shoulder included two periods of deep X-ray therapy in 1947 and 1950. Between March 25 and April 5, 1947 six deep X-ray therapy treatments to the left shoulder were given. Dose and field were not recorded. Deep X-ray therapy to the left shoulder was also administered in December 1950 on eight occasions with a 200 kv machine. Exact fields were not recorded. Records indicated the dose as 105 r. It is not clear whether veteran received a total of 105 r or 105 r for each treatment. Almost six years after the 1950 therapy, a basal cell epithelioma was found on the lateral aspect of the left arm. The same malignancy was discovered shortly thereafter in an old scar on the cheek and subsequently appeared on the temples and right upper lip and cheek. He received X-ray treatment from August to October 1956. Ten X-ray treatments in all were given to the fingers; of these, eight were also directed to the arm. However the exact location and dose were not specified. Dental X-rays were made in December 1946, January 1948 and January 1950.

Medical Evidence: Several advisory opinions from medical experts were obtained by the Board as to whether basal cell carcinoma of the left arm and face was etiologically related to exposure to the sun and/or post-service X-ray therapy for bursitis of the left shoulder. These medical experts were generally in agreement that the X-ray therapy was not related to the skin tumors. One of the experts stated:

The X-ray therapy given this veteran appears to be small in amount, from the record, although exact figures are not stated. This conclusion is confirmed by the appearance of skin, without atrophy, and absence of pathological changes in the skin such as telangiectases and vascular damage. Consequently, it is so unlikely as to be unworthy of consideration that this dosage led to carcinoma formation. Moreover, carcinoma secondary to radiation is squamous, not basal type.

Another expert, a radiologist, stated:

The question at issue in this case is whether the patient developed a radiation induced basal epithelioma in the left upper arm on the basis of treatment by deep X-ray therapy of a benign condition of the shoulder nine years previously.

I believe that the multiple basal cell epitheliomas of the face which developed cannot in any way be attributed to the roentgen treatment of the shoulder and, therefore, need not be further considered. The proper administration of X-ray therapy will have totally excluded the facial area from the affect of the X-ray beam. It is, therefore, only a question of the single basal cell epithelioma of the arm.

It is stated that the patient received six deep X-ray therapy treatments to the left shoulder in 1947. I do not have available the information as to the total dose received. I will assume that the treatment was directed by a properly trained radiotherapist and, therefore, that the total dose given the patient was the standard amount for treating a benign condition in this area and, therefore, well below the amount likely to produce a radiation injury to the skin. There is no mention in the folder of an abnormal appearance of the skin in the area of treatment such as atrophy, depigmentation, telangiectases, or ulceration which would occur in an area of radiation dermatitis. It is not considered likely that a skin cancer would develop in a region where no apparent skin damage existed. Radiation carcinomas of the skin are known to arise in areas heavily damaged by chronic radiation.

Even in these cases there is usually a long period of time before the epithelioma develops. In this case only nine years have passed between the time of treatment and the date of removal of the epithelioma. This is considered too brief an interval for there to be a direct association between the two factors.

In addition, if the point is considered relevant to this case, basal cell epitheliomas are relatively benign and with proper treatment do not recur. They only produce local growth and do not metastasize.

Basal cell epitheliomas commonly occur in males in the later decades

of life, in people of fair complexion exposed to the weather and sunlight

All the available facts indicated that the development of the epithelioma in the area of previous X-ray radiation was probably coincidental. The development of multiple epitheliomas of the face where the question of radiation is not at all involved makes it not unlikely that epitheliomas would appear at random on other parts of the body.

Findings of the BVA and Basis for Decision: The Board concurred in the opinions rendered by the radiology specialists and other medical specialists that the carcinoma was not caused by X-ray radiation. The chest, left shoulder and spine X-rays in service and thereafter did not present a radiation hazard, and post-service dental films were several years apart. Service-connected left subdeltoid bursitis was given deep X-ray therapy at a private hospital about 15 months after discharge, and eight such treatments were authorized by the Veterans Administration in December 1950. No skin changes were noted during such treatments or upon examination in 1951 and hospitalization in 1955. X-ray therapy was also used for nonservice-connected contact dermatitis of the arms and fingers in 1956.

The Board, by a 5-4 decision, however, allowed the claim on other grounds, i.e., that there was a causal relationship between prolonged exposure to sunlight in service and the malignancy which appeared thereafter. In resolving doubt in the veteran's favor the Board indicated that an independent medical expert, contrary to the opinions of other medical and radiology specialists, considered it "probable" that exposure to strong sunlight in service played an important role in the subsequent development of the veteran's skin malignancy. The dissenting opinion disagreed with the finding of service connection as "purely speculative" in nature and said "the evidence in its entirety does not warrant invocation of the doctrine of reasonable doubt."

CASE NO. 19

Type of Injury: Chronic Lymphocytic Leukemia.

BVA's Decision: Denial Reversed.

Date of Decision: 1967.

Appellant's Allegation: That his chronic lymphocytic leukemia was caused by X-ray treatment received for service-connected rheumatoid spondylitis.

Facts: The Appellant served from February 1942 to December 1947. In 1949 he developed rheumatoid spondylitis, which was determined to be service connected. He underwent a series of X-ray treatments for the condition. According to the veteran he had been similarly treated by a roentgenologist in Berlin in 1948. In 1962 he was found to be suffering from chronic lymphocytic leukemia.

Medical Evidence: An independent medical specialist examined Appellant's records and he noted:

According to [veteran's] appeal he received X-ray treatment for spondylitis from a private roentgenologist in Berlin, Germany, in 1948. The dosage is unknown. The dose commonly used on the continent of Europe at that time was about 400 to 1600 r per treatment.

* * *

On April 2, 1949 at [a private clinic] he received X-ray treatments to the back from the occiput to below the sacroiliac joint. Each of the three fields treated received a dose of 130 KV X-ray and amounting to 135 r per field. Some overlap of fields probably occurred during the treatment, doubling the dose for some of the marrow. This treatment was then repeated once.

In addition to the radiation received at the [clinic] there is probably the radiation received in Berlin which would about double the dose. Then there is in the file "he has received a number of diagnostic X-ray studies", which would add 25 to 50 more r. Therefore, the minimum dose he received is 295 r. The maximum dose that his spinal marrow received is 590 r in its entirety with the possibility that portions of the marrow might have received close to 1000 r.

His cervical lymph nodes would, therefore, have received because of absorption and backscatter from 57 to 77 per cent of this radiation, his

mediastinal and abdominal lymph nodes about 38 per cent on the basis of the known physical factors of the [clinic] radiation. The bone marrow of the vertebral column because of the mineral structure of the bone would have received a larger dose, on the order of 155 per cent. The marrow of the posterior ribs and sacroiliac region would have received perhaps somewhat more than the vertebral marrow.

* * *

In 1962 he was found to have chronic lymphatic leukemia. Because chronic lymphatic leukemia often has an insidious course, it is quite possible that this had been present for some years prior to 1962, perhaps three or four, which would place the onset at the time of maximal onset for radiation induced leukemia^{1,2}. A large series of patients with spondylitis who have received X-radiation therapy has been studied in the United Kingdom by Court-Brown and Doll. They found . . . no cases of leukemia developing at less than 250 r, two cases between 250 and 500 r delivered to the spinal marrow. They found four cases they called lymphatic leukemia (probably acute).

* * *

To summarize, the weight of evidence is against the hypothesis that chronic lymphatic leukemia is ordinarily induced by either acute or chronic exposure to radiation. On the other hand, in the cases of spondylitis treated by ionizing radiation over the spine for the relief of pain, the classic study of Court-Brown and Doll . . . indicates the development of an excessive number of cases of lymphatic leukemia (probably acute) above the expected . . . They found four cases they called lymphatic leukemia (probably acute). However, at least one may have been of chronic type. They found one case which they consider to be acute myeloid which was stated to have a count of 42,000 white blood cells, mostly mature lymphocytes. This, therefore, may well have been a case of chronic lymphatic leukemia, although they did not so regard it.

Since the spondylitis from which [the Appellant] suffered has been adjudged to be a service connected disability, since chronic lymphatic leukemia developed within a reasonable time (less than 13 years) after his radiation treatment for this disease and since an excess of lymphatic leukemia cases (at least one of which may have been of chronic type) has been reported to follow radiation treatment of spondylitis, one has to assume in spite of other evidence to the contrary, largely derived from nonspondylitics, that in [the Appellant's] case the chronic lymphatic leukemia may well have developed as a result of the radiation therapy

¹Court-Brown, W. M. and Doll, R.: Leukemia and Aplastic Anemia in Patients Irradiated for Ankylosing Spondylitis. Medical Research Council Special Report Series No. 295. London, 1957.

²Warren, S. and Lombard, O. M.: New Data on the Exposure of the Human Population to Ionizing Radiation. In press-proc. XI International Congress of Radiology.

that he received, (probable in 1948 and certain 1949) for a service connected disability. Therefore, his leukemia might well be considered as service connected.

Findings of the BVA and Basis for Decision: In deciding that service connection for lymphocytic leukemia, secondary to rheumatoid spondylitis, was established the Board noted:

In reviewing the medical literature, we found that a relationship between radiation exposure and leukemia is recognized; that the leukemia reported in this connection was usually of a type other than lymphocytic leukemia. Nevertheless, lymphocytic leukemia was reported in some of the cases after radiation exposure. [An expert] in the field of radiation exposure and its pathological effects . . . reviewed the evidence and it is his opinion that a causal relationship between chronic lymphocytic (or lymphatic) leukemia and previous radiation therapy may not be ruled out in the instant case.

CASE NO. 20

Type of Injury: Acute Lymphatic Leukemia.

BVA's Decision: Denial Reversed. Claim was not supported on basis that leukemia was caused by ionizing radiation but compensation granted on grounds that statutory presumptive service connection for leukemia was granted.

Date of Decision: 1970.

Appellant's Allegation: That veteran's death from leukemia was a result of exposure to ionizing radiation during active service.

Facts: Veteran served on active duty from June 1954 until June 1957. He died in October 1961 and the cause of his death was certified, after autopsy, as acute lymphatic leukemia. The veteran served as a nuclear officer during service. No dosimetry records existed, however, quantitating the veteran's exposure to ionizing radiation during his service as a nuclear officer.

Medical Evidence: Leukemia was not diagnosed during the veteran's active service and no findings specifically diagnostic of leukemia were reported in his service medical records.

In the current consideration of the claims, the BVA remanded the case in May 1968 for the purpose of securing further detailed information concerning the extent of the veteran's exposure to ionizing radiation during service as well as pertinent medical reports and pathologic analyses obtained on postmortem examination. Upon completion of the requested development, the BVA then referred all records and assembled pathologic material to a leading medical school and requested the dean to designate a specialist in the field of pathology and effects of ionizing radiation to study the records and furnish an opinion thereon.

The specialist reported as follows:

It is claimed in behalf of [veteran's] children that the leukemia was related to his exposure to ionizing radiation during his work as a nuclear officer in the Air Force. As a nuclear officer, had he been exposed to radiation, he would have had records quantitating such exposure. No such records exist either at the National Personnel Records Center in St. Louis or at Wright Patterson Base. Hence, it is extremely unlikely that in the course of his work he received any significant radiation.

In the record a statement is made by the [appellant's service] representative that "Modern medical textbooks definitely state that in

the majority of cases where there is exposure to ionizing radiation they later develop lymphoblastic leukemia." This statement is erroneous. The fact is that in those persons exposed to ionizing radiation, some of whom may develop leukemia, the form of leukemia is more commonly myelogenous.

* * *

It is my opinion that the leukemia from which the veteran died was not service connected. It is further my opinion that he may have had chronic lymphatic leukemia, an insidious and slowly progressive disease with relatively little initial disability, in 1955 or 1956 and that the acute leukemia did not necessarily develop *de novo* in 1961 but may have been an acute exacerbation of a previously existing and relatively slowly developing chronic lymphatic leukemia.

Findings of the BVA and Basis for Decision: The Board concluded with resolution of reasonable doubt in favor of the veteran, that leukemia was incurred during the veteran's active service; was manifested during such service to the degree of ten per cent (10%) within the one year period following the official termination of the Korean conflict on January 31, 1955; and, accordingly, that presumptive service connection for leukemia was established. The Board entered the following pertinent findings:

1. The veteran served as a nuclear officer during service but the records do not establish exposure to a significant degree of radioactive substances.
2. A left-sided pain was initially reported in the service records commencing in June 1955 which, in retrospect, may reasonably be considered indicative of enlargement of the spleen due to leukemia.
3. A differential white blood cell count in March 1956 showed an abnormally high percentage of polymorphonuclear leukocytes and lymphocytes, retrospectively considered strongly suggestive of chronic lymphatic leukemia.
4. Acute lymphatic leukemia was clinically identified and diagnosed early in 1961.
5. The entire record now establishes the reasonable probability that the veteran's leukemia was in existence during his period of active service.

CASE NO. 21

Type of Injury: Carcinoma of the Ovary.

BVA's Decision: Denial Affirmed.

Date of Decision: 1965.

Appellant's Allegation: That ovarian carcinoma is due to exposure to X-rays during service or is secondary to a previous service-connected anemia which was noted during service.

Facts: The veteran had active service from February 1944 to December 1944. Service records show she was hospitalized from August 1 to 12, 1944 for secondary anemia. The records also indicate that this condition had existed prior to her entrance into service. The veteran was again hospitalized August 31, 1944, and did not thereafter return to duty. Her disorder was originally diagnosed as anemia, secondary to roentgen ray exposure. It was also noted that from 1938 to 1944 she had been an X-ray technician and had worked with a variety of machines, the majority of which, including the machine she was working on during service, were not properly screened. Service records also disclosed she was invalidated in 1944 by reason of anemia diagnosis which service medical authorities held had existed prior to service and was not aggravated by service. Veteran continued under medical care for anemia and, on occasions, was hospitalized during the period from her retirement from service in 1944 until October 1964. In October 1964, a total hysterectomy, bilateral oophorectomy and left salpingectomy was conducted for carcinoma of the right ovary.

Medical Evidence: The veteran was under the care of a physician from July to September 1944 while both were in the service. In reporting that the veteran had anemia while operating an improperly screened X-ray machine, the physician stated:

I can only tell you that [the veteran] served in the naval dispensary at Vero Beach, Florida in 1944 as an X-ray technician, that she had to use a machine without a safety shield for several months and that she developed rather severe anemia which, in my opinion, was related to this fact.

I believe that there is a definite relation between over-exposure to radiation and the development of blood dyscrasias and of malignant disease in some persons. Therefore, I can say that, in my opinion, there might be a possibility of relationship in her case.

The Board requested a medical opinion concerning any etiological relationship between the veteran's carcinoma and exposure to X-ray. The following opinion was received:

The records in this case have been carefully reviewed. It is my opinion that there is no reasonable medical basis for concluding that the carcinoma of the right ovary initially diagnosed in 1964 was etiological related to X-ray exposure during service in 1944.

The depth dose received during the course of a technician's duties, even with equipment that is defective and relatively unprotected, would be insufficient to be carcinogenic with a lesion appearing twenty years after exposure to ionizing radiation.

The veteran's representative requested that an independent medical opinion be obtained and in response to this request the veteran's claim folder was reviewed by the Chief, Radiation Therapy Department of a leading university medical school. His opinion included the following:

... as far as I can determine, no real attempt has been made yet to estimate what her exposure might have been. The absence of any sort of dosimetry in connection with the irradiation precludes any real reliable quantitation in terms of dose-effect relationship. To arrive at a meaningful figure, factors of kilovoltage, current, and filter, field size, type of table, efficiency of the coning and shielding, plus her position in the room in relation to the radiation would all have to be known. It is obvious that at this late date such information would be next to impossible to determine with any degree of accuracy. However, in making use of what is known about such procedures, Cowing and Spalding made a study of fluoroscopic units in 1949, a time period not too far removed from [veteran's] period of service and association with similar equipment. They reported that the dose to the radiologist at the level of his right elbow was 10 mr, (1/100 of an r) per hour during fluoroscopy. This was determined by means of film badges and ionization chambers. Obviously this figure is only applicable to the conditions under which it was measured. However, it serves as a starting point in an attempt at estimating a dose to which she might possibly have been exposed. Under the most likely conditions, she would have been standing either beside the patient or the radiologist. Thus she would be out of the primary beam and be subjected only to scatter radiation. The principal source of the scattered radiation is the patient being examined. Since this radiation is scattered in all directions, it is obvious that the dose rate at one meter from the patient would be very much less than in the primary beam. On the average, according to Quimby, the rate one meter from the scattering object, the patient, and/or the radiologist in this instance, would be about one tenth of one per cent of that incident on the source of scatter. According to [veteran], her principal exposure was at fluoroscopy. Robbins of Harvard reported that the estimated gonadal dose to the patient during a GI series was 140 mr, and 350 mr for a barium enema. This is to the

patient, and [veteran] at a meter distance would in this hypothetical situation receive a maximum exposure of 0.1% of this or 0.35 mr. Thus, in the unlikely situation that she assisted at twenty such examinations a day, five days a week, her weekly exposure would be as high as 35 mr. The maximum permissible dose even at today's low levels is 100 mr per week. I might add that this is only an exposure dose and does not represent an absorbed dose, which is the important factor. The absorbed dose would be even less at the level of the ovaries, due to the attenuation by the overlying tissues, plus the fact that the primary beam is slightly softened by scatter. Thus, it is estimated that a 100 KV primary beam would be reduced or be equivalent to 84 KV after 90 degree scatter. That is, a beam which is softer and less penetrating, though not significantly so. If she stood behind the radiologist, her exposure would probably be even less because of the increased shielding.

While these figures serve to illustrate the situation possible under one set of conditions, they, of course, are not valid for a case such as this in which none of the factors are known. However, they serve to point up how little her exposure might have been even under these maximum conditions, and also serve to bring up a discussion of the effects of radiation.

* * *

To...direct this discourse toward the possibility of ovarian carcinoma I feel I might point out that the reports of radiation induced neoplasms of the ovary...are rare. The early work of Furth, et al, in 1936 pointed out the striking sensitivity of ovarian tissues to whole body irradiation. X-rays in single or fractional doses or chronic gamma radiation has been carcinogenic in many strains of *mice* with doses as low as 50 to 110 r. Law at the National Cancer Institute stated that the total accumulated dose of radiation is the deciding factor in the induction of ovarian neoplasms though there is insufficient data to indicate the influence of dose rate or fractionation and protraction.

It has been reported that a minimum dose of 600 r is necessary to produce cessation of ovarian function...

* * *

Thus while no consistent conclusion is available in the literature, the opinion of most authors is that the predisposing condition rather than irradiation per se is the etiologic factor in gynecologic neoplasms. Thus as noted by Furth and most radiation therapists, it is exceedingly rare that a carcinoma or sarcoma develops at the site of irradiation following therapeutic doses of X-rays. Doses which are much greater than [veteran] could possibly have been exposed to.

In conclusion then, I would like to reiterate what I point out at the beginning of this letter: I do not believe that the patient's anemia was the result of, nor aggravated by her exposure to radiation. I believe that this patient was anemic prior to her admission in the Navy, and that on

the basis of admittedly indefinite dosimetric calculations, (where the error should be on the side of calculation of doses in excess of what she probably received), she could not possibly have received sufficient radiation to produce or aggravate her anemia. Secondly, I know of no known study relating carcinoma of the ovary to anemia as an etiologic agent. Finally, while there is no unanimity of opinion as to the relationship between radiation and carcinoma of the ovary under the conditions of this case, the preponderance of opinion is that predisposing conditions rather than radiation per se is the etiologic factor in gynecologic neoplasms. Certainly, in view of the report mentioned above, the probability is way, way below fifty per cent.

Findings of the BVA and Basis for Decision: In denying the appeal the Board found that 1) carcinoma of the ovary was not present during service; 2) carcinoma of the ovary was not present within one year after separation from World War II service; 3) carcinoma of the ovary is not etiologically related to the service-connected anemia; and 4) carcinoma of the ovary was not caused by exposure to X-ray during service.

CASE NO. 22

Type of Injury: Acute Monocytic Leukemia.

BVA's Decision: Denial Reversed.

Date of Decision: 1966.

Appellant's Allegation: The veteran's death from leukemia was a result of exposure to radiation during active service.

Facts: Veteran retired in 1954 after 30 years of active service. Veteran allegedly developed acute monocytic leukemia about eight years following exposure to ionizing radiation during various atomic bomb tests. Service records indicate that the veteran was subject to possible exposure to radiation only during the period from November 1950 to November 1953 while he was assigned to an atomic experimental project from March 1951 to May 1951 and to other research and development projects for an indefinite period beginning in October 1951, for 110 days beginning in March 1952, for 120 days beginning in February 1953 and for 4 days during August 1953. At the time of the 1951 experiment, veteran assisted during actual field testing of the equipment because of a shortage of manpower; that all operations were considered routine in nature and were carried out within the safety limits with the exception of one instance when fall-out occurred; that the level of fall-out was considered to be above that normally safe for extended periods of operation; that all personnel were requested to stay under cover shelter until the intensity of radiation subsided to a safe value; that there was no reason to believe that the veteran did not follow this request; that some 2 or 3 hours after the onset of fall-out it was declared safe to resume normal activities. Veteran's dosimetry records were found only for the year 1951 which indicated that he received during the March-May 1951 operations a total of 1.75 roentgens, and for the October-November 1951 operations a total of 0.10 roentgens.

On examination in January 1954 for retirement from service veteran did not complain of radiation exposure and a complete blood count was not done. Defects found following physical examination were slight impairment of hearing, myopia corrected by lenses and recurrent arthritic pains of the knees. Service medical records disclosed hematology examinations of veteran in 1951 and 1952. Examination of the veteran's blood in September 1951 was reported as showing 6,900 white blood cells with 49 per cent neutrophils, 50 per cent lymphocytes and 1 per cent monocytes. The study in July 1952 was reported

as showing 9,600 white blood cells with 45 per cent neutrophils, 51 per cent lymphocytes and 3 per cent monocytes and 1 per cent eosinophils.

Evidence indicated that there was no history of cancer or leukemia in the veteran's family. Outpatient treatment records received from a United States Army Hospital show that the veteran was seen a number of times from February 1956 to February 1960 for unrelated complaints. In October 1956 a complete blood count was done. This examination revealed 6,700 white blood cells with 53 per cent neutrophils, 42 per cent lymphocytes, 4 per cent monocytes and 1 per cent eosinophils. There is no record of outpatient treatment after February 1960 until February 1963 when he had a small keratotic lesion on his lower lip. Later in February 1963 another lesion was noted over the left malar region. Both lesions were excised in March 1963. In May 1963 he complained of sudden onset of pedal edema the preceding day and of other symptoms of one week's duration and he was admitted to a United States Army Hospital. On admission to the hospital it was clinically recorded that for the last few weeks he had had slightly less energy and other symptoms for a week or two and that the whole process had been very insidious. Following physical and laboratory examinations a diagnosis was made of leukemia, acute, subacute, probably myelocytic. He was discharged in May 1963 pending further pathological studies and was readmitted a few days later for treatment. He died on May 25, 1963, of a cerebral hemorrhage due to monocytic leukemia, probably myelomonocytic.

Medical Evidence: The appellant submitted for the record, responses from two medical doctors containing answers to a number of theoretical questions about radiation and leukemia. One doctor stated that long term exposure to small to moderate doses of roentgen radiation can lead to the development of leukemia; that nothing definite can be said about a "safe" level of exposure but that this unquestionably will vary from one individual to another, probably due to genetic, age and environmental circumstances; that over the years the estimated "safe" level has shifted downward because of the awareness of increasing incidental and environmental exposure; that there is a definite and high incidence of correlation between radiation and the development of leukemia but that it cannot be said that radiation as such is causative although it is the only definite factor which has been associated with leukemia with some degree of regularity; that the probability of development of leukemia is increased in individuals exposed to long periods of radiation; and that the leukemia which follows chronic radiation is usually some years in developing, usually within a period of 2 to 5 years after exposure.

The second doctor stated that radiation was an established leukemogenic agent in man; that the "safe" level of radiation exposure would depend on the level of certainty desired and that from available data it was not absolutely certain that any dose of radiation, no matter how small, was safe; that the estimated "safe" limit had been reduced; that there was a definite and high correlation between leukemia and radiation and that it can be assumed that radiation causes leukemia in some cases; that there was no other known cause of leukemia in man although there was increased susceptibility in certain

individuals and in some instances another agent had been incriminated as leukemogenic; that it was believed that a series of small doses of radiation might give cumulative effects appreciably larger than could be produced by one of them alone; that the cumulative effect on an individual who was extensively exposed to radiation for about three years would depend on the magnitude of the exposure, the extent of the body that was exposed, and other factors, and that no specific prediction could be made for a particular individual in such an instance but that the probability of developing certain sequelae of radiation exposure, such as induction of leukemia, would increase significantly; that it would be difficult to state either a minimum or a maximum interval between exposure and development of leukemia where the exposures were small and multiple; and that where leukemia developed in an individual who had had small and multiple radiation exposures it would be very unlikely that it would be attributable to radiation if the onset were immediately after exposure and that it was likely that in such a case the latent period would be longer than in leukemia due to single dose radiation exposure.

