KILLING OUR OWN

The Disaster of America's Experience with Atomic Radiation

Harvey Wasserman
& Norman Solomon

with Robert Alvarez & Eleanor Walters

A Delta Book
1982

A DELTA BOOK

Published by
Dell Publishing Co., Inc.
1 Dag Hammarskjold Plaza
New York, N.Y. 10017

Grateful acknowledgment is made for permission to use the following material:
Excerpts from "Three Mile Island: No Health Impact Found" by Jane E. Brody from *The New York Times,* April 15, 1980; "Nuclear Fabulists" from *The New York Times,* April 18, 1980; editorial from *The New York Times,* November 23, 1980. (c) 1980 by The New York Times Company. Reprinted by permission.
Excerpts from "The Down Wind People" by Anne Fadiman in *Life.* (c) 1980 Time, Inc. Reprinted with permission.
Excerpts from "No Place to Hide" by David Bradley. Copyright 1948 by David Bradley. By permission of Little, Brown and Company in association with the Atlantic Monthly Press.
Excerpts from NAAV Atomic Veterans' Newsletters. Reprinted by permission of the National Association of Atomic Veterans, 1109 Franklin Street, Burlington, Ia. 52601.
Excerpts from the editorial "The Bomb's Other Victims" in the *St. Louis Post-Dispatch,* December 1, 1979.
Excerpts from the editorial "Old or Dead Before Their Time" in the *Seattle Post-Intelligencer,* June 17, 1979. Copyright 1979 Seattle Post-Intelligencer.
Excerpt of letter from Penny Bernstein to authors, used with permission of Penny Bernstein.
Excerpt of letter from Pat Broudy to authors, used with permission of Pat Broudy.
Excerpt of letter from William Drechin to authors, used with permission of William Drechin.
Excerpt of letter from Bob Drogin to authors, used with permission of Bob Drogin.
Excerpt of letter from Frank Karasti to authors, used with permission of Frank Karasti.
Excerpt of letter from Alvin Lasky to authors, used with permission of Alvin Lasky.
Excerpt of letter from George Mace to Joseph Wershba, used with permission of George Mace.
Excerpt of letter from William Shufflebarger to authors, used with permission of William Shufflebarger.
Excerpt of letter from Gregory Troyer to authors, used with permission of Gregory Troyer.
Excerpt of letter from Joseph Wershba to authors, used with permission of Joseph Wershba.
Excerpt of letter from Warren Zink to authors, used with permission of Warren Zink.

Delta (R) TM 755118, Dell Publishing Co, Inc.
Manufactured in the United States of America.
First Delta printing
Designed by Judith Neuman

Library of Congress Cataloging in Publication Data

Wasserman, Harvey.
Killing our own.

Includes bibliographical references and index.
1. Radioactive substances—Toxicology—United States.
2. Ionizing radiation—Toxicology—United States.
1. Solomon, Norman. II. Title.
RA1231.R2W36 363.1'79 81-17438
ISBN 0-440-54566-6 AACR2

A hardcover edition of this work is available through Delacorte Press, 1 Dag Hammarskjold Plaza, New York, New York.

In 1947 Albert Einstein wrote:

"Through the release of atomic energy, our generation has brought into the world the most revolutionary force since the prehistoric discovery of fire. This basic power of the universe cannot be fitted into the outmoded concept of narrow nationalisms. For there is no secret and there is no defense, there is no possibility of control except through the aroused understanding and insistence of the peoples of the world.

"We scientists recognize our inescapable responsibility to carry to our fellow citizens an understanding of the simple facts of atomic energy and its implications for society. In this lies our only security and our only hope—we believe that an informed citizenry will act for life and not death."

It is to that faith in an informed citizenry that we dedicate this book.

Harvey Wasserman
Norman Solomon
Robert Alvarez
Eleanor Walters

CONTENTS

Acknowledgments 5
Notes 6
Introduction by Dr. Benjamin Spock 7

PART I The Bombs

1 The First Atomic Veterans 11
2 300,000 GIs Under the Mushroom Clouds 32
3 Bringing the Bombs Home 54
4 Test Fallout, Political Fallout 73
5 Continued Testing: Tragic Repetitions 89

PART II X Rays and the Radioactive Workplace

6 The Use and Misuse of Medical X Rays 107
7 Nuclear Workers: Radiation on the Job 119

PART III The Industry's Underside

8 Bomb Production at Rocky Flats: Death Downwind 138
9 Uranium Milling and the Church Rock Disaster 147
10 Tritium in Tucson, Wastes Worldwide 158

PART IV The "Peaceful Atom"

11 The Battle of Shippingport 170
12 How Much Radiation? 181
13 Animals Died at Three Mile Island 192
14 People Died at Three Mile Island 199
15 Conclusion: Surviving the New Fire 212

Appendix A The Basics of Radiation and Health 216
Appendix B Summary of Atomic Bomb Tests 223
Appendix C Commercial Nuclear Power Reactors in the U.S. 225
Appendix D Organizations 232
Index 234

Acknowledgments

First and foremost we would like to thank Chris Kuppig and Gary Luke of Dell Publishing, without whose extraordinary efforts this book could not have been brought to completion. We would also like to acknowledge the Environmental Policy Center for its role in establishing the scientific veracity of this book, and in providing resources for its production. Ron Bernstein, Sr., Rosalie Bertell, Jay and Laura Kramer, Mary Brophy, Priscilla Laws, Ada Sanchez, Samuel H. Day, Jr., Monte Bright, Tony Hodges, and Karen Wilson also provided us with important resources.

There are far too many doctors, scientists, farmers, and other concerned citizens on whom we have relied for aid and information to list here. Most appear in the text or footnotes that follow. It should be clear that this book is very much a product of the willingness of private citizens to inquire independently into their own health and that of the community. Therein, almost certainly, lies the hope of the future health of the planet.

For personal love and support in a demanding venture, we would like to thank the Walters, Alvarez, Solomon, and Wasserman families; as well as Kitty Tucker, Shawn Tucker, Amber Alvarez, Ada Sanchez, Anne Betzel, Joiwind and Journey Williams, Carolyn Stuart, George and Ken Gloss, Amy Wainer, Alex Coote, John and Nancy Ramsay B. Lynn; the Chilewich, Shapiro, Stellman, Simon, and Styron families; and the Montague and Allen farmers.

Notes

In researching this book, we have conducted more than two hundred interviews, many of which do not appear in the footnotes. In a number of cases we have interviewed the same person several times, but have denoted our talks with them with a single date. In denoting our printed sources, we have used a number of abbreviations, primarily for U.S. Government agencies. They are:

ABCC:	Atomic Bomb Casualty Commission
AEC:	Atomic Energy Commission
CDC:	Center for Disease Control
DOD:	Department of Defense
DOE:	Department of Energy
DHEW:	Department of Health, Education, and Welfare
EPA:	Environmental Protection Agency
FRC:	Federal Radiation Council
FDA:	Food and Drug Administration
GAO:	General Accounting Office
ICRP:	International Commission on Radiological Protection
JCAE:	Joint Committee on Atomic Energy
NAS:	National Academy of Sciences
NIOSH:	National Institute for Occupational Safety and Health
NRC:	Nuclear Regulatory Commission
OTA:	Office of Technology Assessment
PHS:	Public Health Service
USMC:	U.S. Marine Corps
VA:	Veterans Administration

Introduction
by Dr. Benjamin Spock

This is the frightening story of the damage that has already been done to our own people—to children even more than to adults—by the unlocking of the power of the atom. It investigates the testing of our nuclear weapons, the sloppy practices within the nuclear industry, and the problems with our atomic power plants. It is also about the future damage to be expected from mutation in our genes from radiation.

More than three and a half decades have now passed since the first atomic test at Alamogordo, New Mexico—July 16, 1945—and the subsequent detonations at Hiroshima and Nagasaki. Since then our own military has exploded more than 700 nuclear bombs on our own continental soil and in the Pacific. Many of the health effects are just now being felt.

It seems no accident that we are currently suffering from a national cancer epidemic, in which one of every five Americans dies of that dread disease. It would be plausible and prudent to assume that the radioactive fallout we've introduced into the global atmosphere, literally tens of tons of debris from bomb tests alone, is a significant factor in addition to industrial pollution and cigarette smoking. As early as the 1950s the American Linus Pauling and the Russian Andrei Sakharov—both Nobel prize winners—warned that literally millions of people would die worldwide because of these bomb tests.

There have been American "guinea pigs" who have amply confirmed these predictions. As this book documents for the first time, shortly after the blasts at Hiroshima and Nagasaki, American soldiers were sent in to help clean up the rubble. They were not warned that there was a danger in drinking the contaminated water and breathing the radioactive dust. Many of these men felt the lethal effects of the bombs' radiation almost immediately. Despite glib assurances from our government, they have suffered an extraordinary rate of rare cancers that could only have been caused by that radiation.

Similar tragedies have struck American soldiers present at scores of bomb tests that followed. From 1945 through the early 1960s, some 300,000 men and women in U.S. uniform were exposed to radiation from atmospheric, underwater, and underground bomb tests. The military wanted to know how armies would react to atomic weaponry in war and they used American soldiers to find out. Though the Pentagon has insisted all along that there was little or no danger from these tests, the authors here present irrefutable evidence, which has only gradually come to light, that many of our GIs have suffered and died from leukemia, cancer, chronic respiratory distress, progressive muscular weakness, and mental disturbance. Most tragically of all, some of their children have been born with physical and mental handicaps.

Yet in spite of overwhelming evidence, the Veterans Administration has adamantly refused to admit there is any proof that these illnesses are service-related, the vets and their widows and children have been consistently denied compensation. Of course, no individual case of leukemia or cancer or birth defect carries a label saying exactly what caused it. But the statistics, gathered by the veterans themselves, show that the tests were responsible.

With shocking callousness, our government has even refused to divulge the list of those hundreds of thousands who were deliberately exposed, a list that would greatly aid in the early detection of further cancers and save hundreds of lives.

Civilians unfortunate enough to live downwind from the tests, in towns like St. George, Utah, and Fredonia, Arizona, have also suffered disease and death. They were assured by the Atomic Energy Commission that the radiation would not harm them. But in ensuing years they have been afflicted with an outbreak of cancers and leukemia that could only have come from the test fallout. Yet, like the veterans, they have met a stone wall of governmental denial.

Frightening stories are also coming to light among people and animals living near nuclear weapons facilities, mining and waste storage sites, uranium processing plants, and nuclear power reactors. Farmers in central Pennsylvania, for example, began to observe abnormalities in their animals when Three Mile Island Unit One opened in 1974. They reported much worse problems in the wake of the accident at Unit Two in 1979. Many animals became infertile. Others developed bizarre behavior. Young were born with marked deformities. These farmers had seen such abnormalities only rarely in the past. Now they were occurring repeatedly and on many farms. But government investigators turned in reports that baldly denied a majority of the abnormalities, which had already been witnessed by neutral observers. In fact, the investigators never even visited some of the farms they reported on.

They blamed what few disturbances they admitted to finding on mismanagement and ignorance on the part of the farmers.

Farmers living near the Rocky Flats plutonium factory in Colorado, near the West Valley atomic fuel reprocessing center in upstate New York, near a uranium mining waste pile in Colorado, and near four separate reactor sites—including Three Mile Island—have complained of similar defects and illnesses among their animals. They have documented the same kind of problems that first appeared back in the 1950s in sheep caught downwind from nuclear test blasts.

Parallel evidence is now in hand, from private citizens and independent researchers, that the rates of infant mortality and cancer and leukemia have risen among humans living near nuclear reactors. The government response has again been a condescending and blanket denial.

The government's own record of health studies has been stained with serious scandal and obvious cover-up. In the 1960s, the Atomic Energy Commission engaged a topflight expert named Thomas Mancuso to look into the health of workers at nuclear facilities such as the Hanford weapons plant in Washington state. But when he discovered, after more than a decade of research, that there was an elevated cancer rate at Hanford, the government fired him and tried to confiscate his data. Other top scientists, including Drs. John Gofman, Alice Stewart, Karl Z. Morgan, Rosalie Bertell, and Irwin Bross, have been censored, harassed, fired, or deprived of their grants for standing by their studies, which showed that humans and animals were being harmed.

Our government set up a massive study of the Japanese victims in Hiroshima and Nagasaki. But the data was kept secret, and it was later used in a way that brought charges of manipulation and deliberate suppression of the dangers of radiation. Now, nearly four decades later, it has become clear that radiation released was ten times more dangerous than anyone believed possible, not just to those killed at the time, but to the "survivors" as well.

There are great potential perils in the nuclear power industry that our government and the utilities consistently minimize. The most dramatic is the danger of a meltdown, which could kill many thousands of people immediately, and even more from the aftereffects. The accident at Three Mile Island revealed that the government and utilities are not in full control of this technology. They didn't know for several days what had gone wrong or what to do about it. There had been carelessness in maintenance. There were not adequate plans for meeting such a disaster. Part of the equipment was basically defective in design. The responses of government and the utility at the time, and later, to charges that radiation had already harmed infants and animals, showed again that their predominant impulse was to reassure the public that nothing serious was wrong and that there was no real danger—even when there was no technical or moral basis for such statements.

There are also problems related to the low-level radiation that leaks from all these reactors. *Killing Our Own* documents two cases—Three Mile Island and Arkansas Nuclear One—where strong evidence has been collected indicating an increased infant mortality rate from these emissions. Some scientists have charged that infant mortality rates have risen around other reactors as well. Yet neither the government nor the industry has ever conducted a definitive nationwide survey of cancer and infant mortality rates near atomic reactors, though one would be easy enough to perform.

Danger also arises from the production of nuclear fuel and its transport, and the transport and permanent storage of nuclear wastes, the latter being a problem for which even the government admits it has no solution. As this book documents, health problems have already arisen from even the short-term storage of these deadly radioactive poisons. Yet government and industry leaders continue to try to reassure us.

All of this has long since convinced me that we cannot trust these people and, more important still, that nuclear power is too dangerous to have around. But it is clear that our government is so deeply committed to nuclear weapons and nuclear power that it will ignore damning evidence, deny the truth, mislead our people, jeopardize health and even life itself, and try to blacken the reputation of scientists who disagree with its policies.

Atomic testing in the atmosphere was ended by the test ban of 1963. However, the testing has continued underground, on the assumption that radiation can be confined. The current administration has called for even more tests. But many of these explosions have vented dangerous amounts of radiation. The infamous Baneberry test in Nevada leaked thousands of times more radiation than the accident at Three Mile Island.

Is this dangerous testing really necessary?

A couple of years ago, Norris Bradbury, a former director of the Los Alamos Laboratory, where the first atom bomb was designed, and Hans Bethe, a recipient of the Nobel prize for his accomplishment in nuclear physics, wrote a petition (endorsed by the Federation of American Scientists) to President Carter asking to end the testing. They pointed out that the mechanical reliability of our nuclear weaponry had been proved "almost exclusively by nonnuclear testing"; it has been "rare to the point of nonexistence" for a nuclear test to be required to resolve any problem in our nuclear weapons arsenal. So why go on?

I earnestly believe that as soon as there is a definite suspicion of harm from any source as malignant as radiation, it is time to make every effort to eliminate it. I feel particularly strongly about radiation because children are much more vulnerable than adults—not only in regard to the likelihood of developing leukemia and cancer, but also of being born with physical or mental defects. And once mutations have been produced in genes, they will be passed down forever.

What right do we have to threaten with deformity or death those who are too young to protest or those still unborn? What right do we as adult citizens have to allow our government to take this power for evil into its hands?

Such harm would be bad enough if there were no alternatives. But I believe that the perilous and senseless accumulation of nuclear weapons and their dispersal to more and more nations could be ended if our citizens would demand that our government stop stalling and get on with the negotiation of a true disarmament with the Soviet Union. The damage being done by the mere building of these bombs at places like Rocky Flats would then also be eliminated.

We could solve the problem of our energy needs without the multiple risks of nuclear power if our government would provide leadership for energy conservation and the development of nonpolluting, renewable sources such as the sun, the wind, the tides, the burning of wood.

Only you, as aroused citizens, can stop the terrifying plague of nuclear power and nuclear weapons. But first you should read the estimates of past and future damage assembled here, in order to make up your mind independently. Then, if you are convinced, you will be well-motivated to exert your full influence.

PART I

The Bombs

1

The First Atomic Veterans

Like many millions of other Americans, Marine Corporal Lyman Eugene Quigley reacted to news about Hiroshima and Nagasaki with relief.

A tall, large-framed, handsome man with straight black hair, bushy eyebrows, and a friendly countenance, Quigley had enlisted in the Marines soon after Pearl Harbor, at the age of twenty. Leaving his job assembling electric motors in his native Illinois, Quigley went through boot camp and advanced training in California; by spring 1943 he was on a troop carrier in the South Pacific, headed to Australia and New Zealand.

As part of the 2nd Marine Division, during more than two years in the Pacific, he saw combat at Tarawa, Okinawa, then Tinian and Saipan. Quigley remained in the Mariana Islands, working in a Marines bulldozer crew, clearing away an air base for B-29s loaded with explosive bombs and—twice—with atomic weapons.

"All we knew was the war was over, and some kind of special bomb had been dropped," Lyman Quigley recollected a third of a century later. "All I was thinking was, the war was over, I'm coming back. We were so happy, we were going home. But it didn't turn out that way. Unfortunately."[1] After the long-awaited formal surrender took place on September 2, Quigley's orders sent him not home, but toward Nagasaki.

Peace notwithstanding, U.S. wartime censors kept both Hiroshima and Nagasaki off limits to journalists until mid-September. "The war was ended, as we had reported, but the censorship was not," wrote George Weller, a Pulitzer prizewinning war correspondent. "What the command wanted covered was the [POW] prison camps of northern Japan. . . . away from where the war had been decided a month earlier."[2]

Violating the U.S. Government's edict that declared all southern Japan forbidden to the press, Weller headed to the Japanese island of Kyushu; on September 6, 1945, he became the first known civilian Westerner to enter Nagasaki since its atomic bombardment, arriving four weeks after the nuclear assault. "When I walked out of Nagasaki's roofless railroad station, I saw a city frizzled like a baked apple, crusted black at the open core . . ."[3]

Weller climbed a nearby hill, gaining an overview. "The long inlet of the main harbor looked eerily deserted, with the floating lamp of a single freighter smoking off the blistered, sagging piers and twisted derricks. We could see the main Mitsubishi plant, a long fallen Zeppelin of naked, twisted steel, bent like a child's structural toy crushed by a passing foot. Its form was still almost intact, though it was almost directly under the bomb. The sturdiness of the ceilings had taken the blast and blocked the ray. The workers were more fortunate than their families in the one-story bungalows around the plant. They did most of the dying."[4]

A U.S. military inspection team was dispatched for the nuclear-ravaged cities, reaching Hiroshima on September 8 and going on to Nagasaki a few days later. "In all the areas examined, ground contamination with radioactive materials was found to be below the hazardous limits," the U.S. Army's official history states.[5] Within two weeks after its inspection team began surveying the two Japanese cities, the War Department announced that scientists had ascertained that the residual radiation in Nagasaki did not merit concern. The situation was unprecedented, however,

---

1. Lyman Quigley, and Bernice and Ron Quigley, interviews, November 1978; in addition, authors obtained hundreds of pages of medical and military service records in Quigley's claim file at the regional Veterans Administration office in Portland, Oregon.

2. David Brown and W. Richard Bruner, eds., *How I Got That Story* (New York: E. P. Dutton, 1967), p. 209.

3. Ibid., p. 211.

4. Ibid., p. 217.

5. William S. Augerson, M.D., Director, Health Care Operations, Department of the Army, Office of the Surgeon General, to Harry Shaich, University of Oregon Health Services Center, February 25, 1975, quoting from *Radiology in World War II* (Medical Department, U.S. Army, 1965).

and understanding of nuclear-fission particles' effects was in its infancy. On September 23, U.S. occupying troops disembarked at Nagasaki harbor—forty-five days after the bombing.

"They came along in Jeeps," Kayano Nagai recounted a few years later. She was four years old as she watched the occupiers enter her home city. "Daddy told me they were Marines and lots of them were college students. They were all very nice and they had very good manners, and whenever we said 'Haro' they gave us chocolate and chewing gum."[6] Much of Nagasaki was in ruins. Kayano's mother and an estimated eighty thousand other Nagasaki residents were dead from the atomic bombing; thousands of others were in agony.

"We walked into Nagasaki unprepared, and we were shocked as hell at what was there," Lyman Quigley remembered many years later. "Really, we were ignorant about what the hell the bomb was. We had no idea what we were going to see. We weren't given any instructions whatsoever. We were amazed, shocked—and yet stupefied." It was a grisly scene. Corpses were still being burned in the open air. "Women's hair was falling out, the men all had their heads shaved, and all of them had running sores on their heads, ears, all over."[7]

At the time, gruesome as the panorama of suffering was, it seemed to involve only other people's problems. Quigley and fellow members of Company C, 2nd Pioneer Battalion, 2nd Marine Division, made their way up a steep hill from the docks; about 150 strong, the Marines of Company C billeted at a partially destroyed concrete schoolhouse up the hill from the spot over which the atomic bomb had exploded.

Orders from above did not include any unusual precautionary guidelines or provisions. Quigley and his buddies drank city reservoir water, and worked in the midst of the most heavily damaged area without any protective clothing or special gear. They were not provided with radiation-dose badges or any other equipment to measure their exposure to radioactivity.

Quigley was in charge of a Marine bulldozer crew razing what was left of wrecked structures, cleaning up rubble, clearing out roads, and leveling the ground. For Company C Marines the long days settled into a busy routine amidst the dusty debris—bulldozing, hauling, standing guard duty in the blast center area by day, sleeping in the makeshift camp at the schoolhouse by night. Quigley bought some silk kimonos for his sister and some young women friends back home. But there was little time or incentive for sight-seeing.

Toward the end of autumn many of the Marines were sent out of Nagasaki. On November 4, after forty-three days of working in the radioactive rubble of Nagasaki, Corporal Quigley received a Good Conduct medal ("We used to call it a Ruptured Duck," he quipped with a chuckle) and later that month shipped back to the States.

"When I got back, I had burning, itching, running sores on the top of my head and the top of my ears," Quigley recalled. The sores looked to him like those on Nagasaki's residents. He called the running sores to the attention of a doctor during a routine discharge examination in December 1945. "They listed that in my medical records as a fungus, which is wrong—I know that now." Also: "I had a warm feeling in my lips. I remember that distinctly."[8]

On December 21, 1945, Lyman Eugene Quigley received an honorable discharge from the Marine Corps. On the surface his military service had the trappings of a traditional all-American tale. The troubling radioactive underside, with its ironic and disturbing twists, would not become apparent to him for decades.

A Hollow Triumph

Five months previous to Lyman Quigley's return home, the President of the United States was contemplating the new vistas of atomic energy. "We have discovered the most terrible bomb in the history of the world," President Harry S. Truman wrote in his diary two weeks before the United States exploded nuclear weapons over the Japanese cities of Hiroshima and Nagasaki. "I have told the secretary of war, Mr. Stimson, to use it so that military objectives and soldiers and sailors are the target and not women and children." The atomic bomb, President Truman noted, "seems to be the most terrible thing ever discovered, but it can be made the most useful."[9]

Truman was weighing options left in the wake of an experimental detonation of the first atom bomb on July 16,

---

6. Takashi Nagai, *We of Nagasaki* (New York: Duell, Sloan & Pearce, 1951), pp. 19-20.

7. Quigley interviews.

8. Ibid.

9. Robert H. Ferrell, ed., *Off the Record: The Private Papers of Harry S. Truman* (New York: Harper & Row, 1980); diary entry July 25, 1945, published in *The Oregonian* (Portland), October 12, 1980.

1945. A nuclear blast named Trinity, set off in the New Mexico desert, had been a spectacular triumph for participants in the supersecret Manhattan Project, which developed the bomb.

But some Manhattan Project researchers were uneasy about the new weapon. Warnings, like the confidential Franck Report, which scientists presented to War Secretary Stimson, urged demonstration of an A-bomb at a sparsely populated spot. However, as a chief drafter of the Franck Report, Dr. Eugene Rabinowitch, remarked later, ". . . the American war machine was in full swing and no appeals to reason could stop it."[10]

At the U.S. War Department, senior officers believed "it was very important to prove the bomb a successful weapon, justifying its great cost," observed David H. Frisch, a physicist who worked on the Manhattan Project. Frisch remembered that America’s military strategists were eager "to use the bomb first where its effects would be not only politically effective but technically measurable."[11]

Manhattan Project director General Leslie R. Groves recalled that it was "desirable that the first target be of such size that the damage would be confined within it, so that we could more definitely determine the power of the bomb." For the same reason criteria for targeted cities included absence of previous bombardments.[12] Thirty-five years after the atomic bombings of Hiroshima and Nagasaki, the U.S. Government was listing them as "Announced United States Nuclear Tests."[13]

"Nobody really knows how many people were killed in Hiroshima: anywhere from around 60,000 to 300,000," comments Dr. Robert Jay Lifton, whose study of A-bomb survivors won the National Book Award. "The city of Hiroshima estimates 200,000. It depends upon how you count, which groups you count, whether you count deaths over time. And it depends on emotional influences on the counters. It is of some significance that American estimates have tended to be lower than Japanese."[14]

Japan’s dazed hierarchy in Tokyo had little time to assess the unprecedented, catastrophic chaos of Hiroshima. Three days later another searing flash—this one fueled with plutonium instead of uranium and detonated with a more sophisticated implosion apparatus—devastated Nagasaki. In both cities, despite Truman’s diary vow, women and children were among the primary sufferers. Included were several thousand Americans of Japanese ancestry, stranded in Japan when the war began.[15] And at least eleven American POWs being held in Hiroshima died from the bombing.[16]

"All concerned should feel a deep satisfaction at the success of the operations," Brigadier General Thomas F. Farrell reported about the Nagasaki bombing in a memorandum to General Groves.[17] But when the war ended a few days later at the Los Alamos atomic weapons laboratory in New Mexico, according to journalist Lansing Lamont, "more than one scientist walked cold sober into the dark of that August night and retched."[18]

United States policymakers certainly were anxious to convey the image of a return to normality as soon as possible in Hiroshima and Nagasaki. When U.S. occupation troops reached Nagasaki in late September 1945, they were there to help calm a jittery world.

Entering Nagasaki six weeks after the nuclear bombing, about one thousand Marines and a smaller detachment of

---

10. Richard S. Lewis and Jane Wilson, eds., *Alamogordo Plus Twenty-Five Years* (New York: The Viking Press, 1971), p. 4.

11. Ibid., p. 254.

12. Ibid.

13. U.S. DOE, *Announced United States Nuclear Tests, July 1945 Through December 1979* (Las Vegas: DOE Office of Public Affairs, 1980), p. 5 (hereafter cited as *Announced U.S. Nuclear Tests*).

14. Robert Jay Lifton, "The Prevention of Nuclear War," *Bulletin of the Atomic Scientists,* October 1980, p. 38.

15. Approximately six hundred survived and returned home, mostly to California and Hawaii. Although U.S. citizens, none were able to gain medical assistance from their government for persistent health effects of being subjected to nuclear attack. See *San Francisco Chronicle,* May 12, 1979, p. 30; also, *American Atomic Bomb Survivors. A Plea for Medical Assistance* (San Francisco: National Committee for Atomic Bomb Survivors in the United States, 1979), available from Japanese American Citizens League, 1765 Sutter St., San Francisco, CA 94115.

16. "Government documents and the testimony of former servicemen indicate that the United States has been concealing information about the deaths of these men for 34 years," historian Barton J. Bernstein concluded in 1979. The American government maintained its long silence about the POW deaths, the Stanford University professor contended, "so as not to weaken, impair or damage the reputation of U.S. leaders and to block any moral doubts at home about combat use of the atomic bomb." (United Press International, dateline San Francisco, reporting on July 23, 1979, press conference by Barton Bernstein.) See also *New York Times,* August 21, 1979.

17. Anthony Cave Brown and Charles B. MacDonald, eds., *The Secret History of the Atomic Bomb* (New York: Dial Press, 1977), p. 534.