At the request of the BVA, the Armed Forces Institute of Pathology reviewed veteran's medical record and the autopsy, and expressed the following opinion:

The members of the staff have substantiated the diagnosis of acute monocytic leukemia (myelomonocytic type) from the examination of the available material. No evidence of radiation injury, however, was observed.

The members of the staff are unable to determine the cause of the leukemia process in this man and to the best of our knowledge the etiology of leukemia is unknown.

Findings of the BVA and Basis for Decision: In finding that with resolution of reasonable doubt, the fatal leukemia was due, at least in part, to exposure to ionizing radiation during service, the Board observed:

The cause of the veteran's death in May 1963 was acute monocytic leukemia (myelomonocytic type). Symptoms of this disease did not become manifest until many years after March 1954, when he retired from service after 30 years of active duty. Thus, favorable resolution of the question at issue is contingent on a finding that there was a causal connection between the fatal disease and exposure to ionizing radiation, an established leukemogenic agent under certain circumstances, during active service. Such exposure was possible only between November 1950 and November 1953, during which time the veteran was a participant in experiments involving the use of atomic material. There is a record of the amount of radiation he received in 1951 but there is no available record of the amount of additional radiation which might have been received during his assignment to research and development projects in 1952 and 1953. The total exposure to ionizing radiation shown by the record now available indicates that the veteran's exposure was below the level generally accepted as injurious to critical organs. This evidence is

inconclusive in view of the unavailability of complete dosimetry records. In addition, the effect of small and multiple radiation exposures has not been scientifically established. The absence of evidence of radiation injury on postmortem examination is also inconclusive inasmuch as residual tissue damage studies have not been verified to the extent that dogmatic statements may be made regarding them. There remains for discussion a consideration of the aberrant blood studies, the only evidence of abnormality relevant to the question at issue. It is generally accepted that in the adult the normal white blood cell count ranges from 5,000 to 10,000 and that of these cells 60 percent are neutrophils, 30 per cent are lymphocytes and the remaining 10 per cent are monocytes, (usually from 1 to 4 per cent), basophils and eosinophils. In this case, all hematologic examinations between December 1950 and terminal hospitalization disclosed a lymphocyte count in excess of that generally accepted as normal, with values as high as 50 per cent in 1951 and 51 per cent in 1952. The significance of this tendency toward lymphocytic increase as early as 1951 is enhanced by information contained in radiation hazard studies that there is some evidence which indicates that a diseased or poorly functioning organ may be more susceptible to radiation injury than a normal one. In view of the limitations of present scientific knowledge of the effects of ionizing radiation induced leukemia, the Board is impelled to conclude that the evidence of record is insufficient to either prove or disprove a causal relationship between the ionizing radiation exposure during service and the fatal leukemia but that it is within the range of probability that in this case there was such a relationship.

CASE NO. 23

Type of Injury: Acute Monomyelocytic Leukemia.

BVA's Decision: Denial Affirmed.

Date of Decision: 1970.

Appellant's Allegation: That veteran's death from leukemia was incurred as a result of exposure to atomic radiation at Kwajalein in 1948, and that a prior denial of service connection for leukemia by the Board of Veterans Appeals was in error because it was predicated in part on the lapse of time between exposure in 1948 and clinical manifestations to a degree of 10% within one year following the veteran's discharge from service. It was further alleged that this basis is inconsistent with current medical knowledge.

Facts: Veteran served on active duty from January 1937 to September 1945, and from October 1947 to December 1959. The records disclose that veteran was a communications technician attached to an Air Task Unit on Kwajalein Island from February to May 1948, and took part in Operation Sandstone (atomic bomb tests). The atomic explosions took place on Eniwetok. There was considerable distance between the two islands. Persons in the area potentially exposed to radiation in connection with their work were monitored by film badge and dosimetry and appropriate records maintained. Records of exposure maintained by the Atomic Energy Commission do not reflect any exposure information on the veteran. Records showed no clinical manifestations of leukemia prior to March 1966. Acute monomyelocytic leukemia was diagnosed during hospitalization in February 1968. Veteran died in August 1968 as a result of gram-negative sepsis due to acute leukemia.

Medical Evidence: Clinical manifestations of leukemia were initially noted in March 1966, more than six years after retirement by veteran from service.

An independent medical expert expressed his opinion, as follows:

... I have carefully reviewed the record and have been able to add my personal knowledge of the situation at Kwajalein when he was there having made several visits to Kwajalein in the late 1940's as a nuclear medical officer.

* * *

It is claimed that the leukemia was due to excessive radiation received while involved in Operation Sandstone at Kwajalein between February

10, 1948 and May 10, 1948 . . . There is no evidence that he received any exposure to radiation at this time. It is stated in the record and is a fact that two nuclear detonations occurred at Eniwetok while the veteran served on Kwajalein . . . From none of these explosions, because of the distance and character of the explosion, would there be sufficient radiation to have any effect on a person on Kwajalein. During the period that he was stationed with the Task Force, personnel potentially exposed to radiation in the course of their work were monitored by film badge and dosimetry and appropriate records were maintained. The Atomic Energy Commission in a letter dated October 3, 1967 states that there is no record of any exposure to radiation of [the veteran].

In my own personal knowledge of the situation at Kwajalein during that period I am convinced that [the veteran] could not have received a significant amount of radiation without its having been detected and recorded.

His enlistment physical examinations and subsequent physical examinations up to March, 1954 were essentially negative. He developed persistent epidermatophytosis of his feet. In July of 1955 he was given 225 R radiation at doses of 75 R each, applied to both heels. He also received during May and June of 1955 seven X-ray treatments to the medial aspect of his left ankle totaling 525 R. It was noted that the epidermatophytosis has been almost completely cured by August 13, 1956. On September 15, 1959 he received a retirement physical examination which was negative aside from minor ocular findings such as presbyopia. The skin disease was not present at this time.

* * *

It is my opinion the the veteran did not receive significant occupational exposure to radiation, that the therapeutic radiation that he did receive in 1955 was directed to tissues that did not contain hematopoietic marrow. Hence, exposure to radiation either occupational or therapeutic is not a factor in the causation of the leukemia.

Findings of the BVA and Basis for Decision: In finding that leukemia was not incurred or aggravated in service or manifested to the specified degree within the one-year presumptive period after service, the Board stated:

The Board has given careful consideration to the opinion of [the radiation expert]. It may be pointed out in this connection that the one-year presumptive period for certain chronic diseases, including leukemia, provided in the law and regulations is intended to facilitate the grant of service connection in appropriate cases, and does not preclude a finding of service connection in other situations where such a finding is warranted by the individual facts of the case and medical knowledge.

In this case, leukemia was manifested approximately 18 years after the claimed exposure to atomic radiation in 1948, and approximately six years after the veteran's discharge from service. While the Board agrees that leukemia may develop a considerable number of years following

exposure to radiation, the facts of this case do not lend themselves to a conclusion that significant radiation exposure occurred in this case. As stated in the expert opinion, the lack of exposure information on the veteran in the records of the Atomic Energy Commission is of considerable significance, since records were kept on all persons potentially exposed to significant doses of radiation in connection with their work.

Service connection for leukemia consequent to radiation has been allowed by the Board in some previous cases on the basis of this independent expert's opinion. His negative opinion in this case, and reasons therefor, carry considerable weight because of his expertise, and his opinion is shared by the members of this Board on the basis of an independent review of the record.

CASE NO. 24

Type of Injury: Severe Anemia and Acute and Chronic Lymphocytic Leukemia.

BVA's Decision: Denial Affirmed.

Date of Decision: 1967.

Appellant's Allegation: That veteran's condition was caused by X-ray treatment received for shrapnel wound suffered while in the service.

Facts: Veteran was injured seriously by shrapnel in 1945. He received transfusions and some diagnostic X-rays to diagnose the extent of his injuries and of complicating pneumonia that he had during the course of his post traumatic care. Though he had some disability from these wounds and injuries he was discharged from the Army and did not work as a farmer until 1963 or 1964.

In the fall of 1964 he became incapacitated to the point that he was unable to continue his activities. He did consult a physician. It was found at this time that he was suffering from a leukemia. In spite of therapeutic measures attempting to control the leukemia, he worsened, developed a profound anemia secondary to this leukemic process. As a result of the anemia, he developed a circulatory collapse and died.

Medical Evidence: The case was referred to an independent medical expert for his opinion on whether (a) there was etiological relationship demonstrated between the service connected wound injuries, including treatment thereof and the development of leukemia and (b) there was a reasonable medical basis for concluding that service connected disabilities affected the veteran's physical condition to the extent of being a material influence in producing or accelerating his death.

His opinion is as follows:

It is the contention, as I understand it, of [appellant] that [veteran's] disability suffered in the war (with the necessary employment of X-ray examination and transfusions) resulted in his developing a chronic infection which persisted, weakening him so that he was unable to stand the rigors of his leukemic process and succumbed. There is the further implication that the use of transfusions and the modalities of X-ray were so experimental at that time that they may have had some causative effect in his developing a leukemic process. I am unable to agree with [appellant's] contention and I completely support

the position taken by previous review boards that there is no connection between his service-connected disabilities and those events which finally terminated in his death in 1965.

I would first note that throughout the records that are available when he was in field and general hospitals, all of the blood counts obtained at that time show a completely normal blood picture without evidence of any leukemic process. While it is theoretically possible for a chronic leukemia to persist for a period of 20 years, i.e., from 1945 to 1965, there is no evidence on either detailed physical or laboratory examination that there was any leukemia present in 1945; hence, there could not have been a continuous presence of lymphocytic leukemia during that period of time.

Secondly, while it has been noted that over-exposure to X-rays may result in the development of either a myelocytic or a monocytic leukemia, there is (a) no evidence that he received an unusual amount of exposure to X-rays in the course of his studies, and (b) no known increased incidence of chronic lymphocytic leukemia in individuals who are excessively exposed to such X-rays or related high energy rays, so that this could not possibly be a factor in his development of a chronic lymphocytic leukemia. [Appellant] contends that he suffered continuous infection from the time of his injury in the Army until the time of his death but none of the medical testimony bears this out, and even if it were borne out that he had some infection, there is no evidence that infection as we now understand it has anything to do with the development of lymphocytic leukemia. Certainly many individuals, previously normal, who develop a leukemic status, do have trouble with infections, and it is quite common for the infection that they develop to be a contributing cause in the death of such individuals.

Findings of the BVA and Basis for Decision: In finding that the independent medical expert had substantiated the Board's decision denying entitlement to service connection for the cause of the veteran's death the Board said:

... there was no causative relationship between the appellant's service-connected gunshot wound injuries and leukemia which resulted in his death in 1965 ... and the service-connected disabilities did not affect his physical condition to such an extent that they contributed substantially or materially to cause death.

CASE NO. 25

Type of Injury: Acute Myeloblastic Leukemia.

BVA's Decision: Denial Affirmed.

Date of Decision: 1967.

Appellant's Allegation: That veteran's death was caused by exposure to radiation while in the service.

Facts: Veteran was on active duty from October 1943 to April 1946. No defects were found on examination for service and examination at separation disclosed normal findings. The veteran died on May 29, 1965. The cause of death was established as acute myeloblastic leukemia.

A statement by the appellant alleged, among other things, that veteran was among the first 28 volunteers for testing the first atomic bomb at Los Alamos, New Mexico; that during the first atomic test veteran had lain down behind a fence within a six mile radius of the blast and suffered burns on his neck as a result of the blast; that after the blast veteran suffered a severe nosebleed and that these nosebleeds continued from time to time.

No record of veteran's exposure to radiation was located. Information obtained by the Board indicated that the veteran was assigned to a technical service unit, Corps of Engineers, Manhattan Project; that exposure information on the Manhattan Project was not available; that the morning reports of his unit were missing; and that information concerning the bomb blast in question was not a matter of record in the service department. Further information obtained by the Board indicated that radiation exposure records listed doses for those persons who wore film badges and estimated doses for those persons who did not wear film badges but who entered possible radiation exposure areas and that veteran's name did not appear in the radiation exposure records. Certain other available records showed that veteran was promoted to another detachment which performed maintenance services about the post but was not involved in any technical activity.

Medical Evidence: Hospital records disclosed that veteran received outpatient treatment for an epistaxis in December 1943, was admitted for observation in December 1944 after an accident in which an Army truck overturned and was treated in June 1945 for abrasions and lacerations after he overturned another Army vehicle. There was no indication in the hospital records that he ever worked within any technical areas or received any exposure to radiation.

Findings of the BVA and Basis for Decision: In finding no record of exposure to ionizing radiation during service or of participation in activities involving

possible radiation exposure, the Board concluded that veteran's leukemia was not incurred in or aggravated during service and it said:

The veteran's assignment to the project engaged in development of the first atomic bomb has been verified but no record has been found to show that he suffered any radiation injury or was exposed to radiation, or that he served in a technical capacity, was required to handle radioactive materials, or entered areas where there was a possibility of exposure to radiation. Further, the official report of the first atomic explosion shows that no burns occurred at a distance of six miles although burns were sustained by personnel much closer to the blast. Inasmuch as it has not been established that the veteran was exposed to ionizing radiation during service, referral to a specialist in nuclear medicine is not considered necessary for proper disposition of the appellate issue.

CASE NO. 26

Type of Injury: Chronic Glomerulonephritis.

BVA's Decision: Denial Affirmed.

Date of Decision: 1966.

Appellant's Allegation: That veteran's chronic glomerulonephritis could have been caused by the effects of radiation received at Nagasaki while in the service.

Facts: Veteran had active service from September 1943 to December 1945. Veteran was on ship which was moored in Sasebo, Japan, from September 24 to November 5, 1945 except for the period October 23 and 24 when it was moored at Nagasaki. There is no entry in the ship's log that any personnel were sent ashore either at Sasebo or Nagasaki nor any entries which show he encountered radiation hazards.

Medical Evidence: A doctor reported that the veteran was first seen in his office in December 1964, at which time he gave a history of albuminuria on several occasions in service along with some kidney infection. He also spoke of gradually progressive vomiting and headaches accompanied by weakness since August 1964. On examination he was pale and dyspneic and appeared chronically ill. Blood pressure readings were 220/140 and 200/130. There was albumin in his urine. Blood urea nitrogen 100 per cent. The doctor's impression was that the veteran had chronic glomerulonephritis with uremia. He added that if it was documented that his proteinuria did exist during his service then the glomerulonephritis must be considered as service connected.

A radiological specialist asserted in March 1966 that since the veteran's ship arrived in Sasebo, Japan, approximately 1½ months, and in Nagasaki 2½ months, after the atom bomb had been detonated it can be reasonably concluded that any radiation that might have been present at the time of the bombing would have dissipated by decay or dissemination by natural forces to a degree which would rule out biological hazard. He had no indication that any member of the crew of the ship in question was exposed to or had ever submitted a claim that he suffered from an injury due to radiation resulting from the atomic bombing of Nagasaki or Hiroshima. The ship's log indicated that members of the crew were probably confined to the area in close proximity to the ship. They were not granted leave or recreation privileges which would have made it possible for them to enter the area of maximum destruction from the bomb. In the specialist's opinion, borne out by discussion with other experts in radiological work, the veteran could not have been

exposed to radiation of biologically hazardous proportions as the result of the entering of Sasebo or Nagasaki harbors, or the devastated areas of the bombed cities, at a period from 1½ to 2½ months after the atomic bombing.

Findings of the BVA and Basis for Decision: In denying compensation the Board found that appellant's glomerulonephritis was not service connected; that there was no etiological relationship between appellant's service treated illnesses and the glomerulonephritis; and that during his service he was not exposed to radiation which would have resulted in glomerulonephritis.

CASE NO. 27

Type of Injury: Chronic Brain Syndrome.

BVA's Decision: Denial Affirmed.

Date of Decision: 1966.

Appellant's Allegation: That his brain damage is the result of exposure to Gamma rays and not excessive use of alcohol.

Facts: The veteran was in active service from June 1941 to September 1945 and from December 1945 to September 1961. The veteran testified that he was first treated for the effects of radiation in August 1956; that in 1958 he first noticed that his mind was affected; that he was stationed in the atomic testing area for 13 months during which time there were 27 atomic explosions; that these explosions were supposed to have taken place 15 miles away from him; and that due to a mistake one bomb was exploded about 10 miles from him. He also described his current symptoms. His representative stated that while the Army psychiatrist had diagnosed brain damage of undetermined cause in 1964, he had told the veteran it was his belief the damage was due to radiation fallout since the veteran had never had any type of head injury.

Film badge records reflect that from April 1956 to September 1956 he was exposed to Gamma radiation and received an accumulative total dose of 4.495 roentgens. There is no record of treatment for any type of radiation injury, nor is there any record of complaints or findings indicative of brain damage.

Medical Evidence: In April 1958, September 1960 and July 1961 he was given complete medical examinations. He did not complain of radiation exposure or of symptoms of brain impairment on these occasions and no neuropsychiatric abnormality nor any defect which might be attributable to radiation injury was found on these examinations. In September 1961 he certified that there had been no change in his medical condition since he was examined for retirement purposes in July 1961.

On examination in January 1964 the veteran complained about his left ankle, headaches, and loss of appetite. Examination disclosed no skin lesions and no other abnormality indicative of radiation or brain damage.

In April 1964 the veteran was examined at a United States Army hospital. A complete blood count was within normal limits. He was referred to the Mental Hygiene Consultation Service and, following interviews, observation and intelligence testing, a diagnosis was made of brain damage, etiology undetermined.

The veteran was interviewed in August 1965 as part of a social and industrial survey. At this time he stated he had been a sergeant in command of a unit and had had a strong, firm voice and had won many commendations for his command before he was exposed to radiation; that after his radiation exposure he was hospitalized about 13 months; and thereafter he was relieved of his command and given technical work to do until he retired. He said that the first sign of radiation damage was a rash on his neck and arms; that he was treated for this and was ordered to be evacuated; that while he was awaiting transportation the joints of his knees, ankles and elbows became swollen; that while he was hospitalized his speech began to take on the present characteristics; that his inability to speak clearly had grown worse; that he continued to have difficulty with a skin rash, once a year, generally during the summer; that the rash had been present on his scalp, as well as on his arms and neck; and that he also suffered from chronic headaches, which were worse when the rash was present. From other sources interviewed in the course of the survey, information was obtained that drinking had been a problem for the veteran for a number of years.

In August 1965 the veteran was admitted to a hospital for a period of examination and observation. Physical examination was not remarkable and laboratory findings were within normal limits. Skull X-ray studies disclosed no evidence of old or new fracture or of any other abnormality. An electroencephalogram was normal. Neuropsychiatric examination and psychological testing revealed that he was cooperative, oriented, coherent and relevant. His speech was slow and difficult to understand. His voice had a deep, rough, rasping timber and as he talked his speech became rougher and the words seemed to be forced out by main effort. His movements were slow and seemed to be poorly coordinated when he walked. Memory, judgment and insight were poor. Rote memory and skills learned from past experience were relatively unimpaired but there were significant deficits in his ability to learn new tasks and in motor speed. There was also evidence that he became depressed at times and was concerned about deterioration of bodily processes. He admitted that he drank excessively. The local radiologist stated that he had not been subject to any great amount of radiation during service and that no pathology should result from it. The diagnosis at discharge in September 1965 was chronic brain syndrome, associated with alcohol intoxication.

Findings of the BVA and Basis for Decision: In denying the appeal and concluding that the chronic brain syndrome was not incurred in or aggravated during active service the Board found:

1. The veteran was exposed to Gamma radiation from April 1956 to September 1956, during which time he received an accumulative total dose of 4.495 roentgens as measured by film badge.
2. There is no record of radiation injury nor of any neuropsychiatric abnormality during active service or at separation therefrom.
3. A chronic brain syndrome was first medically established several years after service.
4. The chronic brain syndrome is not related to or a residual of exposure to Gamma radiation during active service.

In making these findings the Board noted:

In addition to injury and alcoholism, a number of other causes for organic brain damage are recognized by the medical profession. Hence, the etiology of the veteran's chronic brain syndrome is material only if it can be associated with some incident of service. It is shown that he received 4.495 roentgens of whole body exposure to Gamma radiation during the period from April 1956 to September 1956. This amount of exposure is below the level established by the National Committee on Radiation Exposure as permissible for adults who are exposed to radiation in the course of employment and, generally, would not be expected to cause any detectable changes in the skin or to have any adverse effects on body organs. Of added significance is the finding on radiation hazard studies that some body tissues are more sensitive to radiation injury than others. Where there is whole body exposure with all tissues subject to equal exposure, it would be anticipated that the most sensitive tissue would be the most susceptible to injury. Since there is no evidence in this case of damage to the bone marrow, the most sensitive tissue, it is unlikely that radiation is the cause of damage to the brain, one of the more resistant tissues. Another important factor in assessing the probable effect of radiation exposure is that the likelihood of injury is greater when the exposure is limited to an acute single dose than when the exposure occurs in small increments, over a period of time, as in this case.

It must be concluded from the foregoing that there is no reasonable probability within the scope of present knowledge that veteran's brain damage was caused by radiation exposure and, in the absence of any evidence to substantiate the veteran's statements that symptoms of his brain disorder initially began during active service, it may not be held that the brain syndrome had its onset during active service.

CASE NO. 28

Type of Injury: Carcinoma of the Cheek.

BVA's Decision: Denial Affirmed.

Date of Decision: 1967.

Appellant's Allegation: That his carcinoma of the left cheek resulted from X-ray burns during Administration hospitalization in 1964.

Facts: Veteran was in active service from June 1953 to June 1955. Military medical records indicated that in February and March 1955 veteran was hospitalized for surgical repair of an inguinal hernia and for minor surgery for an unrelated condition. The hospital course was complicated by development of post-surgical phlebitis and a pulmonary syndrome. After leaving the hospital for temporarily restricted duty the veteran continued on outpatient treatment until the following month and had complaints of persisting pain in the right chest. On examination in June 1955 for release from active duty the veteran's heart and vascular system were reported normal. The examination included a chest X-ray which was negative. In subsequent years the patient experienced repeated attacks of superficial phlebitis of both legs and the right arm and was hospitalized at various times. Evidence indicated that chest X-rays were made in January 1958, February 1963, June 1964 and October 1965. In June and July 1964 when veteran was an Administration hospital patient, multiple view X-rays were taken of the cervical, dorsal and lumbar spine in addition to chest X-rays.

In January, 1965 the veteran was treated as an outpatient at a hospital for basal cell carcinoma of the skin of the left cheek. The lesion was excised without complication being reported. In September 1965 dermatological examination was done. The surgical scar on the left side of the face was described, and it was stated that there were no signs of any dermatoses on the body except for numerous pigmented moles on the trunk and extremities.

Medical Evidence: The Board, in considering the veteran's claim, requested review of the medical evidence by an independent medical expert specializing in dermatology. The specialist reported as follows:

No evidence was found to support the claim that the basal cell carcinoma of the face was due to or the result of X-rays taken during hospitalization in June and July 1964. The bases for this conclusion are as follows:

1. There is nothing to indicate that the diagnostic X-rays taken in 1964 focusing on the cervical and thoracolumbar spine and the chest were either directed toward the face, or that the dose was carcinogenic. Minimum dosages required for carcinogenesis are generally believed to be well over 1000 r. Diagnostic radiation involves only a small fraction of this amount.

2. The time sequence noted is not consistent with the usual history of post-radiation cancer. Intervals of many years, rather than a few weeks, are the general rule.

3. Had there been accidental delivery of such a massive dose of radiation to the infraorbital region as to produce early malignant degeneration, there must inevitably also have been produced the characteristic signs of radiodermatitis. However, there was no evidence of hair loss (lashes), pigmentation, atrophy, telangiectasia etc. on clinical examination by a consulting dermatologist, Only a barely visible surgical scar was noted. A transient pruritic erythema of the cheeks was noted in the hospital records on July 7, 1964. It was possibly of allergic origin, responding to oral Benadryl.

4. Microscopic examination of biopsy slides showed only the usual features of basal cell epithelioma, with no signs of radiodermatitis. It should be noted that squamous cell, rather than basal cell lesions are more characteristic of radiation cancers.

Basal cell carcinoma of the face is a disease of ordinary life. No evidence was found in detailed review of the data furnished to implicate X-radiation as the causative factor in this case. In summary, it was deemed unlikely that the area in question accidentally received any significant dose of radiation; there was no physical evidence of radiation injury to the skin, and the very brief interval between the use of radiation and the onset of the condition invalidated any possible etiologic connection.

Findings of the BVA and Basis for Decision: In finding that compensation is not payable for carcinoma of the left cheek as being the result of Administration hospitalization, treatment or examination the Board said in pertinent part:

The X-rays made during Administration hospitalization in 1964 were for diagnostic purposes and would not ordinarily involve exposure to such an extent as to risk injury from radiation. The detailed clinical records do not suggest that any accidental over-exposure occurred. The manifestation of carcinoma within a few months after the X-rays was inconsistent with exposure being the cause of the tumor.

CASE NO. 29

Type of Injury: Acute Granulocytic Leukemia.

BVA's Decision: Denial Reversed.

Date of Decision: 1969.

Appellant's Allegation: That veteran's condition was caused by exposure to radiation received while in the service.

Facts: The veteran had active service from August 1942 to November 1945. He was assigned to security duty from January 1944 to November 1945. During this period he was assigned as a driver at the Trinity Atomic Test Site in New Mexico (during and after the detonation of the first nuclear bomb in July 1945). Acute granulocytic leukemia was diagnosed during 1967 at which time veteran had a history of fatigability.

Veteran testified that he did not believe the official record that he had been exposed to 2 roentgens of radiation represented even a fraction of the exposure he had received, but only related to one incident. He testified he had been exposed to radiation on many other occasions.

Medical Evidence: The Board of Veterans Appeals referred the veteran's case and records for the opinion of an independent medical specialist on the effects of atomic radiation. This opinion, issued in November 1968, is as follows:

[Veteran] is clearly suffering from acute granulocytic leukemia, and it is established that acute granulocytic leukemia as well as other forms of leukemia may be related to earlier exposure to ionizing radiation. Not all those so exposed develop leukemia even though the exposure might be very high (up to several hundred R), but those individuals exposed to ionizing radiation have an appreciably higher probability of developing leukemia than do those persons not thus exposed. . . .

The veteran, from the records of his film badges, is stated to have received an aggregate of about 2 R. This would have been minimal. In the early days of the Manhattan Project particularly, knowledge in radiation health physics had not yet developed as to the wave length dependency of the photographic emulsions used in film badges. Consequently, determinations made from these emulsions tended at times to be lower than the actual exposures. Hence, we must regard the recorded exposure as minimal rather than maximal. It is clearly established in the record that [veteran] as . . . chauffeur was present at the Trinity test explosion in 1945 and that also approximately 30 days

later he descended into the bomb crater and spent a limited period, perhaps half an hour, there. It is not stated whether he wore his film badge at that time or if so, what the reading of the film badge was. It would be my guess that the residual radioactivity of the crater was not fully appreciated at that time

Calculation of dosimetry in this instance is difficult. Radioactive iron would probably have been the most troublesome radioactive component of the elements activated by neutrons in the soil of the crater. Assuming a reasonable concentration of iron in the soil and only a moderate amount of residual iron present from the structure of the test tower at one month after the detonation, [veteran] might well have received radiation totaling less than 100 R

In addition, [veteran] acted as a courier in transporting radioactive materials. These probably were adequately shielded, as the Manhattan District handled its shipments carefully. However, it is quite possible that there might have been some minor additive exposures occurring in the course of this work. Considering the nature of his work, the fact that he had access to restricted areas at Los Alamos, that he transported radioactive material, that he was present at the test explosion, the evidence that he was present, though at an adequate distance, and apparently in the open air at the time of the Trinity test, the fact that he entered the bomb crater at Point Zero a month later, combine to present a strong probability that he had received much more than the minimal 2 R of radiation recorded by his film badges.

* * *

From all the available evidence it would seem probable that the veteran might have received radiation totaling as much as 100 R in the course of his various opportunities for exposure. Such an amount of radiation would clearly be in the leukemogenic range. The time interval between exposure and disease is not excessive. I know in my personal medical experience of one case where the exposure to radiation was received in 1906 and 1907, and leukemia did not appear until 25 years later. There are many cases where damage from occupational exposure to radiation has been late (over 15 years) in developing. Hence, the remoteness in time of the development of the disease from the time of exposure does not militate against the probability of a causal relationship.

On the basis of all the evidence presented, research in the literature and my own experience, I am convinced of the following:

1. Exposure to ionizing radiation on the order of 100 R or more predisposes to the development of leukemia. The veteran may well have received radiation in this range.
2. The type of leukemia that he has developed—acute granulocytic—is known to appear with considerable frequency among those exposed to large doses of ionizing radiation.
3. The time elapsed between exposure to radiation and onset of

disease does not militate against there being a causal relationship in this particular case.

It is my opinion that a strong probability exists that [veteran's] current illness is service connected.

Findings of the BVA and Basis for Decision: In granting service connection for acute granulocytic leukemia the Board found that the veteran's duties involved association with atomic materials and on occasion known exposure to atomic radiation and it said:

The official record of measured exposure to atomic radiation and other evidence of record do not affirmatively show specific exposure in an amount medically considered to be dangerous. However, the opinion of the independent medical specialist is that, although the case is very complex and reliance must be made on "validity of conjecture" rather than on any definite demonstration of excessive exposure or even any impartial or disinterested corroboration of much of the veteran's history, there is a strong probability that the leukemia was the result of exposure to atomic radiation during service. The specialist has gone into the various ramifications which led him to this conclusion and further discussion does not appear to be necessary. His opinion certainly raises a reasonable doubt, within the range of probability, the resolution of which in favor of the veteran warrants a grant of service connection.

CASE NO. 30

Type of Injury: Rheumatic Heart Disease.

BVA's Decision: Denial Affirmed.

Date of Decision: 1965.

Appellant's Allegation: That veteran's death from rheumatic fever was the result of radiation exposure he received while in the service.

Facts: Veteran was born in 1907 and had active duty from March 6, 1943 to December 31, 1946. Veteran was a photographer aboard a ship in the Pacific during the 1946 underwater atomic tests. Veteran was hospitalized in July of 1961 and died on December 25, 1961 of rheumatic heart disease. Service records revealed that veteran's ship was not at anytime in radioactive waters during the period in question.

Medical Evidence: At the time of veteran's hospitalization in July 1961 he was treated for myocardial infarction. Signs of subacute bacterial endocarditis and renal insufficiency were found. During his hospitalization a bone marrow examination revealed no abnormal cells, or blood dyscrasia. His heart was enlarged, loud diastolic and systolic murmurs were heard, and there was increasing renal insufficiency. In spite of intensive treatment his illness pursued an unremitting downhill course and he died on December 25, 1961. An autopsy revealed an old myocardial infarction, inactive rheumatic heart disease with aortic stenosis and mitral insufficiency, superimposed subacute bacterial endocarditis, pyelonephritis, embolic glomerulonephritis and nephrosclerosis, and focal acute hemorrhagic lesions in the lungs, liver, spleen and skin, which had occurred at the time of death and without evidence of any vasculities. Bone marrow was not unusual. His death was due to cardiac failure and uremia. The pathological material was subsequently submitted by this Board to the Armed Forces Institute of Pathology for review. They concurred in the diagnoses of the hospital and reported that no changes due to ionizing radiation could be recognized in the tissues.

Findings of the BVA and Basis for Decision: In finding that veteran's death was not due to the effects of radiation incurred while in service, the Board observed in pertinent part:

In order to decide whether or not the veteran's death was, as contended, due to atomic radiation, it must be determined that he received radiation, that the type and amount received was harmful, and

that the cause or causes of death are known to result from the type and amount of ionizing radiation received.

[Veteran] was a photographer on board the [support ship] at the time of the underwater atomic test in the Pacific in 1946. However, the [ship] was not at any time during this test exposed to atomic radiation and [veteran] was not exposed to atomic radiation during the time of the test.

The medical records and autopsy show, contrary to the strong feelings expressed in the contentions, that death was due to rheumatic heart disease and superimposed subacute bacterial endocarditis which are not produced by radiation; by kidney diseases due to infection and arteriosclerosis (not due to radiation), and by hemorrhages into the lungs and other organs, at the time of death. When hemorrhages are due to radiation (as in atomic explosions) they are produced by changes induced in the bone marrow, so that the bleeding occurs as a result of lack of normal blood elements. Since the bone marrow examined during the terminal illness and at autopsy was not abnormal it can be concluded that [veteran's] bleeding was not due to bone marrow destruction, and therefore not a response to radiation.

CASE NO. 31

Type of Injury: Malignant Lymphoma.

BVA's Decision: Denial Affirmed.

Date of Decision: 1966.

Appellant's Allegation: That veteran's death from malignant lymphoma was as a result of exposure to ionizing radiation during active service.

Facts: Veteran served on active duty from June 1945 until February 1949. His service records indicated that he served aboard two of the ships which participated in atom bomb tests at Bikini Atoll in July 1946. Malignant lymphoma was not present during service and was first shown in 1963, about 14 years after service. He died in March 1966 and the cause of his death was certified as broncho-pneumonia due to lymphoma.

Specifically, veteran's service records indicated that he was assigned to the USS Dawson from February 9 to August 19, 1946 when he was transferred to the USS Bladen and he was assigned to that ship until December 26, 1946. Both of these ships, among many others, participated in Operations Crossroads which involved the explosion of one atom bomb in the air on July 1, 1946 and a second bomb under water on July 25, 1946.

Deck logs were produced of the USS Dawson and USS Bladen which disclosed the following information:

The USS Dawson was reboarded on July 2, the day after the first test, and the ship was declared safe. By July 3 the entire crew was on board, with the exception of men away from the ship on temporary duty. The crew was again evacuated from the ship prior to the July 25 test. On August 19, the date of the serviceman's transfer to the USS Bladen, the USS Dawson was towed away and it was subsequently placed out of commission.

With respect to the USS Bladen, extracts from the deck logs of this ship indicate that the crew reboarded the ship on July 2, after the first bomb test. After the second bomb test on July 25, the crew returned to the ship on July 29. Under date of August 27 it was recorded that a radiological clearance certificate had been issued after radiological monitors inspected and passed the ship as free of radioactivity. Additional information with respect to the role of the USS Bladen was obtained from an official of the Atomic Energy Commission. This ship was stationed at the outer portion of the target array in both of the bomb tests. It received only minor damage in the first test, was reboarded at H+8 hours and pronounced radiologically clear. After the second

explosion, the ship was reboarded at H+3 hours and pronounced radiologically clear. All indications were that the damage to the USS Bladen was very light. A few screens and windows were blown in but that was about all. The second bomb test was the larger of the two.

The Navy has also reported that a thorough review of available records has failed to disclose any dosage of radiation received by the veteran other than that incident to medical and diagnostic procedures.

Medical Evidence: The veteran's service medical records did not report any complaints, symptoms, treatments or findings which were diagnostic of a malignant lymphoma. Normal findings were recorded on his discharge examination in February 1949. Generalized lymphoma was diagnosed while veteran was hospitalized in April 1963. The physician who made the diagnosis of lymphoma stated at the time that it was his considered opinion that the disease was a direct result of atomic radiation, that it was probable that the disease had been present a long time. In January 1966 veteran was again hospitalized and he died in March. An autopsy report disclosed that the lymphosarcoma was generalized and was manifested in bone marrow and lymph nodes. The BVA certified two questions to the Armed Forces Institute of Pathology for review and opinion:

1. Whether or not lymphoma and lymphosarcoma are caused by ionizing radiation.
2. Whether there is a reasonable expectation that sufficient radiation was received under the circumstances of duty on board the Bladen to cause detectable changes in the veteran's tissues.

The Institute responded, as follows:

Because of the therapy this man received, it is not possible to document the presence of malignant lymphoma in the necropsy material although the changes observed in the sections of the lymph nodes and spleen are consistent with the appearance of malignant lymphoma following therapy.

The cause or causes of malignant lymphoma (lymphosarcoma) remain unknown at this time and no direct relationship between malignant lymphoma (lymphosarcoma) and ionizing radiation has been established in man. We are also of the opinion that the patient did not receive sufficient radiation while on duty in the service to cause detectable changes in his tissues.

Findings of the BVA and Basis for Decision: In finding that the veteran's malignant lymphoma, first manifest about 14 years after service, was not present during service and was not etiologically related to any exposure to ionizing radiation during service, the Board said:

The essence of the veteran's claim was that he had been exposed to radiation on board the USS Bladen for a prolonged period of time in addition to any exposure which may have been caused by his assigned duties during the decontamination of his ship after he reboarded it

following the atomic test. In this connection, the record does not precisely establish the extent of radiation dosage received by the veteran at the time of Operation Crossroads. The Navy has reported that they conducted a thorough review of available records but their search did not disclose any record of radiation dosage other than that incident to medical and diagnostic procedures. Nevertheless, the record is not entirely devoid of information on this matter. The extracts from the deck logs of the USS Dawson and USS Bladen are pertinent and helpful. It is noted that the USS Dawson was reboarded on the day after the first atomic test and it was declared safe. It does not appear that he reboarded this ship after the second explosion on July 25, 1946. The USS Bladen, to which the veteran was assigned on August 19, 1946 was pronounced radiologically clear only three hours after the second atomic test on July 25. A radiological clearance certificate was subsequently issued on August 27, 1946. The significance of this radiological clearance is that it effectively rebuts the contention of the veteran that he was exposed to prolonged radiation while he remained aboard the USS Bladen. However, apart from the evidence which establishes that the veteran was not exposed to a prolonged period of atomic radiation, the Board now has the benefit of the cited opinion from the Armed Forces Institute of Pathology. This opinion presents two material conclusions. The first is that no direct relationship has been currently established between malignant lymphoma (lymphosarcoma) and ionizing radiation. The second is that the veteran did not receive sufficient radiation while in service to cause detectable changes in his tissues.

CASE NO. 32

Type of Injury: Acute Myelocytic Leukemia.

BVA's Decision: Denial Reversed.

Date of Decision: 1969.

Appellant's Allegation: That veteran's illness was caused by radiation exposure received while in the service.

Facts: Veteran served from 1941 - 1961. During this period he participated in the Atomic Test Series at Indian Springs, Nevada, April to June 1952 and April to June 1953; and at Eniwetok and Bikini, Thermonuclear Test Series, May to June 1956.

The record of the terminal hospitalization of the veteran shows age 49 and that he was admitted February 17, 1967, with complaints of headaches and bruises over the lower extremities and chest wall. The white blood count was elevated on admission. History given was of hypertension for one year and low-grade temperature for from 1 to 2 months. His hospital course was steadily downhill. Veteran died March 11, 1967. Diagnosis had been made of acute myelocytic leukemia, confirmed by bone marrow examination. Autopsy confirmed the diagnosis of acute myelocytic leukemia.

The service medical records show an examination of the veteran with a penciled notation of dosage, May 1952, .23 and June 1952, .008.

A report in May 1968 set forth that the veteran's exposure up to August 1956 totaled 890 mR.

Medical Evidence: The Board on its own motion submitted the case to an independent medical expert who expressed an opinion, in part, as follows:

An interval of almost 11 years between the most extensive exposure and the development of leukemia is certainly not excessive in view of the experience among the Japanese atomic bomb survivors followed at ABCC. Although the peak incidence for radiation-related myelogenous leukemia of both the acute and chronic varieties apparently passed some time ago, the prevalence in proximally exposed survivors still exceeds that in the general Japanese population almost 24 years after the explosions.

Findings of the BVA and Basis for Decision: In finding that the veteran was exposed to ionizing radiation on occasion from 1952 to 1956 during service, the Board concluded that leukemia had its inception during the veteran's

wartime service and allowed the appeal. The Board said in pertinent part as follows:

The time element between the service, with exposure to radiation, and the recognition of the fatal disease is important. The independent medical expert has held that the interval from the veteran's most extensive exposure and development of leukemia was certainly not excessive, in view of known experience.

We are not permitted to speculate in the matter of service connection for the cause of death. Decisions must be made on all of the available facts and circumstances in each case. The Board has considered the contention of the appellant concerning the quantity of radiation received by the veteran as compared with standards then and now in effect. Apart from a determination of whether the veteran did or did not receive an over-exposure of radiation, it is the opinion of the Board that the evidence is so evenly balanced in this particular case as to raise a substantial doubt, as distinguished from mere speculation, as to whether the disease causing the veteran's death resulted from radiation exposure during wartime service. Such doubt must be resolved in favor of the claimant.

CASE NO. 33

Type of Injury: Carcinoma of the Prostate.

BVA's Decision: Denial Reversed.

Date of Decision: 1971.

Appellant's Allegation: That the cancer which he now has was caused by radiation exposure from nuclear bomb experiments; that in the alternative, the cancer must be presumed to have existed during his service career, and he is entitled to service connection therefor on that basis.

Facts: The veteran served on active duty from September 1944 until October 1945; October 1946 to June 1952; and September 1954 to September 1966.

Service records indicated that the veteran was exposed to ionizing radiation during his participation in the Airborne Early Warning Barrier Squadron in the Pacific during the test at Christmas Island and Johnston Island in April to November 1962.

A report from the Bureau of Medicine and Surgery, Department of the Navy, Radiation Safety Branch, Submarine and Radiation Medicine Division, indicates that the veteran was exposed to ionizing radiation in the Pacific in 1962; the type of radiation was gamma; dose (rem) was 00.022, the same figure as for accumulated dose (rem). All exposures were whole body exposures and no internal deposition of radioisotopes occurred. It is noted that the Naval Aviation Branch records show that this squadron was stationed at Barber's Point during the period of September 13, 1961, through July 10, 1964, and during the months of May, June and July flew missions between Barber's Point and Midway as observation teams in Exercise Dominick. There was no other available information concerning the extent of such participation.

A statement is of record from the Atomic Energy Commission, Nuclear Explosives Environmental Safety Branch, Division of Operational Safety, indicating that the office's records showed the veteran was exposed to 22 millirems of whole body radiation above natural background radiation during the period of April to November 1962. The statement indicated that this amount of radiation, delivered during the period mentioned, in the area of Christmas Island and Johnston Island was no more than natural background radiation for the area. It was concluded that this level of radiation was not considered an overexposure to man-made radiation.

Medical Evidence: Service medical records disclose that the veteran was hospitalized in 1962 for treatment of sialadenitis, submaxillary gland on the left, and surgery was performed. Staphylococcus aureus was found. Thereafter,

he was in and out of hospitals for treatment of this condition and complications; malignancy was not diagnosed on any repeated testing. He was again hospitalized in July 1966 because of continuing pus discharge. Examination disclosed very tender floor in the left buccal gutter and pus could be expressed from the Wharton's duct on the left. Surgery was performed for a stone in the Wharton's duct. No other pertinent diagnoses, findings or history was recorded at the time of separation from service.

On November 18, 1969, the then 51 year old veteran was hospitalized with a complaint of episodes of gross totally painless hematuria approximately six months prior to admission, without other episodes until one week prior to admission. There had been no anorexia, weight loss or dysuria noted. On flat plate of the abdomen and oblique views, findings were consistent with metastatic disease. Carcinoma involving the bladder and prostate, probably adenocarcinoma of the prostate, was recorded. On needle biopsy of the prostate, there was a diagnosis of adenocarcinoma. A diagnosis was made of adenocarcinoma of the prostate with invasion of the bladder and with distant bony metastasis.

Findings of the BVA and Basis for Decision: In finding that carcinoma of the prostate was incurred in active war time service the Board noted in pertinent part as follows:

The Atomic Energy Commission report establishes that the veteran received such a minute amount of radiation in service in 1962 that no changes of human tissue would be detected or expected. The most radiosensitive tissues are the bone marrow and blood cells, which have been found to show no detectable changes below a dose of 25 r substantially more than the .022 rem reported in this case. The Federal Radiation Council guidelines for public exposure to whole-body ionizing radiation establish a maximum at 0.17 rad (170 millirads) per year. Accordingly, the possibility of such a minute dose as that received by the veteran being the cause of any malignancy is so remote as to be without substantiation. Specifically, it has not been shown that carcinoma of the prostate is caused by ionizing radiation.

In view of the above findings, the question then is whether or not the prostate cancer was incurred in service independent of exposure to radiation.

... several very similar cases of prostatic cancer diagnosed soon after separation from a long career in service have previously been before this Board, and have been submitted to the Armed Forces Institute of Pathology. In a similar study undertaken in 1967, the Armed Forces Institute of Pathology reported that "the life history of carcinoma of prostate is variable, but on the whole, this is slowly growing neoplasm. It may remain latent for many years... or it may eventually manifest itself".

* * *

In the case currently under consideration, the veteran first exhibited

hematuria in the middle of 1969, three years after separation from service. Following hospitalization in November 1969, adenocarcinoma of the prostate, with invasion of the bladder and with distant bony metastasis was indicated. From the nature of the disorder and in view of the statements of the Armed Forces Institute of Pathology in this regard, the Board considers that the clinical evidence demonstrated such advancement in this case as to permit reasonable difference of opinion as to the date of the inception of the carcinoma. When doubt arises which is within the range of probability, and not based on merest conjecture and speculation, then application of the principle of resolution of reasonable doubt to reach a favorable conclusion is a valid exercise of judgment.

CASE NO. 34

Type of Injury: Arteriosclerotic Heart Disease and Cerebral Emboli with Right Hemiparesis.

BVA's Decision: Denial Affirmed.

Date of Decision: 1970.

Appellant's Allegation: That his blood trouble was caused by radiation and that the blood trouble, in turn, caused heart disease.

Facts: The veteran was in active service from January 1945 to July 1946. He arrived in the Asiatic Pacific Theater on September 9, 1945 and returned to the United States on April 9, 1946. The cardiovascular system was normal on examination for service and for separation. There is no record of radiation injury or of exposure to radiation. However, the veteran alleged that about four or five weeks after the atomic bomb explosion he was in the area where the atomic bomb fell. Testimony of three veterans who served with the veteran in Japan in 1945 indicated that they landed about 40 miles from Nagasaki; that two or three days after they landed the veteran and a sergeant went to Nagasaki to see the atomic bomb damage; that they were probably the first Americans to go into that area; that they did not know the area was radioactive; and that the area was not restricted at the time but could have been restricted later.

Evidence indicated that he had a recurrent ganglion excised from his right wrist in November 1957; that in December 1957 he was first treated for thrombophlebitis and pulmonary infarction; that in August 1960 he was first treated for Buerger's disease.

On review by the originating agency, it was held, in pertinent part, that entitlement had not been established to service connection for Buerger's disease. The veteran was duly notified in January 1961.

In January 1965 he was first treated for coronary arteriosclerotic heart disease. In August 1965, the veteran requested that his claim for service-connected compensation be reopened. He stated that he felt his present condition was caused by his service-connected foot condition since his blood and vein condition began in his feet.

A diagnosis of generalized arteriosclerosis was made on examination by the Administration in October 1965. Recurrent pulmonary emboli and recurrent thrombophlebitis were included in the additional diagnoses.

In December 1965, the veteran was hospitalized for observation and examination. Diagnoses were arteriosclerotic heart disease with angina, old myocardial infarction; and history of phlebothrombosis with pulmonary emboli.

He was treated for cerebral thrombosis in July 1966 and February 1967. On review, in April 1967, the agency of original jurisdiction held that entitlement had not been established to service connection for cerebral emboli with right hemiparesis, and confirmed the previous denial of service connection for arteriosclerotic heart disease. The veteran was duly informed in May 1967, including notification of his right to appeal. He replied that he wished to appeal. He stated that he believed he was entitled to service connection because all the doctors seemed to think that the blood condition he had had for 11 years could be due to the fact that about four or five weeks after the explosion he was in the area where the atomic bomb fell.

Medical Evidence: A statement from a medical doctor stated that the veteran apparently did well until the late fifties or early sixties; that he had a generalized arterial disease that had manifested itself with coronary arteriosclerotic heart disease and had had repeated pulmonary emboli and recurrent thrombophlebitis; that a definite etiological factor had not been found to account for his symptoms; that it was within the realm of possibility that he could have some type of tropical fungus disease that he developed as a result of serving in the South Pacific; that he could well have developed some type of hematologic disorder secondary to exposure to the atomic bomb blast in Japan; and that it would be hard to prove, and even harder to disprove, that he had either a tropical fungus disease or that his hematologic disorder was related to the atomic bomb explosion.

Findings of the BVA and Basis for Decision: In finding that there was no relationship between the veteran's visit to Nagasaki or any other incident of service, and the development of generalized arterial disease many years after service the Board said:

Under certain circumstances, radiation can induce leukemia. The veteran does not have leukemia. His heart disease is a result of atherosclerosis or arteriosclerosis. His hemiparesis is due either to the same process or to cerebral embolization caused by his vascular disease. There is no known relationship between radiation and vasculitis, Buerger's disease, thrombophlebitis or atherosclerosis or arteriosclerosis.

Furthermore, it is not shown that he was exposed to radiation during his visit to the Nagasaki bombsite more than a month after the blast, in an amount sufficient to have any deleterious effect on his health. Studies made by various scientific groups on the effects of atomic radiation have shown that the amount of radiation in the Nagasaki area was very slight. From the available information, it is most unlikely that the veteran received radiation of a harmful amount. The bleeding of his gums and other symptoms which he refers to as radiation symptoms are not shown to be such.

The April 1967 determination by the originating agency that entitlement had not been established to service connection for arteriosclerotic heart disease and cerebral emboli with right hemiparesis is a final determination. (38 USC 4005)

CHAPTER II
DIGEST OF
U.S. DEPARTMENT OF LABOR RADIATION CASES

PART A
BUREAU OF EMPLOYEES' COMPENSATION CASES

(Nos. 35 - 46)

CASE NO. 35

Type of Injury: Chondrosarcoma of the Pelvis.

BEC's Decision: Compensation Granted.

Date of Decision: 1969.

Claimant's Allegation: That chondrosarcoma of the pelvis was caused by his exposure to X-radiation in the course of his employment.

Facts: Claimant was a 44 year old medical radiology technician who worked in the radiology service of a government hospital for more than 18 years. His total time in such work was about 22 years. On March 19, 1965 the claimant complained of pain in the left hip and trochanteric area which allegedly had started about 2-1/2 years earlier and had gradually increased. X-rays taken showed a septic lesion. He was taken to surgery on March 29, 1965 and the lesion was excised. The pathological report was chondrosarcoma. Thereafter, he was examined at regular intervals. The tumor recurred and was again resected. In November 1966 a large mass immediately below the surgical incision was noted. In July 1967 an exploration of a pelvic tumor and obliteration of a massive bursa of the left hip, buttocks and thigh was performed. The employee filed his claim with the Bureau of Employees' Compensation on April 10, 1968. He died on April 27, 1968 and his widow pursued his claim.