18. Lansing Lamont, *Day of Trinity* (New York: Atheneum, 1965), p. 268.

Navy Seabees were billeted in the demolished core area around the blast center. Assigned cleanup duties, they arrived as U.S. military-command press releases announced that scientists had found no lingering radiation worth worrying about in Nagasaki. Two weeks later, in less extensive operations, U.S. Army troops moved into the Hiroshima area.[19]

What they endured in ensuing decades closely resembles the ordeals of a wide range of American radiation victims, consistently ignored and denied at every turn by the very institutions responsible for causing their problems. Accorded no place in official histories, many of these U.S. veterans suffered privately, with debilitating and often rare health afflictions as they reached middle age. Some developed terminal illnesses affecting bone marrow and blood production—the kind of biological problems long associated with radiation exposure. Others found that at unusually early ages they were plagued by heart attacks, severe lung difficulties, pain in their bones and joints, chronic fatigue, and odd skin disorders.

The ultimate question of the controversy about these veterans is whether they later suffered significantly higher rates of diseases compared with average occurrences among other American males of their age. Were serious illnesses among those veterans merely random—or were they part of a pattern of extraordinarily high ratios of particular diseases linked to their stints in postbomb radioactive rubble?

Normally among American men in their late fifties one would find multiple myeloma bone-marrow cancer at an average rate of about one-half case per one thousand, according to standard medical incidence tables.[20] So ordinarily perhaps one case of multiple myeloma might be expected to develop later among the one thousand U.S. Marines routinely present within about a mile of the atomic blast center point of Nagasaki during the last week of September 1945. We have found five cases of multiple myeloma among those particular Marines—an extremely high incidence of the terminal bone-marrow disease.

Additional blood-related afflictions—such as Hodgkin's disease, myelofibrosis, and leukemia—have been documented by the veterans, and their widows. And other painfully insidious illnesses became common.

A Legacy Comes Home

In the fall of 1946—a year after the atomic bombings of Japan—Lyman Quigley settled down in Portland, Oregon, where he went to work for the city transit company operating streetcars and buses. Very soon he began suffering acute abdominal attacks. "I'd wake up and be doubled up in pain at night. It kept getting more and more severe. I got haggard-looking. I can't describe it to you. You'd have to go through it to know what it is. Excruciating."[21] In December 1951 doctors removed Quigley's appendix. The severe stomach pains, however, persisted. He later developed stomach tumors.

One day, in March 1953, Quigley's lungs hemorrhaged suddenly, bleeding for over a week. A scar formed on a lung. He was thirty-one by then—married, and a father. "The doctors told me they couldn't figure out what was going on. This is when I first got a suspicion." More than twenty-five years later his memory was vivid about the day in the summer of 1953 when he spoke to his doctor about the bulldozer work in Nagasaki's radioactive rubble. "The doctor starts to diagram on the blackboard about the atom and the half-life and all this stuff. And all of a sudden he turns to me and says, 'I wish you wouldn't come see me anymore.'"[22]

In the late 1950s a painful lump grew out of Quigley's head. Surgery removed the tumor, diagnosed as a lipoma (tumor of fatty tissue). Later doctors took out "a tumor about the size of a hen egg"[23] from the back of his knee.

---

19. Interviews with several dozen American veterans of Nagasaki cleanup. Also, U.S. DOD, *Hiroshima and Nagasaki Occupation Forces* (Washington, D.C.: Defense Nuclear Agency, 1980); U.S. DOD, *Radiation Dose Reconstruction U.S. Occupation Forces in Hiroshima and Nagasaki, Japan 1945-1946* (Washington, D.C.: Defense Nuclear Agency, 1981).

In some respects the U.S. servicemen's atomic cleanup experiences in Japan resembled events more than thirty years later in the South Pacific. In the late 1970s, about three thousand American GIs—some wearing surgical protective masks—obeyed orders to clean up Eniwetok atoll radioactivity left by scores of nuclear tests at those islands. The three-year, $100 million cleanup project was backed by Defense Nuclear Agency officials eager to show that islands in the radiation-covered atoll could be made habitable. (See Steve Rees, "84th Eng Bn Exposed to Cancer Causing Elements on Clean-up Mission: But Why?" *Enlisted Times,* August 1979, pp. 5, 19.)

20. White House Domestic Policy Staff Assistant Director Ellen L. Goldstein to Committee for U.S. Veterans of Hiroshima and Nagasaki, December 18, 1979; available from Committee, P.O. Box 14424, Portland, OR 97214.

21. Quigley interviews.

22. Ibid.

23. Ibid.

Pain and weakness in his legs persisted. By this time Quigley was having trouble breathing; he was diagnosed as having "chronic obstructive lung disease." At the age of forty-three, he suffered a heart attack—the first of five.

Missed work and medical bills outstripped insurance coverage by many thousands of dollars. "We borrowed on the house, borrowed money on the car, borrowed money on the insurance policies we had," Quigley recounted.[24] In the early 1970s worsening health problems forced him into retirement. Monthly Social Security disability payments of about $300 and a Teamsters union pension of $140 did little to ease the financial strain. His wife of a quarter century, Bernice, started working in hospitals to counter the awesome financial toll.

In the autumn of 1978 Lyman Quigley received visitors at his house in northeast Portland. Pain-racked but determined, he sat next to a kitchen table piled high with correspondence from the Defense Department, Veterans Administration, and nongovernmental scientists. Thirty-three years after going ashore in Nagasaki, for Quigley, atomic and personal histories had become inextricably meshed.

He was a quintessential American man, raised in the Depression era, proud of his military service. His political views were mainstream; his favorite magazine, *Reader's Digest*. What set him apart was his belief that an unreported part of history had been telescoped into his own body, his organs and cells—and, he feared, perhaps into the genetic heritage passed on to his children, Ron and Linda, now in their twenties.

"When my father first started putting facts together and came to the realization that his illnesses might stem from exposure to radiation, we found that this was more frightening than the unknown," Ron remembered. "It was not only frightening but also it was financially and emotionally draining for me and my family. . . . I can remember times my father would isolate himself in another part of the house for two or three days at a time, he had such pains in his heart, his legs, his chest, and shortness of breath, so much so that he was unable to participate in family activities or even simple things such as getting the mail or sitting outside for a short time."[25]

For a score of years, with increasing intensity, Lyman Quigley had read everything he could get his hands on about atomic fallout and radiation effects. In *Radiation,* an authoritative book by Ralph E. Lapp and Jack Schubert, he found documentation that the Nagasaki reservoir water he and fellow Marines had drunk so freely was probably radioactive. About a mile from Nagasaki's nuclear blast center, "there was a fall-out at the Nishiyama reservoir area, where a total dosage of as much as 100 roentgens may have been delivered"[26]—a serious dose of radiation if absorbed into the human body.

Quigley had attempted to file a claim for service-connected benefits with the Veterans Administration in the fall of 1973, contending that his severe health deterioration resulted from radiation exposure while a Marine in Nagasaki. The VA official he spoke with dissuaded Quigley from filing a claim, saying there was no chance of approval. Two years later Quigley went back and insisted on filing a claim. In January 1976 the VA issued a denial.

After a hearing in Portland the following year the VA sent him a ruling dated March 10, 1978, reaffirming the rejection. "Service-connection for residuals of radiation exposure involving the heart, lung, stomach, head and knee is not warranted," the VA decision declared. "His present disabilities have been determined to be of nonservice-connected origin."[27]

In Nagasaki "radioactivity decayed very fast and was all gone within five weeks of the blast," said a scrawled VA memo in Quigley's claim file.[28] In a 1976 letter, Dr. John D. Chase, then chief medical director of the VA, wrote: "Navy records indicate that ships did not approach Nagasaki until so long after the atomic blast that any residual radiation which might have existed would have been negligible."[29]

But by now Quigley understood that the Nagasaki bomb exploded with plutonium, known to lodge in human lungs and other internal soft tissue; plutonium diminishes so slowly that it will take twenty-four thousand years for half of its deadly alpha radiation to decay. Other radioactive isotopes left by an atomic bomb include strontium 90, a "bone-seeking" form of radioactivity remaining highly toxic for many decades, and cesium 137—which is assimilated by muscles.

---

24. Ibid.

25. Ron Quigley, *Newsletter,* Committee for U.S. Veterans of Hiroshima and Nagasaki, summer 1979, p. 5.

26. Jack Schubert and Ralph E. Lapp, *Radiation: What It Is and How It Affects You* (New York: The Viking Press, 1957), p. 219.

27. VA claim determination letter to Lyman Quigley, March 10, 1978.

28. VA "Report of Contact," October 26, 1978, Quigley file, No. C-20-303-320.

29. VA Chief Medical Director John D. Chase, M.D., to Congressman Robert B. Duncan, December 27, 1976.

Lyman Quigley pursued a hunch. He suspected that his was not an unusual case among veterans, now scattered throughout the United States, who had traveled up that Nagasaki hill with him as part of Company C, 2nd Pioneer Battalion, 2nd Marine Division.

After three decades it was not easy to track down Marine buddies from the Nagasaki cleanup days. Adding to the logistical obstacles for Lyman Quigley, life had long since become almost steady pain. Utilizing old address books, yellowed letters, and telephone directory assistance, by the end of 1978 he had located five men of the Company C Marines.

In the small town of Sparta in the eastern Tennessee mountains, Junior Hodge—who was with Quigley on the bulldozers in Nagasaki—had been living with chronic anemia for the past twenty years. "Seems like all my strength is going out of me," Hodge told us. One of his testes had become enlarged, while the other, with a small growth on it, had almost disappeared. "I ain't got much money, and I can't afford to go to doctors," he drawled mournfully. Hodge's chronology of stomach and lung afflictions was virtually identical to Lyman Quigley's.[30]

In Pittsburgh, Quigley tracked down John Zotter; in Toledo, Ohio, Willard Good; in Berwyn, Illinois, Philip Leschina; across town in Portland, William Gender. In addition Quigley located the mother of Floyd Crews, who had been part of the Company C bulldozing detail; he had died in 1972.

Quigley took extensive notes and accumulated medical records and affidavits. A pattern was emerging, with some strikingly similar ailments among the seven of them. Hodge, Good, Gender, Crews, and Quigley suffered severe lung difficulties, at times requiring surgery and in all cases causing chronic breathing problems for decades. Consistent intestinal attacks, often within a few months after leaving Nagasaki, became long-term realities of life for Hodge, Zotter, Gender, Crews, and Quigley; each of those men also experienced persisting painful conditions in their legs. And a pronounced chronic infestation of unusual weeping skin sores or ulcerations had been suffered by Hodge, Zotter, Good, Gender, and Quigley.[31]

Willard Good had begun treatments in the mid-1960s for polycythemia vera, an excess of red blood cells found in one out of every 250,000 Americans per year.[32] In 1976, at age fifty-three, Good went on early retirement from his job as a shipping clerk in Toledo.

Most of the men spoke of feeling run down by the time they reached middle age—as though they were much older than their chronological years. Time after time medical specialists had been puzzled about their afflictions.

By mid-1979 Quigley had reached a total of fifteen men—or their next of kin—who had been stationed with him at that roofless Nagasaki schoolhouse. Dispersed all over the United States and unaware of each other's postwar medical woes, most of the men experienced agonizing health problems at an unusually early age. Six suffered heart attacks, four of them fatal, before the age of fifty. Serious lung ailments, ongoing acute stomach pains, bizarre skin afflictions, aching weakness in leg bones—each of these physical difficulties, occurring at young ages, was reported for about half of the fifteen Company C veterans tracked down.[33]

Little more than an hour's drive from Quigley's Portland home, in the southern Willamette Valley town of Lebanon, lived Company C veteran William Hoover. "Bill had been lucky, or so he thought," Juanita Hoover reflected a year after Quigley had located her husband. But rapid-fire events ended the Hoovers' feelings of good fortune. In quick succession, Bill Hoover's wife recalled, "he had a tumor removed from his hip and a skin cancer from his ear—also a testicle operation. Then on October 15, 1979, he discovered he had lung cancer. He had surgery immediately. It had grown so rapidly it had attached itself to the sac around the heart. They removed two thirds of his right lung." Hoover nearly died on the operating table.[34]

The fifteen former Marines' health histories that Quigley documented represented about a tenth of the total number of Company C servicemen who had been with him in Nagasaki. The fifteen had been a fairly random sampling, and had turned up a conspicuous pattern of early onset of particular diseases. What's more, Quigley pointed out, he had begun to do what the U.S. Government had always been in a far better position to accomplish,

---

30. Junior Hodge, interviews, December 1978.

31. Quigley, John Zotter, Willard Good, Philip Leschina, and William Gender, interviews, November 1978 to June 1979.

32. Stephen Chandler, M.D., Portland hematologist, interviews, April 1979.

33. Quigley and other fifteen Company C Marines he located, interviews, November 1978 to June 1979; plus correspondence and medical records.

34. *Atomic Veterans' Newsletter* (National Association of Atomic Veterans, 1109 Franklin St., Burlington, IA 52601), fall 1980, p. 6.

with its resources and access to records; but the government had never tried, refusing even to lend a hand to Quigley's efforts.

For Lyman Eugene Quigley—a veteran of Tarawa, Okinawa, and other bloody battles in the Pacific during World War II—the most tenacious foes turned out to be severe health impairment teaming up with a recalcitrant U.S. Government. The new evidence he had uncovered didn't seem to make any difference to the Veterans Administration, which turned down his claim again. "I got a willpower to live," Quigley said as he leafed through stacks of negative replies under official United States Government letterheads. "I ain't giving up yet. I'm not ready."[35] He continued his research work, until a fifth heart attack killed him in spring 1980 at the age of fifty-eight.

A few hours after the funeral Bernice Quigley drove across Portland to meet a group of Japanese atomic bomb survivors who were visiting the city as part of a speaking tour. As she talked to them, she learned that a number of her late husband's ailments, including odd purple spots that would come and go and reappear on his legs, were quite familiar to the Japanese visitors who had lived in Hiroshima and Nagasaki when the atom bombs fell.[36] For Bernice Quigley, newly widowed, an insidious irony had completed a painful full circle.

Fifty miles east of Portland along the Columbia River, former U.S. Marine Ralph Sheridan Clapp settled down to raise a family after the Second World War. But ever since the autumn of 1945 his life had never been the same. "Before I was in Nagasaki, I had a friend who said I was more like a gazelle than a human being."[37] By the end of his few weeks of Nagasaki cleanup duties, according to Clapp and affidavits from ex-Marines who had been in that city with him, severe breathing problems began. As the years passed, Clapp spent more time in hospitals for oxygen and diagnostic tests.

In early spring 1979 we visited Sheridan Clapp at the Barnes VA Hospital in Vancouver, Washington. Clapp sat up in bed, his voice wheezing but resolute. "It's kind of ironic to go through a war like that with no scratches, hell in a half-acre, and then wind up like this," he said. Clapp had seen combat in Okinawa, but it was another legacy that preoccupied him at age fifty-seven. "I think, really and truly, the American public needs to be told. We went in there green as grass. We were just kind of cleaning up in Nagasaki, one thing or another. You're drinking water and all that, why hell it's all contaminated; it'd have to be."[38]

Turned down for Veterans Administration service-connected benefits, Clapp had developed a thick VA claim file containing the same official assurances—often word for word—as those received by Lyman Quigley.[39] "Why?" Clapp asked during an interview; looking around the noisy hospital wing, he responded to his own question: "It must be all the big money behind nuclear."[40]

Chronic respiratory illness was not the only reason for Sheridan Clapp's hospitalization in the first months of 1979. Doctors had discovered a perplexing blood condition, requiring extensive tests as one after another of the most common blood diseases were ruled out. During the spring a medical verdict finally came in: Clapp was afflicted with a life-threatening lack of blood coagulant "factor VIII"—a condition so rare that no more than one hundred cases had been reported worldwide in the previous three decades, according to the hematologist treating Clapp, Dr. Scott H. Goodnight, Jr., of the Oregon Health Sciences Center.[41]

For Clapp the agony was intense—all the more because he was weary of hospitals, and what he perceived as political motives for VA rejections of claims by American veterans exposed to radiation while in military service. "This country had better get itself in gear if we're going to survive, that's all I've got to say," he told us during a hospital visit in March 1979. "All the doggone money in developing those nuclear plants. I can't understand what they're thinking about. I'm against any further development of it at all. Absolutely none."[42] On April 20, 1979,

---

35. Quigley interviews.

36. Bernice Quigley, interviews, July 1980.

37. Ralph Sheridan Clapp, interview, March 1979.

38. Ibid.

39. Authors obtained both Quigley's and Clapp's complete claim files of record at the VA regional office in Portland.

40. Clapp interview.

41. Scott Goodnight, interview, April 1979. Dr. Goodnight said Clapp's "factor VIII" inhibitor condition had been diagnosed as being a noninherited type, which greatly accentuated its rarity.

42. Clapp interview.

Sheridan Clapp picked up a blunt pencil and wrote a letter mentioning plutonium and ending with the words: "Stop these people. Sincerely, Sheridan Clapp."[43] He died five weeks later.

Sheridan Clapp left behind a widow whose grief combined with outspoken anger. Two years after her husband's death there was a little less audible pain in Delores Clapp's voice, but the outrage had grown stronger. "Sheridan lost his life for his country just as sure as if he had died on a battlefield," she said, sitting in the living room of the house their family had shared in Hood River, Oregon. "If he hadn't been in Nagasaki, he'd be here today to enjoy his grandson. I feel so strongly about this. If it were just a matter of money, the government's refusal to admit the truth wouldn't be so important. But it's the principle of the thing."[44]

Government Response

Beginning in the late 1970s, the federal government publicly solicited toll-free phone calls from former GIs who were directly involved in A-bomb tests between 1946 and 1962. But Hiroshima and Nagasaki veterans were intentionally excluded from the scope of the telephone data-gathering program. At the Defense Department two of the project's top officials each admitted personally responding to about half a dozen such calls or letters.[45]

"We were able to reassure them that they didn't get any significant exposure,"[46] said Lieutenant Colonel Bill McGee at the Defense Nuclear Agency (ironically acronymed DNA), a branch of the Pentagon devoted to governmental assessments of atomic weapons impacts. McGee and other DNA officers would not tell us how many contacts regarding Hiroshima-Nagasaki cleanup their agency received.

At the Veterans Administration headquarters a few blocks from the White House, in January 1979 we inquired about claims for service-connected benefits based on Hiroshima or Nagasaki residual radiation exposure. VA Board of Veterans Appeals chief member Irving Kleinfeld said that "we probably know of a couple of cases" of VA claims in that category. Kleinfeld added he seriously doubted any other VA official would know anything more about it.[47]

In the VA's central public-relations office the story was about the same. When asked whether any claims based on Hiroshima or Nagasaki residual radiation exposure had ever been filed with the VA, public-information official Stratton Appleman replied: "We've had none for the Hiroshima and Nagasaki bomb."[48]

The VA's public-relations machinery was apparently telling other curious journalists much the same thing. In North Carolina, on January 21, 1979, *The Charlotte Observer* published an article about area resident Clifford Helms, fifty-four, a Navy Seabee veteran with paralysis and kidney trouble who had recently filed for VA benefits linked to his cleanup assignment at Nagasaki. The *Observer* article, written by staff reporter Bob Drogin, stated that "Helms is the first veteran to claim disability based on exposure to radiation from the atomic bombs dropped on Nagasaki and Hiroshima, according to Al Rayford, a Veterans Administration spokesman in Washington."[49]

Rayford later denied ever contending that Helms's claim was the only one due to Hiroshima or Nagasaki radiation.[50] Informed of the denial, Drogin responded with a written statement: "Al Rayford unequivocally told me Clifford Helms was the first and only vet to claim disability based on exposure at Hiroshima and Nagasaki. My notes are clear on this. Moreover, I specifically asked him this question several times because it seemed so unlikely to me."[51]

We also called second-level VA officials, some of whose names had appeared in Lyman Quigley's bulky claim file. The trail led to Robert C. Macomber, chief of the Veterans Administration rating-policy staff, a career VA employee who said he had never been asked such a question before by a reporter. As a matter of fact, Macomber said, he happened to have more than two dozen Hiroshima-Nagasaki claims right next to him in his office.[52]

---

43. Clapp to authors, April 20, 1979.

44. Delores Clapp, interviews, May 1981.

45. Lieutenant Colonel Bill McGee and Colonel D. W. McIndoe, U.S. DNA, interviews, January 1979.

46. McGee interview.

47. Irving Kleinfeld, interview, January 1979.

48. Stratton Appleman, interview, January 1979.

49. *Charlotte Observer*, January 21, 1979.

50. Al Rayford, interview, February 1979.

51. Bob Drogin to authors, March 1979.

52. Robert Macomber, interviews, January 1979.

For several hours over the phone Macomber patiently went through the files, omitting only claimant names, identification numbers, and addresses to protect confidentiality. Macomber estimated that approximately fifty such Hiroshima and Nagasaki residual radiation claims had been filed with the VA nationwide, with about twenty of those still at regional VA offices and not yet forwarded to headquarters for appeal. All those claims, he said, had been turned down.[53]

James (Jack) McDaniel volunteered for the Marine Corps when World War II broke out—then a tall athletic young man barely in his twenties. A few years later he was among about two hundred Marines quartered in a bombed-out waterfront hotel near the Nagasaki blast center. (As far as they could tell when they met thirty-three and a half years later, for a few days Sheridan Clapp had been in the same semidemolished hotel on the waterfront.) Like the rest of the U.S. troops assigned to cleanup there, he did not receive any precautionary instructions, radiation monitors, or protective gear.[54]

When discharge came in southern California, just about the only thing on McDaniel's mind was getting back to his wife a thousand miles north. He found employment as a diesel mechanic in the woods of the Pacific Northwest, remaining on the Weyerhaeuser Corporation job for more than twenty years in southwestern Washington. He enjoyed much about his life, working in lush forests and appreciating wonders of nature in the countryside around his home near the small town of Toutle.

But as time passed, McDaniel's health deteriorated drastically. In 1975 doctors diagnosed Waldenstrom's macroglobulinemia, an extremely rare cancer of bone marrow involving overproduction of blood protein.[55]

"I don't know if I'll be able to work the next four years to retirement. I'm going downhill fast," McDaniel said in early 1979. He spoke wistfully of the past—"I had the consistency of a horse, I was strong"—and of the government he had trusted for so long: "They don't want to admit they were wrong to send us in there without any warning, without any preparation, without any protection."[56]

McDaniel had recently applied, unsuccessfully, for Veterans Administration benefits based on his stint in Nagasaki;[57] the main concerns he expressed had to do with the future financial security of his wife. In the opinion of McDaniel's hematologist, Dr. Richard B. Dobrow of Vancouver, "the question of [VA] compensation will probably be answered politically, not medically."[58]

Despite intense pain accompanying his chemotherapy, McDaniel traveled to Washington, D.C. to speak at a press conference in June 1979. At the Commodore Hotel, near the Capitol, in the morning he met other press conference participants. Among them were two people who understood, as few Americans could, what he was going through: Virginia Ralph, whose ex-Marine husband, Harold Joseph Ralph, had died in 1978 from multiple myeloma, a brutal form of bone-marrow cancer;[59] and Harry A. Coppola, a former Marine also suffering from multiple myeloma. Coppola, McDaniel, and Mrs. Ralph's husband had all been in the core bombed area of Nagasaki in late September 1945.

Seated in the hotel lobby, McDaniel reached into a manila envelope and pulled out photos he had kept of Nagasaki's devastation, taken where he was billeted; Virginia Ralph pulled out her husband's photos of the Nagasaki rubble where he had been stationed. They were virtually identical pictures, taken from what looked like the same spot.[60]

Virginia Ralph, who had lost her husband in a protracted and terribly devastating death, sat next to Harry Coppola, who had the same disease's terminal agonies to look forward to in the near future. Alongside them, Jack McDaniel was losing ground to a deadly cancer of the same family of blood cells in his marrow. Atomic legacies were emerging in people's very bones.

---

53. Ibid.

54. James McDaniel, interviews, March 1979.

55. Richard B. Dobrow, M D., to VA regional office in Seattle, February 22, 1979.

56. McDaniel interviews.

57. McDaniel's claim file, 75-1022, obtained from VA Seattle office.

58. Dr. Dobrow, interview, April 1979.

59. Death certificate of Harold Joseph Ralph, state of Illinois, August 18, 1978.

60. Authors were present at June 8, 1979, meeting at Commodore Hotel.

Mrs. Ralph was accompanied by her twenty-one-year-old son Mike. Sorrows of losing a husband and father, in such a terribly painful way, were still fresh after nearly a year since Harold Joseph Ralph's death. For Virginia Ralph, a farm wife forced into the workaday world of secretarial chores in Streator, Illinois, to provide for her children, the runaround from federal agencies was infuriating. Along with the government's blanket policy of turning down all claims for U.S. veterans of Hiroshima and Nagasaki cleanup, she found it particularly galling that their own government never bothered to do any systematic study on the health of those veterans—and would not even admit that such a study was appropriate. "Actually, no one cared," Mrs. Ralph charged. "And now, the U.S. Government is stonewalling." She reflected on her husband's inexorable, anguishing drift toward death at age fifty-four: "The last two years are better forgotten. The last ten days of his life were a nightmare for all of us. I would do anything in my power to spare another family what we have experienced."[61]

She and her son, Mrs. Ralph later recalled, "were saddened by the news that two more veterans had been found who are also suffering from bone-marrow cancer, but we were so happy to meet these two grand fellows, Jack McDaniel and Harry Coppola. Knowing very well how this illness affected my husband's strength and how this illness plays tricks on human beings, I was amazed at their bravery. I was so thankful to have them with us."[62]

Slowly the group walked across the mall area on the west side of the Capitol dome, to the Rayburn House Office Building. Cosponsored by *The Progressive* magazine and Colorado Congresswoman Patricia Schroeder (D), the press conference took place in the ornate grandeur of the House of Representatives Armed Services Committee room. "Far be it from me to bad-mouth my country, or the military. I still love it like I did when I joined the Marines," said McDaniel. "I can't understand in my hillbilly mind why I get a flat no. I want to know why we receive no assistance from our Government. Why no help?"[63]

Virginia Ralph found that her journey to Washington for the press conference in early June 1979 rekindled a flame of optimism. "For two-and-a-half years previous to the Washington trip," she remarked later that summer, "replies from our U.S. Government and the VA to all of my correspondence left me with the feeling of someone who has had his hands tied behind his back with his face pushed up against a brick wall. The trip to Washington offered hope! My hands are unleashed and the wall is beginning to crumble. In view of all we know, the U.S. Government cannot shun its responsibilities much longer."[64]

But the reconciliation Virginia Ralph hoped for was not to be.

Until the summer of 1979 federal agencies had never faced any widespread publicity raised about the U.S. veterans who went into the postbomb wreckage of Hiroshima and Nagasaki. The Washington press conference gave unprecedented visibility to the issue, and some federal officials began to devote more time and resources toward responding.

In late July 1979 at the Pentagon the Associated Press interviewed Defense Nuclear Agency Lieutenant Colonel Bax Mowery, and reported that the agency "has been trying to identify the estimated 250,000 servicemen exposed to radiation in the A-bomb tests and the two bomb blasts in Japan."[65] It was the first published report that the U.S. Government was expressing any interest in learning more about the American soldiers of Hiroshima and Nagasaki cleanup.

But such statements were not to be confused with a substantial change in practices and attitudes. "These guys are getting old enough so that they're just getting sick from being on the good old earth," a November 1979 issue of *Newsweek* quoted a Defense Nuclear Agency officer as saying about U.S. veterans of Hiroshima-Nagasaki cleanup. "Somebody has convinced them to blame it on radiation."[66] At the Veterans Administration and White House, officials responded to questions from journalists with the refrain that there was no reason to be concerned.

The intensifying media coverage included editorials in a number of newspapers criticizing government handling of the issue. The San Jose *Mercury* editors lamented the lack of forthright federal action;[67] the *St Louis Post-*

---

61. Virginia Ralph, interviews, March-July 1979.

62. Virginia Ralph, *Newsletter*, Committee for U.S. Veterans of Hiroshima and Nagasaki, summer 1979, p. 3

63. *Denver Post*, United Press International, June 9, 1979.

64. Ralph, *Newsletter*, Committee, p. 3.

65. *Los Angeles Times*, Associated Press, August 1, 1979.

66. *Newsweek*, November 26, 1979.

67. *Mercury* (San Jose), September 26, 1979 and May 6, 1980.

Dispatch went further—running a series of editorials lambasting the government's conduct with increasing venom: "Either the Veterans Administration has difficulty understanding statistics or it is engaging in some callous stonewalling on the deaths and disabilities suffered by servicemen who were sent into Nagasaki and Hiroshima for cleanup operations. . . . Rather than admit it was wrong, and possibly heighten public doubts about its nuclear policies, the Government has chosen to dodge responsibility and ignore the suffering."[68]

Under the headline "Old or Dead Before Their Time," the *Seattle Post-Intelligencer* editorialized that "grim new evidence comes to us no thanks to the U.S. Government, which, for a third of a century, has swept aside, ignored and apparently suppressed information on the long-lasting effects of radiation exposure. . . . One would have thought that the Government would have kept records on the health of these veterans. Such has not been the case. For the past 33 years, the Government has asserted that radiation levels at Hiroshima and Nagasaki were safe during the cleanup. This seems a shabby artifice."

Concluded the *Post-Intelligencer* editorial: "We believe the Government now must take responsibility for the risks of the Nagasaki and Hiroshima cleanup. The disability assistance that these veterans could gain in the few years remaining to them is a small enough amount to pay for three decades of misery and denial."[69]

On Capitol Hill, few members of Congress were willing to step forward. When Junior Hodge, for instance, sought help from his representative, Al Gore, Jr., the ex-Marine veteran of Nagasaki bulldozer assignments got no help as he lay ailing in eastern Tennessee. An aide to Congressman Gore noted that the Tennessee Valley Authority's nuclear power plants carry enormous political clout back home. "I know nuclear weapons fallout isn't exactly the same thing," the aide told us, "but it's close enough to nuclear power that we'd rather stay away from it publicly."[70]

A few members of the U.S. House of Representatives did speak out. Among them the earliest was Patricia Schroeder. In addition to appearing alongside Nagasaki cleanup veterans at press conferences, Representative Schroeder fired off a strong letter to Veterans Administration director Max Cleland on August 9, 1979.

Terming the VA's treatment of veterans who had cleaned up after the wartime atomic bombings "unconscionable," Schroeder's message to the VA top administrator was blunt: "I am shocked and appalled by your lack of responsiveness to these servicemen who, without adequate precautions or protections, unknowingly subjected themselves to high levels of radiation and are now paying the fatal price." Schroeder went on to suggest that the VA "initiate a comprehensive study" probing the health of U.S. veterans of Hiroshima-Nagasaki cleanup, along with "testing and medical examination of all surviving servicemen, who officially or unofficially, were present at the blast sites within one year after the bombing."[71]

"Now that the latency period for these bone and blood cancers and diseases has expired, we can no longer excuse the Government's gross miscalculation which has resulted in these disorders," she added. "We cannot rectify the damage that has been done. We can, however, admit our mistakes and try to make these terrible afflictions which Marines have come to bear slightly less painful."[72]

VA director Max Cleland responded to Representative Schroeder two and a half months later, in a letter dated October 29, 1979. "At the outset," Cleland replied, "I should like to assure you that there is no effort whatsoever on the part of the Veterans Administration or, so far as I am aware, on the part of any other government agency to obfuscate or withhold the truth about any untoward biological effects of exposure to nuclear radiation."[73]

In Nagasaki, he contended, "one hour after the bomb burst, the radiation present from the fallout was about 10 rads . . . By way of comparison, an x-ray examination of one's gastrointestinal tract can deliver 5 to 30 rads, depending upon the circumstances of the examination. The 10 rads appearing one hour after the burst very rapidly decreased to a fractional amount . . . Radiation levels at Hiroshima declined at a similar rate."[74]

The facile comparison to external penetrating X rays did not take into account an atom bomb's fission products,

---

68. *St. Louis Post-Dispatch*, December 1, 1979.

69. *Seattle Post-Intelligencer*, June 17, 1979.

70. Aide to Congressman Al Gore, Jr., interview, September 1979.

71. Patricia Schroeder to Max Cleland, August 9, 1979.

72. Ibid.

73. Cleland to Schroeder, October 29, 1979.

74. Ibid.

some of which inevitably give off alpha and beta radiation for years or centuries after a nuclear explosion. Even a tiny particle—lodging in lungs, bones, muscles, or other vulnerable human tissue after being inhaled or swallowed—would continue to irradiate from inside the body, with potentially deadly consequences.

Cleland continued: "The Department of Defense advises that a combined United States and Japanese team made a complete survey of the fallout radiation levels at both Hiroshima and Nagasaki from October 3 to 7, 1945, about two months after the bombings. Radiation levels were measuring up to 0.015 milliroentgen per hour from Hiroshima and 1 milliroentgen per hour for Nagasaki."[75]

It all boiled down to no reason for alarm, Cleland insisted. "I again stress that we at the VA have no desire to 'cover-up' or otherwise prejudice the good-faith claims of our veterans. We are dealing, however, with a matter of ongoing scientific inquiry, and the medical knowledge presently available simply does not support a conclusion that malignancies or other diseases which have afflicted or are afflicting veterans are causally related to their proximity to Hiroshima or Nagasaki after the nuclear explosions. Your interest in veterans' benefits is appreciated, and I hope I have allayed your concern that we at the VA are in any way reluctant to address this complex and controversial issue."[76]

A few months after expressing optimism that the government would change its tune at last, Virginia Ralph sounded sadder but wiser. "It's a great cover-up," she said. "They're afraid to admit anything, because then people who are living near nuclear reactors would worry that 30 years from now the same thing will happen."[77]

The Ordeal of Harry Coppola

While certain government agencies were digging in for a protracted struggle, so were some of the victims. A group called the Committee for U.S. Veterans of Hiroshima and Nagasaki formed to take up the fight. Its membership included several hundred veterans and relatives who believed their families' lives had been forever harmed by cleanup participation in the two Japanese cities. One of the first activities of the new organization came in August 1979, when Virginia Ralph and Harry Coppola traveled to Japan on its behalf.

For Coppola—in the throes of an increasingly painful terminal disease—the journey to Nagasaki was his first visit to that city in nearly thirty-four years. Until recently there seemed to be no particular reason to return. A Bostonian of Italian descent, a patriotic Marine with official discharge papers listing combat in battles at Iwo Jima and Bougainville, a bakery worker and then a union house painter who saved a little money and moved to Florida—for three decades Harry Coppola almost forgot having been sent into Nagasaki's atomic blast center area in September 1945.

But in 1978 Coppola learned that he was dying of a cancer in his marrow—multiple myeloma—the cause of unexplained pain and frailty of his bones that had plagued him since 1974.[78] He did not have long to live, according to Dr. James N. Harris, a West Palm Beach specialist. Broward County medical examiner Dr. Abdullah Fatteh, based in Fort Lauderdale, reviewed Coppola's records and concluded it was "probable that Mr. Coppola's condition of multiple myeloma is causally related to the atomic bomb radiation exposure in 1945."[79]

Coppola filed a Veterans Administration claim for service-connected benefits for himself, his three sons, and his widow-to-be, based on a connection between the Nagasaki duties and his terminal illness. As in all such cases the VA's answer was an unequivocal *no*.

Later, after his predicament received national publicity, Defense Nuclear Agency officers tried to undercut congressional concern by telling people at Michigan Congressman Robert W. Davis's (R) office that Harry Coppola had not been in Nagasaki in 1945.[80] But Coppola's Marine Corps discharge papers list his military service as including "Occupation of Japan—September 22, 1945, to October 6, 1945."[81] And an affidavit by Masuko Takaki, who was a young girl living in Nagasaki in the fall of 1945, recollects Coppola's presence as a patrol in the central

---

75. Ibid.

76. Ibid.

77. *Newsweek*, November 26, 1979.

78. Diagnosis summary by James N. Harris, M.D., August 16, 1978.

79. Abdullah Fatteh, M.D., Ph.D., Office of District Medical Examiner, Fort Lauderdale, to John F. Romano, Esq., West Palm Beach, June 17, 1979.

80. Aides to Congressman Robert Davis, interviews, June 1980.

81. Discharge statement for Harry A. Coppola, signed by commanding officer E. W. Autry, Captain, U.S.M.C.R.

A-bombed zone of the city at that time. "I remember specifically," the affidavit declares, "because my father invited him to our home several times for dinner, and I remember he gave my father American cigarettes. I also recognized his pictures in Japan's newspapers during his visit August 6, 1979, and made an effort to have a reunion with him."[82]

Coppola was part of a squad of a dozen crack machine-gunner Marine MPs arriving in Nagasaki shortly before the larger detachment of Marines and Seabees. He would never forget becoming "nauseous as hell" two weeks after getting to Nagasaki; he and another Marine with the same symptoms in the MP squad were quickly removed from the city and put on a Navy ship bound for the States. After a voyage during which he lost large amounts of hair, Coppola was discharged two days after arriving at Oceanside, California.[83] "They rushed us right through," Coppola remembered. "Other guys there were waiting for weeks to get discharged—they asked me, 'Who do you know, a congressman?'" Coppola's impression was that "they wanted to get rid of me fast."[84]

It was to prove far more arduous to return to Japan in 1979 than it had been to arrive the first time.

"I'm going to Japan because the truth must be told," Coppola said in a written statement. "I've already gone to Washington, D.C., and the Veterans Administration doesn't want to help me. I'm feeling very bitter that my own government, that i fought for proudly, refuses to admit that the Nagasaki bomb is killing me. After what I've learned, what I've been going through, I'm against all this nuclear crap."[85]

A few days later, with Coppola beginning to tour Japan, the Associated Press reported his intention to "seek financial aid in Japan to pay his medical costs." AP quoted Coppola as saying: "I know it's a lousy thing to do—to ask the country where we dropped the bomb, but the United States has turned a deaf ear." Owing to expenses of his bone-marrow cancer, Coppola said, "I've blown my life savings, about $29,000, and I'm still in debt."[86]

Ostensibly a beneficiary of the nuclear bombings, at the age of fifty-nine Coppola had become living—and dying—symbolic evidence refuting the illusion that the effects of an atomic weapon can be confined to its intended victims.

"I really didn't know how they were going to accept me. I knew we were going to go on a speaking tour and all that, but the rest of it I couldn't anticipate. I didn't know what the hell to expect."[87] Emotion ran high, as the Japanese hosts and American visitors saw in each other common anguish. Coppola was besieged by scores of journalists; at times he was accompanied by Masuko Takaki, now a middle-aged woman who succeeded in her efforts to "have a reunion" with the former Marine she remembered from those dinner-table visits.

When Coppola reached Nagasaki for ceremonies on the thirty-fourth anniversary of the atomic bombing of that city, a huge amphitheater holding eighteen thousand people awaited his address. "When I got through with the speech, they gave me an applause until I left the arena. And every five or six feet I would give them a bow. And they all stood up. It was something; it was deafening, the roar that they gave me. Because I told them, in that speech, that Truman was livin' in hell, I told them that he shouldn't've dropped the bomb there. He didn't drop it on military targets, he dropped it right in the middle of two cities, with women and children."[88]

Sitting in the living room of his modest home outside of West Palm Beach, expecting his death would not be much longer in coming, memories of his second trip to Japan were bittersweet for Coppola. "They were very good to me. They offered me free medical service, they offered me everything there, live there free. But I figured what the hell, I don't want to die in Japan, I'd have to leave my family, go there, I'm not getting *cured* on it." His wife, Anna, leaned over the armchair and patted his shoulder. "Multiple myeloma means *many,* I'm loaded with it, they're not going to *cure* me. And I was told they could never really arrest it; they were trying to control it, but it'll never be arrested. But if I'm going to *die,* I says, I want to die *home*—I'm not going to die over there. That's the only reason

---

82. Affidavit by Masuko Takaki (1512-5 Waifu, Kikuchi City, Kumanoto-ken, Japan), September 1, 1979; available from Committee for U.S. Veterans of Hiroshima and Nagasaki.

83. The U.S.M.C. honorable discharge certificate for Coppola is dated November 9, 1945.

84. Harry A. Coppola, interviews, March 1979 to April 1980.

85. Press release by Coppola and Committee for U.S. Veterans of Hiroshima and Nagasaki, July 26, 1979. Working to get his passport in time to participate in ceremonies marking the thirty-fourth anniversaries of the atomic bombings, Coppola called his congressional representative, Daniel Mica. Coppola told us that Mica advised him to be careful not to say anything against the U.S. Government while abroad; to do so, Coppola recounted Mica's telling him, might be considered a violation of federal statutes.

86. *Los Angeles Times,* Associated Press, August 1, 1979.

87. Coppola, interview, March 1980.

88. Ibid

why I didn't take 'em up on it. But they can't understand why the United States Government won't help me on this."[89]

Travel became still more difficult for Coppola, subject to frequent, torturous attacks. "Sometimes I feel like I'm in hell," he said, describing the pain searing his bones that all too often left him feeling "like someone cut your leg off." People told him they found it hard to believe, from looking at him, that he was so close to death. "An apple can look shiny, beautiful on the outside. But inside, it's rotten."[90]

Despite the increasing agony Coppola was eager to participate in activities planned for Washington, D.C., in late September.

Over the summer several dozen American veterans had signed a petition, addressed to President Jimmy Carter and Max Cleland, requesting fundamental changes in VA policies. "Some of the U.S. servicemen who were with us in Nagasaki cannot sign this petition, because they are dead—from premature heart attacks, blood disorders, bone marrow cancer or other ailments," the document said. "As time passed, it has become clear that our illnesses, and those of our buddies, were connected to the time we spent in the atomic blast center of Nagasaki in the fall of 1945, as we functioned under orders there."[91]

On Sunday, September 23, 1979—exactly thirty-four years after the Marine occupation troops entered Nagasaki's harbor—Harry Coppola, Virginia Ralph, and several other veterans and widows of Nagasaki cleanup walked through Lafayette Park to the northwest gate of the White House. Coppola, dressed in a suit and tie, and wearing a Veterans of Foreign Wars hat in the bright sunshine, handed a pile of signed petitions to William Lawson, executive director of the White House Federal Veterans Coordinating Committee.

The next morning, thirty-four years to the day after U.S. Marines and Seabees first awoke to begin their cleanup assignments in Japan, VA administrators and a White House aide sat down to discuss the aftermath of those duties with Nagasaki veterans and relatives from New York, North Carolina, Florida, Illinois, and California. There was appreciable tension in the national VA headquarters office suite. What followed were three hours of dialogue and often heated debate.

"We have very little choice but to accept the evidence given to us by the Defense Department as authoritative," John Wishniewski, deputy director of the VA Compensation and Pension Service, informed the delegation. "We have been assured by the Defense Department that the levels of exposure at Nagasaki and Hiroshima were very minimal."[92]

"I have got multiple myeloma, and you say to send new evidence in," Harry Coppola retorted. "Well, I have sent new evidence, medical evidence, by some of the biggest doctors in the country . . ."[93]

Coppola added that while the VA's director "is living high off the hog, big salary, I am looking for—I am ready to eat dog food! I am living on Social Security! And now I submitted that evidence, now you say 'Go back to your military records.' Well I have asked for my military records, and half the stuff isn't in there. I went to a Japanese [language] school in Guadalcanal to learn how to speak Japanese, it is not in my record. I got wounded with shrapnel in the back on Bougainville, it is not in my record. I got wounded in the leg at Iwo Jima—it is not in my record. I am not even on the record that I was patrolling in Nagasaki! What records are you talking about? I applied for disability on this, got a form letter that says 'It is not in your military records.' But I have cancer . . . "[94]

For Margaret E. Powers, widow of a Nagasaki cleanup veteran, the trip to Washington from her home in Castleton-on-Hudson, New York, was propelled by the same kind of long-standing frustrations. Her husband, ex-Marine William S. Powers, had died at the age of forty-eight, from gastrointestinal bleeding due to cancer, in 1965. Soft-spoken, her pent-up bitterness spilled out after a VA administrator offered assurances that the agency was interested in learning all it could about such veterans.

"Do they know the names of these Marines?" Mrs. Powers asked, turning to other visitors in the VA suite. "They

---

89. Ibid.

90. Coppola, interview, September 1979.

91. Petition presented to White House on September 23, 1979, and to VA national headquarters September 24, 1979; available from Committee for U.S. Veterans of Hiroshima and Nagasaki.

92. Transcription of tape-recorded meeting, September 24, 1979.

93. Ibid.

94. Ibid.

never kept track of who was in there or for how long, the VA, did they? I mean, how do they know where to locate these men? Maybe they don't even know that this is going on . . . I only found this out myself, and I have been a widow for fourteen years, and my husband was in there on the day that they went, September 23, and he was there [in Nagasaki] for three months before they sent him to Sasebo, and they were cleaning up the area with bulldozers and whatnot, and still discovering bodies under the rubble, and getting sick just from the smell of the place. Now they weren't too concerned about it then, about sending these boys in there."[95]

Virginia Ralph added that the VA was refusing to accept responsibility for disabilities that cropped up decades after military service ended. "If a man is shot in the leg, or shot in the head, or loses an arm in service, immediately he is taken care of, because there is visual evidence. But when a man is exposed to radiation which is a silent invader, there is no way to detect that he has radiation illness. He may be lethargic; my husband had dizzy spells, the doctor said, 'It is something you must learn to live with.'

"But when his rib cage deteriorated, when the bones fell apart, when he was in his final stages, that is when the doctors at the VA hospital, every doctor that came in to take his history, the first question was, 'Have you ever worked in radiation?'" Ralph, a farmer, never had—except in Nagasaki. "It sounded to me as though the VA thought that my husband's illness struck overnight. This is false. I don't think it is handled individually, because I have seen several denial letters, and they have the same paragraph: 'Your husband received insignificant radiation.' 'Your husband received slight radiation.' In the case of plutonium, what is insignificant radiation? . . . What is slight radiation?"[96]

Back home in Florida, Coppola spoke with a steady stream of interviewers. "I can accept dying, we're not here for good," he told a *Tampa Tribune* reporter. "But I cannot accept the Government giving me a screwing."[97]

As 1979 drew to a close, the bone-marrow cancer grew still more excruciating. In anguish over her husband's worsening condition, Anna Coppola confided: "I don't know how a person can stand so much pain."[98]

Shortly before Christmas *The Miami Herald* quoted Coppola in a front-page article: "Does the Government want me dead? They hope I die tomorrow. Then my case is closed, and they've gotten rid of one royal pain."[99] The same month, Howard Rosenberg, a staff associate of columnist Jack Anderson, called the Defense Department for reaction to the national publicity often spearheaded by Coppola's flamboyant accusations and unswerving persistence. Chatting with an officer at the Defense Nuclear Agency, Rosenberg asked whether the publicized charges were angering the nuclear military brass. Replied the Pentagon official: "We don't get mad, we get even."[100]

In the spring of 1980 Coppola's appeal to the Veterans Administration was denied. The VA justified its decision by declaring that "service medical records do not reveal treatment for any condition which could be considered a result of radiation exposure and do not show any evidence of any early manifestation of multiple myeloma. The condition is not shown to have become manifest to a degree of at least 10 percent within one year of the veteran's release from active military service."[101]

As the *Palm Beach Post* noted in an editorial, "Coppola was outraged by this rationale, and rightly so."[102] The lag time between radiation exposure and multiple myeloma is known to run a quarter of a century or longer. Coppola responded, "I'm a very bitter man against the government. When my country needed me in Guadalcanal I was there. On Bougainville I was there. On Guam I was there. I was there in Iwo Jima; I gave machine-gun coverage while they put the flag up on Mount Suribachi."[103]

Out of his original Marine battalion of one thousand men, he recalled, only a dozen or so had survived the war. He had felt blessed to be among them. But American-made radioactivity seemed about to succeed where Japanese

---

95. Ibid.

96. Ibid.

97. *Tampa Tribune,* November 28, 1979.

98. Anna Coppola, interview, December 1979.

99. *Miami Herald,* December 7, 1979.

100. Howard Rosenberg, interview, February 1980.

101. "Statement of the Case—In the Appeal of Harry A. Coppola," VA regional office, St. Petersburg, March 28, 1980.

102. *Palm Beach* (Fla.) *Post,* April 21, 1980.

103. Coppola, interview, April 1980.

troops had failed—and the Veterans Administration's refusals felt like salt in the festering radiation wounds.

Meanwhile, protests came from other quarters. Delegates to the 1979 national convention of the International Woodworkers of America approved a resolution observing that "the U.S. Government has failed to take responsibility for aiding veterans and their families—suffering from severe illnesses and financial hardships as a result of exposure to residual radiation from the atomic bombing of Hiroshima and Nagasaki." The labor union's resolution proclaimed that "we support the rights of these veterans and their widows to receive compensation from the Veterans Administration for service-connected disability."[104] A few months later the White House received a petition signed by dozens of prominent Japanese scientists and civic leaders, urging aid for Coppola and other U.S. veterans who had been sent into Hiroshima and Nagasaki in autumn 1945.[105]

During the spring of 1980 Harry Coppola was in hospitals much of the time. "In the last week I almost died two times, and I know time is running short," he said, speaking into a tape recorder, his voice still strong though audibly short of breath. "No human should suffer the pains of hell like we're suffering."[106]

By the time Harry Coppola died from multiple myeloma bone-marrow cancer on June 16, 1980—three months short of his sixtieth birthday—he was one of five ex-Marines whose multiple myeloma had been publicly linked to their presence in the core atomic blast area of Nagasaki in late September 1945.

A Toll in Blood

Alvin N. Lasky, a St. Louis business executive, was "doing mostly cleanup and guard duty" in Weapons Company, 6th Marine Regiment, 2nd Marine Division—"billeted on the industrial site of the harbor" immediately next to the core blast site in Nagasaki.[107] Lasky was diagnosed with multiple myeloma in 1974, and was unusually successful in continuing to live with the usually terminal illness.[108]

Richard W. Bonebrake, a member of B Company, 1st Battalion, 2nd Regiment, 2nd Marine Division, was ordered to patrol in the center of Nagasaki's nuclear-blasted area. In October 1977, living in Williamsport, Indiana, where he worked as a bank clerk, Bonebrake learned he had multiple myeloma, and began the long struggle with chemotherapy.[109]

George Proctor, also a 2nd Division Marine sent into Nagasaki's central area for cleanup, was forced to quit his job as a construction worker, suffering through several years of multiple myeloma before dying from the disease in October 1979. His widow, Agnes Proctor, living in Elwell, Michigan, recalled her husband's accounts of experiencing severe nausea and aching joints even while still in Japan during the occupation.[110] His claims to the VA for compensation were rejected.

Multiple myeloma was not confined to the five former Marines we located. Anthony Thomas Sirani, an Army radio operator attached to the 2nd Marine Division, arrived at Nagasaki's central zone on September 23.[111] At age fifty-five, in December 1979, Sirani died from multiple myeloma at Nassau Hospital in New York.[112] The disease also emerged among U.S. naval personnel accompanying the Marines assigned to begin occupation cleanup duties in Nagasaki, and among Army veterans engaged in similar cleanup tasks in Hiroshima starting the second week of October 1945.

"How much longer can the Government ignore such statistics as 10 times the national average for such a rare disease?" demanded Congressman Robert Davis. A constituent of Davis's—Napoleon Micheau of Escanaba, Michigan—contracted multiple myeloma three decades after Army cleanup chores in Hiroshima.[113] His plight prompted Davis to issue a statement, in spring 1980, decrying "the tragedy of the Defense Department's refusal to

---

104. International Woodworkers of America, 1979 Resolution No. 6; available from IWA national headquarters, Portland, Oregon.

105. Petition to White House by Japanese scientists; available from Committee for U.S. Veterans of Hiroshima and Nagasaki.

106. Coppola to authors, tape-recorded message, April 1980.

107. Alvin Lasky to authors, August 20, 1979.

108. Diagnosis summary by Virgil Loeb, Jr., M.D., St. Louis, January 8, 1979.

109. Richard Bonebrake, interview, May 1980; also, *Chicago Sunday Sun-Times*, May 25, 1980.

110. Agnes Proctor, interview, May 1980; also, *Chicago Sunday Sun-Times*, May 25, 1980.

111. Marie Sirani (widow of A. T. Sirani) to Virginia Ralph, February 6, 1981.

112. Death certificate of Anthony Thomas Sirani, New York State Department of Health, December 22, 1979.

113. Diagnosis summary by Robert E. Ryde, M.D., Escanaba, Michigan, July 24, 1979. Ilene and Napoleon Micheau to authors, June 28, 1979.

cooperate in locating the military personnel involved in the cleanup operations in Hiroshima and Nagasak."[114]

The Department of Defense, however, was doing no more than stonewalling. In a letter sent to Illinois Representative Thomas Corcoran (R) on March 18, 1980, Defense Nuclear Agency director Vice Admiral R. R. Monroe contended that "medical science has, to date, identified only a 'borderline' relationship between exposure to radiation and the onset of multiple myeloma."[115]

Later, in a report dated August 6, 1980, DNA officials replayed the same theme: "Medical science believes multiple myeloma has a borderline relationship with exposure to ionizing radiation. That is, there are some indications that exposure to radiation may increase the risk of this disease, but science cannot yet be sure."[116]

Amid recent research scrupulously ignored by the Pentagon was a survey by the Government Accounting Office. Coordinated by Boston blood specialist Dr. Thomas Najarian and made public May 31, 1979, it indicated that veterans who were exposed to atomic bomb testing may have become far more susceptible to multiple myeloma as a result.[117] In releasing the survey results, Dr. Najarian noted that the disease has an incubation period of twenty-five to thirty years[118]—a time span precisely corresponding to the experiences of Nagasaki cleanup Marines Coppola, Ralph, Lasky, Bonebrake, and Proctor.

Meanwhile the Hiroshima-based Radiation Effects Research Foundation was reporting that Japanese survivors of the atomic bombings faced a risk of multiple myeloma 4.7 times higher than normal. It had taken at least twenty years for the excessive multiple myelomas to emerge.[119]

And, in 1981, the *New England Journal of Medicine* published a study linking radiation to increased risk of multiple myeloma. University of Oxford researcher Jack Cuzick pinpointed "a clear excess of myeloma among persons exposed to radiation." The British scientist had compiled information available from two decades of research around the world.[120]

In addition to multiple myeloma many other rare bone-marrow diseases plagued the Nagasaki veterans. When doctors found that former Marine Lyle Wohlfeil's bone marrow was being destroyed by myelofibrosis, "they kept asking him if he was ever connected with radiation," recalled his widow, Marilyn Morris, who settled in LaGrange, Illinois, after remarrying. Wohlfeil had been in the autumn 1945 Nagasaki cleanup, and went on to become a realtor. He succumbed to myelofibrosis, a severe scarring of the bone marrow, in 1968; he was fifty-four. Having heard VA officials discount the possibility that Nagasaki's residual radiation could have been harmful, neither Wohlfeil nor his widow filed with the VA for service-connected benefits.[121]

VA national headquarters records show that a claim was filed in March 1968 on behalf of another veteran who died from myelofibrosis—and who had arrived at the Nagasaki atomic blast center on September 23, 1945, serving there five weeks. Nagasaki-based VA claims also document deaths from such radiation-connected illnesses as Hodgkin's disease, granulocytic leukemia, and oat-cell carcinoma of the lung.[122]

In late 1979 Congresswoman Patricia Schroeder acquired photocopied summaries of sixty-four Veterans Administration claims filed by veterans and widows contending residual radiation had caused severe illnesses among the veterans of Nagasaki and Hiroshima cleanup. We obtained copies of the documents, which made staggering reading. There were a dozen cases of leukemia, plus various forms of organ cancers and several instances each of blood-related diseases like myelofibrosis, Hodgkin's disease, and bone-marrow cancer. A number of claimants mentioned chronic bizarre skin afflictions. All the claims had been submitted before any national publicity on U.S.

---

114. Press release, Committee for U.S. Veterans of Hiroshima and Nagasaki, May 18, 1980.

115. R. R. Monroe to Congressman Thomas Corcoran, March 18, 1980.

116. *Hiroshima and Nagasaki Occupation Forces*.

117. *The Oregonian*, Associated Press, June 1, 1979. See also, letter by Thomas Najarian, M.D., and Benjamin Castleman, M D., *New England Journal of Medicine*, May 31, 1979, p. 1278.

118. Ibid.

119. M. Ichimaru, et al., *Multiple Myeloma Among Atomic Bomb Survivors, Hiroshima and Nagasaki, 1950-1976,* Technical Report No 9-79 (Hiroshima: Radiation Effects Research Foundation, 1979).

120. Jack Cuzick, Ph.D., "Radiation-Induced Myelomatosis," *New England Journal of Medicine,* January 22, 1981, pp. 204-210.