Records from the hospital showed that the decedent was rotated through fluoroscopy, the radiographic room and dark room on a weekly change basis. In May 1949 a Keleket Dosimeter was used to measure X-radiation. No permanent records or readings were kept. Film badges came into use in October 1957. The film badge reports showed that decedent's total cumulative exposure from October 1957 to May 1967 was 420 milli-roentgens. However, evidence showed that the dosimeter was worn in the shirt pocket under a protective apron and the film badge was worn on the waist, right front, also

protected from radiation by the apron from the front. Drawings of fluoroscopy on film showed clearly that when the decedent had turned to open or close the lead lined film storage box at his right, his left hip was exposed to beams from the X-ray machine. The area of his left ischium was the portion of his body closest to the source of X-ray and was unprotected. His film badge and his dosimeter did not show the dose he absorbed in the area of the left hip, left leg, and other parts not covered by the lead apron as he went about his work.

The Bureau's claims examiner noted the facts shown in the record, and he said: "We cannot determine just how much radiation reached the hip, legs and lower trunk, but we know it was substantially more than reached the badge and the dosimeter. Moreover, the exposure was repeated and extended over many years".

A hospital inspection report dated October 1956 stated: "For the past six weeks the charge reader has been defective. Prior to that time readings had been uniformly low." An inspection report dated April 1957 of a visit by the government agency's consultant in radiology, a radiologist, read: "Roentgen output at tabletop in fluoroscopy: 3.0 MA 90 KVP 5.7 r/min." The radiologist's report of July 1961 stated: "Roentgen output at tabletop in fluoroscopy: 0.8 MA 114 KVP 1.9 r/min; 3.0 MA 90 KVP 3.8 r/min." In July 1962 his report stated: "... radiation exposure is recorded on film badges . . . All radiation exposures are well below recommended levels."

Hospital records described the type of machine used by claimant as follows:

Fluoroscopic - 1949 - General Electric, Model KX-11, Type 8 MK3, 60 cycle, 200 MA, 100 KVP. - Replaced May 1962 - General Electric Imperial, KX-19, 60 cycle, 300 MA, 130 KVP.

Radiographic - 1949 - General Electric Model KX-14, Type 8 MK3, 60 cycle, 500 MA, 100 KVP. - Replaced April 1964 - General Electric Aristocrat II, Model 60, 300 MA, 150 KVP.

Urology - General Electric - KX- 14, Type 8 MK3, 60 cycle, 200 MA, 100 KVP.

Portables - 2 each - 1949 Field Unit, Picker X-Ray Field Unit, Style 1348, 30 MA, 100 KVP.

The Bureau asked the hospital to supply information concerning the quantitative data on the levels of radiation present at various points throughout the room where claimant worked under normal operating procedures . . . In response, the hospital submitted a Radiation Survey and Inspection Report dated September 25, 1967 of the equipment used by claimant, in which a certified radiological physicist calculated the maximum expected doses per week at various positions around each X-ray unit. He indicated that in evaluation of the Maximum Permissible Doses per week the following presently accepted (NCRP) values of Maximum Permissible Doses were used as a guide:

Maximum Permissible Dose, controlled or restricted areas - 100 mr/wk

Maximum Permissible Dose, uncontrolled or restricted areas - 10 mr/wk

The report showed that at the hospital all areas containing radiation sources and the entire dark room area were considered controlled. The report further

showed that measurements made in the vicinity of the Picker X-ray diagnostic unit (Imperial) were found to be as follows:

Scattered Radiation Around Fluoroscope				Maximum Expected Dose/wk	
Position	mr/hr	mr/hr*	Position	mr/hr	
1. 1 foot right	300	3.0	Control-door open	3.0	
2. 1 foot left	300	3.0	Control-door clos.	0.2	
3. 1 foot front	300	3.0	Corridor	0.5	
4. Waist	200	2.0	Entrance	0.5	
5. Knees	10		Toilet	0.3	
6. Feet	3.0		Storage	0.5	
7. Eyes	3.0				
8. Three screen	3.0				
9. 3 foot back and 3 foot right	40	1.5			

In conclusion the report stated "All X-ray equipment and installations were found to meet presently accepted standards of radiation protection".

Medical Evidence: The attending physician reported.

It is my medical opinion that the chondrosarcoma of left ischium was the result of [the] cumulative effects of radiation over a period of 22 years from 1943 to 1965 . . .

The Bureau's Medical Director was of the opinion that the employee's death was directly attributable to his exposure to X-radiation:

In reviewing the etiology of chondrosarcoma and its relationship to X-ray exposure, I have referred to the text *Occupational Tumors and Allied Diseases* by Dr. W. C. Hueper. In this reference he states "The causal role which excessive and prolonged exposure to roentgen rays plays in the production of sarcomas in the connective tissue in man has been confirmed by numerous experimental observations made in animals." Roentgen sarcomas are generally histologically fibrosarcomas, spindle cell sarcomas, or polymorphous-cell sarcomas, the latter frequently showing a tendency to myxematous transformations. Chondrosarcoma is a sarcoma of the cartilage. The prognosis of roentgen sarcoma is bad. Thus with this support of relationship, as indicated by the above reference and by the [attending] physician . . . in my opinion there is a very definite relationship between the onset of the sarcoma and the degree of exposure received. The factual information in this record to me confirms the fact that the recorded exposure on the film badges does not indicate the large amount of radiation to the left pelvic area.

*The report indicated that the measurements were made with fluoro drapes (simulated drapes with lead apron) and measurements made in the vicinity of the other units were similar to those shown above for the Picker X-ray unit.

BEC's Decision: The case was allowed for chondrosarcoma of the hip and death due to injury from X-rays. Under the death provisions of 5 USC 8101 et seq. the Bureau made an award of compensation to the widow and her three minor children.

CASE NO. 36

Type of Injury: Cataract of the Right Eye.

BEC's Decision: Compensation Denied.

Date of Decision: 1969.

Claimant's Allegation: That a cataract of his right eye was caused by exposure to 1) concentrations of chemical di-isopropyl-carbo-di-imide (DICDI) and 2) to ionizing radiation emitted by three sources of Cesium-137 while he was employed as an electrician at an arsenal.

Facts: Claimant worked at a testing machine from late July 1962 to April 13, 1963. This machine contained three sources of Cesium-137: 200, 200 and 180 millicuries respectively. These sources were immersed in mercury contained within a lead cylinder. The sources were not removed from the mercury filled cylinder at any time during claimant's tour.

As an electrician he helped install and adjust the machine when it was put in service. This required him to be near it for that period of 3 to 4 weeks for many hours each week. After installation was completed he serviced it regularly on numerous occasions. At other times he was not in close proximity to the machine.

Evidence indicated that the source of radiation was operated in the "open" position during the installation period.

The "open" position of the radiation source did not involve a "shutter". Exposure was accomplished by moving the Cesium forward within the mercury toward a stainless steel source port or window in the cylinder wall. When the source was in this "open" position it was capable of emitting 1000 mr per hour through the stainless steel window. When it was in the "closed" position the radiation around the cylinder was down to 14.4 mr per hour or less because of the mercury and lead shield.

There were two safety provisions to indicate when the source was in the open position: (1) a light on the control panel, and (2) a visible mark on the mechanical actuating device which controlled the movement of the Cesium within the cylinder. These could be disabled manually.

The entire machine was properly shielded to keep radiation to a safe level. With the source in its "open" attitude the highest point of radiation outside the shielding was point "o" directly in front of the plastic window. This point measured 13 mr per hour. Claimant was at this point for significant periods of time with the source "open" although it was general practice to "close" the source if a person was expected to be at this point for more than a few moments. As an electrician his duties required him to observe the machine in

operation from this vantage where 13 mr per hour illuminated his face.

Photos of the machine showed the door clearly as 22 inches wide, 28 inches high and 46 inches off the floor. Normally, this door was padlocked and was opened only to make adjustments.

The record does not show that claimant ever gazed directly into the "open" Cesium source.

Claimant wore a ring badge on his left hand and a badge on his left breast pocket, (estimated to be about 44 to 48 inches above his shoe soles). The window was large enough to admit his head, right arm and shoulder. The badge on his left breast pocket was well within the rectangular area illuminated by the Cesium source each time he stood in front of the open door to open or close it, and received radiation while he was making the adjustments.

Tests around the outside of the machine showed radiation from negligible to 13 mr per hour with the source "open" and the 22 x 28 door closed. A further test was run with the source on a wooden pallet with the yoke and supporting table removed entirely. The highest radiation measured in this test was 14.4 mr per hour at a point very near the cylinder wall, with the cylinder in "closed" attitude.

The complete film badge record was on file for claimant. His accumulated total was .035 or (35 mr) for the period of about 8½ months he worked around the machine. No prior significant exposure or work with radiation was claimed or supported.

Records showed that monitoring and "wipe" tests were made regularly to check to see if the source was emitting any harmful rays and to measure the amount of any radiation in the area. Testimony of the safety officer where claimant worked indicated that none of the readings showed any radiation that would be harmful to an individual.

Claimant first noted blurred vision about May 1964 (about 22 months after starting adjustments on the machine). He also alleged skin lesions and soreness of the face and head during the period of exposure. Records indicated that on October 21, 1963, claimant had 20/20 vision in each eye. By November 10, 1964, vision in the right eye was 20/100. The B & L screening tests on October 5, 1965 and November 15, 1966 showed "0" (zero) visual efficiency in the right eye. Recorded vision in the right eye in March 1967 was 1/200. Dispensary notes of March 11, 1963 indicated a "tender, slightly raised circumscribed area on occipital area of scalp approximately 2 cm in size". Patient had had symptoms for about five days. Diagnosis was "probable cyst".

The cataract was removed from the right eye on March 8, 1967.

The employee also worked near a drum of DICDI. The drum was closed. There is no record of him receiving any quantity of this chemical in his eye and no reason to assume that he did so. A co-worker had his eyes examined and there were no cataracts.

The Bureau's Claim's Examiner summarized the issue as follows:

To summarize briefly, a worker at the highest point of radiation in the room under normal operation would receive 13 mr per hour or 520 mr during a 40 hour week if he stood in front of the window at point "o". Claimant worked steadily for 3 or 4 weeks about the machine at various points during installation and thereafter on numerous occasions for short periods.

There was a potential danger of his being directly in the collimated beam path at eye level with the detector unit pushed aside and the source in the open attitude. This is an extremely unlikely occurrence due to the safety precautions observed. Nevertheless, had such been the case he would have received radiation at the rate of several hundred rem per hour. This raises the question of just how long his right eye must remain in a half inch beam of radiation to receive a cataractogenic dose of radiation, and just what effect scatter would have on his film badge if such an event did occur. The likelihood that claimant held his head quite still while the beam struck his eye directly for an extended period of time is highly unlikely.

These questionable points in this summary are raised for the comments of a qualified specialist as they require specialized judgments bearing on the merits of the claim.

Medical Evidence: The case file was referred to a specialist in the field of ophthalmology for a determination of whether the claimant's cataract was caused by radiation. In his opinion that claimant's cataract was not related to factors of employment he said:

... It is agreed that a single dose of 500 r to 800 r to the human eye will produce a cataract (1)(2). The greater the dose, the shorter the latent period before a cataract develops that will impair vision. Duke-Elder (3) states that 600 r is the minimum required to produce a cataract, or 1500 r over a period of one month. Gamma rays, with which we are concerned here, permeate the entire eye. In contrast, "soft" X-rays (6 to 12 kV) do not reach the lens in any significant dose. Fractionated irradiations show a definite cumulative effect upon the lens (4).

Epilation (in rabbits) by fractionated irradiations occurs only after 4 to 8 times the cataractogenic dose, whereas a single radiation dose sufficient to cause epilation also caused cataract (5). Correlation between epilation and cataract in animals serves as a parameter for application of this data to man (1).

Assuming that a 50% increase in radiation dose is needed to cause permanent epilation of the eyelashes compared to that needed to epilate scalp hair in man, at least 750 r/air in a single dose would be required to epilate the eyelashes. This would cause a cataract in some humans. Over a long period of time, however, 4 to 8 times this dose (3000 to 6000 r/air) in fractionated doses would be necessary to cause epilation—much more than necessary to produce a cataract since damage to the lens epithelium seems to be cumulative, regardless of the fractionation. With these higher doses, however, the latent period of cataract formation would be shorter, a few months. Permanent damage to cornea and conjunctiva also occurs with dosages over about 750 r, extrapolating animal data (1).

Clinically, radiation cataract is first noted at the posterior pole of the lens. There is a latent period varying from 6 to 72 months (6) (7). This lag is because the damaged lens epithelium takes several months to develop into lens fibers and to migrate to the posterior pole of the lens.

By slit lamp, discrete dots are seen in the cortex of the lens near the posterior pole. These spread and later a clear area appears giving a doughnut appearance. About this time granules are noted in the anterior subcapsular region. Later a dense diskshaped opacity occupies the region of the posterior cortex. If extensive damage has been sustained by the lens, liquefaction of the cortex can occur. The lesion may arrest itself at any stage.

Microscopically these changes can be identified as "being consistent with" radiation cataract. Unfortunately the specimen removed 8 March 1967 . . . has been discarded.

On the other hand, "cataracta complicata" is characterized by a polychromatic luster at the posterior pole—a rainbow play of colors. Then opacities spread in a rosette form; later the opacity spreads axially toward the lens center. The rosette also spreads over a greater area of the back surface of the lens. Eventual complete opacification of the lens may occur. Usually evidence of other disease of the eye is present; e.g., uveitis, pigmentary degeneration, retinal detachment, etc.

Comment:

a. The surgeon noted in the hospital chart that the cataract has the appearance of the "cataracta complicata" type; but he noted "anterior and posterior subcapsular opacities".

b. There is no evidence at the examination of 18 November 1968 of any radiation damage to either eye or to surrounding structures. There was no evidence of progressive cataract formation in the left lens.

c. The occipital scalp lesion described in the dispensary record of 11 March 1963 was a cyst or a skin abscess. Gamma radiation would have caused an erythematous, desquamating lesion, and would not have been confined to a single circumscribed area of only 2 cm.

d. Nowhere in the record does it show that [claimant was] in the direct path of the Cesium⁻¹³⁷ beams, in the open or the closed attitude of the source. It would have been impossible for him to place head between the source and detector units mounted on the yoke. Study of the drawings and radiation readings show that with the source "closed" maximum radiation was 14.4 mr/hr; when "open", 1000 mr/hr (at the port from which emanated the collimated beams). If he had been exposed to 1000 mr/hr for long periods such as 40 hours a week for 4 weeks, the dose to the small area of body surface would have been 160 r—not sufficient to cause a radiation cataract. The radiation survey report of 19 January 1961 indicates that even with the source "open", there was only 5 mr/hr at the rear of and below the detector head (point Q); and only 10 or 13 mr/hr immediately to either side of the detector head (points O and P).

e. There is presently no indication of radiation injury to the right hand or arm. Radiation sufficient to cause cataract would have caused some skin damage.

f. Again from the diagrams and descriptions, [claimant's] right eye was not significantly closer to the radiation source than the left eye if he was able to see the micrometers for adjustment.

g. The tiny-dot-like opacities presently noted in the lens of the left eye are probably indication that the same opacities existed in the right lens before July 1962. Technically this is a form of congenital cataract.

h. Di-isopropyl-carbo-di-imide (DICDI) has not been implicated as an agent causing cataract. If exposure to some noxious substance did cause cataract, it is doubtful that the process would be confined to one eye, leaving the other unaffected insofar as cataract is concerned.

The specialist also responded to five questions asked him by the BEC as follows:

1. *Question:* Approximately what dose of radiation to the eye would have produced a cataract in the interval between [claimant's] exposure and the appearance of his eye disease?

Answer: About 600 r in a single dose or at least 1500 r over a month would produce a cataract in a human eye — assuming immobility of the target in a collimated beam. The latent period of 22 months would indicate a lower limit of cataractogenic dosage.

2. *Question:* If [claimant] had received such a dose to the head, arm and right shoulder, what other signs and symptoms would have been likely to appear?

Answer: Skin changes such as erythema, pigmentation, blister formation, loss of hair and ulceration. However, dose-fractionation decreases the skin effect of ionizing radiation (8). He certainly would have had damage to the eyelids, including loss of eyelashes and brow hair. None of these signs have been noted.

3. *Question:* Does any medical record in this file disclose any signs or symptoms other than the cataract which suggest that [claimant] was exposed to a cataractogenic dose of radiation?

Answer: No medical record indicates any other possible radiation damage. The scalp lesion was a localized lesion not at all typical of radiation effect.

4. *Question:* Did the cataract result from exposure to the ionizing radiation as a primary cause? Did such radiation aggravate, accelerate or hasten the cataract?

Answer: In all probability there was not sufficient exposure to radiation to cause a cataract. Judging from the safety precautions in effect . . . and from the lack of other evidence of radiation damage, it would be highly unlikely that a cataract was caused by the total radiation received by [claimant]. If there was a congenital cataract in the right eye (manifested by minute dot-like opacities) which did not functionally impair vision, this might have spontaneously developed into a mature cataract. Such unilateral cataract development is seen

not rarely in younger persons (fourth and fifth decade) who give no history of trauma, exposure to radiation, exposure to drugs, or to any other known etiologic agent. It is possible, but not probable, that radiation might aggravate a congenital cataract. Again, however, the left eye appears uninvolved.

5. *Question:* Did the combined effect of radiation and exposure to a minute concentration of DICDI cause, aggravate, accelerate or hasten this cataract?

Answer: Exposure concurrently to a minute concentration of DICDI would not aggravate the cataract formation.

References:

- (1) Cogan, D. G.: Lesion of the eye from radiant energy. J.A.M.A., 143-145, 1950.
- (2) Cogan, D. G. and Dreisler, K. K.: Minimal amount of X-ray exposures causing lens opacities in the human eye. Arch. Ophthalm., 50:30-34, 1953.
- (3) Duke-Elder, Stewart: System of Ophthalmology, Vol. VII, page 791. C. V. Mosby Co., St. Louis, 1962.
- (4) Ellinger, Friedrich: Medical Radiation Biology, page 219. Charles C. Thomas, Springfield, Ill., 1957.
- (5) Rohrschneider, W., and Glauner, R.: Experimentell Untersuchungen ueber die Wirkung der fraktionierten and protrahierten Roetgenbestrahlung auf die Linse des Kaninchens. Arch. F. Ophth., 140:700, 1939.
- (6) Clapp, C. A.: The effect of X-ray andradium radiations upon the crystalline lens. Am. J. Ophth., 15:1039, 1932.
- (7) Milner, J. G.: Irradiation cataract. Brit. J. Ophth., 18:497, 1934.
- (8) Ellinger, Friedrich: *ibid*, page 136.

The Bureau's Assistant Medical Director concurred in the ophthalmologist's opinion:

The rationale given by [the ophthalmologist] appears overwhelming and I concur with his opinion that work factors were not responsible for the cataract in the right eye.

The medical officer where claimant worked stated that the chest and ring badge worn by claimant did not show excessive exposure to Cesium-137; that the extent of exposure was far below the amount necessary to cause or competent to cause cataracts; that even if the claimant's film badge worn on the chest pocket was below the level of the open steel door on the conveyor line that his ring badge should have also picked up any radiation if it was present; and that even if the claimant's film badge on the chest pocket was in a position where it would not record the exposures, the monitoring and wipe test performed periodically would have shown any extensive amount of radiation exposure.

BEC's Decision: In rejecting the claim for compensation for the reason that the disability was not due to injury sustained in the performance of duty or to disease proximately caused by the employment, the Bureau made the following pertinent findings of facts:

1. That the employee was not exposed to harmful concentrations of the chemical di-isopropyl-carbo-di-imide.
2. That exposure of his person to the potentially harmful rays of Cesium-137 contained within a metal cylinder filled with mercury was minimal and not of sufficient duration, frequency and extent so as to cause injury to the employee's head, eyes or other parts of his person.
3. That the cataract of the right eye and incidental, transitory skin changes about the head . . . were not caused, aggravated, hastened, accelerated or otherwise adversely affected by any condition imposed upon the employee by his employment.

CASE NO. 37

Type of Injury: Chronic Myelogenous Leukemia.

BEC's Decision: Compensation Denied.

Date of Decision: 1971.

Claimant's Allegation: That disability resulted from exposure to radiation and solvents while at work.

Facts: Claimant was employed as a pipe coverer and insulator for an agency of the federal government from July 2, 1955 until October 1957. He then worked for private industry in a similar position from November 1957 to March 1958 and again from August 1962 to October 1964. He returned to his position with the government agency from April 1966 until January 1970. In January 1970 at the age of 48, he became ill and was hospitalized by his personal physician. A diagnosis of chronic myelogenous leukemia was established. He filed his claim in January 1970 contending that his disability was related, among other things, to radiation. The claimant retired effective February 4, 1970.

A review of the claimant's work record showed that his job was non-nuclear in nature but that he could have had some exposure to ionizing radiation, to asbestos and to organic solvents, namely "synal 250" and "studdard solvent". He worked on a nuclear submarine on April 4, April 21, May 2 and May 8, 1969 but his work was removed from the reactor compartment area. From August 22 to 25, 1969, he did work in a radiation area and his film badge exposure was 20 millirem. Evidence indicated this was the only time the claimant worked in a known radiation area. On five occasions in 1969 he worked on nuclear submarines but he was not assigned to work in the nuclear reactor compartments or other radiation areas. His lifetime radiation exposure records indicated that the claimant had a total lifetime dose of 20 mRem of ionizing radiation. His annual chest X-rays from 1966 through 1970 were interpreted as normal. A whole body scan performed June 11, 1970 was within normal limits.

Medical Evidence: The claimant's complete file with a record of his exposure was sent to a medical radiation expert for review. With respect to the claimant's exposure to organic solvents, he pointed out that the lack of claimant's pulmonary disease demonstrated that adequate ventilation was provided in his working environment.

With respect to the claimant's radiation exposure the radiation expert, in referring to the fact that claimant's film badge and lifetime radiation exposure record indicated that the claimant received a total lifetime dose of 20 mRem stated:

The maximum permissible radiation exposure established by the AEC for radiation workers is 3,000 mRem (3 Rem) per calendar quarter and lifetime exposure of 135,000 mRem (135 Rem) for a man [claimant's] age. Any exposures to external radiation below these levels are considered safe. In addition, [claimant] had a whole body scan performed . . . which was within normal limits thereby indicating that he had at no time developed an internal contamination of radioactive material.

* * *

Since the amount of ionizing radiation received by [claimant] was so small, the ventilation in his working environment was adequate, and the solvents he used are not known to produce blood dyscrasias, it is my opinion that the development of [claimant's] chronic myelogenous leukemia was coincidental and not related to his occupation.

The medical director of the Bureau agreed "completely" with the opinion of the radiation expert and stated that he could find "no relationship whatever" between the conditions of employment and the claimant's disease.

BEC's Decision: In rejecting the claim for compensation for the reason that the disease causing disability was not caused by the factors of employment, the Bureau based its decision on the following pertinent findings of facts:

1. That the evidence showed claimant's job was non-nuclear in nature;
2. That the only exposure to radiation was for a twenty-six hour period between August 22 to August 25, 1969;
3. That his film badge exposure was 20 millirem; and
4. That the solvents used are not known to produce blood dyscrasia.

CASE NO. 38

Type of Injury: Aplastic Anemia.

BEC's Decision: Claim Accepted. No compensation. No permanent disability and no lost time. All intermittent periods of absence were covered by annual and sick leave. Reimbursement for medical expenses and travel expenses incidental to testing was made.

Date of Decision: 1970.

Claimant's Allegation: That his illness was caused by radiation exposure during employment.

Facts: Claimant was employed as an electrician for a Government agency. He first commenced work in September 1961. He was assigned as an electrician to assist in the installation and testing of an MeV electron generator, a dynamitron accelerator. His job included maintenance, trouble shooting and electrical construction on certain jobs. He also worked on a night shift for a period of time and evidence indicated there was less supervision of his exposure to radiation. The claimant wore no film badge or dosimeter. In performing work in one building evidence showed he worked in two or three feet of work space and that four dosimeters were shared by eight men involved in this job. The occasions and amount of exposure could not always be determined since dosimeters were not available for all workers and the monitoring was only checked at intervals. It was necessary for him to remove the belt whenever he replaced defective tubes or parts. After this particular assignment was completed he returned two or three hours a week. The period of exposure was from September 1, 1961 through January 1962 and on infrequent occasions until October 1962. No symptoms of radiation exposure were found in any of the other personnel on this job.

On March 19, 1963 a private contractor was called in to inspect a simulator in another building. The job site was on a bridge crane suspended from the ceiling and about 60 feet from the floor. The job of the private contractor was to make radiographic records of some 300 high stress points. They shot these X-rays on March 20, 21, 25, 26, and 27, 1963. Two employees of the contractor stood behind the X-ray machine and the claimant was also on the bridge the entire time of the operation pointing out where the pictures were to be made and positioning the direction of the shots. He was within 10 to 15 feet of the X-ray machine which was a LX 140 KVP with a fixed 2mA. Seventy-one exposures were made and the exposures were of 3 minutes each. The radiation found at floor level was in the range of .02 mR/hr which was considered safe tolerance for personnel. However, danger signs were placed on the catwalk

leading to the job site. There is no evidence that protective clothing was worn.