121. Marilyn Morris, interview, March 1979.

122. Robert Macomber, interviews, January and February 1979. Regarding radiation and lung cancer tissue, see Archer et al., "Frequency of Different Histological Types of Bronchogenic Carcinoma as Related to Radiation," *Cancer,* Vol. 34, no. 6, 1974, pp. 2056-2060.

veterans of Hiroshima-Nagasaki cleanup. Quietly the VA had been systematically rejecting all of them.[123]

There were good reasons to believe that the sixty-four claims acknowledged by VA headquarters represented a tip of the iceberg of claims filed by Hiroshima and Nagasaki cleanup veterans. The two dozen that VA rating-policy staff chief Robert C. Macomber described to us in January 1979 included a number that never turned up in the stack of claims that VA administrator Max Cleland later provided to Representative Schroeder. And some of the claims submitted in the late 1970s were not included in that stack of documents sent along to the congressional office.

Chicago Sun-Times journalist Claudia Ricci reported in December 1979 that "of 13 veterans of Nagasaki and Hiroshima whose cases have surfaced here, 10 have died, nine of them from cancer."[124] A Chicago widow, Margaret Ryan, recounted a discussion with physicians who discovered her husband, James—a Navy veteran who had been in Nagasaki after the atomic bombing—was suffering from myeloblastic leukemia: "At the time, the doctors asked if he was ever in Japan. We were in shock. 'Yeah, I was there,' he said. 'Well, you have the same kind of leukemia the Japanese had.'"[125] Ryan's application for VA benefits was rejected in the spring of 1977, a year before his death.

William Shufflebarger was twenty-two years old while a Marine stationed in Nagasaki at the end of September 1945—"just a few blocks from the devastated area of the city," as he described the location. Living in Oak Lawn, Illinois, thirty-five years later he was battling Hodgkin's disease, and cancer of the lymph nodes.[126]

Severe breathing problems have been frequently cited by America's veterans of assignments to clean up after atomic warfare. Sam Scione, of Warwick, Rhode Island, a Marine veteran of Nagasaki cleanup, was the subject of an article published in the Disabled American Veterans' magazine in March 1980. As a result of the article Scione heard from 180 veterans involved in the occupation of Hiroshima or Nagasaki; nearly half—eighty-three—reported severe respiratory maladies.[127]

A Continuing Dispute

For the most part federal officials responded to the emerging controversy as they always had—by denying the danger of the radiation exposure. A December 1979 White House letter to veterans and widows maintained that maximum doses "received by any U.S. serviceman in either city, in an absolute *worst case*, is less than one rem. The estimate assumes the man arrived with the first unit in September 1945, remained until the last unit left in July 1946, and worked eight hours a day, seven days a week, for nine and a half months, in the highest-intensity portion of the very small fallout field (a few hundred meters in diameter). Since, in the actual situation, no one approximated this worst-case pattern, DNA believes the maximum dose any individual received was markedly less than one rem." The letter added that this dose was far below that allowed for radiation workers, and lower than common medical X rays.[128]

By the middle of 1980 the Department of the Navy was sending out a new batch of letters designed to soothe veterans of Hiroshima or Nagasaki who had contacted a wide range of federal agencies with their concerns. "The Department of Defense and the U.S. Government continue to be deeply interested in the welfare of veterans and determined to insure that issues such as these are fully investigated, with wide dissemination of the results," Navy Captain J. R. Buckley wrote. Furthermore, Captain Buckley informed veterans receiving his letter, "It is reassuring to note that the likelihood of exposure to any radiation was quite low, that there was no possibility of any occupation force member having received a significant dose, and there is no cause whatsoever for concern over an increased risk of adverse health effects."[129]

The Defense Nuclear Agency prepared a lengthy "fact sheet" titled *Hiroshima and Nagasaki Occupation Forces,* releasing it to the media on August 11, 1980. The thirty-page Pentagon report did not stray from any previous

---

123. VA claim files obtained from Schroeder's office, November 1979.

124. *Chicago Sunday Sun-Times,* December 23, 1979.

125. Ibid.

126. William Shufflebarger to authors, April 30, 1979.

127. Log of informational phone calls and correspondence compiled by Dora and Sam Scione.

128. Ellen Goldstein to Committee for U.S. Veterans of Hiroshima and Nagasaki, December 18, 1979.

129. Captain J. R. Buckley, USN, to Maurice E. Wilson, Portland, Oregon, October 22, 1980.

positions. "The maximum radiation dose any member of the U.S. occupation forces in Japan could have received—considering his external dose, his inhaled dose, and his ingested dose—was less than one rem. . . . the health risk from a dose such as this is negligible—so small statistically that it cannot be expressed in meaningful terms."[130]

The hot-off-the-press Defense Department document clearly impressed the Associated Press reporter on the Pentagon beat, Fred S. Hoffman, who promptly turned the DNA "Public Affairs Office" handout into article form[131] without seeking any contrary points of view.[132]

While conceding that "unquestionably there would have been occasions during the Nagasaki occupation on which patrols or other groups entered the areas of residual contamination to carry out specific missions,"[133] the Pentagon report stated that the troops closest to ground zero generally remained out of the blast center area.[134] Many Nagasaki cleanup veterans and widows found the depiction infuriating.

Virginia Ralph responded by pointing out that "no mention is made of the school building where Lyman Quigley was quartered, nor the bombed-out waterfront hotel where Jack McDaniel stayed nor the bombed-out warehouse where Joe [Ralph] was billeted."[135]

The Defense Department's description of the Marines as aloof from cleanup activities in the ground zero area did not jibe with remembrances of the ex-Marines themselves. Nor was it consistent with the results of a painstaking search of U.S. military archives, in 1979 and 1980, by a Hollywood-based independent documentary filmmaker, Trell W. Yocum.

Sifting through scene-by-scene descriptive logs accompanying thirty-two reels of footage lodged in the U.S. Marine Corps Histories Division, Yocum cross-referenced the information with interviews of ex-Marines who participated in the Nagasaki occupation. Yocum confirmed that a few companies of U.S. Marines totaling several hundred of the men who arrived in Nagasaki on September 23, 1945, were billeted in the immediate area of the atomic blast hypocenter—in direct contradiction to the claims made by the Defense Nuclear Agency thirty-five years afterward.[136]

The Pentagon's retrospective report, complete with tidy hand-drawn maps, portrayed the 2nd Marine Division occupation troops closest to the hypocenter as members of the 2nd and 6th Regiments billeting at Kamigo Barracks seventy-five hundred yards south of the hypocenter, and at Oura Barracks five thousand yards southwest of the hypocenter.[137]

But by matching up official maps, Marine Corps archival footage records, and independently conducted interviews, Yocum confirmed that at least three Marine companies from those regiments were actually billeted within a mile of the hypocenter. The partially destroyed schoolhouse occupied by Lyman Quigley and other Marines in the 2nd Pioneer Battalion's Company C "engineers" unit was approximately one thousand yards from the atomic blast's ground zero, according to Yocum's research for his film *The Other Victims of Hiroshima and Nagasaki.*[138] (In a scientific consultant's report distributed in 1981, DNA quietly acknowledged the 2nd Pioneer Battalion's constant involvement in hypocenter-zone cleanup, and noted the battalion was used "to rehabilitate two athletic fields in the 'bombed' area of the city.")[139]

Throughout, the well-publicized 1980 "fact sheet" from the Pentagon strove to assert that scientific research had found insignificant levels of residual radiation at Nagasaki and Hiroshima.[140] Thus, the official story went, troops were ordered into an area where no threat to health existed.

---

130. *Hiroshima and Nagasaki Occupation Forces,* pp. 25, 29-30.

131. *San Francisco Chronicle,* Associated Press, August 12, 1980.

132. Fred Hoffman, interview, August 1980.

133. *Hiroshima and Nagasaki Occupation Forces,* p. 22.

134. Ibid., p. 21.

135. Virginia Ralph, interview, August 1980.

136. Trell Yocum interviews and correspondence (7471 Melrose Ave., Hollywood, CA 90028), December 1979 to February 1981.

137. *Hiroshima and Nagasaki Occupation Forces,* pp. 16, 21.

138. Documents were obtained by Yocum from Motion Picture Film Video Tape Depository, Quantico, Virginia, aided by Support Branch, History and Museums Division.

139. *Radiation Dose Reconstruction,* p. 23.

140. *Hiroshima and Nagasaki Occupation Forces*, pp. 25, 29-30.

But four months before the DNA released its report, *The Washington Post* had unearthed a declassified survey[141] from the National Archives on residual radiation levels in Hiroshima and Nagasaki that had been completed in 1946. In an article published April 13, 1980, the *Post* stated, "The once-secret reports are bound to increase the controversy that has developed over whether U.S. troops sent to Nagasaki and Hiroshima in 1945 absorbed enough radiation to cause cancers that appeared after 20 years or more." The *Post* noted that two teams of U.S. Government researchers, surveying the outskirts of Nagasaki two months after the atomic bombing, found radiation "that was twice the level now considered safe for nuclear workers and over 10 times the radiation safety standard for the general population."[142]

Left unacknowledged were the lethal qualities of minute alpha particles capable of lodging in human bone marrow, lungs, and other organs. The Defense Nuclear Agency preferred to focus attention on gamma—external—radiation doses left in the wake of Hiroshima and Nagasaki nuclear attacks, while parenthetically claiming that plutonium and other forms of alpha-particle radiation were virtually nonexistent. It was not a bad assumption—if those veterans hadn't been breathing.

"The U.S. Defense Nuclear Agency estimate of the radiation dose received by these Marines is not accurate," concluded Dr. Ikuro Anzai, a Tokyo University professor and secretary general of the ten-thousand-member Japanese Scientists Association, who conducted a detailed study of the issue. Anzai was concerned with alpha-radioactivity intake: "Though, by my calculations, the external exposure would have been relatively small, the internal radiation dose received by the bone marrow of these men could have been exceedingly high. This was due to plutonium deposited in the water and soil of Nagasaki."[143]

Dramatic substantiation of that view came on October 10, 1980, at a medical symposium held in Tokyo. Not only was plutonium released at the time of the bombing; it is still there.

"Thirty-five years after the atomic bombing of Nagasaki, large amounts of deadly plutonium still lie buried under the city, a professor of medicine says," United Press International reported. "Professor Shunzo Okajima, a specialist in the effects of the atomic bombings in Japan, told a radiotherapeutics conference . . . that unusually large amounts of the radioactive substance were detected 3 kilometers (1.9 miles) east of the blast's center in the city's Nishiyama district."[144]

"Radioactivity levels in the Nishiyama district were far higher than I had expected," said Professor Okajima, who had just completed a study of radioactivity in Nagasaki's soil. "I don't expect immediate effects on human beings," he added.[145]

But, UPI recounted, Okajima "cautioned that extreme care must be taken with plutonium, which is believed to cause lung cancer. . . . The professor said he was alarmed because 76 percent of the plutonium was concentrated within 10 centimeters (4 inches) of the surface."[146]

All but two paragraphs of the nine-thousand-word Defense Nuclear Agency report issued August 6, 1980, skirted the specific health problems among United States veterans of Japan atomic bomb cleanup. As had been government policy before, the DNA report—dated precisely thirty-five years after the day in history when the atomic age was introduced to the world—still espoused the U.S. Government's theoretical conclusion that no appreciable health risks were involved.

The report's few sentences commenting on actual subsequent health ills among Nagasaki cleanup Marines illustrate how far down the road of misinformation the Pentagon had gone.

"One specific health risk deserves mention because it has received some recent publicity. This concerns a type of bone marrow cancer known as 'multiple myeloma.'" Conceding that "four veterans of the Nagasaki occupation have been diagnosed as having multiple myeloma," the report claimed, "This does not appear to represent an abnormal

---

141. Naval Medical Research Institute, *Measurement of the Residual Radiation Intensity at the Hiroshima and Nagasaki Atomic Bomb Sites,* NMRI-160A (Bethesda: National Naval Medical Center, 1946).

142. *Washington Post,* April 13, 1980.

143. Trell Yocum interviewed Dr. Ikuro Anzai in March 1980.

144. 144. United Press International, dateline Tokyo, October 10, 1980.

145. Ibid.

146. Ibid.

incidence of this disease. The following statistics from the National Cancer Institute are pertinent. If you start with 10,000 males age 25, in 1945 (which approximates the Nagasaki Marines); then today, in 1980, about *7.7* deaths from multiple myeloma should have already occurred, based on normal statistics." The report concluded, then, that "the four multiple myeloma cases that are known are less than the number that would have been expected for a normal, non-radiation-exposed group of this age and size."[147]

In those few sentences the Pentagon had thoroughly distorted the situation. Use of the ten thousand Marines figure was misleading in the extreme, grossly inflating the statistical "data base" against which the multiple myeloma cases would be compared. By the Defense Department's own account the vast majority of those ten thousand Marine occupation troops remained several miles from ground zero in Nagasaki. But the five—not four—cases of multiple myeloma were all among the approximately one thousand Marines billeted in the immediate central area, within a mile of the hypocenter in late September 1945. In effect the Pentagon's DNA report was multiplying the epidemiological data base ten-fold by including the Marines stationed at the 6th Regiment's Oura Barracks three miles to the southwest and the 2nd Regiment's Kamigo Barracks more than four miles to the south of the hypocenter.

With the correct data base of one thousand, according to medical incidence tables cited by all sources in the dispute, the occurrence of multiple myeloma among the five Marine veterans was between 6.5 and 10 times higher than normal. And for all we know, Harry Coppola, Harold Joseph Ralph, Alvin Lasky, Richard Bonebrake, and George Proctor were not the only ones among the Marines at the blast core area that first occupation week who later developed multiple myeloma. The five of them represented the minimum, not the maximum of actual incidences of the rare bone-marrow disease.

Federal officials have refused to make detailed records available for systematic research on the cleanup veterans. Thanks to government intransigence, the full dimensions of the health toll probably will never be known.

U.S. servicemen sent into Nagasaki and Hiroshima amid residual radiation were the first Americans to confront the specter of invisible radiation from atomic weaponry. They were by no means the last. After 1945 nuclear bomb explosions proliferated—and so did their victims, in uniform and out.

147. *Hiroshima and Nagasaki Occupation Forces*, p 28.

2

300,000 GIs Under the Mushroom Clouds

Dr. David Bradley sat among colleagues aboard a U.S. Navy ship docked just off the main island of the Bikini atolls in the midst of the Pacific Ocean, about two thousand miles southwest of Hawaii. Bradley, a young Army doctor, was one of a score of assembled physicians in training to be radiation monitors for the first peacetime atomic detonations.[1] He listened attentively as Colonel Stafford Warren, head of the Radiological Safety Section, explained the scenario set for seventeen days later, on July 1, 1946.

An atomic bomb—the same size as the weapon that exploded over Nagasaki—was scheduled to detonate at Bikini. In more ways than one the U.S. military high command and its civilian counterparts were testing the waters with this "Operation Crossroads"—the name given to the 1946 Bikini test series. There was very little question that the two plutonium bombs ready for detonation that July would work; the purpose of Operation Crossroads was to evaluate impacts of existing nuclear weapons rather than to experiment with any new designs.[2]

The psychological aspects of atomic detonations—among direct participants as well as the general public—were being carefully considered. It was no accident that journalists from around the world, photographers, and newsreel crews were solicitously encouraged to observe Operation Crossroads in all its breathtaking, awe-inspiring atomic glory. But the atomic test supervisors were able to meticulously control the stories those journalists turned in. All information about the blasts—including the quantity and significance of radioactive fallout affecting plants, animals, and humans—was most definitely the sole province of official sources.

To be stressed to the world in the summer of 1946 was the theme of fantastic power of nuclear weaponry, held only by the United States—a nation capable of controlling nuclear explosions to protect its own citizens and allies while inflicting enormous and selective damage on adversaries. The leadoff test, appropriately enough, was code-named Able.

The first lectures that Dr. Bradley and other scientists aboard the U.S.S. *Haven* heard were about keeping quiet. Sitting on the balmy navigation deck of the sleek white ship equipped with elaborate laboratory instrumentation, Bradley had listened to the initial briefing three days after the *Haven* left San Francisco. "The naval equivalent of a Trial Judge Advocate read us the riot act on security, backing it up with selections from the Federal Espionage Act. Before he got through it began to look as though Bikini would be but a brief stop on the way to Leavenworth," Bradley later recorded in his personal log.[3]

The tests were mounted with assiduous attention to detail. Along with forty-two thousand U.S. armed forces personnel, and an armada of about two hundred ships and 150 planes dispatched to both withstand the atomic damage and help in assessing it,[4] there were hundreds of military and civilian specialists. The government had assigned an entire ship, carrying animals and physicians, to study effects of radioactivity on the fish, plant life, and coral atolls, and its spread by air and sea.[5] Over four thousand nonhuman test animals[6] were to be involved in the Able atomic blast—including goats, pigs, rats, and specially bred mice—in addition to fruit flies.

As he concentrated on the final briefing from Colonel Stafford Warren, one of the American military's top

1. David Bradley, *No Place to Hide* (Boston: Little, Brown and Company, 1948), pp. 18-20.

2. Herbert York, *The Advisors: Oppenheimer, Teller, and the Superbomb* (San Francisco: W. H. Freeman and Co., 1976), p. 19.

3. Bradley, *No Place to Hide,* p. 5.

4. Michael Uhl and Tod Ensign, *GI Guinea Pigs* (Chicago: Playboy Press, 1980), p. 34

5. Bradley, *No Place to Hide,* p. 15.

6. Uhl and Ensign, *GI Guinea Pigs,* p. 34.

radiation authorities, Bradley found himself both fascinated and concerned. To him, medicine was always destined to be practiced "somewhere in that intermediate zone which combines both science and humanism."[7] The scientist in Bradley was fascinated; the humanist in him was concerned.

Colonel Warren explained that a B-29 would fly over Bikini to drop an A-bomb. A mobile "live" fleet would be about twenty miles away, on the sea and in the air. The bomb would explode with a power of about twenty thousand tons of TNT, sending off blinding heat equal to the sun's.[8]

As the initial flash dissipated, two of the Navy's Marin PBM-S flying boats (Bradley was assigned to be in one of them) would cruise closer and closer to the blast until detecting radiation levels deemed "dangerous." While planes and destroyers would be sent off to follow the mushroom cloud's travel path, the "live" fleet would gradually head toward the blast center—where ships berthed under the nuclear explosion would be examined to find out what an atom bomb of twenty kilotons or so could do to aircraft carriers, battleships, and other military equipment.[9] U.S. commanders had designated seventy-three ships to serve as the atomic explosion's target fleet.[10]

Having heard the last briefing and received their assignments, Bradley and most of his scientific colleagues went ashore on Bikini's main island—four miles long and about two hundred yards wide—a sandy sliver in the Pacific immensity. "The sun was rich with its tropical intensity, and the sky full of the clustering thunderheads," Bradley wrote in his notebook. "The beauty of this Bikini setting seems to belong to another world entirely, having no relation to the strange mission which brings us here."[11]

Indeed, Bikini's beauty masked radioactive poisons that would prove fatal to natives and GIs alike.

Tested, and Ignored

It is not entirely accurate to describe the veterans of America's nuclear weapons tests as "guinea pigs." Until the late 1970s the U.S. Government had made no epidemiological inquiries into the health of these servicemen, established no studies about long-term effects of their radiation exposure. As "guinea pigs," at least 250,000 U.S. troops[12]—directly exposed to atomic radiation during seventeen years of nuclear bomb testing—were neglected by their overseers.

Between 1946 and 1962 orders routinely sent American soldiers close to hundreds of atomic blasts. The logistics of their roles changed, as did the kinds of terrain. But what did not vary were the presence of radioactive fallout and official assurances that it was harmless.

In the 1970s as some media attention focused on charges that participation in nuclear tests had caused serious diseases, the U.S. Government denied any responsibility. Continuing to reject service-connected radiation claims from veterans and their widows, the Veterans Administration asserted that servicemen had been exposed to harmless "low-level" radiation.

In 1977, more than thirty years after Able exploded, pressure from publicized battles between the VA and atomic vets moved a federal agency—the Center for Disease Control—to conduct the first health study of America's nuclear veterans.[13]

The survey was confined to the 3,224 men who were in the Nevada desert military maneuvers at a 1957 atomic test code-named Smoky. An initial eighteen-month assessment, released in 1979, discovered more than twice the normal leukemia rate among those servicemen. In more detailed statistics that followed, the federal researchers found nine cases of leukemia among those same soldiers—a ratio nearly three times the average. "This represents a significant increase over the expected incidence of 3 1/2 cases," reported a research team headed by Center for

---

7. Bradley, *No Place to Hide,* p. 15.

8. Ibid., pp. 18, 19.

9. Ibid., p. 20.

10. *Time,* July 8, 1946, p. 20.

11. Bradley, *No Place to Hide,* p. 21.

12. The U.S. Department of Defense has estimated there were approximately 210,000 atomic test servicemen. Most other sources say the number was higher. The National Association of Atomic Veterans has calculated the figure at between 250,000 and 400,000. These estimates do not include the many thousands of civilians who participated in the testing at close range.

13. G. C. Caldwell, et al., "Leukemia Among Participants in Military Maneuvers at a Nuclear Bomb Test: A Preliminary Report," *Journal of the American Medical Association,* October 3, 1980, pp. 1575-1578.

Disease Control official Dr. Glyn C. Caldwell, in a study summary published in the *Journal of the American Medical Association* in autumn 1980.[14]

The Smoky test soldiers, however, represent only about 1 percent of U.S. servicemen exposed to nuclear testing. Extrapolation of the completed federal study conclusions would strongly indicate that several hundred veterans died from leukemia alone as a result of their involvement in the tests. The estimate does not include deaths from numerous forms of cancer, blood disorders, and other ailments.

The implications of the federal government's own study seemed to make no impact on the VA. Consistent with policies toward the veterans of Hiroshima and Nagasaki, the agency continued its practice of turning down the claims. The VA granted an occasional publicized atomic vet's request for benefits—being careful not to concede that the terminal illness was tied to bomb test radiation exposure. But for the overwhelming majority of irradiated veterans, the Smoky study results notwithstanding, encounters with the VA continued to mean dealing with an administrative stone wall.

Sensitive to mounting public accusations of unfair treatment toward nuclear test veterans, VA general counsel Guy H. McMichael III told Congress in 1979 that no individual autopsy or diagnosis could establish connection between an illness and prior radiation exposure. "There are serious difficulties inherent in the adjudication of claims involving more lengthy post-exposure development of cancer," he maintained, "when there is no pathological evidence to indicate that the disease process began in service."[15] The VA cited as a complicating aspect of radiation compensation policies "the fact that radiation-induced cancers have no unique pathological characteristics to distinguish them from cancer due to 'natural' factors. This makes it impossible to determine with *certainty* whether such a disease would have occurred regardless of the radiation exposure."[16]

Meanwhile, as of 1981, the VA has turned down more than 98 percent of radiation-based claims for atomic veterans' service-connected benefits.[17] In the summer of 1980 the Pentagon issued a widely circulated press release claiming that "most exposures to DoD [Department of Defense] personnel during the tests were quite low—averaging about half a rem. . . . Of course, many received no exposure at all, and some received more. Our research indicates that only a very small percentage exceeded 5 rem per year, the current Federal guideline for allowable annual dose to radiation workers."[18]

The Defense Department statement, released thirty-four years after America's first peacetime nuclear test, concluded on a soothing note: "In summary, based upon research to date, the average exposure of atmospheric nuclear test participants is about *one-tenth* of the level that is generally agreed as an acceptable annual exposure for radiation workers."[19] Despite the Center for Disease Control's findings a year earlier, the Pentagon stated that "approximately one fatal cancer per 20,000 individuals" would result.[20]

But many of America's veterans of nuclear testing were in no mood to be placated by Pentagon press releases. Their voices, scattered around the nation, had grown louder and more cohesive as the 1970s progressed. In 1979 the National Association of Atomic Veterans was founded by former Army sergeant Orville Kelly, and his wife, Wanda. Kelly had witnessed twenty-two nuclear weapons test explosions while serving as commander of Japtan, a small land mass in the Marshall Islands, two decades earlier.[21]

Kelly's experiences were fairly typical. As described in an NAAV newsletter he "wore a film badge, which measured gamma radiation, from April 1, 1958 to August 31, 1958. During that time, the badge recorded an

---

14. Ibid., p. 1575.

15. U.S. Congress, Senate Committee on Veterans' Affairs, "Statement by Guy H. McMichael III," June 20, 1979, p. 6.

16. Ibid.

17. Lewis Golinker, attorney, National Veterans Law Center in Washington, D.C., interviews, February-May 1981.
Atomic veterans appealing to the courts for help, after VA rejections, have been blocked by the government's use of a 1950 Supreme Court decision in the case of *Feres v. United States*. The "Feres doctrine" has made it nearly impossible for veterans or family members to sue the government for injuries inflicted while in the U.S. military. (For an analysis of political and legal issues involved, see Lewis M. Milford, "Justice Is Not a GI Benefit," *Progressive*, August 1981, pp. 32-35.)

18. U.S. DOD, *Nuclear Test Personnel Review* (Washington, D.C.: Defense Nuclear Agency, 1980), pp. 5-6.

19. Ibid., p. 11.

20. Ibid.

21. Account of Orville Kelly's life and founding of NAAV is drawn from *Atomic Veterans' Newsletter*, September-October 1979, pp. 6-7.

exposure of 3.445 rems. At no time was he measured for beta radiation or for possible internal deposition of radionuclides. The equipment used on the island for environmental monitoring also only measured gamma radiation."[22]

Formation of NAAV in August 1979 brought a strong response from atomic veterans and widows all over the country. Within a year three thousand had become members of the association, operating out of headquarters in Burlington, Iowa, the hometown of Orville and Wanda Kelly. Together with nuclear veterans and supporters in every state, they set about challenging the Veterans Administration's treatment of former servicemen exposed to radiation while in the military.

Diagnosed as suffering from lymphocytic lymphoma in June 1973, Orville Kelly's claims for service-connected benefits were repeatedly rejected by the VA.[23] Hobbled by the pain of his cancer and powerful chemotherapy drugs, Kelly traveled as much as he could, meeting with atomic veterans and speaking out on their behalfs. In the process Kelly's own often-rebuffed claim became a cause celebre, and a severe embarrassment to the VA and Defense Department.

In November 1979, after five years of denials, the VA's Board of Veterans Appeals granted Kelly's claim. The decision conceded the *plausibility* of a link between in-service radiation exposure and later cancer, but stopped short of acknowledging a definite connection. The VA made clear that the Kelly decision would not serve as a precedent for other such claims, which would still be processed case-by-case.[24]

Kelly was well aware that only a handful of atomic vets had been successful in gaining compensation. In April 1980, two months before he died, Orville Kelly said from his sickbed: "Although our claims are difficult to prove because we cannot feel, taste, hear or smell radiation, it is more deadly than bullets or shrapnel."[25]

Articulating the sentiments of thousands who had joined the National Association of Atomic Veterans, Kelly added: "I believe I should have been warned about the possible dangers of radiation exposure and that medical examinations should have been conducted on a regular basis after my exposure. The truth is that I was never warned nor were examinations ever performed. During all the years after I left the Army, I was never once told to get a physical because I participated in nuclear weapons testing. Even though I won my case, I have still lost the overall battle because doctors have told me I have but a short time to live."[26]

After Kelly's death it became clearer than ever that the NAAV would not disappear. In fact the organization showed signs of continued growth, issuing bimonthly newsletters to its thousands of members and establishing field organizers in every region of the nation. The federal department perhaps most hostile to the NAAV's aims was the Defense Nuclear Agency at the Pentagon. "We're not in the health effects business—we're in the defense business," DNA spokesman Colonel Bill McGee told an interviewer in 198O.[27] However, responding to adverse publicity, DNA had set up a toll-free telephone number in the late 1970s to gather information from veterans of nuclear testing—and by early 1981 had accumulated more than forty thousand names and current addresses of atomic veterans or next of kin.[28]

DNA refused requests by the National Association of Atomic Veterans for those names and addresses.[29] The Veterans Administration, meanwhile, after more than a year's delay, in January 1981 agreed to provide NAAV with its record of atomic vets' names and addresses.[30] But the VA had only 2 percent of the number of names

---

22. *Atomic Veterans' Newsletter,* September-October 1979, p. 6.

23. Ibid., p. 7.

24. *New York Times,* November 27, 1979, p. 18.

25. "Statement of Orville Kelly," *Citizens' Hearings for Radiation Victims* (hereafter cited as *Citizens' Hearings*), Washington, D C., April 11, 1980 (National Committee for Radiation Victims, 317 Pennsylvania Ave., SE, Washington, D.C 20003.)

26. Ibid.

27. *People,* November 10, 1980, p. 44.

28. Years after they called DNA's toll-free phone number and submitted information, all the scores of atomic veterans we interviewed said they had received at most a form letter, and no substantial follow-up, from the government. For its part the Pentagon continued to gather informational responses from atomic veterans. In 1981 the overwhelming majority of backlogged responses from veterans were not being put to any apparent use by Pentagon agencies. Meanwhile the Defense Department was paying the National Academy of Sciences—an institution with long-standing and harmonious ties to governmental nuclear interests—to study the health of veterans who participated in a few bomb test series. With no results expected before 1982 at the earliest, that study addressed the health of about 15 percent of the veterans who took part in atomic tests.

29. Golinker, interview, February 1981; Golinker to authors, January 13, 1981.

30. VA Administrator Max Cleland to Golinker, January 2, 1981.

accumulated by the Defense Nuclear Agency.[31]

DNA's refusal to share its large cache of data was consistent with the agency's combative posture toward the nation's nuclear veterans. A DNA refrain has been the contention that servicemen received very low levels of radiation.

But support for the NAAV cause came in the form of a rebuttal from Dr. Edward Martell, a former fallout analyst for the Air Force and Atomic Energy Commission. Testifying at a citizens' hearing in Washington on April 12, 1980, he said: "The best way of deceiving all of you about the effects of radiation is to talk about the effects of one kind of radiation when you're measuring the other."[32] A scientist at the National Center for Atmospheric Research based in Colorado, Martell stated that internally absorbed alpha and beta particles are intentionally ignored by government authorities.[33]

Martell alleged that Pentagon officials "take film badge records, which are a measure of penetrating radiation, and they discuss the small degree of effect expected in the way of cancers and leukemias. But most cancer and leukemias are due instead to internal emitters"[34]—nuclear-fission by-products such as strontium, cesium, and plutonium, which were not measured by dosimetry badges.[35]

Even journalists priding themselves on hard-hitting investigative research are inclined to defer to seemingly superior knowledge of Defense Department experts. Such was the case on September 28, 1980, when the CBS television program *60 Minutes* broadcast a segment on nuclear vets.

60 Minutes showed brief interviews with atomic veterans Orville Kelly and Harry Coppola, filmed only a few weeks before their deaths. But the program focused on DNA director Vice Admiral Robert R. Monroe.[36]

Admiral Monroe informed CBS correspondent Morley Safer—and tens of millions of TV viewers—that at the nuclear tests "meticulous precautions were taken to ensure that the exposures were within limits thought to be safe. We have almost no indication today that there is a statistically higher proportion of cancer deaths." And, the admiral added, "This weapon testing exposure is a very, very, very, very tiny amount of very low-level radiation." Admiral Monroe explained that about 16 percent of American men die of cancer, so of course the disease would occur among some nuclear veterans.[37]

The Pentagon representative's on-camera assertions went unchallenged as CBS presented no contrary scientific view. The *60 Minutes* segment did not mention the government's own Center for Disease Control study—public for well over a year by that time—showing a leukemia rate more than twice expected among veterans who participated in the Smoky test.[38]

Numerous veterans wrote angry letters to *60 Minutes*, which quoted from a couple of critical ones on the air. But the CBS editors seemed to have retained unshaken faith in the Pentagon's integrity. The program quoted a viewer's letter charging that "the government's treatment of these men is a national disgrace and perhaps the biggest whitewash since Tom Sawyer painted his Aunt Polly's fence." But *60 Minutes* immediately sought to dispel the aspersion on the Defense Department's sincerity, as anchorman Mike Wallace declared flatly: "However, the government is interested in getting the facts, and wrote to us to please tell atomic vets to call, toll-free 800-336-3068."[39]

---

31. Golinker interview.

32. *Citizens' Hearings*, pp. 26-28.

33. Ibid.

34. Ibid.

35. The Defense Nuclear Agency, in support of its claim that the exposure received by atomic soldiers was too small to cause cancer, uses an average obtained from film-badge readings. This approach is fraught with distortions. First, not everybody wore a film badge. Often a badge was issued to only one person in the platoon. Second, and perhaps most important, the largest source of exposure to the troops was probably the inhalation of radioactive dust, or the ingestion of contaminated water—neither of which was measured by badges. The several hundred isotopes produced immediately after an atomic detonation were swirled around by high-speed winds. Although only a small percentage of this fresh fallout is made up of long-lived isotopes like plutonium, there would still be a significant amount produced. Because the distribution of the fallout would not be uniform, there were no doubt several "hot spots" in the areas where troops were posted.

36. *60 Minutes*, CBS television network program segment titled "Time Bomb," September 28, 1980, transcript provided by CBS News.

37. Ibid.

38. Ibid.

39. Ibid., letters segment broadcast.

Among the outraged atomic veterans was a Hagerstown, Maryland, resident—George E. Mace. In a letter to *60 Minutes* producer Joseph Wershba, Mace pointed out that "you graciously provided interested atomic veterans with the Defense Nuclear Agency toll free telephone number, so they could seek information and help from a Government which just the week before had said they were insignificant and financially not worth the bother."[40]

Three weeks after the atomic veterans segment was aired, in a one-sentence footnote to its mailbag excerpts, *60 Minutes* finally mentioned the high leukemia rate among atomic vets found by the Center for Disease Control.

For George Mace, a participant in twenty-two atomic tests in 1958, the issues went far deeper than a sophisticated journalist was likely to convey.[41] "Cancer is not the only disease or health problems encountered by the atomic veteran," he wrote. "There are blood and bone marrow diseases, respiratory diseases, general deterioration of health, sterility, mental stress or breakdown, and genetic damage."[42]

In late 1980 the National Association of Atomic Veterans published a brief article advising members not to donate blood or sign up for organ donor programs. The newsletter notice expressed a deep sadness common to radiation victims: "All veterans who were exposed to radiation during atomic tests and are now participating in such programs are urged to notify the state or national organization that they are atomic veterans and request a decision on acceptability of future participation. It is a scientific fact that radioisotopes concentrate in specific organs of the body, one of which is bone marrow which produces mature blood cells. Let us not perpetrate this curse on another human being!"[43]

Selling the Bomb

The root of the curse that plagued the atomic veterans had in fact been resisted as early as the 1946 Bikini detonations. Though their voices were overwhelmed by the emotions of the nascent Cold War, numerous top-level American scientists had argued strenuously against nuclear bomb testing. Some pleaded, with tragic foresight, that the testing would be biologically dangerous. Others warned that it was unnecessary and would make more difficult the job of controlling atomic energy worldwide.[44] The Federation of Atomic Scientists also expressed fear that in the midst of a vast ocean, the nuclear explosions would seem relatively puny, creating an unrealistic image of their power—which would be used to devastate cities rather than isolated battleships or remote atolls.

Before sending mushroom clouds up over the Bikini atolls, Operation Crossroads was the subject of several months of intensive media buildup.[45] U.S. military and civilian commanders carefully and successfully set the tone for press coverage of nuclear displays—thus defining the formative notions of atomic weapons for most citizens. Motivations for U.S. atomic tests were increasingly depicted as benign, circumscribed, and well-meaning.

Newsweek first headlined its advance coverage of Operation Crossroads scenarios "ATOMIC BOMB: GREATEST SHOW ON EARTH."[46] By the time the week of Crossroads' first test blast arrived, *Newsweek* headed its preview coverage "SIGNIFICANCE: THE GOOD THAT MAY COME FROM THE TESTS AT BIKINI."[47]

Washington bureau chief Ernest K. Lindley urged *Newsweek*'s readers to keep in mind that the atomic explosions

---

40. George Mace to Joseph Wershba, October 20, 1980.

41. We asked Joseph Wershba for his response to the criticisms leveled by nuclear veterans regarding the *60 Minutes* story he produced. Wershba replied with a note, dated January 22, 1981, saying: "As for personal comment, we're responsible for what goes out over the air so the script and follow-up will have to stand for itself."

42. Mace to Wershba, October 20, 1980.

43. *Atomic Veterans' Newsletter,* winter 1980, p. 13.

44. Uhl and Ensign, *GI Guinea Pigs,* p. 37.

45. Originally announced for early May 1946, Operation Crossroads was delayed for a few weeks. The postponement enabled President Truman's emissary Bernard Baruch to proclaim U.S. support for worldwide nuclear controls, in his speech to the fledgling United Nations, *before* the U.S. proceeded with atomic bomb tests; "it was felt," noted historian Robert Jungk, "that they would be a discordant accompaniment to the forthcoming presentation of the American plan for international control to the United Nations Organization" (Robert Jungk, *Brighter Than a Thousand Suns* [New York: Harcourt Brace 1958], p. 240.) Other motives were involved, however. "The real reason for the delay was closer to home" than global tensions, *Newsweek* reported. "Operation Crossroads would have drawn 120 senators and representatives, a record-breaking number for Congressional junkets, away from Washington for six weeks and thus endangered the Administration's legislative program." At stake were proposals for extension of the peacetime draft, military appropriations, and measures to boost development of atomic energy. (*Newsweek*, April 1, 1946, pp. 21-22.)

46. *Newsweek,* February 4, 1946, p. 30.

47. *Newsweek,* July 1, 1946, p. 21.

were for scientific and military research, not for planetary saber-rattling: "None of these tests is planned as a spectacle; none is intended to show the world what a powerful weapon the atom bomb is. None is intended for diplomatic or political effect."[48]

With mass media uncritically relaying the military’s line, the public image of Operation Crossroads became one of self-defense and even humanitarianism. "The Bikini tests are set up to measure the effects of atomic explosions, not only on ships but on a wide variety of equipment and military ground weapons and on life itself," *Newsweek* declared on the eve of the first Crossroads blast. "The tests on animals, at varying distances from the explosion should be especially valuable, through their contribution to medical knowledge."[49] *United States News* informed readers that "only the coming tests can give the final answer to the main question of how today’s modern warship can stand up in combat in an age of atomic warfare."[50]

The humanistic theme was reiterated. "One of the answers being sought in the tests will be to see whether more sensitive or more exact devices may be needed to indicate quickly enough the need for special medical treatment of atom bomb victims," reported *Science News Letter,* adding: "Whether the radiation injury from atom bombs will cause sterility in the victims or cause defects in such children as they might have will also be studied. While it will take many years before such genetic effects could be determined from following atom bomb survivors in Japan, laboratory animals and insects, such as drosophila, can provide the answers much faster."[51]

And, a later issue of the periodical went on—with unknowing irony—"Cancer research may get some help from the atomic bomb explosions at Bikini."[52]

Missing from the press billing of Operation Crossroads were any serious suggestions that subjects of the atomic test experiments included human beings.[53] *United States News* dubbed the blast target ships the "guinea-pig fleet," but devoted scant attention to the forty-two thousand human beings in uniform nearby.[54]

Experimenting at Bikini

In a twin-engine plane twenty miles from the falling atomic bomb Dr. David Bradley waited anxiously, looking out through black goggles toward the Bikini lagoon. "Then, suddenly we saw it—a huge column of clouds, dense, white, boiling up through the strato-cumulus, looking much like any other thunderhead but climbing as no storm cloud ever could." The atomic conflagration was rising from its midair detonation point at a speed of two miles per minute. "The evil mushrooming head soon began to blossom out. It climbed rapidly to 30,000 to 40,000 feet, growing a tawny-pink from oxides of nitrogen, and seemed to be reaching out in an expanding umbrella overhead."[55]

In the hours immediately after the explosion, with Geiger counters clicking rapidly, radiological monitoring planes swept through the air around the mushroom cloud. No one seemed to know whether the gas masks worn by the crews would filter out harmful radioactive particles.[56]

As Bradley’s plane drew closer to the cloud, passengers could see many of the target ships afire below; a few were sinking. "Expecting much more dire and dramatic events our crew was disappointed," he recalled. "There was much pooh-poohing of the Bomb over the interphone."[57]

The Able test countdown and explosion seemed to bring the atomic bomb within human scale. "Awful as it was, it was less than the expectations of many onlookers," remarked *Time* magazine. "There was no earthquake, no ‘tidal’

48. Ibid.

49. Ibid.

50. *United States News,* February 1, 1946, p. 27.

51. *Science News Letter,* May 11, 1946, p. 294.

52. *Science News Letter,* July 6, 1946, p. 4.

53. Some apprehensions about the Bikini atomic blasts were publicized. Fears of cracked ocean floors, vaporized seas, and gigantic oceanwide tidal waves—plausibly destined to be disproved—received more general press attention than the issue of long-term radiation effects. See, for example, *Newsweek,* July 1, 1946, p. 20.

54. *United States News,* February 1, 1946, p. 26.

55. Bradley, *No Place to Hide,* p. 55.

56. Ibid., pp. 22-23.

57. Ibid., pp. 57-58.

(seismic) wave or other catastrophe to justify the fears of crackpots that the bomb would bring the end of the world."[58] And *Newsweek* expressed some optimism in its coverage: "Man, pygmy that he is in the endless stretch of time, set off his fourth atom bomb this week. Trembling, he waited once again to see if he had wrought his own destruction. . . . Yet, as the macabre cloud of his fourth explosion rose majestically from Bikini's environs . . . he could sigh with relief. Alive he was; given time and the sanity of nations, he might yet harness for peace the greatest force that living creatures had ever released on this earth."[59] The limitation of visible physical impact was in the spotlight; little attention was devoted to invisible radioactive fallout.[60]

A week after the Able explosion Dr. Bradley boarded a patrol gunboat at Bikini and headed westward, reaching a small atoll after an hour's journey. "Even below the high water mark, on the south shore, whose rocky ledges are constantly being sluiced by the foaming breakers, even here we found radioactive material, invisibly and almost permanently adsorbed to the surface of the rocks. It isn't enough to be serious, but illustrates the difficulty of trying to clean any rough surface of fission products. Even the great Pacific itself cannot wash out a roentgen of it."[61]

The radiation could not be cleansed away. The situation became severely aggravated when the U.S. went ahead with its second postwar nuclear shot, code-named Baker, set off three and a half weeks later. Baker exploded underwater at a shallow location beneath the lagoon surface, displacing two million tons of water.[62]

Instruments in Bradley's monitor plane detected radiation from the targeted ships and the ocean water. Needles on all Geiger counters quickly went off scale.[63] Radioed orders to abandon the survey task were a great relief to the crews—"with radiation so intense at such an altitude, that at water level would certainly be lethal. And this wasn't just a point source, it was spread out over an area miles square."[64]

For many weeks afterward monitors found radiation permeating the ecosystem of the Bikini atolls.[65] Meantime many thousands of sailors were aboard ships anchored in Bikini's lagoon. Four days after the Baker detonation Dr. Bradley and his coworkers became aware that "the live fleet is lying at anchor in dangerous water. . . . By noon the intensity was such as to endanger our water intakes and evaporators."[66] The entire fleet pulled up anchors and moved in an attempt to escape the radioactivity.[67]

But U.S. servicemen were being sent aboard the target fleet—about one hundred ships—under orders to scrub off the persistent radiation. More than a week after the Baker blast Dr. Bradley observed "most of the ships are still in quarantine because of radioactivity." The decks were "still so hot as to permit only short shifts of twenty minutes to an hour. The rain which fell contained the equivalent of tons of radium."[68] For Navy hands accustomed to swabbing the decks, it was an exercise in frustration. Scrubbing the vessels, with help from fire-fighting equipment, provided "no relief from the 'damned Geigers.'"[69] Two years later those ships remained highly radioactive.[70]

For all the official public talk about Operation Crossroads being a crucial experiment, from the standpoint of scientific inquiry it had a number of peculiarly flawed aspects.

---

58. *Time,* July 8, 1946, pp. 20-21.

59. *Newsweek,* July 8, 1946, p. 19.

60. American media eagerly lacquered events even indirectly linked to the atomic test with thick coats of patriotic heroism. An Associated Press article—headlined "SCIENTISTS RISK LIVES TO SAVE ATOMIC SECRETS" in the *Los Angeles Times*—disclosed that "a group of famous scientists flying to the United States from Bikini, deliberately gambled their lives today in a thunderstorm over Nebraska by refusing to bail out to save top secret photographic and instrument records of the atomic blast." (*Los Angeles Times,* July 5, 1946.)

61. Bradley, *No Place to Hide,* p. 73.

62. Bruce A. Bolt, *Nuclear Explosions and Earthquakes* (San Francisco: W. H. Freeman and Co., 1976), p. iv.

63. Bradley, *No Place to Hide*. p. 95.

64. Ibid., pp. 96-97.

65. Ibid., pp. 98, 107-108, 126.

66. Ibid., pp. 100-101.

67. Ibid., p. 101.

68. Ibid., p. 102.

69. Ibid., p. 103.

70. Uhl and Ensign, *GI Guinea Pigs,* p. 44.

For example the Navy killed Bikini atoll insects before the first atomic explosion there—preventing any accurate assessment of the bomb radiation impacts on the land food chain. Unlike mass circulation periodicals, the small journal *Science News Letter* noticed the action, reporting after the first blast: "The atom bomb's effect on Bikini's ecology will have a blurred record because DDT was sprayed over the atoll islands before Seabee forces went to work there weeks ago. This was done to abate the plague of flies that wrecked comfort and threatened health. Biologists making the 'before-B day' survey objected but Navy authorities decided in favor of the Seabees."[71]

Whether the test supervisors were merely concerned about servicemen's comfort—or whether they also wished to preclude the possibility of news accounts revealing that an atomic explosion had wiped out insect life—remained unclear. But, as *Science News Letter* correspondent Dr. Frank Thone pointed out, DDT indiscriminately kills almost all aboveground insects—including those transferring pollen to sustain plant life. So use of the DDT predictably clouded reasons for insect and plant deaths on Bikini.[72]

The government's DDT dousing prevented systematic evaluation of radiation effects on other atoll life as well. "Some birds and almost all lizards depend mainly on insects for food," Thone reminded readers. "Recent experiments indicate that DDT-poisoned insects do not kill birds and fishes that eat them but if the insects are killed off, where will the birds find food? . . . This one monkey-wrench, thrown into this atoll's ecology, sprinkles question marks all over the biological record."[73]

Those life forms that escaped the DDT were not missed by the radiation. After the Baker test ordinarily bright-hued coral heads were white, and dead; their normally nurturing surroundings remained highly radioactive. Dr. Bradley's "first netfull of sand dumped upon the fantail of our boat proved to be so radioactive that in a panic I had the whole catch thrown overboard."[74]

The implications were disturbing. Intensive radiation on the lagoon bottom threatened to contaminate the ocean food chain. After two more weeks passed, Bradley found that nearly all seagoing fish caught around the atoll were radioactive.[75]

Government authorities and the mass media neglected such biological issues. More conspicuous, however, was the failure to decontaminate the target ships; the military had little choice but to concede a lingering problem.[76] In the words of Bradley's log, there remained "a real hazard from elements present which cannot be detected by the ordinary field methods. . . . recent studies with the alpha counter have established the presence of alpha emitters, notably plutonium."[77] A month after the Baker explosion it became clear that ship surfaces would shed radioactivity only through sandblasting or administering huge quantities of strong acid.[78] Seven weeks after the blast, laboratory studies were consistently detecting "a small but definite amount of plutonium spread atom-thin over most of the contaminated areas."[79]

The public version of Operation Crossroads was that no long-term harm had been inflicted by the tests. Bradley's conclusions were far different: "We don't know to what distances from Bikini the radiation disease may be carried. We can't predict to what degree the balance of nature will be thrown off by atomic bombs."[80]

Crossroads Veterans

Like their later counterparts, servicemen at the 1946 atomic testing were almost nonpersons—little more than props in a grandiose show. Early onset of health problems among American troops sent onto the radioactive ships was not publicized. Operation Crossroads veterans were to recall, sometimes bitterly, that they were provided no

---

71. *Science News Letter*, July 6, 1946, p. 3.

72. Ibid.

73. Ibid.

74. Bradley, *No Place to Hide*, pp. 107-108.

75. Ibid., p. 126.

76. Ibid., pp. 115-116.

77. Ibid., pp. 116-117.

78. Ibid., pp. 131-132.

79. Ibid., p. 147.

80. Ibid., p. 149.

special cleanup garb as they scrubbed the contaminated decks. Most emphasize they were provided no radiation-detection badges or other monitoring gear.

Three decades later, under short-lived congressional pressure, U.S. Department of Energy acting assistant secretary Dr. Donald Kerr admitted that the government could document radiation-exposure badges for only about one quarter of the servicemen at Operation Crossroads. The ratio dropped to about one tenth for the next atomic test series.[81]

For participants at Operation Crossroads the pair of twenty-three-kiloton nuclear detonations were only the start of their hazardous ordeals. Sent onto the targeted vessels within days—sometimes merely a few hours—after the atom bomb explosions, they scoured the irradiated surfaces for weeks on end, at times living on the same ships. They routinely drank water distilled—through frequently contaminated evaporators—from the lagoon that Dr. Bradley and his colleagues were finding to be so intensely radioactive.[82] Former Navy servicemen tell of entire crews falling violently sick soon after boarding ships hot with radioactivity. Chronic, painful illnesses inexorably followed.

Vice Admiral W. H. P. Blandy, commander of the Operation Crossroads joint Army-Navy task force, had been quick to proclaim the atomic experiment "highly successful." *Newsweek* reported at the time: "There had been no human casualties, though Admiral Blandy cautiously warned some might yet be overexposed to radiation [a rare public admission that received no substantive media follow-up]. For, he said, the personnel were eager to board the ships for the military and scientific findings that would affect the future of mankind."[83]

Judging from dozens of interviews with Operation Crossroads veterans contacted for this book, Admiral Blandy may have greatly overstated just how eager "the personnel" were to climb aboard the radioactive vessels.

Jack Leavitt, for instance, had enlisted in the Navy in 1941, before his eighteenth birthday. Stationed in California, he was twenty-two years old when he learned he was headed for Operation Crossroads in early 1946. "Someone told me it was volunteer only, but I was not asked if I wanted to participate, only to report for duty. I had volunteered to join the Navy, and I guess that was good enough."[84]

After the Able atomic blast Leavitt was ordered to board the U.S.S. *Pensacola,* a heavy cruiser among the hardest-hit large ships in the Bikini target zone. He was assigned to a team "to scrub down the decks to wash off any radioactive fallout." Leavitt was aware that "at no time did I or anyone working with me—that is, naval personnel—have a Geiger counter, nor any other testing device to measure danger of radiation."

Leavitt and the others in his crew ate K-rations and sandwiches, and drank water filtered from the lagoon.[85]

Leavitt's stint aboard the *Pensacola* was cut short by news of the death of his mother, and he left for the United States after nine days on the radioactive cruiser. Ever since boarding the *Pensacola* his health had deteriorated. "I had diarrhea for some time after the test, but was told it was emotional and would go away. I had accompanying pain in the lower abdomen, and in the right side. And have had since. I have had stomach trouble since 1946."[86] His later ailments included colitis, bleeding of the bladder, and obstructive lung disease, all malfunctions of organs vulnerable to internally absorbed radioactive particles. The Veterans Administration refused to provide medical treatment.[87]

In 1981, at age fifty-seven, Jack Leavitt spoke to us from his home in Mesa, Arizona. "They asked me to participate in a test I knew nothing about, and gave no guarantee as to what could result from these tests. Upon completion of tests I felt I was forgotten and rejected for further testing of any ailments." For Leavitt, who served in World War II and the Korean War, the continuing injustice of Operation Crossroads remained hard to accept. The government, he noted, "still doesn't want to admit any possible guilt for cause of alteration of the lives of those 'volunteers' who *gave* at that time—but when they ask now for help they are rebuffed and told to simply forget it

81. Uhl and Ensign, *GI Guinea Pigs,* p. 43.

82. Bradley, *No Place to Hide,* pp. 103-104, 152.

83. *Newsweek,* July 8, 1946, p. 20.

84. Jack Leavitt, taped statement to authors, December 1980.

85. Ibid.

86. Ibid.

87. Ibid.

ever happened."[88]

Like so many other atomic veterans Jack Leavitt refused to forget. "I am bitter because I have lost my ability to work, to take care of myself. I collect five hundred thirty-four dollars and ten cents Social Security. I am totally disabled." With a sad anger in his voice he said that the government declined to pay for his needed prescription drugs. His situation, Leavitt stressed, only represented a small part of a much larger problem. "There must be thousands still suffering, and loved ones left behind prematurely by early death to veterans who have passed on with claims pending, and some could still be alive today if proper treatment was given, and the responsibilities accepted by those responsible in the first place."[89]

Kenneth H. Tripke, of Brooklyn, Wisconsin, was aboard the U.S.S. *Quartz* supply ship at Operation Crossroads. "I personally was so sick," he recalled, "with diarrhea and vomiting for days. I went from 128 to 70-some pounds. I turned a funny color, lost all my hair on my body." Taken onto a hospital ship, Tripke was fed intravenously. Ever since, severe weight loss plagued him, along with calcium deposits in his eyes impairing his sight, and sharp hip pains. "My back, shoulders, nerves, etc., are in poor shape."[90]

A day after the Baker underwater blast Frank F. Karasti and three other seamen were sent aboard the destroyer *Hughes* to keep it from sinking. Karasti who later settled in Winton, Minnesota, was twenty-six years old at the time. "Out of the four hours we spent on her, two were spent vomiting and retching as we all became violently ill." Like many Crossroads veterans, Karasti never forgot that drinking water came from conversion of the Bikini lagoon water. Lesions appeared on his lungs about a month after the second Crossroads explosion; serious breathing problems evolved. Since 1948 he suffered from "uncontrollable hypertension." As with many Crossroads veterans Karasti's skin developed frequent severe disturbances. "My skin is deteriorating on my whole body and it is possible to wash off parts of it while bathing. . . . I have been aging ahead of my time and should I use any physical effort, I get ill for three days after."[91] Frank Karasti's afflictions—serious damage to breathing, nervous system, and skin, along with overall feelings of premature aging—are frequently reported by people exposed to atomic radiation.

The day after the first Crossroads blast, Karasti was assigned to putting out fires on several of the target vessels, including the bull's-eye ship, the U.S.S. *Nevada,* which had been painted orange.[92] About two weeks later a Navy crew of about sixty men boarded the *Nevada,* where they worked, ate, and slept. Among the crew was seaman Michael W. Stanco, who had in years past been wounded in the Japanese attack on Pearl Harbor, and again in the Philippines. On board the U.S.S. *Nevada,* "We became deathly ill after eating. I remember being so ill along with the others."[93]

Reflecting on the events, from his home in New Port Richey, Florida, Stanco recalled reading that the *Nevada* was later among ships intentionally sunk because of long-lived intensity of residual radioactivity. "If this ship was sunk for reasons of contamination, what effects do you think it had upon the 60 men who ate and slept aboard it?" he asked. "And what about the divers who sank to their armpits in ooze—and the other 42,000 men that also participated?"[94]

George McNish of Tampa, Florida, was on the U.S.S. *Coucal* as part of a radiation survey group at Bikini. "We scuba dived, ate coconuts from the island and swam, unaware of the danger involved. We had scientists dressed like for 'outer space,' with instruments like I had never seen. But when it came to diving or bringing up samples, all we had were 'skin and tanks.'" Seven years later he began treatment for tuberculosis; he later suffered from severe spine deterioration.[95]

A few days after the Baker test Navy seaman Richard Stempel "anchored among the ships in the target area, swimming nearly every day and using the water freely. We were never told not to do either. At one point in operations during rough seas, three other crewmen and I tied our landing craft to a mooring buoy anchored in the

---

88. Ibid.

89. Ibid.

90. *Atomic Veterans' Newsletter,* winter 1980, p. 4.

91. Frank Karasti to authors, December 8, 1980.

92. Ibid.

93. *Atomic Veterans' Newsletter,* fall 1980, p. 11.