In April 1963, at the age of 33, claimant experienced dizziness, malaise and being short-winded and he sought medical attention. During the summer of 1963 claimant noted a striking loss of hair on his face and body. Because of persistent anemia he was hospitalized. In September 1963 he was hospitalized with the finding of aregenerative or aplastic anemia. He received repeated transfusions, cortico-steroids, hormones and vitamins from September 1963 until March 1966. By May 1969 the marrow had completely recovered and claimant was then asymptomatic.

Medical records showed that during claimant's periods of exposure he received no medication except "griseofulvin" - 9 tablets of 500 mg each for trichophyton, an infection of the skin. The lesions cleared and did not recur for one year. In June 1962 he took six more tablets again with prompt disappearance of the skin lesions.

Medical Evidence: A hematologist reviewed claimant's entire hospital records and he expressed the following opinion:

[Claimant] was working in an area where there was potential exposure to X-ray radiation. He did not always wear a dosimeter to detect the amount of radiation exposure . . . In addition, there is no record of any blood examinations during the period of his employment.

From a review of the history and pertinent clinical and hematologic findings, in my opinion, there is a definite causal relationship between [claimant's] occupation and the development of the aplastic anemia.

The attending internist supported the relationship as probably being due to prolonged exposure and the same opinion was expressed by the staff of one of the hospitals where claimant had been treated.

The possibility of a drug induced marrow depression was considered and it appeared that the drug fulvicin (griseofulvin) an antifungal drug, was the only medicine that might have been involved. One medical doctor expressed the opinion that the radiation was the more likely cause of the claimant's illness than was the drug. He supported this opinion by stating that the administration of the second course of the drug did not immediately effect any noticeable change in the patient's symptoms.

The Bureau's Medical Director noted that the medical opinion negating the drug in question as a causative factor was based on facts that were "not quite accurate" since other medical evidence showed that the claimant's lesions cleared after a ten-day course of treatment with the drug. However, he also noted the medical support for the relationship between the radiation and the disease and he said:

In summary the Bureau has accepted that the claimant has been exposed to a degree of radiation, shortly following which he had symptoms consistent with anemia and the subsequent diagnoses of aregenerative anemia treated for several years with good response and return of normal marrow-function. There is support for the relationship between the radiation and the disease, the time relationships are good and in my opinion, after reviewing the entire record, the relationship

between the radiation exposure is much more probable than with the short use of the drug fulvicin. This relationship is supported by several physicians involved in the medical management of this claimant.

BEC's Decision: In accepting the claim the Bureau informed the claimant: "After a study of all the factual and medical evidence in the case the Bureau has determined that the aplastic anemia was proximately caused by conditions of employment." However, no compensation benefits were payable as claimant had no lost time from work and no permanent disability.

CASE NO. 39

Type of Injury: Granulocytopenia.

BEC's Decision: Claim Accepted. No compensation; No pay loss.

Date of Decision: 1970.

Claimant's Allegation: That his granulocytopenia was caused by his exposure to ionizing radiation as an X-ray technician.

Facts: Claimant, a 42 year old male, had been an X-ray technician in a hospital for 20 years, since about 1948. A routine blood count on October 23, 1969, showed a depression of his white blood count and by November 18, 1969 to as low as 3,300 white cells with only 40 percent neutrophiles.

Records of the employing hospital showed that claimant's routine work as an X-ray technician consisted of taking X-rays, assisting radiologists during fluoroscopy, and taking X-rays in wards and surgery with portable machines. The employee worked continuously from 1951 until January 1970. His prior exposures are unknown. A statement from the hospital indicated that monitoring of the claimant from date of employment was done with pocket dosimeters and film badges worn on his person.

Medical Evidence: The medical diagnosis from the hospital was granulocytopenia due to radiation exposure.¹ In the hematology report dated March 18, 1970 to the Bureau the hospital's medical doctor said concerning diagnosis:

Employee is asymptomatic . . . Diagnosis: Impression was "granulocytopenia due to radiation exposure" with recommendation of "absolute avoidance of further radiation exposure." Employee was assigned . . . to duties where no radiation exposure exists. Employee continues to get repeat blood counts on a monthly basis. Recent counts show improvement of white blood cell count. On March 12, 1970 white blood count was 4,260 differential showing 51 neutrophiles, 40 lymphocytes, 2 monocytes and 7 eosinophiles. If this improvement in his monthly blood counts continues there is a possibility of his return to his duties as Medical Radiology Technician within the next year.

¹ It should be noted that the medical opinion establishing a causal relationship between the claimant's exposure and his disease, made no reference to the amount of claimant's exposure during his employment as an X-ray technician. However, a review of the hospital's film badge records on file with the Bureau, indicates that claimant had received a total cumulative exposure between 1951 and 1969 of 12.870 roentgen.

The Bureau's Medical Director concurred in the hospital's opinion and in a report dated April 16, 1970 he said:

In this case I feel that the decrease in white count, particularly the neutrophils, represented a biological monitor and was the result of the long term radiation exposure. With removal from radiation sources the white count is improving. I have no further recommendation except those provided by [the hospital], that is, removal from radiation pending return to normal of the white count, with periodic blood checks.

On May 6, 1970 the claimant's white blood count was 5,600 and he was reassigned to his previous position in the X-ray department of the hospital. In a statement dated October 1970, the Bureau's Medical Director noted claimant's blood count had returned to normal. He also pointed to the possibility of latent effects reappearing after further X-ray exposure and he said "claimant is protected by his claim should he in years develop a myeloproliferation disorder".

BEC's Decision: In allowing the claim the Bureau said:

The Bureau has determined that [claimant's] disease is related to his exposure as an X-ray technician since 1948.

CASE NO. 40

Type of Injury: Epidermoid Carcinoma, Dorsum of the Right Hand.

BEC's Decision: Claim Approved. No compensation; No lost time; No medical expense; No permanent disability; and No residual of the injury.

Date of Decision: 1971.

Claimant's Allegation: In March 1970 claimant filed "information" concerning his injury with the BEC "as a matter of interest to BEC and others interested in the incidence, prevalence and natural history of those exposed to ionizing radiation".

Facts: Claimant was a physiologist and assistant to the radiologist at a Government hospital. In April 1969 he noticed a lesion on the dorsum of his right hand. It was removed and diagnosed as a well differentiated epidermoid carcinoma. He continued to work as there was neither residual recurrence nor dissemination of the lesion. On March 4, 1970 he retired on disability for cardiac insufficiency. Since he had accrued an excess of 3,000 hours of sick leave he went on sick leave, and on the same day he filed "information" with the Bureau concerning the lesion in question. The information was treated by the Bureau as a claim.

Evidence showed that between 1946 and 1959 claimant had performed "hundreds" (between 15 and 20 a day) of fluoroscopic and X-ray examinations on mentally ill patients in the T.B. unit of the hospital as part of gastro-intestinal tract studies. He used no film badge and wore no protective gloves. Since all the patients examined were mentally ill their behavior or inability to cooperate in positioning for the examinations made it necessary for his protective gloves to be removed. Claimant alleged that he had had no significant exposure to ionizing radiation prior to 1946. The old vertical fluoroscope was later condemned and all the X-ray equipment claimant worked with was disposed of. However, the fluoroscopic unit with which the claimant had done most of the pneumothorax and pneumoperitoneum examinations was described by a radiation physicist as "hazardous". In a *Protection Survey* report of 1958 on the fluoroscope in "Room 1010, Radiography and Fluoroscopy, Medical Surgical Building" the machine was described in pertinent part as follows:

This room contains a Keleket 300 ma multicron with a Keleket type C table adjustable from trendelenberg to upright. The room is used principally for fluoroscopy with some general radiography. Fluoroscopy is carried out at 65-95 Kvp, 4 - 5 ma and there is a 3mm Al filter in the

fluoroscopic unit. Measurement of the output at the table panel gave a value of 4.5 r/minute for 90 Kvp and 5 ma. Room shielding is adequate. There is a lead lined protective shield for the technician. Persons needed in the room wear protective aprons and where needed, protective gloves. No lead shielding is needed on the doors as the hallway has only partial occupancy (occupancy factor y 4) and the distance is sufficient to reduce the barrier requirement to a negligible value since secondary protection is all that is required.

A condemned T.B. Building fluoroscope was also described in the 1958 report as follows:

This installation consists of an antique vertical panel fluoroscope powered with an old mechanically rectified high voltage unit and an air insulated X-ray tube in a lead glass shield. This unit is considered unsafe and should probably be junked. The milliammeter does not function and therefore it is not possible to know the value of the milliamperage. However, screws have been installed to lock or limit the adjustment of the control switches to certain maximum values.

The Kv selector is locked at button C although the minor Kv switch has full range of adjustment. When the unit has been set for what appears to be the normal setting the dose rate at the panel was 9 r/minute which is within handbook 60 requirements. However, it is not possible to determine what the actual kilovoltage or milliamperage is. Also no attempt was made to determine the filter as this would have required dismantling the equipment. No attempt was made to measure the stray radiation but due to the open construction it probably is quite large. If this unit is retained, the control should be modified or repaired so that the milliammeter is operable and a careful protection survey made of the stray radiation. It is suggested that consideration be given to the question as to whether a fluoroscope is actually needed for this service and if so, the unit should be replaced with a modern type of equipment.

In a letter dated September 18, 1970, the chief technician of the department of radiology at the hospital stated that prior to the installation of the Keleket 300 ma Radiographic-fluoroscopic unit described in the above report the claimant used from 1946 to 1950 a Keleket fluoroscope (no radiography) consisting of a tilt-type table with air insulated X-ray tube in a lead glass shield, installed approximately in 1930. He further stated that there was no record of the output of this fluoroscope and both the radiologist and the chief technician at the hospital are deceased. "However," he said, "the fluoroscope being of open construction similar to the condemned T.B. Building fluoroscope, probably allowed a considerable amount of stray radiation".

Medical Opinion: In a report dated December 18, 1970 the acting medical director of the Bureau made the following statements regarding the claim:

1. Cutaneous damage from X-ray often appears many years after significant exposure. The type of lesion which claimant had on the

dorsum of his right hand certainly could have been caused by radiation exposure. It should be noted, however, that similar lesions may also be related to active radiation.

2. I would recommend acceptance.

3. There appears to be no residual disability.

BEC's Decision The claim was approved for epidermoid carcinoma dorsum right hand. However, no compensation benefits were payable as claimant had no lost time; had accrued no medical bills; there was no permanent disability; and no residual of the injury.

CASE NO. 41

Type of Injury: Cutis Laxa.

BEC's Decision: Compensation Denied.

Date of Decision: 1970.

Claimant's Allegation: That his skin condition was caused by unknown amounts of ionizing radiation to which he was exposed in the course of his employment.

Facts: Claimant was employed in an administrative capacity from September 21, 1958 to February 22, 1959 at a missile defense site in the supply and maintenance division. Claimant alleged that in his position of responsibility for logistical support of all operations and activities on the base, it was his duty to "get around", to know what was going on in the area; that he did this every day; that he thought a film badge was required for his job, since he was under the impression it was entirely possible he was exposed to ionizing radiation during this time, but he did not know when or if he was exposed. Records did not show claimant was ever issued a film badge.

Statements from the Nuclear Effects Director and the Supply Management Analyst of the Missile Base in question indicated that there was no possibility of radiation exposure at the missile base during the period of claimant's employment; that nuclear reactors were not installed until 1960; and that reactors did not become operable on the base until August 1964.

Evidence did not show that any other persons who had worked with claimant had been sick or had required treatment for radiation exposure.

In February 1959 claimant decided to leave the job at the missile range and return to a job he had previously held at another base in an administrative capacity as a Program Coordinator. Service records and a statement from the military surgeon indicated that from February 1959 to November 1963 the claimant's job required on-site visits to certain missile installations; that these various missile site facilities "may have had sources of microwave and ionizing radiation" which was "very limited"; that claimant's assignment did not require him to wear a film badge; and that his personnel records did not include any records of exposure to ionizing radiation. He further stated that claimant did not personally operate or maintain any equipment; that he never had any contact with radiation tests and calibration equipment but that he did operate radar vans on several occasions.

A review of military medical files did not indicate any event where uncontrolled exposure to ionizing radiation occurred at any worksite where claimant was present.

Claimant first noted rapid deterioration of the skin on his neck and face in 1963 when he began to develop deep creases, swollen eyelids, heavy jowls, very enlarged pores, fine wrinkles all over his face and bad discoloration. He attempted self treatment with no success and in 1966 went to a dermatologist who diagnosed his condition as cutis laxa and recommended plastic surgery. Chemical peels of the face were performed in 1967 and 1968 and a face lift was done in 1968.

Medical Evidence: At the time of his initial visits the dermatologist allegedly asked claimant if he had ever had X-ray treatments. Claimant said he indicated to the doctor he had been exposed to radiation in his job at the missile site but could not identify his exposure.

In a letter to the plastic surgeon the dermatologist stated that claimant had a skin condition "which may or may not be a result of radiation received while employed by [the] missile range," that its etiology was not certain but that the condition "probably" resulted from a violent reaction to radiation to which claimant was at some time exposed.

The plastic surgeon noted the dermatologist's opinion and he said:

It is impossible to state with assurance what the etiology of the marked elastosis and cutis laxa of the facial skin is It must be assumed that the patient has been subject to irradiation which has speeded the aging process by causing atrophy and loss of elasticity and tone in the facial skin.

After a review of the file the BEC Medical Director reported in pertinent part:

The claimant apparently suffers from and has been treated for cutis laxa, a disease of unknown etiology, The microscopic appearance of this may be similar to that seen after X-ray or other radiation treatment to the skin resulting in a burn and subsequent premature aging.

There is no indication in the record that the claimant received anywhere near the amount of radiation exposure that would be required to produce such a disease process. If such an exposure were obtained, the claimant would certainly know when, where and how he received it. It appears that he misled the treating physicians in telling them that he was exposed to radiation. They accepted his history and have considered that it might be the etiological factor. This opinion was not based upon objective laboratory or other scientific evidence, but only the history as given to them by the patient.

In my opinion there is no relationship between the employee's skin condition and factors of radiation exposure received at work.

BEC's Decision: In denying compensation the Bureau said:

The Federal Employee's Compensation Act provides that a civil employee of the United States who is injured while in the performance of his official duty is entitled to 1) payment of compensation for

disability resulting from such injury, and 2) medical treatment for such injury¹.

After a thorough study of all the factual and medical evidence submitted in your case, it has been determined that your skin condition was not caused by or aggravated by your working condition prior to 1966.

There were no radiation programs in existence until 1960 at the . . . missile range; there were no known sources of radiation in your primary environment since February 22, 1959 when you were employed at [the army base] and your field work was administrative.

¹ Federal Employee's Compensation Act, 5 USC 8101, 8102 and 8103.

CASE NO. 42

Type of Injury: Stromal Herpetic Keratitis and eventual loss of sight in one eye.

BEC's Decision: Compensation Denied.

Date of Decision: 1970.

Claimant's Allegation: That her eye condition is causally related to radioactive "spills" on two occasions during her employment.

Facts: Claimant worked as technical editor and clerk typist in a government nuclear defense laboratory. Her desk and regular post-of-duty was in an anteroom outside of the actual laboratory where radioactive materials were handled. Records indicated that on November 13, 1961, 2 mg. Radium equivalent of Thorium 228 was moved into the laboratory in question. During experimental procedures on November 14, 1961, just before lunchtime, a laboratory worker spilled approximately two micro-curies of Thorium 228, in solution, on the top of a stainless steel table. The spill was not discovered until right after lunch and the laboratory was ordered to suspend all routine operations. Monitors equipped with portable alpha survey meters were used to monitor all personnel prior to leaving the building. Claimant underwent such a check. She was not found to be contaminated with alpha particles. The monitors found one case of skin contamination. The left hand reading of the contaminated person was 250 c/m. All contamination was cleaned up promptly and claimant was not involved in the spill or cleanup operation. The laboratory resumed its regular work on December 19, 1961. A routine survey performed on that day revealed no removable contamination and external radiation levels of 0.03 mr/hr.

On or about January 23, 1962 evidence indicates that one of the laboratory workers flushed a small quantity of "slurry" (wet waste) from a diamond cutting saw without realizing the material was radioactive and the sink trap became slightly contaminated. None of the slurry was spread about the laboratory and because there was no distributed contamination the incident was not treated as a "spill". Unaware of the incident, the claimant entered the laboratory to get her coat which was on a coat rack near the work area. The next day the laboratory was closed and the sink was dismantled and cleaned before the laboratory resumed work. A survey record dated January 25, 1962 showed insignificant removal contamination. Fixed Thorium 228 was indicated in a hood containing the Thorium. Contact readings were 17 mr/hr. Readings in the office portion of the laboratory was 0.02 mr/hr. No other injuries of any kind were ever reported, even from persons much closer to the incidents than claimant had been.

Film badge records show claimant's total cumulative whole body exposure between August 1961 and July 1965 as 1.69 rem. Her total accumulated whole body dose of beta-gamma from August 3, 1961 to March 21, 1962 (during the period of the spills in question) was .006 rem.

The first week of February 1962 the claimant experienced irritation in both eyes. She went to a medical doctor who diagnosed the condition as conjunctivitis. Since pain and swelling continued the claimant went to an ophthalmologist in March 1962 and he saw a lesion on her retina which he could not diagnose in relationship to radioactive spills and he advised her to report the illness to the commanding officer of the laboratory. She was sent to a hospital where a diagnosis of deep stromal herpes simplex keratitis was made and she was treated until September 1962. No indication that radiation exposure had a causal relationship was made at this time. Her condition steadily worsened and during a routine eye examination in October 1965 it was found that claimant had very little sight in her right eye. She filed a claim for compensation in January 1966.

Medical Evidence: The claimant requested an opinion of a medical radiology specialist concerning the probable relationship between the exposure to radiation and the injury suffered.

In his report the radiologist stated his opinion in terms of mere "possibility" that the herpes may have been related to exposure, since, he said, he did not have a record of the claimant's exposure. In a subsequent opinion based on the claimant's film badge exposure the radiologist offered the following opinion in pertinent part:

There is virtually no reference in the scientific literature which can elucidate underlying mechanisms in the pathogenesis of radiation-caused herpes virus infection. It has never been studied to my knowledge as a scientific problem.

A film badge record of radiation dose must be considered an approximation of the average radiation dose; the radiation dose received by the part of the body monitored by the film-badge may be more or less than to other regions. From a practical point of view, the radiation dose to the eye at the time of the accident could not be determined with any precision by the amount of exposure to the film-badge.

There is no reliable method, to my knowledge, of determining the level of exposure which would cause active herpes infection under the circumstances of this accident. There is little or no experimental or clinical information which bears directly on this unique combination of events.

I can draw no firm scientific or clinical conclusions. It is possible that the radiation accident triggered the herpes infection, but this is conjectural. The underlying mechanism remains unknown. Of importance, in my mind, is not the dose-response relationship in terms of very crude quantitative estimates which may or may not have relevancy here, but the possibility that at the cellular level activation or reactivation of the herpes virus evidently occurred as the result of some biological event--and it is the subsequent course of the pathogenesis of

the disease which has amplified the initial changes into a clinical problem of significance.

The Bureau's medical director was of the opinion that there was no relationship between the exposure and the disease because the degree of exposure was "extremely minimal."

BEC's Decision: The Bureau rejected the claim for compensation for the reason that the disability did not result from conditions proximately caused by the employment.

CASE NO. 43

Type of Injury: Leukopenia and Lymphocytic Leukemia.

BEC's Decision: Compensation Granted.

Date of Decision: 1971.

Claimant's Allegation: That her husband's death was causally related to his occupational exposure to radiation prior to 1962.

Facts: The decedent was a X-ray technician at a government hospital. Hospital records indicated he had been a hospital attendant for about five years when in October 1946 he filed a claim for tuberculosis which was accepted by the Bureau. The tuberculosis was treated by pneumoperitonium procedures without drugs. During the period of treatment he had multiple X-ray exposure made in connection with a fracture of the femur. Claimant's medical history further showed that he was hospitalized in 1958 for acute maxillary sinusitis and bronchial pneumonia. Just prior to admission he had been treated for the sinusitis with chloromycetin one gm. four times a day. In 1961 he was hospitalized because of a four year history of leukopenia with the white count ranging between 3,000 and 3,300, a marked depression of neutrophils and a relative lymphocytosis. A bone marrow done at that time was non-specific. In 1962 the decedent filed a claim alleging that his persistent low blood count was the result of occupational exposure. By 1962 claimant had worked as an X-ray technician for about sixteen years, both while in the armed services and as a civilian. Radiation exposure records from 1956 to 1961 showed 1 rem with a maximum exposure in 1960 of .99 roentgen, equivalent to approximately 990 mrem.

Medical Evidence: A hematologist and a radiation expert were asked for an opinion on causation. The hematologist reported in July 1962 that claimant's hematologic findings had no connection with X-ray exposure and he said:

The blood count on July 9, 1962, was normal except for a moderate granulocytopenia. A sternal marrow aspiration obtained the same day disclosed excellent overall cellularity. However, the granulocyte precursors were decreased in number and the lymphocytes increased. No primitive, abnormal, or malignant cells were seen. There was a fair amount of marrow hemosiderin. [The radiation expert] and I have discussed this man's X-ray exposure and current hematologic picture and are convinced there is no connection. We both agree that he should be

permitted to resume his work as an X-ray technician. His blood picture neither represents the effect of radiation nor does it make him any more liable to X-ray damage than the next person.

The hematologist also reported at that time that claimant's past medications included occasional polaramine, achromycin, and declomycin but that "He never received chloromycetin, any of the chlorothiazide, anti-thyroid, antiepileptic treatment." He further stated:

There is an infiltrate in his marrow of mononuclear cells that resemble lymphocytes. They do not look particularly malignant or granulomatous. The exact diagnosis is uncertain at this time.

The radiation expert offered the following opinion:

The film badges indicate a total exposure of 4.1 r in 5 years. Supposing total body exposure and moderately penetrating radiation this would give an average absorbed dose of about 1.3 rads—an integral dose of nearly a tenth of a megagram rad. The average absorbed doses from his diagnostic radiography plus the fluoroscopies give a total integral dose of about two megagram rads in sixteen years.

In estimating the chance of harm from the claimant's absorbed dose the radiation expert then said:

The British spondylitis cases indicate doubling of the natural leukemia rate by a total absorbed dose of 7.5 megagram rads. The leukemogenesis appeared to be mostly between one and six years after exposure. Since no leukemia had appeared in the first twelve of the sixteen years observation in [claimant], it seems we should calculate recent and future chance of leukemia on only the last third of his exposures, i.e., on 0.7 megagram rads.

If one takes a linear extrapolation, this dose—about a tenth of the doubling dose—would give 5 chances per million of leukemia (per year for 5 years) a total of 25 chances per million.

He further pointed out that if one thinks the leukemogenesis goes as the square of the dose, this would mean that one tenth the doubling dose would give one hundredth the natural leukemogenesis, i.e., one quarter chance in a million and he said:

A more understandable way to put it is this: If [claimant] develops leukemia, one estimates the chances are one in ten that the X-rays were the cause of it. Or, if you adopt the quadratic relationship, one chance in one hundred.

The chief of radiology service at the employing hospital reported in 1962:

I have carefully reviewed all the evidence on [claimant's] condition including numerous blood counts on him . . . It is noted that a rather

Careful workup including bone marrow study has failed to reveal any conclusive evidence as to the nature of this blood dyscrasia. Review of all of [claimant's] records with regard to radiation exposure in his employment show no evidence of undue exposure at any time during his employment here. However, it is to be remembered that he was disabled by tuberculosis (resulting from his employment here) about 1950 and that he sustained a fracture of the femur, with many X-rays made during its treatment during the course of his employment as an X-ray technician here. Whether these could be considered to have any bearing I do not know.

The Bureau rejected the 1962 claim. The chief of radiology at the employing hospital recommended retirement and on April 6, 1962 claimant retired and then became a real estate salesman. He was admitted to a hospital in March 1969 primarily for incision and drainage of a right axillary abscess. Claimant died April 7, 1969. The cause of death was broncho-pneumonia secondary to aplastic anemia. A post examination confirmed a diagnosis of chronic lymphocytic leukemia, aleukemic type with its complications.

The widow filed a claim in 1969 alleging that decedent's death was related to lymphocytic leukemia caused by his employment as an X-ray technician prior to 1962. Accordingly, the Bureau made a further study of all medical records. Upon review of the records in the case, the Bureau's Medical Director noted that (contrary to medical evidence submitted in 1962) decedent had been treated in 1958 with chloromycetin which at that time was not known to be responsible for bone marrow depression and its leukemogenic effects; that the 1962 report of the hematologist did indicate an infiltration in the bone marrow of mononuclear cells that resembled lymphocytes and he said:

In my interpretation of this report this would represent the pre-leukemic phase of aleukemic lymphocyte leukemia. . . . In my opinion, therefore, the decedent's demise was due directly to the leukemia and its complications particularly the infectious aspects of leukemia, including in this instance lobar pneumonia and leukemic infiltration of the lung.

In addition, he noted the 1962 radiation expert's report estimating claimant's chances of developing leukemia were 1 in 10 and that X-ray exposure would be the cause of it. He further pointed out that he had found a causal relationship between a blood disease and job related radiation exposure in another BEC claim¹ in which there was a similar factual situation. In finding a causal relationship between the claimant's blood disease and his exposure the Bureau's Medical Director said:

In summary, this decedent had prior X-ray exposure while in the military service and has had significant exposure as a radiology technician for the . . . hospital with the initial effect of leukopenia resulting in his separation from government service in 1962. He has also

¹ See BEC Case No. 39, *Studies In Radiation Injury*-Vol. VI, in which the claimant was an X-ray technician and a co-worker in the same hospital.

been treated with chloromycetin currently considered a drug toxic to bone marrow not known at that time. I, therefore, consider the leukopenia while in government service to be the direct result of the radiation exposure superimposed on the prior administered chloromycetin. Further, in my opinion, the decedent's leukemia represented the latent effect of his many years of X-ray exposure and his death directly related to the lymphocytic leukemia. As previously mentioned, it is also my opinion that the leukopenia between 1959 and 1962 and subsequent years is also related to these duties as an X-ray technician for the . . . hospital.

BEC's Decision: In granting compensation the BEC found that decedent's leukopenia was proximately caused by his employment as an X-ray technician prior to February 2, 1962 and that his death was related to the lymphocytic leukemia.

CASE NO. 44

Type of Injury: Bilateral Subcapsular Cataracts.

BEC's Decision: Claim Approved. No lost time from work due to condition. No Compensation.

Date of Decision: 1970.

Claimant's Allegation: That her cataracts were due to handling radioactive materials over a period of time involving various assignments as a chemist.

Facts: Claimant was employed as a physical science technician at a shipyard in 1957. She worked with radioisotopes in the radiochemical section of the chemical laboratory. Her job was to assist a radiochemist by performing numerous chemical tests and other work in connection with research and development projects and particularly in evaluating radiation samples taken from reactor plants of nuclear powered ships. Most samples were of reactor plant water containing a mixture of radioisotopes that must be separated before final analysis. She used electronic counting equipment such as multi-channel gamma spectrometers designed for use in radiochemical laboratories.

The two most important functions of her position were: 1) the use of prescribed radiochemical techniques and methods for the purpose of isolating specific radionuclides on a quantitative basis; and 2) the concomitant application of techniques and methods of gamma ray spectrometry and beta ray counting techniques for the purpose of evaluating the amount of a specific radionuclide on an absolute basis.

Her responsibility was to maintain "good housekeeping" in the laboratory by performing scheduled monitoring for radiation contamination, taking "wipes" and other samples and evaluating them, recording results and observing meticulous care against contamination. Accordingly, her work required continual surveillance to minimize contamination of working areas, apparatus, utensils and personnel inasmuch as contamination posed both a health hazard and might ruin an analysis.

A report from the radiological health officer where she was employed indicated that claimant occasionally assisted with the calibration of film badges. The calibration apparatus consisted of a 10 curie cobalt-60 source in a collimated projector. The operators were protected by shielding and by a barrier between them and the radiation beam. On one occasion she assisted in the calibration of a thermal neutron generator. The generator consisted of a shielded box containing a 10 curie neutron source. Access to the interior of the box was through holes, one or two inches in diameter, large enough to admit

neutron measurement probes. He reported that neutron exposure outside the box was negligible and that this operation lasted less than a month. This report indicated she also assisted on a few occasions as a radiation monitor, using a survey meter to monitor personnel leaving a radiation area to assure that they were free of radioactive contamination and using a survey meter to measure the radiation intensity of radiation areas.

A report from the head of the chemical laboratory stated that the employee spent 50% of her time in a "low-activity-level" area; that external exposure was negligible; that the major hazard was from ingestion or inhalation of unsealed radioisotopes; that no specific incidents or violations are known; that no shielding of radioactive materials in work process was used or considered necessary; that activity levels were generally such that Atomic Energy Commission regulations did not require "Radiation Area" posting; and that stored radioactive materials consisting of a total of less than 10 millicuries were shielded by two inches of lead.

Records further indicated that claimant had been in the film badge program continuously from 1957.

In January 1965 claimant received a routine eye examination as part of a radiological safety check. At the time for the examination she had no specific complaints. At that time film badge records showed her total cumulative exposure was 1.690 rem.

Medical Evidence: The eye examination showed claimant's vision was 20/25 right eye and 20/20 left eye best corrected. Slit lamp examination showed posterior subcapsular cataracts in each eye. The examining physician recommended that claimant undergo regular eye examinations at six-month intervals for at least a year and continue her regular duties and if no progression of the lesions became apparent in the next year the patient be examined annually for several additional years.

The eye specialist further said:

If there is still no apparent progression after this time, it would be very doubtful if her work was related to the occurrence of her lens opacities. A congenital basis or early pre-senile change would then be the most likely etiology, and no treatment would be indicated and the visual impairment is so slight that there would not be a notable disability.

In June 1965 she was seen by another eye specialist who reported as follows:

The findings are in the right eye. There is a thin fluffy beaten gold vacuolized posterior subcapsular opacification in the visual axis which obviously does not interfere with vision since there is 20/20 visual acuity. In the left eye the changes are identical but not as marked. There is no fetal embryonal or nuclear change and no persistent or primary hyperplasia of the fetal vascular systems remnants are evident. The lesions are discrete and there is no branching or opacification towards the equatorial region which, of course, is obscured by the iris. The only

feature lacking of a typical post cataract secondary to radiation would be the extension of fine full lines of opacification toward the equatorial region. On the other hand, the posterior polar cataracts on a congenital basis, are associated with remnants of the hyaloid artery systems, are more solid and are not as fluffy and vacuolated as this beaten gold type of opacification is. The stated radiation dosage is admittedly minimum. However, this could be an unusual sensitivity of the germinal epithelium to a low volume of radiation. This could, on the other hand, be a precocious senile change which was diagnosed at the age of 35 . . . My impression is that this is, in fact, an early senile change which is probably progressive.

With respect to the question of whether or not the claimant should be allowed to continue in her present employment and to have continued exposure to low levels of radiation the eye specialist said:

I feel there is enough doubt as to the relationship between the radiation and lens change as to advise the patient to seek employment in another field, particularly if there is any progression as observation is continued.

In September 1965, a repeat eye examination showed no progression of the lesions. She continued to have periodic eye examinations as recommended and an examination in January 1970 showed that in addition to the central posterior opacities, peripheral opacities had developed at the lens equator.

In a report dated April 1970 the Bureau's Medical Director stated:

. . . the report of January 13, 1970 does show a minimal progression with some spotting in the upper half of the lens.

I must conclude, therefore, that the slight progression of these cataracts, subcapsular in type, were initiated or certainly aggravated by the radiation exposure.

The Bureau's Medical Director recommended continued observation at the Public Health Service Hospital and lens extraction when that becomes necessary.¹

At this time claimant stated that her film badge now read 3 rem and that this was her total dose over a 14 year period.

BEC's Decision: The Bureau approved the claim on the basis that the progression of her cataracts was causally related to her exposure during employment. However, no compensation benefits were payable as claimant had no lost time from work due to her condition.

¹ On her last eye examination in February 1971, the patient complained of some blurring of vision in the right eye. On examination the patient had a little further progression of her lenticular opacities both centrally and equatorially. Vision in the right eye was 20/70 and the left eye 20/50. Refraction was -0.75 +1.25 x 100 = 20/50+in the right and -0.50+1.25 x 80 = 20/20 in the left with a +2.00 add for near.

CASE NO. 45

Type of Injury: Leukopenia.

BEC's Decision: Compensation Denied.

Date of Decision: 1970.

Claimant's Allegation: That his leukopenia resulted from radiation to which he was exposed during his work as a medical X-ray technician.

Facts: Claimant is a 30 year old medical radiology technician employed in a government hospital. His work history showed that he was first employed at this hospital on August 28, 1967. Following graduation from high school in 1958 he trained and worked as a medical X-ray technician for two years in a private hospital. The following seven years he was chief X-ray technician at that hospital. Evidence indicated that his training was very good, that protection against X-ray was stressed and that radiation protection in his work environment was good. In July 1968 the chief of the laboratory service of the hospital reported to the chief of the hospital's outpatient service that repeated examinations of claimant's blood revealed a persistent leukopenia. Re-evaluation of the case in August 1968 revealed a provisional diagnosis of "Persistent Leukopenia of unknown origin". Hospital film badge records dated March 1, 1959 through March 10, 1959 showed a total exposure of 13 mr.

Film badge records from September 1960 through October 1967 showed a total cumulative exposure of 1460 mr.

Medical Evidence: In view of the continuous employment of the employee in the hospital's X-ray department, a medical recommendation for further investigation into the possibility of X-ray induced leukopenia was made. Accordingly, in December 1968 the claimant was examined by a hematologist who reported as follows:

. . . present and recent hematology studies reveal a white blood count (and neutrophile count) in the low-normal range. I would think it very important from both a diagnostic and psychologic viewpoint, to perform a bone marrow aspiration in the near future. Whether there is an X-ray effect at present can only be speculative . . .

The bone marrow aspiration was performed on December 12, 1968 and reviewed by the hematologist who reported:

. . . marrow was of normal cellularity and all elements were present.

The granulocytic series consisted predominantly of the mid-mature to mature forms and showed no abnormalities in maturation or morphology. Megakaryocytes are present. ME ratio is 4:1.

Impression: Normal bone marrow.

Recommendation: Continued periodic hematologic examinations. There is no evidence of blood dyscrasia at present.

In January 1969 the chief medical doctor of the government hospital's out patient service expressed the following opinion:

... I feel this employee should have more frequent hematological examinations as compared to the average. I believe, however, that there is no evidence that X-ray exposure has produced this hematological picture.

The Bureau's medical director made the following report regarding the claim that the persistent leukopenia had been caused by X-ray exposure during employment:

Leukopenia of this degree can and frequently does occur spontaneously without any known cause. All safety devices have been provided this technician and the film badge records indicate a quite insignificant degree of exposure. The preexisting radiation exposure from September 1960 to October 1967 while employed by a private hospital prior to government employment totals only 1,460 mr or 1.46 roentgen which is a quite insignificant amount of cumulative exposure during that time.

The cause of the leukopenia at this time thus is quite speculative and the leukopenia was merely an incidental finding. The bone marrow aspiration performed December 12, 1968 was completely normal. The leukopenia level varies from 3500 to 5000 which is on the low-normal side. The record does not indicate the claimant had had any intercurrent bacterial infections secondary to the moderate leukopenia. Therefore, at this time I cannot consider this injury job related.

BEC's Decision: In advising the claimant that he was not entitled to compensation benefits, the Bureau offered the following reasons:

A study of your file and all the medical evidence does not support that the leukopenia is work related. The records show an insignificant degree of exposure to X-ray.

Your condition is not disabling. The Bureau suggests you have examinations every three months for the next two years to determine the course of your leukopenia.

CASE NO. 46

Type of Injury: Hypertension, Chronic Anxiety Reaction and High Blood Pressure.

BEC's Decision: Compensation Granted.

Date of Decision: 1971.

Claimant's Allegation: That his condition was caused by exposure to fast neutrons and high energy X-rays in the course of his employment.

Facts: Claimant, a 47 year old male, was employed in 1964 as a Materials Treatment Process Inspection Specialist in radiography at a U.S. Military Ordnance Laboratory. In October 1968 claimant began feeling tense and dizzy and he experienced fatigue, weakness and loss of energy. A physical examination indicated an elevated blood pressure and he was referred to a private medical doctor for treatment. His condition was diagnosed as hypertension of a labile type and anxiety reaction. He continued to feel dizzy and tense and to complain of fatigue, lightheadedness and mild chest pains and his symptoms progressively increased to the point where he was intermittently impaired in his ability to function.

A statement from claimant's supervisor concerning his occupational history at various ordnance laboratories showed that he was employed from May 10, 1946 to November 20, 1946, and from April 1948 until April 1957 in ammunition explosive testing, inspection and demolition work. From April 1957 until December 1961 he was a metals inspector in an X-ray facility using a 250 KV, a 2 MeV Resotron and a 10 MeV Linear Accelerator. In December 1961 he began work as a Materials Treatment Process Inspection Specialist in radiography using a 25 MeV Linear Accelerator. In July 1964 he continued in radiography and began work at the employing facility using a 250 KV, a 2 MeV Resotron, a 140 KV and a 13 MeV Linear Accelerator X-ray machine. The rated output (Target Peak) of the 13 MeV Accelerator was 120 MA, 17 MeV, with a normal operating output of from 1500 R/min. to 2000 R/min. It had a 15° cone, a tungsten steel target and a 1 mm. focal spot. A four inch lead shield was placed in front of the control room door after approximately 400+ beam hours on the 13 MeV X-ray machine "which" the supervisor's statement indicated "did not appreciably effect radiation level in control room as indicated in radiation surveys". The control room had a one foot concrete wall and a 3/4 inch steel door. With respect to the lead shield, the supervisory's statement read:

There were no uncontrolled incidents of exposure to radiation since 1967 when the radiography section came under the cognizance of the present department. Since discovery of some radiation levels at the 13 MeV facility, a lead shield was installed in front of the control room, and the door to the control room was kept shut during radiation production.

The statement also indicated that there was no known information on possible prior exposures but that some exposure may have occurred at one of the 2 MeV facilities where claimant had worked but that such exposures would be "minimal".

Claimant was assigned to supervise the operation of these X-ray facilities and was for 1½ years solely responsible for the interpretation of all radiographs. During this period he averaged 50 - 60 hours per week and read, interpreted and reported on approximately 10,000 radiographs a month. Due to lack of space he utilized the control room of the 13 MeV facility. For the period of 1965 to 1970, claimant was present in the control room for about 500 hours of beam time of the 13 MeV unit. Claimant was also sent to various other government and private industry facilities to interpret radiographs, set up X-ray procedures, and train technicians in the field of film interpretation.

In a statement concurred in by the employing laboratory the claimant said:

The radiation survey taken . . . showed by instrument a count of 2 mR/hr of X-ray and 2 mR/hr of fast neutrons on my desk in the control room. This count converted to Rem shows a radiation per hour count seven times greater than allowed by the Atomic Energy Commission and the National Bureau of Standards which is 3 mRem/hr. The conversion:

$$\begin{array}{l} \text{X-ray } 2 \text{ mR/hr. } \times \text{ RBE } \times 1 \\ \text{Fast Neutrons } 2 \text{ mR/hr. } \times \text{ RBE } \times 10 \end{array} = \begin{array}{l} 2 \text{ mRem/hr.} \\ 20 \text{ mRem/hr.} \\ \hline 22 \text{ mRem/hr.} \end{array}$$

The Rem factors above are calculated from low energy X-ray machines, not from high energy output X-ray equipment.

Coupled with the unknown factors in the radiation surveys taken at the 13 MeV X-ray facility, there appears to be unknown factors in the biological effects of low doses of high energy radiation accumulated over a period of time.

Medical Evidence: A statement from the employing laboratory's Medical Officer read in pertinent part as follows:

In summary . . . patient has complained for about two years of intermittent fatigue, weakness, dizziness, mild chest pains and dyspnea. (Claimant) has for years worked with high energy X-ray equipment. He is certain that this exposure has caused damage to his health and that the above symptoms are manifestations of this damage.

Physical findings on all occasions since 1968 in this Dispensary have been positive, only in the finding of elevated blood pressure.

* * *

Diagnosis is hypertension of a labile type. This hypertension may be essential or may be the result of the second diagnosis, i.e., anxiety reaction. Its lability is in support of its etiology in part being secondary to (claimant's) anxiety.

This medical department has not been responsible for continuing care and treatment of (claimant's) problem. Intermittent observation indicates probable adequate control by use of mild tranquilizers and anti-hypertensive medications. "Cure" of (claimant's) problem is not anticipated.

* * *

I have little doubt that (claimant's) anxiety is a by-product of his occupation in that he is most concerned that high energy radiation exposure has made him an unhealthy man. This concern has led to his constant anxiety. His hypertension may or may not be a result solely of his anxiety. There is no evidence to support or refute the premise that (claimant's) problems are the result of physical damage caused by high energy radiation.

Various statements from the claimant's private physician indicated that claimant was "very anxious"; he seemed to have a "fixation on the bombardment with irradiation which he gets at work"; that he continued to have hyperventilation syndrome and that "even the slightest little thing seems to turn him into a severe anxiety reaction". The physician stated:

. . . possibility must be considered of being exposed to fast neutrons and high energy X-rays causing these symptoms of fatigue and weakness. . .

The Bureau's Medical Director was of the opinion that claimant should continue under medical supervision.

BEC's Decision: The Bureau accepted the claim for hypertension with anxiety reaction and granted authority for necessary medical treatment.

PART B
 EMPLOYEES' COMPENSATION
 APPEALS BOARD CASES

(Nos. 47 - 49)

CASE NO. 47

In the Matter of _____ and Department of the Air Force

22 ECAB 5

Type of Injury: General Disability; Numbness in Arms, Headache, Nervousness, Backaches, Difficulty in Walking and Other Symptoms.

ECAB's Decision: (1) BEC's Denial on the ground that claim was barred by Statute of Limitations: Affirmed. (2) BEC's Denial of causal connection between ill health and employment: Affirmed.

Date of Decision: 1970.

Appellant's Allegations: That claim was timely filed and that her ill health was caused by exposure to radium during employment.

Facts: Appellant was employed as a mechanic's helper from January 25, 1951 until May 26, 1952, when she resigned because of ill health. More than 14 years later, on November 29, 1966 she wrote to the Bureau of Employees' Compensation requesting compensation benefits for disability beginning May 26, 1952 which she alleged was due to radiation exposure at the employing establishment. Appellant alleged that she was exposed to radium in handling, cleaning, and inspecting radium painted dials on instruments and panel boards. She stated that she thought she had a condition due to exposure to radiation at work when she saw her personal physician on April 15, 1952 and complained of numbness in the arms, headaches, nervousness, backaches, difficulty in walking and other symptoms. The doctor's records confirm appellant's April 15, 1952 visit. At that time she told him that a blood test made at the employing establishment indicated a reaction to radium, but that she did not at

any time tell her supervisors that she believed that she had an injury due to radiation exposure. The employing establishment's files did not contain any written notification prior to November 1966 in which appellant asserted an employment injury due to radiation exposure. Her explanation for the delay in filing a claim was that she was too ill and that the employing establishment did not counsel her properly. She contended that the employing establishment should have taken the necessary steps to assure her receipt of compensation benefits.

The evidence established that the instrument and panel board dials were coated with a clear lacquer or shellac and were in air-tight glass covered containers, and that it was unlikely that radium painted dials were in use or were processed at the employing establishment during the period of appellant's employment there.

Medical Evidence: Appellant had extensive medical examinations during 1966 and 1968. She also had psychiatric examinations in 1968 which revealed that she has an emotional condition, but the examining psychiatrist did not relate it to her employment.

ECAB's Decision: The Board found that appellant's claim for disability was barred by the 5-year time limitations provisions of 5 USC Sec. 8122, and it said:

Under the time limitation provisions of the Act, a claim for disability compensation is barred if it is not filed within 5 years after the injury. The term "injury" includes a disease proximately caused by the employment.¹ In cases of disease, the statutory period for giving notice of injury and filing a claim commences to run when the employee first becomes aware, or reasonably should be aware, of the condition and its possible relation to the employment.²

The evidence in the record establishes that in April 1952 appellant related her disabling condition to her employment. Under the circumstances, the time for giving notice of injury and filing a claim for disability compensation began to run at that time. Appellant did not file a claim until November 1966, more than 14 years later.

The 5-year period prescribed by the Act for filing a claim is a mandatory, maximum period which may not be waived by the Bureau or the Board, regardless of the reasons underlying the failure to file on time.³ Knowledge of an employee's illness is not sufficient to satisfy the notice requirements of 5 USC Sec. 8119; it must be shown that the circumstances were such so as to put the immediate superior on notice that the alleged illness or impairment was causally related to his employment or that he attributed it to his employment.⁴

¹ 5 USC §8101(5).

² *Veston H. Casey*, 9 ECAB 901; *Gladys F. Skolnick*, 13 ECAB 439; *Kathleen T. Liscum*, 15 ECAB 348; *Alvin E. Hollister*, 16 ECAB 617.

³ *Patricia A. Pembroke*, 4 ECAB 648; *Ralph M. Buckley*, 7 ECAB 79; *Marion A. Cramer*, 9 ECAB 900; *Joseph L. Colello*, 10 ECAB 578; *Avelino L. Franco*, 20 ECAB 14.

⁴ *Arthur L. Tucker*, 11 ECAB 274; *James W. Jeffrey*, 16 ECAB 112; *Luther E. Bates*, 16 ECAB 658; *Kenneth A. Downey*, 17 ECAB 693; *Fred R. Walsh*, 18 ECAB 96.

The Board also found that "the disability for which claim is made did not result from exposure to radiation in the course of employment" and that the Bureau's rejection of appellant's claim was proper.

The Board further stated:

There is no indication that she had any significant exposure to radium. Moreover, her personal physician's records, as well as extensive medical examinations during 1966 and 1968, do not establish that appellant has or had an organic condition traceable to radium exposure.

CASE NO. 48

In the Matter of _____ and *Department of the Navy*

20 ECAB 330

Type of Injury: Contracture of Hand.

ECAB's Decision: Denial Affirmed.

Date of Decision: 1969.

Appellant's Allegation: That the contracture of his right hand was causally related to his employment exposure to radiation.

Facts: On a prior appeal, in a decision issued January 11, 1966, (17 ECAB 264, Volume V, page 78, *Studies in Workmen's Compensation and Radiation Injury*, AEC 1969) the Appeals Board affirmed a determination by the Bureau of Employees' Compensation that appellant did not sustain a compensable disability as a result of his exposure to radiation at work, and that the contracture of his right hand following amputation of the right index finger after a nonemployment-related injury in 1963 did not result from the radiation exposure. In 1968 appellant petitioned the BEC to reopen the case based on submitted statements by two physicians: one physician's statement reported a diagnosis of "radiation effect" but contained no other information or explanation. The other physician stated that appellant had a contraction and fixation of the wrist and fingers of the right hand due to radioactive contamination, but did not submit any medical rationale for the opinion.

Medical Evidence: Appellant was examined by a Board certified internist. The diagnoses were arteriosclerotic heart disease with angina, diabetes, borderline low white blood count and platelet count without significant hematological disease, causalgia of the right arm with amputation of the right index finger, mild organic brain syndrome, obstruction of the left common carotid circulation, early bilateral senile cataracts, nystagmus secondary to a cerebrovascular accident, dermatitis of the left wrist compatible with neurodermatitis, angiokeratoma of the scrotum, a keratotic lesion of the nose compatible with senile keratosis, and bilateral tinea pedis. Bone marrow and urine tests were nondiagnostic. An examination for residual radioactivity revealed minimal presence of radium consistent with past exposure. Appellant had his right arm in a cast and complained of pain in the right arm when the fingers of the right had were touched lightly. The doctor stated, "While most of the current findings are consistent with physiologic aging, radiation effect

cannot be ruled out, particularly with respect to total body count findings, persistent borderline leukocyte and platelet counts, and perhaps the poor wound healing".

BEC subsequently referred appellant, with the case record and a statement of accepted facts, to a Board-certified radiologist, for an examination and opinion regarding causal relation between appellant's exposure to ionizing radiation and the delayed healing of his hand. He was also asked to express an opinion as to whether appellant's other disabling conditions were caused or adversely affected by his employment-related radiation exposure. He examined appellant on January 3, 1968. He pointed out that there was "no evidence of radiation change as evidenced by atrophy, hair loss or telangiectasia in the skin of either lower extremity, of the left hand, the visible remaining right fingers, or in the mucous membranes of the oral cavity" and he further stated that because of the short range of beta rays given off by strontium 90, any injury caused by such radiation would have been to the most superficial tissues, that is, the skin, that skin healing had not been a problem after the injury to the right index finger; that a review of the contemporaneous medical notes indicated that healing of the finger progressed normally but that osteomyelitis, perhaps complicated by a foreign body, had perpetuated infection and required amputation, and that the normal white blood count at the time of the finger injury and the lack of any increase in pulmonary infections secondary to appellant's preexisting chronic pulmonary condition indicated that the exposure to radiation had not resulted in a depression of his body defenses to infection. He concluded that the right arm disability due to causalgia and loss of function from disease was not causally related to the radiation exposure. He also negated causal relation between the radiation exposure and appellant's cardiac and cerebral vascular disease, dermatological findings, bilateral cataracts and chronic pulmonary condition.

To further assist in resolving the question of causal relation, the BEC referred appellant, with the case record and the statement of accepted facts, to another Board-certified radiologist, who examined him on July 2, 1968. The radiologist had blood and bone marrow tests made, which were nondiagnostic. A consultant in dermatology also reported that the skin lesion on the left leg was typical of localized neurodermatitis and that the nose lesion appeared to be an actinic keratosis. The radiologist reported, after a careful study of the case history, that the radiation exposure was only 10 percent of the permissible maximum and that this was insufficient to result in decreased resistance to infection. He stated that the healing of the primary infection of the right index finger was complicated by a secondary infection involving the tendon sheaths. He negated causal relation between the radiation exposure and the infection of the right index finger, pointing out that the bone marrow studies had excluded the possibility of disease in the bone marrow or blood forming organs. He stated that the only disability which could possibly have been caused by radiation would have been the leg skin lesions, but that those lesions did not have the characteristics of radiation dermatitis. The doctor concluded that appellant did not have any disability causally related to his exposure to radiation in his work.