94. Ibid.

95. *Atomic Veterans' Newsletter,* summer 1980, p. 13.

blast area and climbed aboard. About two hours later, a high ranking officer came by and checked the radiation level of the moss on the buoy. The Geiger counter pegged and he ordered us off. He didn't advise us of any decontamination procedure."[96]

Within a few weeks Stempel "was being treated by ship's doctor for a skin disorder the doctor was unable to diagnose." The following year Stempel filed for service-connected VA benefits because of the severe skin affliction physicians had dubbed "atopic eczema"; the VA rejected his claim.[97]

Initially the VA's rejection had contended that "the evidence shows that you had had this affliction since early childhood and there was no evidence to show that it was aggravated by your military service."[98] Refiling the claim in 1980, Stempel, living in Grants Pass, Oregon, submitted "three notarized letters from my father and two brothers stating I had no skin problems before enlisting in the U.S. Navy. Again it was refused." Uncompensated, Stempel's skin "has now deteriorated to where the total skin surface is either red raw, white scales, or open bleeding sores that itch constantly."[99]

By the early 1980s numerous other Crossroads veterans had begun to speak out. As Navy veteran Jack Sommerfeld recalled: "We remained berthed in the lagoon and had to use sea water from the lagoon to make water with which to wash, bathe and brush teeth and for other purposes. . . . We were not issued radiation badges."[100] An in-service photo of Sommerfeld shows a cherubic, smiling youngster in sailor garb. But in 1980 he was blind, confined to a wheelchair, suffering from deteriorating skin, and diagnosed with mouth and throat cancer. His continued efforts to obtain VA compensatory aid went unrewarded.[101]

Warren E. Zink, an eighteen-year-old fireman first class at Operation Crossroads, was assigned to go aboard the heavy cruiser U.S.S. *Salt Lake City* two days after the Able explosion.[102] He was "accompanied by a scientist who was equipped with a Geiger counter," Zink explained. "We had no way of telling the severity of the level of radiation other than noticing the indicator went as far as it could on the counter."[103] After the Baker test Zink and his crew returned to the *Salt Lake City* for cleanup and repair work. The ship was eventually torpedoed because of its extreme contamination.[104]

"Within two years of my discharge from the U.S. Navy in 1948, I began having severe headaches, nausea and vomiting," recounted Zink, a resident of Woodridge, Illinois. After months of hospital tests the diagnosis was "migraine." In 1973 doctors found that Zink's lungs had deteriorated severely. "At that time, and I quote my doctor, 'my lungs are 15 years older than the rest of my body.' Today I am classified as an emphysema patient, I am also bothered by constant muscle spasms in my legs which never seem to let up."[105]

Pervasive among former military participants in Operation Crossroads—as well as for others exposed to radiation—are deep concerns about genetic damage to their children and future generations.

For William A. Drechin, of Old Forge, Pennsylvania, worries began on deck of the U.S.S. *Ottawa*, as he faced toward Bikini. He was nineteen years old. Dizziness and painful headaches soon became part of his life, and a softball-size lipoma tumor was surgically removed from his back three years later. But the most painful was yet to come. In 1954 he and his wife had a son, born nonambulatory. A year afterward another son was born with the same condition, later diagnosed as cerebral palsy. The first child died at age twenty-one; the second at age nine. "There is absolutely no history of defective births on either side of families," according to Drechin, who blames his participation in Operation Crossroads for the birth defects of his two sons. "The seeds of their physical woes were implanted when the destructive forces of the A-bomb were released on Bikini."[106]

---

96. *Atomic Veterans' Newsletter,* winter 1980, p. 9.

97. Ibid.

98. Ibid.

99. Ibid.

100. *Atomic Veterans' Newsletter,* spring 1980, p 11.

101. Ibid.

102. Warren Zink to authors, December 15, 1980.

103. *Atomic Veterans' Newsletter,* fall 1980, p. 5.

104. Ibid.

105. Ibid.

106. William Drechin to authors, December 10, 1980; *Atomic Veterans' Newsletter,* summer 1980, p. 9.

Charlie Andrews, of Riverview, Florida, also was left to agonize over the genetic legacies of Operation Crossroads. For the last six months of 1946 he worked on radioactive ships that had been at Bikini. "We lived on board, drank the water filtered by contaminated evaporators, and some of the food had been aboard the vessels at the time of the blast, making it also contaminated." In 1980 the aftermath of Crossroads was still very much with Andrews: "I find it very difficult to explain to my 15-year-old son who was born with deformed legs and no heels, which have been corrected over the years no thanks to Uncle Sam, the possibility of his children . . . being deformed also."[107]

Living in Lower Lake, California, Howard C. Taylor harkened back to his early pride in the Navy. At Bikini in 1946 he was a ship's officer on the target-zoned U.S.S. *Dawson,* sent onto the vessel after both test explosions. In the late 1950s, health problems appeared: lesions on his lungs, calcium deposits in his shoulder, and black, brittle teeth. They were only the start of his ills. Suddenly he lost nearly all his vision. He was forced into retirement in 1963. "I had five children and we were soon quite destitute. My children all have eye problems. I have a son in a mental institution and another son who is abnormal and in a foster home. My wife had several miscarriages."[108]

As occurred for so many atomic veterans, Taylor's strong patriotism and pride in the U.S. armed forces soured. "I am now disenchanted and disgusted with the Navy and our government. I and many more veterans have been deprived of the ability to enjoy and provide for our families and are now being treated like a bunch of 'social bums.'"[109]

There were civilians involved in Crossroads test operations as well; they and their families gained no more consideration than their military counterparts.

Thomas W. Scott received top-secret clearance as a civilian aerial-ground photographer to film the Able test for the government. After the explosion his plane followed the dissipating radioactive cloud for several hours. Scott's wife, Helena, of Camarillo, California, saw that "for 26 years following 'Able Day' his ailments slowly, but steadily, kept increasing: the choking cough, nausea, vomiting, nose bleeds, severe back pains, depression and so on, became a daily routine." Scott died of bone cancer in 1972.[110]

Nor did Americans' radiation exposure from Operation Crossroads end when the U.S. ships involved left the Bikini area. Scores of the vessels remained highly radioactive, and some were taken to Hawaii for disposal.

Gregory Bond Troyer, eighteen, was in the Navy at the time, working in the Base Craft, Pearl Harbor shipyard. His duties included securing vessels, still hot from Bikini, to a tug, towing them out to sea about ten to fifteen miles from Pearl Harbor, and sinking the ships. He worked without protective clothing; often his chest and feet were bare. His crew had no exposure badges or radiation monitoring gear.[111]

A few years later, after honorable discharge from the Navy, Troyer got married. Attempts to start a family were unsuccessful, intensive physical exams by doctors determined that Troyer was sterile. In the mid-1970s physicians discovered Troyer was suffering from hyperthyroidism. A lesion appeared on his scrotum, attributed to eczema. Arthritis of neck and shoulders, cysts around his eyes and forehead, prostate problems, and hearing loss set in also. In 1980, living in St. Paul, Minnesota, Troyer at age fifty-three remained under medication for his long-standing thyroid damage.[112]

Living with Nuclear Weapons

Considering the government's deliberate control of information before and after Crossroads, it is perhaps no surprise that the test blasts actually allayed domestic fears of atomic war. "On returning from Bikini," wrote William L. Laurence, a *New York Times* science reporter, "one is amazed to find the profound change in the public attitude toward the problem of the atomic bomb. Before Bikini the world stood in awe of this new cosmic force. Since Bikini this feeling of awe has largely evaporated and has been supplanted by a sense of relief unrelated to the grim

---

107. *Atomic Veterans' Newsletter,* fall 1980, p. 8.

108. *Atomic Veterans' Newsletter,* winter 1980, p. 8.

109. Ibid.

110. Helena Scott, "Written Statement," *Citizens' Hearings* April 12, 1980.

111. Gregory Troyer to authors, December 1980; Troyer's complete VA file, C-13470812.

112. Ibid.

reality of the situation. Having lived with the nightmare for nearly a year [since Hiroshima and Nagasaki], the average citizen is now only too glad to grasp at the flimsiest means that would enable him to regain his peace of mind".[113]

Many years later the public-relations role played by the Bikini tests of 1946 seemed apparent. "Their spiritual effect was great," wrote historian Robert Jungk. "For they soothed the fears of the American public almost as much as the bombs dropped on Japan had aroused them."[114]

There had been some opposition to the atomic explosions at Bikini. After the Federation of Atomic Scientists unsuccessfully attempted to prevent the tests protesters gathered in New York's Times Square.[115] But America's nuclear machinery—forged through extremely close cooperation between government and private industry during the wartime Manhattan Project—was picking up speed and consolidating alliances along the way.[116] America had entered the cold war, and atomic bombs were requisite materiel.

Rhetorical abhorrence of nuclear bombs accompanied the beefed-up nuclear weaponry appropriations and further atomic bomb test explosions.[117] President Truman inaugurated "an American political tradition," as authors Michael Uhl and Tod Ensign described it: "Denounce the proliferation of nuclear weapons, urge disarmament, and advocate peaceful uses of atomic energy, while continuing to produce and test nuclear weapons under the guise of national security."[118]

The issue of how the government should supervise atomic energy came to the fore in 1946, with a struggle over whether regulation should be entrusted to the U.S. military or civilian administrators. A petition campaign, spearheaded by the Federation of Atomic Scientists, deluged Congress with messages favoring civilian control of the atom. When the law establishing the Atomic Energy Commission (AEC) took effect in August 1946, its provisions seemed to reflect a victory for the forces backing civilian authority over nuclear development.[119]

The U.S. Government's executive and legislative branches, with appointments by the president and confirmation powers plus oversight duties by Congress, would keep watch over the AEC. Yet, underneath the proclaimed civilian umbrella, America's top military officers retained basic roles in the government's atomic policy decisions.

The 1946 law that established the AEC also set up the Military Liaison Committee, located in the Pentagon and charged with supervising America's nuclear program from a "national defense" standpoint. While usually a civilian, that panel's head represented the Defense Department; the committee's members were military officers.[120]

Supporters of civilian nuclear control soon began to realize they had won a hollow victory. The AEC was effectively interwoven with U.S. military authority—which was, after all, the prime user of the atom.[121]

Those eager for nuclear proliferation American-style found that in many respects they could enjoy the best of both worlds: the appearance of civilian control, with the military still calling the shots.[122] In the face of Pentagon

---

113. Jungk, *Brighter Than a Thousand Suns,* p. 240.

114. Ibid.

115. Bolt, *Nuclear Explosions and Earthquakes,* p. xiv.

116. Most members of a blue-ribbon consultant board, entrusted by the State Department to come up with an initial plan for international control of atomic capabilities, were top executives in large American business institutions—General Electric Company, Monsanto Chemical Company, and New Jersey Bell Telephone Company. The pattern of policy formulations dominated by representatives of corporations, standing to reap huge profits from further nuclear expansion, was well established.

117. For details on proposals and negotiations regarding international control of atomic energy in the late 1940s, see D. F. Fleming, *The Cold War and Its Origins,* Vol. I (Garden City and New York: Doubleday, 1961), Chapters 13 and 14; see also, Jungk, *Brighter Than a Thousand Suns,* Chapters 14 and 15; also, *The H Bomb* (New York: Didier, 1950), pp. 170-171, for comments by Professor Hans J. Morganthau.

118. Uhl and Ensign, *GI Guinea Pigs,* p. 32.

119. Fleming, *The Cold War and Its Origins,* pp. 382-383.

120. York, *The Advisors,* p. 61

121. See Jungk, *Brighter Than a Thousand Suns,* p. 244.

122. It soon became clear that entrenched enthusiasts for civilian jurisdiction over atomic matters generally saw it as the most effective way to bring the nuclear age to rapid maturity. In a speech aimed at rallying support for the civilian-control concept, one of its most influential boosters, Connecticut Senator Brien McMahon, left no doubt that he was seeking the most productive way to develop a wide array of atomic technologies: "Of course the military should be consulted on the military aspects of atomic energy and this is as far as any civilian commission should be required to go. The military is noted for its reactionary position in the field of scientific research and development. The most successful weapons of war throughout history have been conceived and developed by civilians and the atomic bomb was no exception. It is because I am concerned about the nation's security, as well as the development for peaceful use of atomic energy, that I want civilians to control this force unhindered by the military." (Fleming, *The Cold War,* p. 382.)

expertise and clout, the legislative branch quickly accepted a junior role in nuclear matters. When the 1950s began, members of the congressional Joint Committee on Atomic Energy still were not privy to the number of bombs in the U.S. nuclear stockpile.[123]

The American military, meanwhile, rapidly became the primary source of funds for scientists in numerous fields. And those who paid the pipers composed the tunes. By autumn 1946 the trend was becoming painfully obvious to many atomic scientists, including Philip Morrison. Speaking at an annual public-affairs forum sponsored by the *New York Herald Tribune,* Morrison commented on this evolving relationship: "At the last Berkeley meeting of the American Physical Society just half the delivered papers . . . were ‘supported in whole or in part’ by one of the [Armed] Services . . . some schools derive 90 percent of their research support from Navy funds . . . the Navy contracts are catholic. . . . The now amicable contracts will tighten up and the fine print will start to contain talk about results and specific weapon problems. And science itself will have been bought by war on the installment plan.

"The physicist knows the situation is a wrong and dangerous one. He is impelled to go along because he really needs the money."[124]

The nation’s major universities grew steadily entangled in the atomic funding net. In spring 1947 prime academic institutional involvement came from the University of California—operating Los Alamos in New Mexico and the Radiation Laboratory in Berkeley—and from the University of Chicago, main operator of the Argonne National Laboratory along with dozens of other colleges acting as copartners. By the end of the decade scores more large universities were under large atomic contracts from the government.

Less than seven months after the AEC came into existence, President Truman issued a "loyalty order" authorizing police investigations into the moral fiber and political fidelity of federal employees.[125] Atomic researchers with government grants were also subject to such inquiries. Robert Jungk characterized the results as an "unhealthy climate of suspicion, accusations and time-wasting defense against false charges."[126]

"From 1947 on," he added, "the atmosphere in which the Western scientists lived became more and more oppressive every year." Throughout the U.S., England, and France scientists faced "loyalty committees," firings, interference with international travel, and general harassment—so that "in the laboratories of the Western world people started whispering to one another, anxiously on the watch for the State’s long ears, as had hitherto been the case only in totalitarian countries."[127]

The fear ran from the lowest lab intern to the most esteemed scientific pioneer. Attending the University of California, physics student Theodore Taylor and a few other pupils devised a proposal for a general strike by American physicists. They approached J. Robert Oppenheimer, then at the height of his considerable national power in nuclear policy circles. Taylor always remembered Oppenheimer’s words. After he read over the written proposal, Oppenheimer said, "Take this paper. Burn it. Never recall it. Anyone who knew of this would label you a Communist and you would have no end of trouble the rest of your life."[128]

---

123. *The H Bomb,* p. 158.

124. Jungk, *Brighter Than a Thousand Suns,* p. 248. For an account of the military’s atomic research contracting activities on campuses the spring after Morrison’s speech, see *Business Week,* March 22, 1947, pp. 32-38.

125. Jungk, *Brighter Than a Thousand Suns,* p. 249.

126. Ibid., p. 251.

127. Ibid.

128. John McPhee, *The Curve of Binding Energy* (New York: Farrar, Straus & Giroux, 1974), Ballantine paperback edition, p. 41.

Eniwetok

When American students opened *Scholastic* magazine's first issue of 1948, they read that their country was planning more nuclear bomb tests. Under the headline "ADVANCING SCIENCE" was the periodical's account of upcoming Operation Sandstone:

> Eniwetok is a lonely spot. It is a sort of coral necklace of 40 tiny island "beads," far out in the vast Pacific. It lies about halfway between Hawaii and the Philippines. The nearest land is more than 100 miles away. The 147 natives of the atoll are being moved to another island.
>
> But don't get the idea that you can spend a nice, quiet vacation there. You couldn't even get near the place. Even the United Nations is barred.
>
> For Eniwetok will become a "forbidden fortress of the atom." The U.S. Atomic Energy Commission plans to test atomic weapons there.[129]

Just two years after Operation Crossroads the United States was back exploding nuclear bombs in the Marshall Islands. About twenty thousand American servicemen were there,[130] during three atomic detonations from towers on Eniwetok in April and May 1948. Men like David Lloyd and John E. Knights and Claude E. Cooper participated, like the good soldiers they were, in the Pentagon's scenarios.

Ten years after Operation Sandstone, Air Force veteran Lloyd got married. His son Scotty was born in 1960; at the age of ten, Scotty was diagnosed with bone cancer. A year later Scotty was dead. His father was left with skin cancer, which doctors termed recurring basal cell carcinoma, on his nose. Twenty years after the death of his son, Lloyd, living in Topeka, Kansas, could not forget. "At the present time," he said, "I feel nothing but bitterness towards my Government for using me and thousands like me as human guinea pigs."[131]

Lieutenant Colonel John Knights, of Tampa, Florida, had a long military career spanning service in the Army, Navy, and Air Force. He was an Army major in 1948, exposed to high amounts of radiation a few days after the first nuclear shot at Eniwetok, when he helped extricate a tank from a blast crater. Knights testified about the experience in front of a citizens' commission in Washington, D.C., thirty-two years later: "Back on board the radiological safety ship, the needle on the radiation meter bounced off scale and I was sent to the showers for a scrub-down with stiff brushes. I was still very hot and in a state of shock after the shower and I was sent back to my state room to recuperate. An hour later I suffered severe nausea and vomited." Twenty years later he had bladder cancer, combined with chronically itching skin and sharp pain in his groin that persisted for decades.[132]

U.S. Navy Lieutenant Claude Cooper died in 1979, after suffering from prostatic cancer with metastases to his vital organs and all his bones. "I feel in my heart that my husband's death was attributable to the radiation he received while participating in Operation Sandstone at Eniwetok," said his widow, living in Long Beach, California.[133]

The response to Lloyd and Knights and Mrs. Cooper from the U.S. Government was the standard one: Denial of responsibility.

At Eniwetok in 1948 atomic weaponry took a substantial leap. Under joint auspices of the Defense Department and AEC, the Operation Sandstone tests "evidently did result in substantial improvements in the efficiency of use of fissile material," according to physicist Herbert York, a key researcher in U.S. nuclear weapons design.[134] One forty-nine-kiloton blast, code-named Yoke, expended more than twice the force of any atomic bomb detonation in previous years.[135]

Operation Sandstone gave a lift to the politicians, industrialists, generals, and scientists pushing for bigger nuclear

---

129. *Scholastic,* January 5, 1948, p. 6.

130. Uhl and Ensign, *GI Guinea Pigs*, p. 43.

131. *Atomic Veterans' Newsletter,* fall 1980, pp. 9-10.

132. *Citizens' Hearings*, pp. 17-19.

133. *Atomic Veterans' Newsletter,* summer 1980, p. 9

134. York, *The Advisors*, pp 19-20.

135. *Announced U.S. Nuclear Tests,* p. 5. Unless otherwise noted, nuclear bomb blast dates and magnitude figures were derived from this source.

weapons outlays. "Success" of the Sandstone tests "boosted morale at Los Alamos and helped garner further support for the laboratory in Washington," observed York. "As a result, the construction of a new laboratory, located nearby on South Mesa, was authorized as a replacement for the wartime facilities that were still being used."[136] More than ever the fix was in for nuclear testing to be perpetual scenery on the American political, economic, scientific, and media landscapes; its tangible benefits had become obvious to its prime constituents.

One of the Los Alamos laboratory's leading physicists, Edward Teller, recognized that nuclear bomb test explosions would be pivotal for continually gearing up the nuclear weapons assembly line: from research and development to production of warheads in bulk. Offered the directorship of the Los Alamos theoretical division, Teller said he would accept the post only if the U.S. would conduct a dozen nuclear tests per year—a rate that seemed unrealistic to Los Alamos chief Norris Bradbury in the late 1940s.[137]

Unable to force such a commitment, Teller declined the position.[138] But his vision soon prevailed. In the first five years after the end of World War II the U.S. tested a total of five atomic bombs; from 1951 to 1955, the American government tested sixty-one nuclear bombs.

The H-Bomb

The Soviet Union exploded its first atom bomb on August 29, 1949, in Siberia.[139] U.S. planes detected the fallout. On September 23, 1949, President Truman announced: "We have evidence that within recent weeks an atomic explosion occurred in the U.S.S.R." The President added, "Ever since atomic energy was first realized to man, the eventual development of this new force by other nations was to be expected. This probability has always been taken into account by us."[140]

Edward Teller called fellow atomic scientist Robert Oppenheimer and asked what to do in response to the news. According to Teller, Oppenheimer replied: "Keep your shirt on."[141] But for Teller and others demanding more federal monies to develop weapons, the revelation that the Soviets had the atom bomb provided a strong additional argument. The nuclear arms race was on!

A few days later *Time* commented on "a change in mood and tempo. Military planners were suddenly faced with a whole new timetable of strategic planning. . . ." Under the subheading "Red Alert," *Time* declared that "with atom bombs and bombers in the hands of an enemy, the Army and Navy, as well as the Air Force, took on new and immediate importance. If the U.S. wanted security, it would have to buy the full, costly package."[142]

While virtually everyone recognized that a nuclear war would cause unprecedented casualties and suffering, few people realized that more insidious peacetime effects were already under way. Routine operation of the atomic weapons assembly line—exposing an increasing number of Americans to radiation under normal conditions—was taking its toll. Ironically, Americans became primary victims of their own country's nuclear weapons program.

Like other major nuclear decisions before and since, the hydrogen bomb go-ahead came first. Public comment was welcome later. When it came to atomic development, the general public was in a position of reacting to one fait accompli after another. And proliferation of radiation victims followed as a consequence.

As the new decade began, the White House, Defense Department, and Atomic Energy Commission were coordinating hush-hush meetings about the H-bomb—a weapon involving fusion of hydrogen into helium. The required high temperature of hundreds of millions of degrees would be possible only from an atomic bomb detonation—so A-bomb capability was a prerequisite for triggering an H-bomb's "thermonuclear" explosion. Scientists estimated that if an H-bomb were possible, it could bring about one thousand times the explosive force of an A-bomb.

---

136. York, *The Advisors*, pp. 19-20.

137. Ibid., p 18.

138. Ibid.

139. Prior to the first Soviet atomic test, in 1948 and 1949, public speeches by a number of high-ranking American generals had contended that a preemptive nuclear attack on the Soviet Union's major cities and industrial centers might be a good idea. (See Fleming, *The Cold War*, p. 391.)

140. York, *The Advisors*, p. 34.

141. Ibid., p 63.

142. *Time*, October 3, 1949, p. 7.

Albert Einstein was among those in 1950 who viewed current events with trepidation. Within the U.S. he warned of "concentration of tremendous financial power in the hands of the military, militarization of the youth, close supervision of the loyalty of the citizens, in particular, of the civil servants by a police force growing more conspicuous every day. Intimidation of people of independent political thinking. Indoctrination of the public by radio, press, school. Growing restriction of the range of public information under the pressure of military secrecy."[143]

It was in this atmosphere that deliberations over whether to proceed with H-bomb research reached their climax. That secretive process is important to understand "because it is one of the relatively few cases where those who explicitly tried to moderate the nuclear arms race came within shouting distance of doing so," according to Herbert York, the first director of the Lawrence Livermore Laboratory where much of the hydrogen bomb R and D subsequently took place. Behind the scenes there was, in York's words, "a brief, intense, highly secret debate."[144]

Under federal law a key source of recommendations for the Atomic Energy Commission was its General Advisory Committee. Called upon by the AEC to take up the question of prospective H-bomb development, the Advisory Committee—chaired by J. Robert Oppenheimer and including such luminaries of nuclear physics as Enrico Fermi and I. I. Rabi—met in late October 1949. While urging continued efforts to magnify the power of atomic weaponry, the Advisory Committee urged that the United States *not* plunge ahead with developing the H-bomb, also known as the "super bomb."[145]

The panel presented arguments in terms of military strategies, technical aspects, and optimum use of present nuclear resources, concluding that the H-bomb was not needed for U.S. national security. The report also depicted the H-bomb choice as a profound moral issue: "It is clear that the use of this weapon would bring about the destruction of innumerable human lives; it is not a weapon which can be used exclusively for the destruction of material installations of military or semi-military purposes. Its use therefore carries much further than the atomic bomb itself the policy of exterminating civilian populations."[146]

An addendum to the Advisory Committee report, written by James B. Conant—later president of Harvard University—and signed by five other committee members including Oppenheimer, underscored the moral moment of the H-bomb decision: "Let it be clearly realized that this is a super weapon; it is in a totally different category from an atomic bomb. . . . Its use would involve a decision to slaughter a vast number of civilians. We are alarmed as to the possible global effects of the radioactivity generated by the explosion of a few super bombs of conceivable magnitude. If super bombs will work at all, there is no inherent limit on the destructive power that may be attained with them. Therefore, a super bomb might become a weapon of genocide."[147]

These and other anti-H-bomb scientists were in effect muzzled from openly expressing their viewpoints at critical junctures, held back by security-clearance status. Thus in the crucial months before Truman proclaimed his decision on H-bomb development, the public was allowed little information about a decision that could potentially result in millions of deaths and change the course of human history.

In top-secret circles the debate was fierce. Senator Brien McMahon, chairman of the Joint Committee on Atomic Energy, confided in Edward Teller that the anti-H-bomb Advisory Committee report "just makes me sick."[148] For their part McMahon and a constellation of atomic scientists, including Teller and University of California Radiation Laboratory director Ernest Lawrence, were determined to bring about development of the H-bomb as soon as possible, believing it to be the best possible response to Soviet possession of the atom bomb.[149]

Teller went out of his way to tell *Bulletin of the Atomic Scientists* readers at the time: "The scientist is not responsible for the laws of nature. It is his job to find out how these laws operate. It is the scientist's job to find the ways in which these laws can serve the human will. However, it is *not* the scientist's job to determine whether a hydrogen bomb should be constructed, whether it should be used, or how it should be used. This responsibility rests

---

143. *The H Bomb*, pp. 13-14.

144. York, *The Advisors*, pp. ix, 2.

145. Ibid., pp. 150-159.

146. Ibid., p. 155.

147. Ibid., pp. 156-157.

148. Ibid., p. 60.

149. Ibid., p. 45.

with the American people and with their chosen representatives."[150] But in the real world—as Teller well knew—secrecy restrictions prevented the American people from participating in the deliberative process until the basic decisions had already been made at governmental top levels, by men very much like himself.

The Pentagon provided important support for the hydrogen bomb. Defense Secretary Louis Johnson, Military Liaison Committee chairman Robert LeBaron, and, less strongly, the Joint Chiefs of Staff urged proceeding with the H-bomb.

Most of the five-member Atomic Energy Commission opposed development of the H-bomb, at least for the present. But commissioner Lewis Strauss vehemently argued that the AEC's Advisory Committee had inappropriately raised issues of morality.

In a letter to President Truman in late November 1949 Strauss urged approval of a crash program to come up with the H-bomb. Strauss—who later became chairman of the AEC—warned that the Soviet Union could be expected to develop the H-bomb. "A government of atheists," Strauss added, "is not likely to be dissuaded from producing the weapon on 'moral' grounds."[151] Neither would a government of Christians and Jews.

On January 31, 1950, President Truman announced he was ordering full-speed-ahead research and development for the H-bomb.

Atomic Escalation

Without so much as hinting that tests of the H-bomb could vastly increase harmful radiation fallout, America's mass media applauded the President's latest nuclear-related action. "No presidential announcement since Mr. Truman entered the White House seemed, in the opinion of many observers, to strike such an instant or general chord of nonpartisan congressional support," *The New York Times* reported.[152] "Under the circumstances," *Newsweek* added, "it was the only answer he could give."[153]

Reporting of the AEC Advisory Committee's moral objections to the H-bomb was lacking. As for the more general matter of scientists' compunctions about assisting research for a weapon of such mass annihilation, *Newsweek* did affirm that "many, if not most, of the nation's atomic scientists had developed 'a Hiroshima complex'; they were appalled by the death and destruction which the A-bomb had wrought; and they detested the idea of developing an even more murderous weapon." But, said the magazine, "as patriotic Americans, they were ready to squelch any moral reservations they might have if the AEC gave the go-ahead signal."[154]

Dissenting voices, published in some small periodicals, were all but ignored. "One difficulty created by the cold war is that it makes everything America does right and unquestionable for Americans and everything Russia does wrong and indefensible," observed a lengthy analysis in *The Nation.*[155] Much was being demanded in the name of *patriotism,* including the setting aside of moral reservations.

The Nation perceived that a perverse logic had taken hold of nuclear policy-making: "The decision to proceed with the construction of the hydrogen bomb carries the folly of present thinking about defense close to suicide. If fear is to be man's defense, the fear must be magnified to the greatest possible extent. That is to say that the greater the fear the greater the safety, another way of saying that the greater the danger the greater the safety."[156]

As a corollary in the prevailing atomic syllogisms, horrors of the past justified more lethal atomic weaponry for the future. Allied firebombing sieges of Dresden and Tokyo had been recalled as justifications for the later atomic bombings of Hiroshima and Nagasaki; these nuclear bombings, and the very existence of an atom bomb arsenal, in turn, provided rationales for preparing the hydrogen bomb.[157] In nuclear escalation today's awesomely repugnant

150. Ibid., p. 71.

151. Ibid., p. 58.

152. *New York Times,* February 1, 1950.

153. *Newsweek,* February 13, 1950, p. 20.

154. Ibid., p. 19.

155. Raymond Swing, "Prescription for Survival," *Nation,* February 18, 1950, p. 152. For another contemporary critique of Truman's H-bomb decision, see *Christian Century,* February 15, 1950, p. 198.

156. Swing, "Prescription for Survival," p. 151.

157. For an example of the public arguments used to justify the H-bomb on grounds of earlier forms of brutality, see the 1950 essay by Robert F. Bacher, head of the California Institute of Technology physics department who had been a charter AEC commissioner, in *The H Bomb,* p. 142.

spectacle became tomorrow's diminutive old hat.

The 180 American atmospheric nuclear bomb detonations between 1950 and 1960 carried with them great political power. Senators Millard Tydings and Glen Taylor were object lessons.

Tydings, an aristocratically mannered parliamentarian from Maryland, was chairman of the Senate Armed Services Committee. Taylor had been elected to the Senate from Idaho after a barnstorming career as a Western vaudevillian earned him the sobriquet "the handsome cowboy singer." Both men had become vocal foes of unbridled nuclear weapons development and indiscriminate disloyalty charges against dissenters from the cold war.[158] And, in 1950, both Tydings and Taylor were up for reelection.

At the same time Senator Joseph McCarthy was in the midst of launching to new depths his crusade to depict a wide array of citizens and organizations as un-American and pro-Communist—a drive that was to put the word *McCarthyism* into the political lexicon as a synonym for unsubstantiated, scurrilous smear tactics. Only ten days after Truman's directive favoring the H-bomb, McCarthy delivered a famous speech in Wheeling, West Virginia, claiming that there were many Communists in the U.S. State Department. McCarthy's witch-hunting star was on the rise, with nuclear weapons enthusiasm and anti-Communist hysteria dovetailing nicely for him and his backers.[159]

But, in 1950, Senator Millard Tydings unrepentantly advocated comprehensive disarmament talks to halt and reverse the nuclear arms race. He was one of McCarthy's prime targets. That autumn, running for reelection, Tydings went down to defeat in a campaign filled with charges that he had amiable relations with Communists and was not in favor of vigorously combating reds.[160]

Glen Taylor, elected to the Senate in 1944, was given to committing serious breaches of contemporary political etiquette. In 1948 Taylor ran as the vice-presidential candidate on the Progressive Party's national ticket headed by Henry Wallace. Taylor's decision to run for vice-president came after a meeting with Truman, who expressed views favoring military confrontation with the Soviet Union—an approach that Taylor found appalling in the atomic age. The Progressive Party involvement clearly jeopardized Taylor's Senate career, and even his future ability to support his children and send them through school. "Well hell, honey, if there's an atomic war, it won't matter none if the kids are educated or not," Taylor told his wife.[161]

During his unsuccessful campaign for reelection to the Senate in 1950 Taylor was called to account for his staunch opposition to nuclear boosterism; he was branded disloyal and worse. The sort of conduct that had made him a target was epitomized in a Senate debate two days after Truman's announcement that the U.S. was going ahead with the H-bomb.

"I feel that we have handicaps to overcome," Taylor told the Senate. "The fact that the evil influence of Dillon, Read & Co. was largely responsible for shaping our foreign policy and creating mistrust in many areas of the world, has placed us at a disadvantage."[162] Taylor had committed a severe indiscretion.[163] He had raised the issue of corporate control over U.S. nuclear policies.

The leading Wall Street banking firm of Dillon, Read & Co. was, in fact, well represented in the top echelons of the federal administration that brought the nuclear industry over the billion-dollar-a-year mark in 1950. Truman's secretary of defense, James V. Forrestal, was formerly president of Dillon, Read & Co.; William H. Draper, a high-ranking executive of the same firm, became undersecretary of defense.[164]

Truman's appointee as the AEC's research director, Dr. James B. Fisk, was a former executive of Bell Telephone

---

158. See Peter Collier, "Remembering Glen Taylor," *Mother Jones,* April 1977, pp. 43-53. For Senator Tydings' position on disarmament and ending U.S.-Soviet tensions, see Fleming, *The Cold War,* p. 527.

159. For news coverage of McCarthy and Tydings during this period, see *Newsweek,* July 31, 1950, pp. 25-29; also, *Newsweek,* March 5, 1951, p. 25.

160. Fleming, *The Cold War,* p 534.

161. Collier, "Remembering Glen Taylor," p. 48.

162. *The H Bomb,* p. 94.

163. Senator Brien McMahon, chairman of the Joint Committee on Atomic Energy, leapt up to chastise the errant Senator Taylor. "I cannot let go unchallenged the Senator's assertion that the foreign policy of the United States has been written by any banking firm be it Dillon, Read & Co. or any other firm," McMahon declared on the Senate floor. McMahon added: "We cannot tolerate without speaking up the attack which I feel has been made by the Senator from Idaho on the sincerity of our position, and which does not help the cause of peace." (*The H Bomb,* pp 94-95.) Idaho Senator Taylor had indeed touched a sensitive nerve.

164. Fleming, *The Cold War,* p. 437.

Laboratories. The AEC commissioners included Sumner Pike, who had been a Republican member of the Securities and Exchange Commission, and Lewis Strauss—a rear admiral and New York banker.[165]

To astute financiers the late 1940s signaled prospects for huge profits to be made from nuclear investments.[166] Fairchild, General Electric, and Monsanto Chemical were taking the lead in postwar corporate nuclear involvements.[167] By the start of 1949 the list of postwar corporate investors had lengthened to include such major companies as Du Pont, Westinghouse, Standard Oil Development Co., Union Carbide, Kellex Corp., Blaw-Knox, and Dow Chemical.[168] A cornucopia of government contracts was anticipated.

"ATOM BECOMES BIG BUSINESS AT BILLION DOLLARS A YEAR," blared a 1950 headline in *US. News & World Report*. "All across the country, research installations and industrial projects are to be built or expanded as part of the rapid growth of the atom into a big business. Hydrogen-bomb development will be fitted into this pattern."[169]

There was talk, too, of developing nuclear power for electricity—a prospect that would evolve into the "Atoms for Peace" program a few years later. More certain to investors as the 1950s began, however, was the lure of nuclear weaponry.[170]

"To What Extent Can We Trust Ourselves?"

With the twentieth century at its midpoint the United States geared up for a quantum leap in the magnitude and frequency of atomic bomb tests. Wrapped in the flag, the testing package grew bigger, costlier, and deadlier.

Even before the first of hundreds of U.S. nuclear test explosions took place in the 1950s, some nuclear scholars warned about the biological implications of large-scale atomic blasts. One of the first was Hans Bethe, a Nobel laureate credited with discovering energy mechanisms present within the sun—knowledge that proved integral to H-bomb development.

Bethe had served as director of theoretical physics at the Los Alamos laboratory during World War II. A professor at Cornell University, he and eleven other prominent physicists expressed deep concern about the H-bomb in a public statement issued at a Columbia University meeting of the American Physical Society, a few days after Truman's directive approving the new weapon.[171]

In late February 1950 Bethe appeared on an NBC radio round-table discussion that provoked national controversy. When the moderator raised the question of radiation dangers from thermonuclear weapons, Bethe responded: "You are certainly right when you emphasize the radioactivity. In the H-bomb, neutrons are produced in large numbers. These neutrons will go into the air; and in the air they will make radioactive Carbon-14, which is

---

165. *Business Week,* March 15, 1947, pp. 38, 41.

166. In 1948 the Atomic Energy Commission sought suggestions on how to best draw in the private sector, setting up the "Industrial Advisory Group" headed by the president of Detroit Edison and including executives in such corporations as Standard Oil of Indiana, Gulf, and Babcock & Wilcox. See *Newsweek,* January 10, 1949, p. 63.

167. *Business Week,* March 29, 1947, p. 22.

168. *Business Week,* January 1, 1949.

169. *U.S. News & World Report,* February 10, 1950, p. 11.

170. The issue of corporate interests in perpetuating atomic development and the nuclear arms race is commonly viewed as a rather indiscreet subject—perhaps all the more so because of its critical importance. Within the nuclear weapons and arms control establishment even those individuals who have served as voices of moderation prefer not to talk about it publicly. Herbert F. York, director of the Lawrence Livermore Laboratory from 1952 to 1958, later served in prominent positions related to nuclear arms control under Presidents Eisenhower, Kennedy, Johnson, and Carter. York became a fervent and articulate supporter of disarmament. Yet, in a book he wrote in the mid-1970s, York blamed the momentum of technology while disregarding corporate influence: "The possibilities that welled up out of the technological program and the ideas and proposals put forth by the technologists eventually created a set of options that was so narrow in the scope of its alternatives and so strong in its thrust that the political decision makers had no real independent choice in the matter." (*The Advisors,* p. 11.)

While stating that in his view responsibility for the cold war and arms race "is widely shared among the major powers of the world," York wrote "I do believe that the United States has pursued policies which caused the technological arms race to advance at a substantially faster pace than was really necessary for America's own national security." In diagnosing why this has happened, however, York sanitized the issue so that no one on Wall Street, in nuclear laboratories, or at government agencies need squirm: "The reasons for this are not that American leaders have been less sensitive to the dangers of the arms race than the leaders of other countries, nor that they are less wise or more aggressive. Rather, the reason is that the United States is richer and more powerful, and its science and technology are more dynamic and generate more ideas and inventions of all kinds, including ever more powerful and exotic means of mass destruction. In short the root of the problem has not been maliciousness, but rather a sort of technological exuberance that has overwhelmed the other factors that go into the making of overall national policy." (*The Advisors,* p. ix.)

171. *Science,* February 17, 1950, p. 190.

well known to science. This isotope of carbon has a life of 5,000 years. So if H-bombs are exploded in some number, then the air will be poisoned by this Carbon-14 for 5,000 years. It may well be that the number of H-bombs will be so large that this will make life impossible."[172]

Another panelist on the NBC program was Leo Szilard, a University of Chicago professor of biophysics who had been influential in getting the U.S. to embark on atomic development for military purposes at the start of World War II. A physics pioneer whose work on uranium's neutron emissions had made it possible to sustain chain reactions, Szilard posed a profound overview for the national radio audience to ponder. Said Szilard:

> In 1939 when we tried to persuade the Government to take up the development of atomic energy, American public opinion was undivided on the issue that it is morally wrong and reprehensible to bomb cities and to kill women and children. During the war, almost imperceptibly, we started to use giant gasoline bombs against Japan, killing millions of women and children; finally we used the A-bomb. I believe there is a general uneasiness among the scientists. It is easy for them to agree that we cannot trust Russia, but they also ask themselves: To what extent can we trust ourselves?[173]

Such talk from impeccably credentialed individuals, if widely disseminated, could have been a roadblock to the nuclear weapons testing program. David E. Lilienthal, who had just retired from his post as chairman of the Atomic Energy Commission, promptly denounced the scientists who had appeared on the NBC round-table radio show as "oracles of annihilation." Lilienthal, speaking at a Town Hall forum in New York City, warned that the "new cult of doom" was liable to bring about "hopelessness and helplessness. . . . And hopelessness and helplessness are the very opposite of what we need. These are emotions that play right into the hands of destructive Communist forces."[174]

If physicists of Bethe's and Szilard's stature could be taken to task for warning the public about perils of radiation, less secure critics had better watch their step. Those running the nuclear machinery were anxious to make clear that they would employ derision and innuendo to fight anyone opposing atomic proliferation. Such pressure would be felt for decades to follow as scientists attempted to investigate the full implications of radiation effects on human health.

Dr. Szilard's unpleasant question, however, would prove prophetic for many thousands of Americans whose lives were forever altered by the mushroom clouds that followed his broadcast words: *To what extent can we trust ourselves?*

---

172. *The H Bomb,* p. 112.

173. Ibid., pp. 118-19

174. *New York Herald Tribune,* March 2,1950; reprinted in *The H Bomb,* pp. 121-122.

3

Bringing the Bombs Home

In 1951 few people openly objected to the U.S. Government's announcement that it would begin exploding atomic bombs over Nevada along with continuing atmospheric tests in the Pacific. The reasons were couched in national-security terminology. The Korean War was well under way. Nuclear tests in Nevada would mean a far shorter supply line from weapons laboratories and materiel depots.[1] And continental testing meant diversified atomic war game scenarios for U.S. troops. These logistical and economic advantages all supported the government's decision to expand the nuclear test program by bringing it closer to home.

A test site on the mainland, stated the AEC's director of military application, would serve as "a location where its basic security and general accessibility cannot be jeopardized by enemy action."[2] Rejecting alternative spots in New Mexico Utah, and North Carolina, the AEC's commissioners agreed upon the desert area northwest of Las Vegas.[3]

The location in southern Nevada seemed almost ideal for the purpose at hand. The Nevada Test Site would be buffered from access by being placed within the Tonopah Bombing and Gunnery Range, which had already claimed over five thousand square miles. On the southern edge of the site the Air Force had already erected temporary buildings at Camp Mercury that could be handy in administering the nuclear tests.

Government nuclear planners held a series of meetings to pinpoint "radiological hazards" involved with exploding atom bombs in Nevada. A secret conference of more than a score of officials—including Enrico Fermi and Edward Teller—at Los Alamos on August 1, 1950, discussed anticipated off-site safety aspects. Concern was raised for keeping the most densely populated areas out of the heaviest fallout zones. Official minutes of the meeting acknowledged "the probability that people will receive perhaps a little more radiation than medical authorities say is absolutely safe."[4]

America plunged ahead with an intensive atomic bomb test program. During the 1950s and early 1960s more than two hundred nuclear weapons sent huge mushroom clouds of radioactivity into the atmosphere from the Pacific and Nevada. Total explosive force of those bombs, according to official figures, surpassed ninety thousand kilotons—ninety megatons—equivalent to more than seven thousand atomic bombs the size of the one dropped on Hiroshima.[5]

Some people were in the way, living in the wrong places at the wrong time.

Downwind Residents

Routinely, large atomic clouds blew from the Nevada Test Site to rural communities like Enterprise—a small town, more than one hundred miles away in southwestern Utah, surrounded by productive farms and arid grazing country dotted with sagebrush and juniper trees.

---

1. For description of Los Alamos Laboratory discussion that led up to establishment of a continental test site, see McPhee, *Curve of Binding Energy*, pp. 59 60.

2. "Location of Proving Ground for Atomic Weapons," AEC Memo 141/7, December 13, 1950, p. 2.

3. Meeting on December 12, 1950, the AEC approved recommendations for proceeding with plans to use the Nevada site, although some staff memoranda conceded that assumptions of safety for downwind residents were speculative. "These questions may be answered satisfactorily as test knowledge increases . . . but they're not satisfactorily answered at present," said one memo. (Uhl and Ensign, *GI Guinea Pigs*, p. 55.) For details of test-site selection, see Howard L. Rosenberg, *Atomic Soldiers* (Boston: Beacon Press, 1980), pp. 26-31.

4. "Meeting: Discussion of Radiological Hazards Associated with a Continental Test Site for Atomic Bombs," AEC, Los Alamos, New Mexico, August 1, 1950, pp. 13, 23, 24. Conferees concluded that "a tower-burst bomb having a yield of 25 kilotons could be detonated without exceeding the allowed emergency tolerance dose of 6-12 r [roentgens] outside a 180-degree test area sector 100 miles in radius."

5. *Announced US Nuclear Tests*; "Joint Force Seven, Report WT-933: Cloud Photography," U.S. Government, January 27, 1958—cited in York, *The Advisors*, p. 86.

The same year nuclear testing began, a boy named Preston Truman was born near Enterprise. His parents, ranchers and farmers, taught Preston to ride a horse at the same time he learned to walk. "I can remember," he would recall, "several times getting up with the rest of the family and driving out to my father's farm in the moments before dawn and watching the western sky light up with the flash from the bombs in Nevada approximately 112 miles away. I remember on occasion hearing the sound waves come over. I remember later in the mornings watching on a couple of occasions clouds come over. To a little child that didn't mean much. The atomic tests were very much a part of our lives."[6]

When he was in high school, Preston Truman was diagnosed with a form of cancer called lymphoma. Chemotherapy and other medical treatment over the next thirteen years cost about $100,000. As was true for all other downwind residents, the government did not provide a penny. But Truman was relatively lucky. In 1980 he was in remission from the usually fatal lymphoma. Out of nine children who were his friends in the immediate area of Enterprise when he was a child, Truman was the only one who reached the age of twenty-eight. The rest died of leukemia or cancer.[7]

The lethal potential of the nuclear tests was not immediately apparent to Truman and others. Especially in the first years of the A-tests there was confidence in the government's trustworthiness. "It was kind of almost a carnival atmosphere in the beginning with the radio telling us where the clouds were going, following the tests, and always assuring us there was no danger," Truman recalled. "But that wasn't the way it continued."[8] The incubation periods, from initial radiation exposure to the development of consequent diseases, began to expire.

Always to remain vivid in Preston Truman's memory was a day when, five years old, he heard that all was not well for the young children of Enterprise. "I remember one morning going to the store with a friend of mine to cash in pop bottles, and listening to some people from the town talk about a boy our age who was dying of leukemia and listening to the details of the nose bleeds and the suffering he was going through. And this was a shock. I remember talking with my friend and wanting to know; we didn't know that little children could die, we had never seen that."[9]

Forty miles east of Enterprise, in Cedar City, Blaine and Loa Johnson buried their twelve-year-old daughter in 1965. She died of leukemia. A total of seven leukemia cases occurred for people within a two-hundred-yard radius of their home, in the space of a dozen years.[10]

In the next sizable town, twenty miles farther northeast along Interstate 15, residents in the devout Mormon community around Parowan were similarly hard hit. In 1978 Frankie Lou Bentley, whose mother and stepfather both died of cancer a year apart, listed more than 150 cancer victims in the Parowan-Paragonah-Summit area, which contained about fourteen hundred people during the nuclear tests in neighboring Nevada. The cancer was particularly startling because so few people smoked in the community. "It's amazing that there should be so many cancer cases in an area as small as this," she told a county newspaper. "It's to the point now where there's not a person in town who hasn't lost at least one relative or knows of several people who have died of cancer."[11]

A coworker with Frankie Lou Bentley at the Bank of Iron County office in Parowan, Wilma Lamoreaux, watched her fifteen-year-old son Kenneth die of leukemia in 1960.[12] During a two-year period, leukemia struck four youngsters in Parowan and Paragonah,[13] an extremely high rate for towns with a combined population of about one thousand. Normally, not even one leukemia would have been expected by medical statisticians.[14]

Eighteen years after her son's death from leukemia, Wilma Lamoreaux declared, "There's been wrong done. There's no relief in knowing your son died of negligence." She added: "I don't want to be a rabble-rouser or anything but I don't want another generation to go through this. Cancer is such a long, painful, drawn-out death.[15]

---

6. *Citizens' Hearings,* pp. 8-9.

7. Preston Truman, interviews, February 1980, December 1980, June 1981.

8. *Citizens' Hearings,* pp. 8-9.

9. Ibid.

10. *The Tribune* (Salt Lake), Associated Press, November 21, 1978; Loa Johnson, interview, June 1981.

11. *Color Country Spectrum* (Utah), December 22, 1978.

12. Ibid.

13. *The Tribune* (Salt Lake), Associated Press, November 21, 1978.

14. Clark W. Heath, Jr., M.D., Chief, "Subject: Leukemia in Fredonia, Arizona," U.S. Public Health Service Memo, Leukemia Unit, Epidemiology Branch, August 4, 1966.

15. *Color Country Spectrum,* December 22, 1978.

In the nearby Escalante Valley cancer caused forty-eight of sixty-three "natural" deaths in official records since the atomic testing began—an extraordinarily high ratio.[16]

And there were other worries. One fifth of the male high school graduates of the 1950s and early 1960s in Cedar City discovered they were sterile,[17] a particularly grievous condition in a Mormon culture which places great stress on holy edicts to raise large families. For those who became parents, there were fears of genetic damage.

Elizabeth Catalan, who was a teenager while growing up in southwest Utah during the 1950s, lost her father to leukemia when he was forty-three, and a sister to complications from an enlarged thyroid. A surviving sister's daughter remained on her mind: "I watched my beautiful little niece, Kay's child, cope with the birth defect that left her with a ganglia that doubled the size of her tongue and wound around, like a weed, inside her neck and down into her shoulder."[18] Elizabeth Catalan thought too about girls she abnormalities in their children.

When Beth Catalan became pregnant, the fetus dissolved *in utero*. "One of the things I always wanted to be was a mother," she told a citizens' commission inquiry in Washington in 1980, adding that "you run a Geiger counter over my body and it'll click."[19] She decided not to take the risk of trying again to give birth to a baby.

Nestled in a picturesque valley, Beth Catalan's hometown of St. George long enjoyed bounties of the land. Since the days that Brigham Young, elder of the Church of Jesus Christ of Latter-Day Saints, wintered in St. George, the town seemed to epitomize reasons for Mormon references to the Utah region as "Zion." Benefiting from a warm winter climate, proudly sustaining a college, in the middle of the twentieth century St. George was a tranquil and in many ways idyllic place to live.

On a sunny day about three decades after nuclear weapons testing began upwind, a seventy-three-year-old woman named Irma Thomas opened the front door of a trim house on East Tabernacle Street in St. George. She had grown accustomed to welcoming out-of-state researchers carrying notepads and tape recorders and cameras.

Irma Thomas offered the visitors chairs in her living room, next to the shelves of ceramics she had made with her hands until disquiet with the gathering tragedies in the neighborhood had compelled her to put aside the potter's wheel. Few questions were necessary to prompt her to speak about painful realities: a town, and an entire region, devastated.

"We're not numbers, we're not statistics, we're human beings," she said, motioning to her living-room wall covered with family photos, an acute blend of pain and fury and vulnerability seeming to lace her words as she spoke. She did not mention the skin cancer across her back. Sometimes she laughed, an irrepressible zest for life surfacing through outrage and anguish. She talked about the suffering of her cancer-ridden husband, of her daughter, whose nervous system was in the process of falling apart, of her children's blood damage, stillbirths, hysterectomies, and miscarriages, of her brother, destined to die of bone cancer less than a year after the interview.[20] grew up with, now women, coping with aftermaths of miscarriages and physical

And she pointed through the living-room walls toward the homes of neighbors in the residential area. She had compiled a list of thirty-one cancer victims who lived in the houses within a block radius;[21] smoking was rare in the heavily Mormon community.

"They couldn't pay anyone for the loss of a child. I hope they realize that," she said, hands folded in her lap. "And the people of my generation are just dropping by the wayside."[22]

Punctuated by her special kind of laughter, and silences, eyes often brimming with tears, Irma Thomas shared her perceptions about living in a town A-bombed by its own government:

> We accepted all this. It was our government and we accepted it. . . . We didn't connect it to people's cancer at first. It takes a while. . . . I've been at work on this for two years. I was concerned about it many

---

16. Samuel H. Day, Jr., "Rebellion in the Rockies," *Progressive*, February 1981, p. 9.

17. Ibid.

18. *Los Angeles Times*, April 11, 1980.

19. *Citizens' Hearings*, p. 6.

20. Irma Thomas, interview, February 1980.

21. Ibid.

22. Ibid.

years before that. The people of St. George, after the 1953 blast, some of the people got a little nervous . . . People had to have cars washed down . . . The AEC guys came by to soothe all the ruffled feathers. . . . And yet so many people died from that. You'd have to be blind, deaf, and dumb not to see it. And it's pretty horrendous....

I work to raise my children. And later I find out this has happened, it just infuriates me so I can hardly stand it. I get so upset and frustrated, I can hardly stand it . . . The victims are outraged. . . . Our earth is getting so filled with radioactive waste. And it doesn't go away. . . .

One of my favorite sayings, "Oh too much talk, hit 'em on the head with a rock." . . . I'm going to keep pounding, here and there and everywhere, till somebody hears me. . . . All I can do is right here, in this house. All I can do is do what I can, the way I can. . . . Look how long we suffered, for thirty years. Nobody makes a peep. When the congressional hearings were happening last year, I told them it looks like a big show for the politicians. . . . At the hearings it came out, about the government trying to confuse us with "fission" and "fusion" [a secret directive from President Dwight Eisenhower]. That big old Army president we had. I'd like to dig him up and hit him in the head.[23]

By 1980 recent national publicity had often left the impression that St. George and nearby towns were the main recipients of radioactive clouds from Nevada bomb blasts. But test fallout was not limited to the southern part of Utah. More than two hundred miles northeast of St. George, between the cities of Provo and Salt Lake City, is the town of Pleasant Grove, populated by several thousand people. Affidavits filed in federal court in 1980 cited ten leukemia deaths among people living in Pleasant Grove during the 1960s; seven of those leukemia fatalities were children.[24]

Still farther away from the Nevada Test Site, in the Uinta Mountains of northeast Utah some four hundred miles from where the atom bombs exploded aboveground, severe impacts have been reported as well. The Uinta mountain range tended to have a "sweeping effect," bringing down fallout on grasslands in the dairy country below the Uinta peaks. In the summer of 1980 a U.S. District Court suit charged that the government should be held liable for radioactive contamination of milk in the area and resulting cancer.[25]

One of the plaintiffs, David L. Timothy, grew up on a dairy farm in the mountainous region of northeastern Utah. When he was nineteen cancer was discovered in his thyroid—where radioactive iodine 131 from fallout is known to lodge. In 1981, after undergoing thyroid surgery eight times, Timothy angrily demanded to know "why the hottest spot in the state has been ignored by not only the officials but the news media too."[26]

Rose Mackelprang also wondered about lack of attention to the town of Fredonia in northern Arizona, about two hundred miles from the nuclear test site. National journalists visiting St. George across the Utah border had not bothered to report what happened to Fredonia's residents in the wake of atomic fallout that regularly passed over their town.

Soft-spoken, demure, devoted to the Mormon Church, Rose Mackelprang was willing to talk about what she could never forget. "My husband and I moved to Fredonia in 1948. It's just a little town, and we have a very happy atmosphere down there. We did rather, anyway. They raise their own gardens and most of 'em have their own cows, a lot of them do, and they have gardens and bottle their own food, put it up, store it, that's just the life of a small community."[27] Rose Mackelprang's husband, Gayneld, became a teacher in the public schools of Fredonia, where the lumber industry was assuming economic importance alongside farming and livestock.

"At that time, when they started the testing in Nevada, it'd be at dawn when the tests would go off and we could see this big light and then the ground would shake, it'd billow up you could see the big mushroom cloud go way up and it was really quite exciting, it was different, we didn't really know that much about it. As far as we knew, why, it was really going to help us out, it was really something that our government was doing and it would be for our own

---

23. Ibid.

24. *The Tribune* (Salt Lake), May 17, 1980.

25. *The Tribune* (Salt Lake), August 13, 1980.