BEC medical advisers concurred in the opinions of the two radiologists, and the BEC denied modification of its earlier decision.

Findings of the ECAB: In affirming the Bureau's denial the Board stated:

The medical evidence submitted since its prior review does not establish any compensable disability due to appellant's employment-related exposure to radiation. The reports by the two radiologists, together with medical evidence previously in the record, establish that the right hand condition is not causally related to the radiation exposure and that appellant does not have any employment-related disability.

CASE NO. 49

In the Matter of *and Department of Interior,
Geological Survey*

21 ECAB 290

Type of Injury: Cancer of the Parotid Gland.

ECAB's Decision: BEC's Decision Denying Compensation Set Aside and the Case Remanded for Further Development of the Record.

Date of Decision: 1970.

Appellant's Allegation: That cancer of the parotid gland and other conditions were causally related to exposure to atomic radiation during the course of his employment on May 29, 1957.

Facts: In April 1967 the Bureau denied appellant's claim for compensation. Appellant requested reconsideration of the Bureau's decision. In February 1968 the Bureau denied modification of its original order rejecting the claim. Appellant again requested modification of BEC's denial. In March 1969 the Bureau again denied modification of its original decision. Appellant filed an appeal.

Appellant was employed as an airplane pilot. On May 29, 1957, he was copilot of an aircraft flown in pursuit of the fallout pattern which followed the explosion of a 12-kiloton atomic device at the Nevada Test Site approximately 24 hours earlier. It appears that the flight was made in cooperation with the Atomic Energy Commission to obtain radioactivity and other data for that agency with respect to an atomic test detonation on May 28, 1957. The program under which the flight on May 29, 1957 occurred was carried out in cooperation with the Civil Effects Group of the Atomic Energy Commission. The Geological Survey was reimbursed by the AEC, which made use of the radioactivity measurements obtained. The aircraft, a DC-3, was equipped with instruments to measure the radioactivity encountered. Members of the crew did not wear individual dosimeters. While pursuing the fallout cloud to delineate its pattern, the aircraft passed through 3 rain storms. There was a leak in the windshield of the plane on appellant's side, and rain water entered the cockpit through it and drenched appellant's clothing, earphones, face, neck and hands, and he swallowed a small portion of the water. The radiation counters in the aircraft indicated that the rain water was contaminated with radioactive material. After the aircraft landed upon completion of the mission, the background radiation count was higher than normal.

A supervisor of the team during the flight reported that following the rain storms encountered on the flight the radioactive contamination on the skin of the aircraft was "on the order of ten times the normal level of such contamination"; that this alerted the members of the crew who were responsible for maintaining, operating and monitoring the testing and recording equipment installed in the aircraft that the skin of the airplane had been contaminated by the radioactive rain water which had fallen upon it during the flight; that the scintillometer on the plane, which charted and recorded the radioactive fallout within the conical area below the plane, would not have accurately recorded the radioactive level of the rain water falling upon the plane; that after landing, the skin of the airplane was washed twice because when the radioactive level of the plane's skin following the first washing was measured it was found to be still contaminated to an unacceptable extent; that appellant remained with the plane to supervise its maintenance including several washings to remove the radioactivity; that appellant continued to wear his wet clothing during this period and for several hours thereafter.

Further testimony indicated that the clothing worn by appellant during the flight was contaminated; that the needle of the Geiger counter used to measure the radioactivity of his clothing held steady at a high level several times that of the normal background but that the values measured by the hand counter were not recorded and could not be recovered; that appellant was directed to take a hot shower and scrub his body with soap in an effort to remove any radioactive material on his body, which appellant did; that shortly thereafter appellant became weak, feverish, and generally ill and was unable to perform his duties with the team.

Circumstances of the flight and information with respect to appellant's exposure to radiation incidental thereto, were also furnished by the Chief, Airborne Operations Section, Geological Survey, U.S. Department of the Interior, in a statement dated June 5, 1964. He was appellant's supervisor at the time of the flight and stated the records relating to that flight showed that the aircraft was contaminated by the fallout and that it passed through three rain showers; that the plane passed briefly through the edge of the first rain shower, the second lasted approximately 6 minutes, and the aircraft was in the third shower area for approximately 3 minutes. With respect to the extent of the radioactivity encountered, his report said:

The aircraft contamination of gamma radiation as measured by the Geological Survey airborne equipment was 10,000 counts per second (c.p.s.). This measurement resulted from contamination on the aircraft skin below the scintillation crystal array. Comparative measurement using a hand counter showed the vicinity of the engines to be much higher. Normal radioactivity background as measured on the ground at the Las Vegas, Nevada, Airport ramp was 820 counts per second. During the period of the first rain shower radiation levels ranging from 200,000-500,000 c.p.s. were measured, 220,000-420,000 c.p.s. during the second shower, and 10,000-12,000 c.p.s. during the third shower. It appears that the aircraft contamination resulted from nuclear fallout products in the rain showers.

He pointed out in his report that with the U.S. Geological Survey equipment, 70,000 c.p.s. are equal to one milliroentgen per hour (mr/hr.) and

he said: "The actual results in measurements during the rain showers of 4.3-7.1 mr/hr., 3.1-6.0 mr/hr., and .14-.17 mr/hr. with the aircraft contamination at .14 mr/hr."

A few days after the flight, on June 1, 1957, appellant went to see a medical doctor complaining of nausea, diarrhea, abdominal pressure, numbness of his legs and body, dizziness, skin irritation and a sore throat. The doctor reported that he treated appellant on more than 30 occasions between June 1 and July 23, 1957; that during this period he had blood and mucus in his stools, and nose bleeds. The skin on the right side of his body, particularly his face, right elbow and right heel, was red, irritated and highly sensitive. He was treated with penicillin injections, sulfa drugs, and between July 30 and October 1, 1957 appellant was treated by another medical doctor for urinary and rectal complaints. Examinations indicated gastrointestinal tract bleeding. He was referred to a surgeon for evaluation of these symptoms. Although evidence indicated that his surgeon had been treating appellant, there was no report from this doctor in the record.

In November 1958 a benign osteoma was surgically removed from appellant's right mandible. On February 2, 1961, he was seen by a surgeon for a swelling of the right parotid gland below the ear lobe. He complained that he had had tenderness in that area for several months. A biopsy revealed adenocarcinoma of the parotid gland. On February 17, 1961 the surgeon performed radical surgery for the removal of the right parotid gland. The surgery entailed the excision of the right facial nerve, resulting in a complete and permanent facial paralysis which involved the right eye and eyelids.

Appellant retired on disability under the Civil Service Retirement Act, effective April 29, 1965. He filed a claim for compensation under the Federal Employees' Compensation Act, attributing the development of the bone tumor removed from his lower right jaw in 1958 and the adenocarcinoma of the right parotid gland for which surgery was performed in 1961, and the attendant paralysis of the right side of his face and right eyelid, to his exposure to radiation on May 29, 1957.

Medical Evidence: The surgeon who removed appellant's parotid gland gave some support to appellant's claim. He felt that the symptoms for which appellant was treated in June and July 1957 closely resembled those of radiation sickness. However, he felt that he was not qualified to give an opinion as to whether appellant's cancer condition and osteoma were related to his exposure to radiation.

The Bureau of Employees' Compensation requested a Board-certified specialist in radiology to give an opinion with respect to the issue. The Bureau forwarded the case record to the radiologist and requested that he use the statement of the facts accepted by the Bureau, dated September 30, 1966, as the basis for his opinion. The findings incorporated in that statement with respect to appellant's radiation exposure were derived from the statement of June 5, 1964 submitted by the Chief, Airborne Section, Geological Survey, U.S. Department of Interior. The doctor reviewed the record, and he examined appellant on November 23, 1966.

In his discussion of the case, the radiologist stated in a report to the Bureau that it was an established fact that radiation is carcinogenic; that in cases

involving long, protracted, chronic exposure, a dose in the order of one-half to one roentgen daily, approximately 5 days a week, over a period of several years, would increase the likelihood that the exposed individual would develop some form of malignancy; in cases of acute exposure, in which the individual is exposed to ionizing radiation to a portion of his body or his entire body over a short period of time, a dose in the order of 50 to 100 roentgens to the entire body in 1 day or less would probably increase the chances of that individual developing a malignancy or leukemia later in life; that there is a latent period of approximately 10 to 20 years following exposure of either the chronic or acute type before one would expect the malignancy to develop.

He then negated a causal relation between appellant's cancer of the parotid and exposure to ionizing radiation based largely on the Bureau's findings that appellant's exposure amounted only to 35 milliroentgens:

If [redacted] was exposed to radiation contamination at the highest level as recorded in the monitoring equipment, namely 7.1 mr/hr. and wore his clothes for five hours following this exposure, and ignoring radioactive decay, the surface dose that he would have received would be in the order of 35 milliroentgens.

This level of radiation is infinitesimal and could not be considered under any circumstances a hazardous dose of radiation. In fact, in diagnostic X-ray studies, a person having his chest X-rayed will receive a dose in the order of 35 milliroentgens or greater during the course of the chest X-ray.

As has been noted . . . for radiation to be carcinogenic a dose in the order of hundreds of roentgens absorbed in the body is necessary and the latent period between exposure and diagnosis of tumors had not been less than four years as reported in the medical literature. In addition to this, the smaller the dose the greater the length of time required for tumor to become apparent if the etiology is radiation. If a person would receive an exposure of 500 roentgens or more to a portion of his body, it would not be anticipated that a tumor would result from such exposure before several years, probably ten to fifteen. For higher doses of radiation in the order of 5000 roentgens, the latent period between exposure and the development of tumor would become shorter, perhaps five to ten years.

Because of these facts that [redacted] during his exposure, received a very low dose of radiation, and that the latent period was approximately three and one-half years between exposure and the development of his cancer of the parotid it appears extremely unlikely that radiation could be considered a causative factor in the development of the tumor of the right parotid of

He then questioned the accuracy of the Bureau's findings and said:

I am assuming that the dose figures given in the report which you have forwarded me are correct. At one place in the record, it is stated that the radiation detector devices aboard the plane were designed to survey the solid angle of radiation beneath the plane, a cone for each

... it might be feasible to suggest that the radiation level in the cabin of the airplane could not be adequately monitored by the devices in the plane itself. Also, if it is true that the instruments went off scale, as stated, it does not seem plausible that such equipment would "go off scale" at a dose level of 7 mr/hr.

In his letter transmitting his report to the Bureau, the radiologist emphasized that there were certain factors in the case, relating to the extent of appellant's radiation exposure, that were "not certain". He noted that the statement of appellant's supervisor dated June 5, 1964 contained the only available record of the actual dose rate in the plane; that in the letter the counts per second dose rate were converted to a mr/hr. dose rate and that he had to assume that this was an accurate and valid interpretation of the radiation dose rate in the plane.

He concluded his report by saying:

... it is hard to understand why the crew of this airplane who were doing cloud tracking after an atomic weapons tests were not wearing radiation detection devices on their bodies, such as film badges or pocket dosimeters.

In 1966 a skin cancer was removed from appellant's nose. In January 1967 further surgery was performed on appellant's neck for adenocarcinoma of the lymph nodes.

In April 1967 the Bureau denied appellant's claim for compensation. The appellant requested reconsideration.

Other Evidence: In his request for reconsideration the appellant challenged the accuracy and sufficiency of the radiation monitoring data accepted by the Bureau as a measure of the type and amount of radiation to which he was exposed during the flight in question and upon which the radiologist's medical opinion was based. In support of his contention, appellant submitted a supplementary statement by a qualified electronic technician who was responsible for the maintenance and operation of the recording equipment aboard the plane. The electronic technician stated that the measuring equipment aboard the plane consisted of six crystals, mounted just inside the skin of the plane, about 3 inches above the belly, in such a way that they looked down toward the tail end of the aircraft so that they would see a cone in a 45-degree angle in all directions from it. The crystals were encompassed in a metal shield to keep out radiation scattered from the side of the plane, so that most of the radiation which they saw would be from below the airplane. The equipment measured only the gamma rays, not the lower energy X-rays, or alpha or beta rays; and it was designed to discriminate against and did not measure gamma rays of energy below 50 KeV.

He further stated that the readings of the equipment were not exact, and the degree of exactness varied from month to month, or from one season to another; that changes in the sensitivity of the equipment occurred; that sometimes the equipment went "off scale". He explained that in addition to

the 6 large crystals there were 2 small crystals for use in areas of very high radiation when the large crystals had reached their saturation point; that when the radiation level exceeded the ability of the 6 crystals to count it, as it did during the May 29, 1957 flight, they switched to a small crystal; that the small crystals were not as accurate or as sensitive, that they were capable of reading much larger quantities of gamma rays but could not read small quantities; and that the use of the small scintillation crystals drove the equipment "off scale".

He stated that there was no precise means of translating the counts per second reading into other common yardsticks of radiation, such as milliroentgens. The readings taken by the equipment aboard the plane did not provide a reliable measure as to the amount of radioactivity contained in the rain water; that there may have been alpha and beta radioactivity associated with the atomic debris in the rain water which the equipment on the plane was not capable of measuring; and that the reading of the radioactivity below the airplane made by the equipment was only applicable to the particular rain water which was within the cone, and had no relevance with respect to the rain water which struck the front of the plane and entered the cockpit.

On July 31, 1967 a Bureau examiner prepared a supplemental statement of the facts accepted by the Bureau, in which he dismissed the challenges to the accuracy and sufficiency of the radiation monitoring data previously accepted as a measure of appellant's radiation exposure on May 29, 1957. In the statement of facts he said, among other things:

... There is no competent evidence to indicate the instruments were in error to any great degree. The suggestion of error is argument which will not be permitted to cloud the issue.

... The Bureau accepts that the monitors were capable of measuring as much as 500,000 c.p.s. and that at no time during the flight did the gamma count exceed that value. The fact that momentary saturation or overloading occurred on a more sensitive range of the monitor does not invalidate the recorded readings.

The Bureau submitted the case record to another Board-certified specialist in radiology for an opinion with respect to the issue. The Bureau again requested that its statements of accepted facts dated September 30, 1966 and July 31, 1967 should serve as the doctor's frame of reference.

In his report the specialist in radiology noted that the dose-rate equivalency upon which the conclusions of the prior medical opinion and the Bureau's denial rested were "without supporting documentation" and impressed him as "very low"; that, accordingly, he had obtained an analysis of the dosimetry data by a research physicist in the Radiation Branch of the National Cancer Institute which showed that the dose to which appellant was exposed was, in fact, 35 roentgens rather than 35 milliroentgens, as assumed by the Bureau. The radiologist was of the opinion that the stated exposure was not valid and he said:

As you can see from my development, I have very strong doubts about the validity of the stated dosimetry and in any event it is very

Further, it is stated that the contamination in the region of the engines of the aircraft was much greater than elsewhere and the claimant evidently participated in the cleaning of the aircraft. How much is "much greater" I do not know, but obviously, this is a factor in the direction of increase of dose.

And again he said:

If the Bureau is committed to the stated dosimetry then it can only be concluded that there is no causal relationship between the radiation exposure and the disabilities and lesion claimed by . . . My own judgment is that the claimant himself may be a better dosimeter than the equipment carried and that [the research physicist's] theoretical analysis is valid. This being so . . . I conclude that Mr. had a significant radiation exposure.

Although he was of the opinion that the claimant had a significant gamma-ray dose of total body irradiation which produced moderate symptoms and an inhomogeneously distributed beta-ray exposure, he concluded that neither of these exposures was carcinogenic. His testimony, in part, is as follows:

One can consider the claimant himself as, so to speak, a biological dosimeter. The time sequence, the symptom complex, and the findings described could all be associated with and due to moderate total-body gamma ray and cutaneous and mucous membrane beta-ray exposure, the latter being both direct contact with rain and with the rain-wetted garments which were known to be contaminated. There are no inconsistencies of this interpretation with the calculated dosimetry and one must remember that in any biological response there are those few subjects which react at the lowest end of the dose scale.

With respect to the cancer of the right parotid gland the radiologist concurred with the other specialist and concluded that this was not radiation-induced and he said:

At the presumed level of the total-body exposure such would not have been carcinogenic in so short a time. With respect to the beta-ray exposure such was not intense as the skin was not described as blistered or ulcerated and the penetration of beta-radiation through the skin would not have been sufficient to be carcinogenic in the parotid gland. Radioactive debris could not have reached the parotid gland by retrograde movement through its duct.

On February 22, 1968, the BEC denied modification of its original order rejecting the claim.

Thereafter, further evidence with respect to the accuracy and completeness of the data recorded by the instruments aboard the plane was furnished by the

Chief Geophysicist, Airborne Geophysics Section of the U.S. Geological Survey. Appellant's supervisor, who had submitted the June 5, 1964 statement of the circumstances and extent of appellant's exposure, which the Bureau accepted and relied upon, was his deputy. He stated that the instruments in the aircraft were designed to measure radioactive material on the ground, specifically radioactive ore deposits; that it was "not designed to measure the radioactivity in the aircraft along its surface, or the presence of small, high-intensity sources distributed within the plane." He explained:

By empirical [methods] and probably by calculation, it had been determined by the AEC Civil Effects Test Group that 70,000 counts per second in the aircraft at the instrument position meant that the plane was in gamma radiation flux of one (1) milliroentgen per hour. Small areas within the aircraft could experience high levels of radiation which would not be fully detected by the instrument.

He stated, in summary, "The radiation level obtained by multiplying the counts per second by an empirical factor has little meaning in determining what level of radiation . . . experienced."

The Bureau examiner appraised this report and determined that it contained no significant material which had not been already presented to the radiologist, or which altered the facts in any material way. A Bureau medical adviser agreed.

Thereafter, the research physicist was given an opportunity to review the case again, and he submitted a supplemental statement of January 17, 1969. He re-emphasized the insufficiency of the information relating to appellant's exposure to radiation, and concluded with the following observation:

I believe, in the absence of adequate instrumentation and the impossibility of reconstruction of the events that took place with adequate instrumentation, that an individual exposed to radiation can serve as a biological dosimeter. This has been proved to be of value in several radiation accidents.

The Bureau determined that the above reports were not sufficient to require a change in its original decision, and on March 12, 1969 it again denied a modification thereof.

Findings of the ECAB: The Board found that the case was not in posture for final decision. It set aside the compensation orders of the Bureau of Employees' Compensation and remanded the case for further development of the record "to determine as accurately as possible the nature and extent of appellant's exposure to radioactivity . . ."

In its decision the Board noted that the Bureau Examiner's evaluation of the accuracy and validity of the data with respect to the nature and extent of appellant's radiation exposure on May 29, 1957 and the supplemental statement of facts based thereon which he made on behalf of the Bureau, involved a technical analysis and it said "However, there is nothing in the record showing his qualifications to offer expert evidence of this character."

The Board spelled out what information the Bureau should obtain for the Record:

1. A report from the Atomic Energy Commission, presenting all available data with respect to the atomic test detonation on May 28, 1957 and the fallout resulting therefrom.
2. More detailed information regarding the nature of the radioactive measurement instruments on the plane, and the specific reading of those instruments.
3. More complete medical findings including, if any, blood tests and reports of laboratory test results.

The Board also gave guidelines for medical opinions concerning causal relationship if the additional information, coupled with that already in the case, did not permit an appropriate expert to make "a fairly accurate determination regarding the nature and amount of appellant's radiation exposure, and it said:

... an appropriate medical specialist should be requested to make an estimate of the nature and amount of such exposure, using appellant and his symptoms as a biological dosimeter, as suggested by the experts. Based upon these estimates and the evidence in the case record, the appropriate specialist should then express an opinion as to whether there is any relationship between appellant's radiation exposure and his medical conditions.

CHAPTER III

DIGEST OF CALIFORNIA STATE
COMPENSATION INSURANCE FUND RADIATION CASE

CASE NO. 50

*v. The California State
Compensation Insurance Fund*

Claim No. 330442

Type of Injury: Cataracts.

California Decision: Compensation Granted.

Date of Decision: 1965.

Claimant's Allegation: The cataracts in both eyes resulted from radiation exposure during the course of his employment.

Facts: Claimant went to work as a physicist at a radiation laboratory in October 1950. In his work he was around accelerators but his entire recorded external whole body exposure from the time of his employment through August 15, 1962 was shown by his film badges to be only 0.61 R. His medical history, as given to the State Compensation Insurance Fund by his personal physician did not indicate any history of radiation exposure other than chest X-rays and dental X-rays. Neither his past history, his preplacement physical examination on October 25, 1950, nor subsequent physicals in 1952, 1953 and 1955 revealed any cataract problem.

Medical Evidence: As part of a routine examination on July 9, 1956, for employees who worked around accelerators, an ophthalmologist discovered the cataracts and suspected radiation. At this time the claimant was 36 years old. The doctor found claimant to have a very definite posterior sub-capsular area of lens opacity of moderate extent in the right eye and slight in the left eye, the entire lens of both eyes being otherwise free of opacities. He suggested claimant be examined by another oculist with more experience with radiation cataracts. He was then examined on October 9, 1956 by an ophthalmologist who was selected because he had spent some time in Japan studying the radiation effects resulting from atomic bombs dropped there and had seen a number of radiation cataracts. He advised that the lesions in claimant's eyes

were "quite typical of the cyclotron cataracts, and the type I saw in Hiroshima." Claimant was reexamined by the ophthalmologist on November 13, 1957, at which time the visual acuity of the right eye was found to be reduced. In a letter commenting upon this examination, the doctor stated:

The posterior sub-capsular cataract in the right eye has the bivalve appearance which is so characteristic of radiation cataracts. Therefore, it doesn't seem to be much doubt that he has radiation cataracts.

On April 16, 1959, claimant was examined by a medical doctor at the request of the State Compensation Insurance Fund. He determined that there was no doubt that claimant had bilateral cataracts, more marked in the right eye than in the left, and that the cataracts were of the location and appearance associated with radiation cataracts. He advised that while these cataracts can occur without radiation and while claimant's record of exposure was very low, the situation was "highly suggestive" in view of claimant's work, and that he "has developed a cataract which appears to be a radiation cataract in an age group in which the ordinary so-called senile cataracts do not develop." He further stated, "it is my impression that one would have to accept these cataracts as being due to radiation in light of the factors mentioned." On June 13, 1961, the right eye was operated on for this condition. Cataract surgery on the left eye was performed on November 28, 1961.

Findings of the Referee: The State Compensation Insurance Fund accepted the case in May 1959 on the basis of its conclusion that the cataracts resulted from exposure to radiation at the laboratory.

CHAPTER IV

DIGEST OF COLORADO DEPARTMENT OF LABOR AND
EMPLOYMENT URANIUM MINER LUNG CANCER CASES

(Nos. 51 - 55)

CASE NO. 51

v. Carl Tucker and/or Union Carbide Corp.

Claim No. WC 2-003-064; SF 160441

Type of Injury: Epidermoid carcinoma, left upper lobe; carcinoma oat cell, right upper lobe with metastasis, ribs, vertebral column and liver.

Colorado Decision: Compensation Granted.

Date of Decision: 1967.

Claimant's Allegation: That deceased's lung cancer was contracted as a result of exposure to radon gas in uranium mining.

Facts: The claimant's husband became ill on or about August 10, 1966, was thereupon admitted to the hospital with a diagnosis of malignancy of the lung and expired on August 16, 1966, only one week after the diagnosis of his condition. The widow timely filed her claim for compensation benefits.

Evidence indicated that for approximately 37 years prior to his death the deceased smoked on an average of one pack of cigarettes per day and that he did inhale. The deceased had two brothers who also died of lung cancer as a result of employment in uranium mining.

The deceased's occupational history showed that there were 26 years from first exposure to radiation in uranium-vanadium mines and his death from lung cancer at age 54. His last employment in the mines was with the respondent employer, Union Carbide Corporation, from December, 1960 to May, 1962, approximately one and one half years. He stopped mining about four years before his death. From 1962 until his death in 1966, the deceased worked on a cattle and sheep ranch.

Deceased was a member of the uranium miner study group of the Occupational Health Program of the U.S. Public Health Service. The medical

doctor in charge of this program estimated that the decedent's cumulative radiation exposure in uranium mines was about 2,840 working level months. He further estimated deceased's exposure while in the employ of Union Carbide Corp. as 85.2 WLM. Because of this relatively light exposure compared with the total exposure, the principal issue was whether or not the decedent's short employment with the respondent constituted injurious exposure within the meaning of the Colorado Occupational Disease Act.¹

Medical Evidence: All of the medical specialists agreed that the immediate cause of death was from bronchial pneumonia due to the oat cell carcinoma of the right upper lobe.

The autopsy report revealed that the claimant had two separate carcinomas of the lung: (1) carcinoma mature epidermoid, left upper lobe, and (2) carcinoma, oat cell, right upper lobe with metastasis mediastinal, ribs, and vertebral column and liver.

The results of the radiochemical analysis on specimens of the deceased's body revealed that the concentration of lead-210 in his bone was 6,500 pCi/kg.

A medical specialist in internal medicine testified concerning the last days of deceased's life and the findings after death and he said:

Now as to the situation as it exists. We have an individual who had two tumors, either one of which could have caused his death. The oat cell tumor is the more malignant and devastating of the two. According to the pathology report the metastases that were seen were attributed to the oat cell tumor. We have learned to associate the oat cell type tumor to this man's radiation exposure. In reviewing his mining exposure, the length of the time he mined, the working level month factor, we find is excessive.

I believe that we have to conclude that this patient did suffer from exposure to radioactive material and that he did die from an oat cell tumor of the lung. We do not have the amount of radioactive substances recovered from his tissues to support the above comments.

While it is true that he had a rather heavy smoking history and that he had a tumor which would be commensurate with tobacco inhalation, the patient could not have been treated for this tumor as he was already dying of an oat cell tumor according to the pathologist. Therefore, even though he had two types of tumor, it would appear from the pathologic report that the prime tumor was due to radiation. As you know, at the present time there is no treatment for oat cell carcinoma from whatever cause.

The Director of the Public Health Service program for uranium miners estimated the odds that deceased's epidermoid cell type carcinoma was the result of his occupational exposure at "about 2 to 1". A similar estimate for the oat cell carcinoma was placed at about 100 to 1 and he said, "certainly, the

¹ For a discussion of the problem of last injurious exposure see Vol. V, *Studies in Workmen's Compensation and Radiation Injury*, AEC 1969, Case No. 64, *Rice v. Denver Golden Corp.*, pp. 142-143; *ibid* Case No. 72, *Dwyer v. Climax Uranium Co.*, pp. 159-160.

odds are very high that his occupational exposure caused at least one of the carcinomas".

At the hearing the Public Health Service physician testified for the decedent that considering the fact that the deceased had oat cell carcinoma in the upper right lobe, which was metastasized throughout his body at the time of death, the high lead-210 readings, the length of his illness, also even considering the possibility of heredity in cancer, he still was of the opinion that the deceased's lung cancer was most probably caused by his occupational exposure to radiation in uranium mines. However, he further testified that although decedent's preceding employment probably caused the onset of the oat cell carcinoma and that the decedent might have died in any event without any intervening cause, he could not say that the decedent's exposure to radiation with the defendant employer did not hasten his death.

Respondents' medical expert testified that the decedent had too little exposure too late while working for Union Carbide Corporation to hold this employer liable and he did not think the exposure hastened the disease or hastened his death.

Colorado Findings: An award was entered compensating the claim. The Referee found that the decedent's death occurred from an occupational disease arising out of and in the course of his employment in uranium mining; that the malignancy which caused his death was caused by harmful exposure to radioactive materials; and that the last employer in whose employ he suffered injurious exposure was the Union Carbide Corporation.

The award was reviewed and confirmed by the Director of the Colorado Division of Labor. In confirming the award the Director referred to the Referee's review of two Colorado Supreme Court cases in which he noted that the Colorado Court used as "a yardstick" in construing the Colorado Act the following language from another jurisdiction:

The Workmen's Occupational Disease Act is a practical statute, having for its purpose the accomplishment of a definite humane purpose. It should be mantled in the spirit of the objective, not shrouded in a haze of over-technical interpretations.

CASE NO. 52

v. Union Carbide Corp.

Claim No. WS 2979-681; SF 164465

Type of Injury: Lung Cancer

Colorado Decision: Compensation

Date of Decision: 1970.

Claimant's Allegation: That he contracted lung cancer due to exposure to radon gas in uranium mining.

Facts: This case was initiated by [redacted] on behalf of himself by the filing of a claim on October 4, 1967, wherein he alleged that he became disabled and left work on May 31, 1967 as the result of lung cancer. An X-ray taken during the claimant's yearly physical examination on March 31, 1967 showed an abnormal shadow in the upper lobe of the left lung and sputum studies on that date showed Class II, Stage II cells present. Claimant was admitted to the hospital on June 23, 1967 where various tests including X-ray and biopsy were again done. Studies at this time showed Class IV cells of an undifferentiated squamous cell carcinoma which eventually infiltrated both lungs. Claimant died on January 31, 1968 at age 60.

Evidence indicated that the deceased started smoking cigarettes at age 17 and smoked between 1-¼ and 1-½ packs per day for about 40 years. Information concerning his work history showed that he was engaged in non-uranium hard rock mining from 1946 until 1952 and mined uranium for thirteen years from 1953 until 1966. He started working for the defendant corporation in January 1961. According to corporation records claimant suffered a total exposure of 204 WLM during the period of employment from January 1961 through May 1967.

Medical Evidence: Prior to the claimant's death a hearing was held during which an epidemiologist from the U.S. Public Health Service reported claimant's estimated cumulative exposure as approximately 900 Working Level Months and he said "... I would estimate that this exposure had increased his chances of developing lung cancer by a factor of 5 to 10". When asked at this time whether or not from the information contained in the various medical reports he could state what type of cancer cell was present, he answered that he could not do so to his satisfaction. He pointed out that the word "undifferentiated" used with the word "squamous" presented a rather conflicting description of the cancer cell type and he said:

... this is a one cell type that we have had trouble with previously in that sometimes it might be called one thing and sometimes another. It depends upon what section of the tumor they are looking at; which pathologist is doing it. So that from what we have here I would be a little reluctant to make an assumption as to whether it is really epidermoid or whether it is an undifferentiated type.

In summary he stated that without knowing the cell type of the cancer he did not have a definite opinion at the time of the hearing as to the cause of the cancer, and at that point in the case it was a "fifty-fifty proposition" as to whether his cancer was due to cigarette smoking or to exposure to radon gas, and that it was a fair statement that at the time of the hearing an intelligent opinion as to causation could not be given in this particular case.¹

Following the claimant's death an autopsy and a radiochemical analysis of tissue from deceased's body were performed. Reports of these studies were submitted to the epidemiologist for his further opinion. He commented as follows:

The new information is that his bone content of Pb²¹⁰ was 3800 pCi per Kg. of bone, and that the final microscopic diagnosis of his lung cancer was [World Health Organization] WHO 2B squamous cell undifferentiated. (WHO 2B is defined as small cell undifferentiated, similar to oat cell, but having larger or polygonal cells.)

Both of these new items definitely increase my estimate of the odds that occupational radiation was the cause of his lung cancer.

In summary, [redacted] had mined uranium for 14 years, had between 1000 and 1500 Working Level Months of exposure (as judged by ²¹⁰Pb in bone), had smoked about 30 cigarettes per day for about 40 years, had a WHO 2B lung cancer, was 60 years of age at development of lung cancer, and who had 14 years from start of mining to development of lung cancer.

All of the above factors except cigarette smoking are consistent with radiation as the cause of his cancer.

Colorado Findings: The Referee found that decedent expired from an occupational disease produced by radioactive materials contracted at the respondent employer's uranium mines. An award compensating the case was made.

¹ For comments on cell type and causation see Vol. V, *Studies in Workmen's Compensation and Radiation Injury*, AEC 1969, Case No. 61, *Athey v. Merry Widow Mine*, pp. 136-137; for comments on cigarettes as causative factor, *ibid* at 137; Case No. 66, *Williams v. Union Carbide Nuclear Co.*, at 142.

CASE NO. 53

v. Union Carbide Corp.

Claim No. WC 2-190-100; SF 176277

Type of Injury: Epidermoid Carcinoma of the Lung.

Colorado Decision: Compensation Granted.

Date of Decision: 1970.

Claimant's Allegation: That he became afflicted with lung cancer as a result of exposure to "radioactive dust".

Facts: The occupational history of the claimant showed that he began his mining career in 1937 at the age of 24 as a heavy equipment operator at an open pit copper mine. He worked in this capacity until 1942. From 1942 until 1950 he worked in and around copper and other hard rock mines about four years of which time was spent working underground. He then worked as an underground miner in various uranium mines until 1963. From April 4, 1962 to September 3, 1963 he worked underground for the defendant corporation. He continued working for the defendant on the surface operating heavy equipment until he left work in August 1968.

An estimate of the claimant's total cumulative radiation exposure in uranium mines was given by the medical director of a field office of the U.S. Public Health Service as 3,220 Working Level Months. With respect to this amount of exposure he said "this puts the claimant in a rather high risk group from the standpoint of lung cancer." A report of working level exposures by the respondent employer indicated an exposure of 64 Working Level Months while in the employ of that company.

A review of claimant's smoking habits showed that he began smoking cigarettes at age 17, that he smoked about 10 cigarettes a day for 38 years and that he occasionally smoked a pipe.

On August 12, 1968, claimant underwent a thoracotomy. Surgery revealed squamous cell carcinoma (WHO 1A) [World Health Organization] of the right upper lobe. Due to the presence of extensive metastatic node involvement the prognosis was indicated by his physician as unfavorable. The claimant died on October 25, 1969.

Medical Evidence: The death certificate indicated the cause of death to be bronchogenic carcinoma. Pertinent portions of the report of radiochemical analysis of samples taken from deceased's body is as follows:

	pCi/gm lead-210	pCi/gm polonium-210
Rib	4960 ± 50	5080 ± 60
Sternum	3750 ± 30	4350 ± 60

In offering his opinion of the case an epidemiologist from the U.S. Public Health Service stated:

To summarize the information on this case, both our estimate of Working Level Months (3220) and the bone lead-210 indicate that had quite high exposure to radiation while mining uranium. He was relatively young (56) at the time of cancer development. The time from start of uranium mining to lung cancer was 19 years. The cell type of this cancer was [diagnosed] epidermoid (1A) by [a pathologist]. However, the pathology panel which reviewed the slides said that the cell type was a combination of 2B and 1C in the WHO classification. I would therefore regard the cell type as neutral with respect to both radiation and cigarettes in this case, and decide causation on other grounds.¹

All of the above facts except the cell type and cigarette smoking point strongly toward radiation as the cause of his lung cancer. The relatively light smoking habit and the mixture of cell types tend to minimize both of these items as factors in deciding etiology.

It is therefore my opinion that the radiation exposure incurred by while mining uranium was probably the cause of his lung cancer.

Colorado Findings: The Referee of the Division of Labor approved an admission of liability by the State Compensation Insurance Fund. The reason for accepting liability was that although the deceased's exposure to radon daughters while in the employ of Union Carbide was small in proportion to exposure elsewhere the exposure was in excess of what was considered to be a safe level² and was therefore deemed to be injurious exposure.³

¹ For comments on cell type and causation see Vol. V, *Studies in Workmen's Compensation and Radiation Injury*, AEC 1969, Case No. 68, *Javernick v. Javernick and Javernick*, p. 151 at 152. See also Vol. VI, *Studies in Workmen's Compensation and Radiation Injury*, AEC 1971, Case No. 55, *Floyd A. Trone v. The Golden Cycle Corp.*

² In 1967 the Federal Radiation Council recommended exposure of no more than 12 WLM in an consecutive twelve month period and no more than 6 WLM in any consecutive three month period. Report No. 8, *Guidance for the Control of Radiation Hazards in Uranium Mining*.

³ For a discussion of the problem of last injurious exposure see Vol. V, *Studies in Workmen's Compensation and Radiation Injury*, AEC 1969, Case No. 64, *Rice v. Denver Golden Corporation*, pp. 142-143; *ibid* Case No. 72, *Dwyer v. Climax Uranium Co.*, p. 159 at 160. See also Vol. VI, *Studies in Workmen's Compensation and Radiation Injury*, AEC 1971, Case No. 51, *Elmer F. Andress v. Carl Tucker and/or Union Carbide Corp.*

CASE NO. 54

*v. Humphries Engineering Company
Federal Insurance Company,
United Mining and Leasing Corporation, et al.*

Claim No. WC 1-910-747, SF 170374

Type of Injury: Lung Cancer.

Colorado Decision: The case was denied by the Referee and by the Industrial Commission of Colorado on the ground that the case was barred by the statute of limitations in effect between 1954 and 1956, the years of decedent's last injurious exposure. The case was appealed to the District Court and before the appeal was finally disposed of the case was settled.

Date of Decision: 1971.

Claimant's Allegation: That her husband died as the result of lung cancer caused by his experiences in uranium mining.

Facts: The decedent, who had been in mining and construction work for about 40 years, first complained of symptoms referable to the gall bladder or bile ducts in November 1964. In December of that year he first showed signs of bile duct obstruction. Diagnostic procedures revealed a tumor in the lung which had already metastasized widely and had caused the bile duct obstruction. He died on January 4, 1965. His widow filed a claim on April 19, 1965 alleging that his death was due to lung cancer and silicosis. Before the case was set for hearing the attorney representing had a heart attack and ultimately withdrew from the case. She sought new counsel and shortly before the three-year statute of limitations for filing claims had run, as set forth in the 1961 amendment of the Colorado Occupational Disease Act, her then counsel filed a motion on January 2, 1968, to make 27 employers parties to the action, alleging in the motion that there was not time to file separate claims and the shortest way would be to make them all parties and work out the issues later.

The case ultimately came on for hearing before a Referee of the Industrial Commission on September 5, 1968. At the hearing there was considerable evidence concerning the decedent's work history. Evidence showed that the deceased began his mining career in 1923 as a coal miner and worked in this capacity until 1938. From 1938 to 1954 he worked in several hard rock mines. These mines contained complex ores of lead, zinc and silver. In May 1954 he began work as a uranium miner in two mines, the Carroll and the 2 Sisters Mines operated by the defendant United Mining and Leasing Corporation.

These mines were producing uranium ore at the time, although they also had complex ores which contained lead, zinc, etc. He continued working in this capacity through 1957. Although he also worked in a uranium mine in 1958, his exposure while in the employ of the United Mining and Leasing Company was the exposure at issue in the claim. He continued working for various mining and construction companies until 1964. He began smoking cigarettes at age 21 and smoked about a pack a day.

A report from the medical director of an Occupational Health Field Station of the U.S. Public Health Service stated that they had no information on radon daughter levels in the Carroll and 2 Sisters Mines, "... but because of the ore we have estimated that the radiation levels were probably quite low". He estimated that decedent's cumulative exposure to radon daughter products in his mining career was about 260 Working Level Months.

Medical Evidence: The autopsy report indicated that the carcinoma was of an undifferentiated oat cell type.

The medical director of the U.S. Public Health Service offered the following opinion as to causation:

The cell type of his cancer, his age and the time period from start of uranium mining to development of cancer are consistent with a radiation-induced lesion. The only problems here are our low estimate of cumulative exposure and his cigarette smoking.

My estimate of lung cancer risk at his age from cigarette smoking is approximately the same as my estimate of his lung cancer risk from 260 Working Level Months of exposure. However, the fact that the cell type of cancer, his age and the time period from start of uranium mining to development of cancer are all consistent with a radiation-induced lesion would tend to tip the scales in the direction of occupational cancer. A lead²¹⁰ analysis on bone would be of great help in determining the possible error in the above Working Level Month estimate.

It appears that no lead²¹⁰ analysis was ever made on any of the decedent's tissues. A specialist in thoracic surgery reported as follows:

Carcinoma such as this can be related to occupational exposure if the ore mined and the dusts are radioactive. Uranium miners are particularly prone to this type of malignancy. If had indeed been exposed over many years to radioactive ore such as uranium, then his death was proximately related to the environment of his employment.

I have noted that the silicosis found was moderate in degree. Silicosis, as such, is not considered a causative agent in the genesis of lung cancer. In my opinion, if no radioactive ores or dust were present, then occupational exposure was not the proximate cause of death. In these cases, prolonged excessive exposure to cigarette smoke is the usual cause of the cancer.

Colorado Findings: At the conclusion of the hearing, counsel for the Humphries Engineering Company filed a motion to dismiss and the State

Compensation Insurance Fund, on behalf of United Mining and Leasing Company, and itself, also filed a motion to dismiss, alleging that since there was no exposure while in the employ of United Mining and Leasing Company after July 1, 1961, the rights of the widow were determined by the statute as it existed in 1954 to 1956, and as a basis for the motion, cited pertinent sections of Colorado Revised Statutes 1953.

The Referee entered his order granting the motion to dismiss which reads in part as follows:

The only claimed exposure to radon gas in uranium mining was while the deceased was in the employ of the above named employer in 1954, 1955 and 1956. The controlling statute in effect at that time was 81-18-11, 1953. In order to be compensable, the disablement had to occur within 120 days of the employee's last injurious exposure if the claim was filed by the employee, and in death cases, the death had to occur within one year from the date of the employee's last injurious exposure, and the statute provided that a claim for death benefits had to be filed within six months from the date of death, thus all rights of the deceased or his widow expired not later than one year from his last injurious exposure which would have been sometime in 1957. The respondents further allege that the amendment which became effective July 1, 1961 does not apply because it cannot be considered retroactive.

The claimant's reply brief alleges that the law in effect at the time of death governs.

The Referee having reviewed the entire file and briefs submitted by counsel finds that the respondents' motion is well taken and should be granted on the grounds stated therein.

The Referee dismissed the claim. Counsel for the widow filed a petition for review of the case by the Industrial Commission, alleging that the law in force and effect at the time of the death governed, rather than the law in effect at the time of last injurious exposure. The Industrial Commission affirmed the order of the Referee. The case then was appealed to the District Court of the City and County of Denver, after a second petition for review was filed and the prior order of the Commission affirmed.

When the case came on for hearing in the District Court the Judge stated that he desired to have the Commission make a finding on the merits of the case, so that the whole case would have all major points decided, and accordingly remanded the case to the Industrial Commission to make findings on the merits of the case.

After due consideration of the matter the Industrial Commission entered its further order. The Commission found that the death of the deceased was due to exposure to radon gas and that the deceased did sustain injurious exposure to ionizing radiation during the years 1954 to 1956, while working for the United Mining and Leasing Corporation, and the prior decision dismissing the case on the ground it was barred as not meeting the basic conditions of liability was affirmed.

The case was then returned to the District Court. Prior to a decision by the District Court, a stipulation for settlement was made.

CASE NO. 55

v. The Golden Cycle Corporation

Claim No. WC 2-215-062; SF 180170

Type of Injury: Cancer of the Lungs.

Colorado Decision: Compensation Granted.

Date of Decision: 1970.

Claimant's Allegation: That he acquired lung cancer due to exposure to uranium over a period of years where he was in contact with uranium and vanadium.

Facts: The claimant left work approximately July 9, 1969. He was treated until he died on September 29, 1969 from lung cancer. The deceased was a member of a uranium miner study group of the U.S. Public Health Service. Pertinent portions of the work history and exposure record of the deceased indicated that between 1934 - 1941 the deceased was engaged in farming but did "some" copper mining and development of a vanadium mine; that between 1941 and 1962 he spent 16 years in underground uranium mining and three years on the surface. Estimates of the U.S. Public Health Service of the deceased's radiation exposure in uranium mines were 2850 Working Level Months. Evidence showed that he began smoking cigarettes at about age 20 and smoked about 1 pack a day.

Medical Evidence: A report of the radiochemical analysis of samples of the deceased's body is as follows:

The results, listed below, are in terms of defatted bone weights, and the errors shown are one standard deviation of the counting error.

	²¹⁰ Po (pCi/Kg.)	²¹⁰ Pb (pCi/Kg.)
Rib	1050 ± 20	1290 ± 40
Vertebra	1040 ± 20	1210 ± 30
Sternum	1510 ± 20	1980 ± 40

The cell type was identified as "Adenocarcinoma" by a medical investigator from a Veterans Administration Hospital. In view of this identification the

State Insurance Fund requested the opinion of the medical director of the U.S. Public Health Service as to whether or not the malignancy was due to radiation exposure. In reply the following report was received:

This is a cell type which has not been definitely associated with either uranium mining or cigarette smoking. We are in the process of writing a new paper on the cell type of lung cancer among uranium miners. This new analysis again emphasizes the preponderance of small cell undifferentiated. There are appreciable percentages of other cell types which occur among the miners - even among the most heavily exposed. Our present thinking is that radiation may cause any of the cell types, but that they are much more likely to produce the small cell undifferentiated types than the others.

Accordingly, I would not presently regard the cell type in this case as a negative factor in deciding causation. Rather, I would regard it as neutral with respect to both radiation and cigarette smoking, and make the determination on other factors.

In view of the relatively high radiation exposure (attested to by our WLM estimate and by bone lead-210), the appropriate interval between start of mining and lung cancer, and his relatively young age, it is my opinion that lung cancer was probably caused by his occupational radiation exposure.

An inquiry concerning cell type was also made of the physician who did the autopsy and he replied as follows:

I would classify the "Bronchitor (alveolar cell) carcinoma" as type III, sub-type A, sub-type I, (III, A, I).

I have never seen this type of carcinoma before in a uranium miner exposed to radon gas but my experience in lung cancers in uranium miners has been limited to two or three cases. I would doubt that this type of tumor is often seen in uranium miners but then it is not a common tumor of the lung and accounts for only 3-4% of all malignant tumors of the lung. Perhaps because of this rarity, it is rarely seen in uranium miners. While I could not make a positive causal relation between this type of malignancy and his exposure to radon gas in uranium mining, I certainly could not exclude this possibility.

A further opinion was requested from a pathologist who had done a great deal of research on the relationship between lung cancer and exposure to radon daughters in uranium mining. In his reply he stated:

... I have maintained that all people can develop an oat cell carcinoma of the lung whether the individual is a miner or not, and actually the degree of exposure should be the determining factor in whether or not the case is compensable. From the data you presented on the lead and polonium levels, it is quite obvious with the support of estimates of WLM of 2,850 that this case has sustained a tremendous amount of radiation.

If the latent period, that is the time from the beginning of

employment in underground uranium mining to the time which the tumor was developed, is at least 15 years, then I would feel that this case is compensable, for I would certainly feel that cause of cancer was probably radiation.

Colorado Findings: Following receipt of the medical reports from the various physicians involved, the State Compensation Insurance Fund decided to admit liability and, accordingly, a formal admission of liability for death benefits due the widow was filed. This admission of liability was approved by order of the Division of Labor.

PERTINENT INFORMATION OF RECORD CONTAINED IN FOURTEEN (14) ADDITIONAL COLORADO WORKMEN'S COMPENSATION CASES
ALLEGING LUNG CANCER DUE TO UNDERGROUND URANIUM MINING

Claimant	State W.C. Claim No.	Work History			Latent Period of Disease (Years)	Death Case	Age at Death or of Discovery of Cancer	Total Estimated WLM of Exposure to Radon Daughters	Radiochemical Analysis Report of Highest Concentration Bone Lead ²¹⁰ (pCi/kg)	Medical Opinion as to Type of Cancer Cell	Evidence of Record as to Cigarette Smoking Habits		Evidence of Exposure				Decision		
		Hard Rock Mining	Uranium Mining								Approximate No. Years Smoker	Type of Smoker or No. of Cigarettes Per Day	Radiation Records	Medical Records	Personal Records	Unrecorded Exposure Estimated	Compensated	Denied	
		Approximate No. Years Underground	Year Begun	Approximate No. Years Underground															
	1-965-316	None indicated	1947	15½	19	X (1966)	46	2,850	10,400 ± 180	Undifferentiated, poorly Differentiated, Epidermoid	No information	No information	X	X	X	X	X	X 1970	
	2-223-163	29	1957	8	10	X (1967)	62	780	1,330	Small Undifferentiated	30	20 Cigarettes	X	X	X	X	X	X 1970	
	2-021-646	None indicated	1954	8	13	X (1967)	61	1,100	No information	Small Squamous, Epidermoid, small Undifferentiated	No information	Heavy Light (for 5 yr)	X	X	X	X	X	X 1969	
	2-176-725	8	1951	4	17	X (1968)	49	Various estimates range from 265 to 1,784	670	Undifferentiated, Squamous	34	1 to 2 packs a day	X	X	X	X	X	X 1969	
	2-049-697 and 2-223-227	None indicated	1953	8	16	No	No info.	892	10,210 ± 120	Squamous, Epidermoid	14	1½ packs for 14 years. Did not smoke last 8 years	X	X	X	X	X	X 1970	
	1-625-654	12	1918	15½	43	X (1963)	55	Between 800 and 2,000	No information	Out, Squamous; Small Undifferentiated	40	1 pack	X	X	X	X	X	X 1969	
	2-282-947	None indicated	1936	22	34	X (1970)	No info.	4,880	No information	Out	Did not smoke last 10 yrs. life	1 pack	X	X	X	X	X	X 1970	
	2-147-179	4	1953	13	15	X (1968)	45	2,600	No information	Squamous, Basal, Out; Small Undifferentiated	12	2 packs	X	X	X	X	X	X 1970	
	1-886-982	18	1954	5	11	X (1966)	53	826	662	Squamous; Epidermoid	25	5 or 6 cigarettes	X	X	X	X	X	X 1970	
	1-898-126	None indicated	1939	18	24	X (1965)	49	4,000	2,982	Out, Squamous	20	1 to 2 packs	X	X	X	X	X	X 1969	
	2-151-797	13	1943	19	25	X (1968)	55	1,600	7,180 ± 80	Undifferentiated Out, Basal	No information	No information	X	X	X	X	X	X 1969	
	2-028-962	6	1940	18	27	No	52	1,400	No information	Epidermoid (moderately differentiated); Squamous	30	20 to 30 cigarettes	X	X	X	X	X	X 1969	
	2-176-025	None indicated	1956	12	12	X (1968)	35	2,125	3,100 ± 40	Oak, Undifferentiated, Small Cell	No information	1 to 10 cigarettes	X	X	X	X	X	X 1970	
	1-902-847	20	1957	1	9	No	38	No information	No information	Leiomyosarcoma	No information	30 cigarettes	X	X	X	X	X	X 1969	