26. David Timothy, interview, January 1981.

27. Rose Mackelprang, speech to National Conference for a Comprehensive Test Ban, University of Utah, Salt Lake City, December 12, 1980.

good. We trusted the government, we figured that it was necessary because, after all, the government does look after us, and they're over the people and they will take care of anything that needs to be taken care of to see that it's healthy, or otherwise . . . So we didn't worry about it."[28]

In 1960 the population of Fredonia was 643. By 1965 four had passed away from leukemia—a truck driver, who died at age forty-eight; a fourteen-year-old girl; a lumber crane operator, thirty-six; and Gayneld Mackelprang, by that time forty-three years old and superintendent of the Fredonia Public Schools. A secret memorandum by the U.S. Public Health Service's leukemia unit director, Dr. Clark W. Heath, Jr., noted, "This number of cases is approximately 20 times greater than expected."[29] In the entire previous decade 1950 to 1960 no cases of leukemia had been reported among Fredonia residents. The memo, dated August 4, 1966, and sent to the head of the federal agency's Communicable Disease Center, was marked "FOR ADMINISTRATIVE USE ONLY, NOT FOR PUBLICATION."[30]

Soon after learning it was leukemia, Gayneld Mackelprang was dead. His widow recalled, "The doctors said it was a lot farther advanced than they ever guessed. It was a shock, I can tell you. We hardly knew what to do, no plans, no nothing. I had six children home, and I was expecting my seventh in six weeks."[31]

Cancer became commonplace in Fredonia. Rose Mackelprang ticked off the names of the next towns north along Highway 89—Kanab, Orderville, Glendale—where cancer and leukemia had appeared. "Some of them have died with leukemia, we have a lot of cancer, and it's not the end of it. It's still going on." Federal agencies continued to deny responsibility. "One thing that really upsets me," she added, "is that instead of telling us it was dangerous, they have denied it all the time, they've said they're not at fault."[32]

AEC Denials

In the 1950s few Americans knew of the health risks associated with bomb fallout. The test program had been cast in a patriotic light by the official releases that the press circulated. For those who feared ill effects from radiation, government assurances were profuse. Year after year media conveyed U.S. Atomic Energy Commission announcements to downwind residents: "There is no danger."[33]

But sheep, thousands of them, abruptly sickened and died. Country dwellers noticed that wildlife, from deer to birds, thinned from expansive rangelands regularly dusted with fallout from the Nevada Test Site upwind. And in one small community after another, people died from diseases rarely seen there before: leukemia, lymphoma, acute thyroid damage, many forms of cancer.

"My father and I were both morticians, and when these cancer cases started coming in I had to go into my books to study how to do the embalming, cancers were so rare," remembered Elmer Pickett, a lifelong resident of St. George, Utah. "In '56 and '57 all of a sudden they were coming in all the time. By 1960 it was a regular flood."[34]

As latency periods came due, towns like St. George began to reap a grim harvest sown by the atomic whirlwinds. They were mostly populated by Mormons, devoutly obeying their Church's instructions not to smoke tobacco or drink alcohol. Cancer had never been a noticeable problem before. But, as the 1950s wore on, and for decades afterward, the ravaging effects came like a pestilence in serial form: the leukemias, usually quickest to result from radiation exposure, came first; numerous types of cancer, emerging in body organs or in bones, tended to arrive later.

Despite its claims that neither the detonations nor fallout were harmful, the Atomic Energy Commission routinely waited until the winds were blowing in the "right" direction.[35] That meant away from big cities like Las Vegas and Los Angeles. Occasionally at the last minute shifting breezes dumped fallout on large metropolitan areas—Las Vegas was sprinkled with radioactivity in 1955, for example, and three years later fallout clouds dropped on Los

---

28. Ibid.

29. Heath, "Subject: Leukemia," August 4, 1966.

30. Ibid.

31. Rose Mackelprang speech.

32. Ibid.

33. Jack Willis and Saul Landau, *Paul Jacobs and the Nuclear Gang* (New York: New Time Films, 1979), transcript p. 1.

34. *Life*, June 1980, p. 36.

35. This policy was reflected in numerous AEC deliberations and decisions; for example, commissioners' meetings of March 1 and March 14, 1955.

Angeles. But for the most part America's continental nuclear tests went according to plan. The most deadly concentrations of fallout came down in rural areas of Nevada, Utah, and northern Arizona.

After southern Utah sheepherders lost massive numbers of their livestock, they unsuccessfully brought suit against the federal government in 1955. In court the government response was that "a combination of factors including malnutrition, poor management, and adverse weather conditions" led to the animals' deaths.[36] (Two decades later complaints near the Three Mile Island nuclear power plant in Pennsylvania, the Rocky Flats weapons production facility in Colorado, and other atomic installations would meet similar explanations.) Internal memos to the contrary from AEC researchers were suppressed. Sworn statements by sheepherders, who testified such epidemics among their livestock had never happened until the mushroom clouds rose upwind, were discounted.

However, the sheep were a kind of early-warning system for what was to follow. Starting in the mid-1950s, *leukemia* became a household word in Utah towns like St. George and Enterprise and Parowan; the same held true for communities like Tonopah in Nevada, Fredonia in Arizona. Children were especially vulnerable.

As early as 1959 a study disclosed higher radioactive strontium 90 levels in young children living downwind of the atomic tests.[37] In 1965 another suppressed study—this one by U.S. Public Health Service researcher Dr. Edward Weiss—correlated radioactive fallout with an inordinately high leukemia rate among downwind Utah residents. Weiss's report concluded: "An examination of leukemia death records in southwestern Utah" during the years of heavy fallout "shows an apparently excessive number of deaths."[38]

A joint AEC-White House meeting about the Weiss report took place in early September 1965; AEC representatives criticized the study. A week later the AEC's assistant general manager told AEC commissioners that researching such topics as downwind leukemia rates would "pose potential problems to the commission: adverse public relations, lawsuits and jeopardizing the programs of the Nevada Test Site."[39] Although atmospheric testing had been banned by then, underground tests were still releasing radioactivity into the air. And the AEC was gearing up for the civilian nuclear power program, predicated on the contention that low levels of officially permitted radiation were harmless.

The White House shelved the Weiss report in 1965, and blocked any follow-up research.[40] In fact there were many nuclear-testing-related documents and AEC meeting minutes that remained secret until 1979, when they were made public by journalists or Senator Edward Kennedy.[41] For the Weiss study that meant staying locked up in federal vaults for a full thirteen years.[42]

In 1979, however, University of Utah epidemiology director Dr. Joseph L. Lyon independently confirmed the validity of the Weiss report. In an article published in the *New England Journal of Medicine*, Dr. Lyon and associates documented that children growing up in southern Utah during the aboveground atomic weapons tests suffered a leukemia rate two and a half times higher than for children before the testing began and after it ended.[43]

In early 1981 results of the federal executive branch's Interagency Radiation Research Committee inquiry were made public—stating that a profusion of childhood cancer in southern Utah "remains unexplained on grounds other than possible fallout exposure."[44]

Health risks of living downwind from the nuclear tests were shared by Indians—particularly Duckwater Shoshones north of the test site, and Southern Paiutes to the east. Poor medical record-keeping has handicapped

---

36. *Life*, June 1980, p. 38.

37. *Washington Post*, April 14, 1979.

38. U.S. Congress, House Committee on Interstate and Foreign Commerce, Subcommittee on Oversight and Investigations, and Senate, Labor and Human Resources Committee, Health and Scientific Research Subcommittee, and the Committee on the Judiciary, *Health Effects of Low-Level Radiation*, 96th Cong., 1st sess. Serial No. 96-42, April 19, 1979, Vol. 2, p. 2195 (hereafter cited as *Health Effects of Low-Level Radiation*).

39. *Washington Post*, April 14, 1979.

40. *Deseret News*, February 27, 1979; *Washington Post*, April 14, 1979.

41. See *Health Effects of Low-Level Radiation*, Vols. 1 and 2.

42. *Washington Post*, April 14, 1979.

43. Joseph L. Lyon, et al., "Childhood Leukemias Associated with Fallout from Nuclear Testing," *New England Journal of Medicine*, February 22, 1979, pp. 397-402. Lyons's study has been criticized by nuclear proponents because in spite of the increase in leukemia rate among children in Utah, the rate was still below the U.S. average. This attitude seems to assume that every area of the U.S. "deserves" to be as polluted as the East Coast, where synergistic effects of multiple carcinogens and wash-out of radioactive chemicals from contaminated clouds compound the health problems.

44. *The Oregonian*, Associated Press, January 1, 1981.

efforts to assess fallout effects. But in 1981 Paiute Tribe of Utah vice-chair Elvis F. Wall blamed the radiation for adding to health woes among tribe members.[45]

Through it all, during three decades that started with the first mushroom clouds over Nevada in 1951, the U.S. Government nuclear weapons testing spokespeople continued to proudly observe that federal authorities had never lost a lawsuit based on radioactive fallout.[46] With about a thousand plaintiffs seeking damages in federal court as the 1970s ended, U.S. Justice Department attorneys were anxious to sustain their "perfect record" of eluding judicial pronouncements of atomic fallout culpability.

In 1979 plaintiffs accused the federal government of failing to inform area residents that fallout from the tests could cause cancer. Federal statements filed in U.S. District Court in Salt Lake City denied the charges, stating that citizens were told "there was some risk associated with exposure to radioactive fallout" during the 1950s.[47]

Those denials infuriated citizens, who produced numerous written proclamations distributed by the federal government throughout the 1950s, claiming the radioactive fallout posed no danger. One widely posted statement, dated January 1951 and signed by AEC project manager Ralph P. Johnson, read: "Health and safety authorities have determined that no danger from or as a result of AEC activities may be expected . . . All necessary precautions, including radiological surveys and patrolling of the surrounding territory, will be undertaken to insure that safety conditions are maintained."[48]

In March 1957 the AEC distributed a booklet titled "Atomic Tests in Nevada" among downwind residents. "You people who live near Nevada Test Site are in a very real sense active participants in the Nation's atomic test program," the federal pamphlet said. "You have been close observers of tests which have contributed greatly to building the defenses of our country and of the free world. . . . Every test detonation in Nevada is carefully evaluated as to your safety before it is included in a schedule. Every phase of the operation is likewise studied from the safety viewpoint." Readers were assured that after six full years of open-air nuclear tests upwind, "all such findings have confirmed that Nevada test fallout has not caused illness or injured the health of anyone living near the test site."[49]

And, in an effort to keep the local citizenry from looking too closely, the AEC included in its booklet a drawing of an unshorn, bowlegged cowboy raising his eyebrows at a clicking meter in his hand. "Many persons in Nevada, Utah Arizona, and nearby California have Geiger counters these days," the pamphlet counseled. "We can expect many reports that 'Geiger counters were going crazy here today.' Reports like this may worry people unnecessarily. Don't let them bother you."[50]

Few residents of Utah, or Nevada, or northern Arizona were surprised by the conclusions of a 1980 report issued by the U.S. House of Representatives Subcommittee on Oversight and Investigations: "The Government's program for monitoring the health effects of the tests was inadequate and, more disturbingly, all evidence suggesting that radiation was having harmful effects, be it on the sheep or the people, was not only disregarded but actually suppressed."[51]

Nevada Veterans

In early January 1951 President Truman approved the first series of Nevada atomic tests scheduled to begin later that month. When the nuclear testing started there, little information—let alone consultation—had been accorded residents in the surrounding region.

The first series of nuclear tests within North America was labeled "Operation Ranger." Over a period of ten days beginning January 27, 1951, five air-dropped A-bombs exploded over the Nevada Test Site, ranging from one to twenty-two kilotons. Sixty-five miles away, Las Vegas took the tests in stride; the only ostensible negative effects

45. Elvis F. Wall, vice-chairperson, Interim Tribal Council, Paiute Indian Tribe of Utah, Cedar City, Utah, printed statement, undated, distributed May 1981.

46. *Deseret News,* February 15, 1979.

47. *The Tribune* (Salt Lake), December 17, 1979.

48. "WARNING," sign dated January 1951, obtained from Citizens' Call organization in Utah.

49. AEC, *Atomic Tests in Nevada,* March 1957, pp. 2, 4, 15.

50. Ibid., p. 23.

51. U.S. Congress, House Committee on Interstate and Foreign Commerce, Subcommittee on Oversight and Investigations, *The Forgotten Guinea Pigs,* 96th Cong., 2nd sess., Committee Print 96-1FC 53, August 1980, p. 37.

were a couple of broken windows resulting from an eight-kiloton blast code-named Baker-2.[52]

As with the Pacific test program, no plans were incorporated to evaluate the impact of radiation on human beings. Rather, the Army chose to evaluate servicemen's psychological reactions to participating in atomic bomb tests. The plan got under way in the summer of 1951, financed by the Department of Defense and administered by George Washington University, under the heading of the "Human Resources Research Office."[53] The Pentagon also entered into a similar arrangement with the Operations Research Office of Johns Hopkins University.

When soldiers arrived at Camp Desert Rock to participate in "Operation Buster-Jangle" in autumn 1951, they knew little about what they were in for.

Introduction to the bare facilities at the Nevada Test Site came partly from an "Information and Guide" booklet distributed to incoming GIs. "The officers and men of this operation share with you the hope that your visit to Camp Desert Rock will prove an informative and revealing experience which you will always remember," read a greeting signed by U.S. Army Major General W. B. Kean.[54] Every page bore the inscription "RESTRICTED," and the booklet was replete with injunctions against talking too much.

"To assist in maintaining the security of Exercise Desert Rock it is desired that you maintain secrecy discipline regarding classified information observed here. Everyone will want to know what you have seen—officials, friends, *and the enemy*."[55]

The Army booklet handed to the first nuclear soldiers at the Nevada Test Site did not discuss atomic bomb radiation hazards. It did discuss possible hazards from indigenous reptiles and poisonous insects.[56]

Scenarios for tactical war games, assuming an enemy invasion sweeping inland from the West Coast, postulated that "the decision has been made to employ an atomic weapon to effect maximum destruction of the enemy." The maneuvers, while testing numerous facets of infantrymen's responses to atomic weaponry exploding in their midst, were depicted as realistic dry runs for future combat situations.[57]

"Indoctrination in essential physical protective measures under simulated combat conditions, and observation of the psychological effects of an atomic explosion are reasons for this desired participation," said a preparatory memorandum from the Pentagon's Military Liaison Committee to the AEC chairman. Added the Defense Department panel: "The psychological implications of atomic weapons used close to our front lines in support of ground operations are unknown."[58] The AEC ordered strict exclusion of the media during the forthcoming autumn nuclear tests in Nevada.[59]

Like Army buddies with him in the engineers A Company and other servicemen who arrived at the Nevada Test Site that October of 1951, twenty-two-year-old private William Bires did not know that military authorities were placing major importance on gauging mental and emotional impacts of close-range atomic blasts on foot soldiers like himself.[60]

Sleeping on the desert ground got very cold in October and November. ("We didn't even have decent sleeping bags. We froze our asses off.")[61] Of far more lasting significance was the actual experience of seeing half-a-dozen nuclear bomb detonations, ranging up to a thirty-one-kiloton blast code-named Easy.

Bires participated in the series of atomic tests over a period of a few weeks, with the largest nuclear explosions coming from bombs dropped by aircraft. Several thousand men watched from about seven miles away as fierce atomic light slashed across the desert; some were marched to within half a mile of ground zero. After the indescribably vivid bright flash Bires took note of "bizarre effects of the bombs"—weird designs of permanent

52. Rosenberg, *Atomic Soldiers*, p. 34.

53. For detailed account of role played by Human Resources Research Office in the U.S. nuclear testing program, see Rosenberg, *Atomic Soldiers*.

54. U.S. Army, "Exercise Desert Rock Information and Guide," 1951, p. 1.

55. Ibid., p. 8.

56. Ibid., p. 19.

57. Ibid., pp. 9-11.

58. Military Liaison Committee Memorandum MLC 31.4, July 16, 1951, pp. 1, 2.

59. AEC memo by General Manager M. W. Boyer, September 20, 1951.

60. William Bires, interview, March 1981.

61. Ibid.

shadows left in the atomic wake, charred into test range buildings, vehicles, gun emplacements. Animals situated in calibrated proximities to the A-blasts were singed and sometimes pathetic. "I can still see this damn sheep with its rump burnt," Bires commented three decades later.[62]

The Pentagon eagerly assessed behavior of GIs as they responded to orders soon after the half-dozen nuclear detonations, which totaled seventy-two kilotons. The more intimate, and more lasting, consequences apparently were not of great concern to the military brass.

"I was then, and I still am," William Bires said in 1981, "living with the firsthand knowledge that we do indeed have within our power the ability to destroy ourselves. Most people have heard this, but have not been able to observe firsthand the effects of those terrible weapons."[63]

When he filed the first in a series of claim statements with the Veterans Administration in 1978, Bires cited the psychological jolts left by his hitch at the Nevada nuclear tests. Recurrent fits of depression, the tenacious imagery of atomic weapons exploding close by, and an acutely painful spinal affliction came to plague him.[64]

Less than five months after the first troop maneuvers in the shadow of a mushroom cloud over Nevada, the U.S. military was pushing for more daring escapades for GIs. The distance of seven miles from nuclear blasts seemed too remote, and tame, to high-ranking occupants of Pentagon offices along the banks of the Potomac River. In the future, declared Air Force Brigadier General A. R. Luedecke, a less cautious policy would be appropriate. In a secret letter to the AEC in early 1952 he attributed "unfavorable psychological effects" among soldiers "to the tactically unrealistic distance of seven miles to which all participating troops were required to withdraw for the detonation."[65]

The Pentagon now suggested that soldiers be stationed a little less than four miles from the exploding nuclear weapons in subsequent tests. The AEC's director of biology and medicine, Dr. Shields Warren, didn't like the sound of it. "The explosion is experimental in type, and its yield cannot be predicted with accuracy," he warned. "Deviations from established safety practices would result . . . in larger numbers and more serious casualties the closer the troops were to the point of detonation."[66]

Despite such in-house warnings from its own staff experts the AEC capitulated to the Pentagon plan. Commission chairman Gordon Dean promised the Department of Defense that the AEC "would enter no objection to stationing the troops at not less than 7,000 yards from ground zero."[67] All discussions leading to the decision that would affect thousands of soldiers were conducted in secrecy. The Pentagon had exercised its unwritten dominance over the AEC.

In Nevada nearly eight thousand Army, Navy, Marine, and Air Force personnel were in the early stages of "Operation Tumbler-Snapper"—involving eight nuclear weapons dropped from airplanes or perched on towers, with total explosive force of over one hundred kilotons. During the largest blast of the series—a thirty-one-kiloton bomb air-dropped on April 22, 1952—selected reporters and television crews were allowed for the first time to record an A-bomb shot in progress.[68] At that test, and again the following month, soldiers were less than four miles from the explosions, often moving into the central blast area within two hours.

Back in Washington, according to classified AEC minutes, Commission chairman Gordon Dean "commented that a popular article on fall-out to reduce the possibility of public anxiety resulting from lack of information might be helpful."[69]

The kind of publicity the AEC sought did not come from Army veterans like James W. Yeatts, whose description of Operation Tumbler-Snapper would calm no public fears—neither at the time, nor twenty-eight years later, when Yeatts issued the following statement from his home in Keeling, Virginia:

---

62. Ibid.

63. Ibid.

64. Ibid.

65. USAF Brigadier General A. R. Luedecke to Director, AEC Division of Military Application, March 7, 1952.

66. Shields Warren, M.D., "Draft Staff Paper on Troop Participation in Operation Tumbler-Snapper," AEC memo, March 25, 1952.

67. Gordon Dean to Brigadier General H. B. Loper, April 2, 1952.

68. Rosenberg, *Atomic Soldiers,* p. 58.

69. AEC Commissioners Meeting Minutes, May 14, 1952.

> At the test site we had no protective clothing or equipment, not even a gas mask. When the bomb was detonated, we had our backs to the blast, kneeling with our hands over our eyes and our eyes closed. The flash was so bright we could see the bones in our hands. Then we turned to see the fire ball form. The shock wave hit us and knocked me backward. The dust was so thick that we could not see anything. After the dust settled we marched toward Ground Zero until the radiation got too hot. We then turned back and had a Geiger counter check for radiation.
>
> By the time we arrived back at Camp Desert Rock, most of us had severe headaches and were nauseated. We were told to lie down—that it would go away.
>
> Two days later, back at Fort Bragg, North Carolina, I was told to turn the uniform that I wore in the tests in to the stock room. It was put in a rubber bag. Nothing was said about how much radiation we had received.[70]

Two months later Yeatts began having serious health problems—"rectal abscesses, headaches, nausea and severe back pains," which persisted into the 1960s. Ten years after his participation in the atomic testing Yeatts lost all his teeth. "They became so loose, I could pull them with no pain. About a year later I began having breathing problems." By the late 1970s Yeatts was unable to work. In 1980 his weight had declined to 103 pounds. "I can only walk a few steps. I am now losing control of my bowels and urine."[71]

As far as the family was concerned, the aftermath of Operation Tumbler-Snapper did not end with James Yeatts. "My son was born in 1969, with many birth defects—the sutures in his head were grown together, a severe heart problem, an imperforate anus, he had only one kidney and an obstruction in the urinary tract. He had to have a colostomy at one day old. At three months old he had a 'Pots procedure' operation on his heart. He had a ureterostomy at six months, which will be permanent. A pull through was done on his rectum at 2 years old. At the age of 5 he had open heart surgery. He cannot attend school and still suffers from these problems. . . ."[72]

Ultimately Yeatts asked physicians at the M.C.V. Hospital in Richmond, Virginia, "if radiation exposure I had could cause my son's defects. The doctors asked me why I did not tell them about the radiation exposure when my son was born. They said my son would have to have close check-ups for other problems that could come up."[73]

The Veterans Administration denied Yeatts any service-connected benefits. "It is not enough for the Government to use me for a guinea pig," he said, "but to cause something to children years later is more than I can take."[74]

Operation Upshot-Knothole

As the U.S. Government prepared for "Operation Upshot-Knothole," slated for the spring and summer of 1953, civilian restraints over nuclear testing continued to erode. In a meeting between the AEC and the Department of Defense it was established that "in the forthcoming tests the usual limits of physical exposure to weapons effects would probably be exceeded." The AEC commissioners then acquiesced to a suggestion "that responsibility for the physical safety of the troops participating in the exercise be delegated to the DOD [Department of Defense] and that the DOD be informed of the possibility that exceeding the normal limits of exposure to radiation or pressure might endanger the participating personnel."[75]

Servicemen at the atomic tests were thus left to the tender mercies of the Department of Defense. Official notes depicted AEC chairman Gordon Dean's view that "since the DOD apparently considered it necessary to conduct the exercises in this manner, the AEC was not in a position to recommend that the normal limits [of radiation exposure and blast pressure] be observed."[76] For good measure, the AEC commissioners endorsed plans for a joint announcement that the Defense Department would be taking responsibility for the safety of troops during the

70. *Atomic Veterans' Newsletter,* summer 1980, p. 12.

71. Ibid.

72. Ibid.

73. Ibid., pp. 12-13.

74. Ibid., p. 14.

75. AEC Commissioners Meeting Minutes, December 23, 1952.

76. Ibid.

forthcoming series of atom bomb tests in Nevada.[77]

As the newly elected President, Dwight Eisenhower, prepared to unveil his "Atoms for Peace" program, promoting use of nuclear energy for electric power, the AEC and Pentagon put finishing touches on Operation Upshot-Knothole. During the spring and early summer of 1953 a total of eleven nuclear test shots sent mushroom clouds over the Nevada desert, concluding with a sixty-one-kiloton explosion code-named Climax. In less than three months the Nevada blasts had unleashed a cumulative force of over 250 kilotons—about twenty times the power of the atom bomb that destroyed Hiroshima.

About seventeen thousand military personnel participated in Upshot-Knothole. Routinely thousands were in trenches within two miles of ground zero as a nuclear bomb exploded; obeying orders, they moved toward the blast center inside of an hour after detonation in mock attack. The exercises even included, for the first time, direct charges immediately after detonation. The Pentagon had nearly doubled the AEC's prior theoretical limit for radiation exposure of the servicemen, raising it to six roentgens.[78]

Meanwhile A-test overseers had been experimenting with nonhuman subjects as well—sheep, rabbits, and pigs confined at varying distances from the blast site. Scores of porkers were clothed with specially fitted "uniforms" made out of standard Army material, to test for protection of their skin. One of the more bizarre expenditures came when one set of pigs had to be refitted with new uniforms after they outgrew their originals while waiting for the weather to break.[79]

Former Army sergeant Cecil G. Dunn, an Operation Upshot-Knothole veteran, recounted from his home in Pensacola, Florida, "After the blast, they marched us to ground zero. I will never forget the smell after that shot. I have no idea how much radiation was there. I know of no film badges. I don't remember seeing any of the men wearing any. I know I never had one." Recalling subsequent chronic headaches lasting years, followed by nosebleeds, a nervous breakdown, festering spots on his legs, and dizzy spells, Dunn said: "I feel like I am drunk all the time, but I don't drink. I tire very easily now. . . . All I have ever asked is to live like other people. But I cannot help blaming the Government for subjecting me to nuclear testing without warning me of the potential consequences and I will always wonder why it happened."[80]

Outside the borders of the Nevada Test Site fallout clouds intensified as Operation Upshot-Knothole progressed. On April 25, 1953, four and half hours after a forty-three-kiloton[81] blast named Simon, a spot outside the Nevada Test Site boundaries registered 460 milliroentgens per hour along Route 93—nineteen miles north of the Nevada town of Glendale. The potential dose was far in excess of the current standards set by governmental agencies. Caught off guard, the federal government hastily set up roadblocks. A report by the U.S. Public Health Service estimated about fourteen hundred people were living in the immediate fallout area. Starting nine hours after the Simon explosion, for 150 minutes, traffic was stopped on major roads; out of some 250 vehicles stopped and checked for radiation, 40 were judged to require decontamination. A Greyhound bus, bound for Las Vegas with 30 passengers, gave off readings of 250 milliroentgens outside, 160 milliroentgens inside.[82]

Three hours after the blast the tiny town of Riverdale registered readings of sixteen milliroentgens an hour.[83] An Armed Forces Special Weapons Project report, which was to remain secret for twenty-five years, commented: "The amount of fallout was expected to be much larger than usual. However, due to the fact that no populated communities were expected to be in its path, the decision was made to fire on schedule."[84] But the Simon fallout cloud also passed over Utah, Colorado, Kansas, Missouri, Illinois, Indiana, Ohio, and Pennsylvania before it encountered a tumultuous thunderstorm over upstate New York, southern Vermont, and parts of western

---

77. Ibid.

78. Rosenberg, *Atomic Soldiers,* p. 57.

79. Ibid., pp. 61-63.

80. *Atomic Veterans' Newsletter,* spring 1980, p. 3.

81. In contrast to a continued official listing of forty-three kilotons, documents declassified in the late 1970s refer to the Simon test as a 51.5-kiloton blast. (*The Tribune* [Salt Lake], New York Times News Service, August 12, 1979.)

82. *The Tribune* (Salt Lake), New York Times News Service, August 12, 1979.

83. Ibid.

84. Ibid.

Massachusetts. It was one of the heaviest flash storms in memory, bringing down torrents of rain.[85]

Two days after the Simon explosion a group of students at the Rensselaer Polytechnic Institute in Troy, New York—twenty-three hundred miles from the blast—noticed Geiger counters at their school radiochemistry lab were registering high readings. They went outside to discover that the previous evening's rain had brought down large amounts of fallout. Radiochemistry Professor Herbert Clark called the AEC, where an official first thought Clark was joking.[86]

But students systematically measured the area for radiation. Some samples from rain puddles showed 270,000 times more radioactivity than usually found in drinking water. Tests from city reservoir water showed levels 2,630 times higher than normal. Professor Clark and the Rensselaer students also discovered another problem. Radioactive fallout clung to the roof and walls despite hours of scrubbing; the surface radioactivity in Troy/Albany was comparable to measurements taken two hundred to five hundred miles from the point of the Simon detonation in Nevada.[87] In the mid-sixties that contamination would lead to a bitter controversy over health damage in the wake of bomb testing.

"Dirty Harry"

Some downwind residents became apprehensive after the Simon blast when they witnessed the official concern over fallout levels on the highways outside of the test site. But the worst was yet to come that spring when the U.S. Government detonated a thirty-two-kiloton atomic bomb from atop a tower at the Nevada Test Site. The code name was Harry; people downwind now remember it with bitterness as "Dirty Harry."

As sixty-eight-year-old St. George resident William Sleight recorded the event in his diary:

> *May 19, 1953:*
>
> Beautiful morning. We left St. George at 4 a.m. for Las Vegas, Nevada. We were watching for the A-Bomb explosion on the desert north of Las Vegas. At 5 a.m., just dawn, we saw the flash which lit up the skies, a beautiful red, visible for hundreds of miles away. It was a beautiful sight, a hundred miles or more away from it. I had my car radio on and at 5:01 a.m. the announcer on KFI, Los Angeles, Calif., said at 5 a.m. the bomb had been exploded and that it was visible at that station, and also in Idaho. I drove for ten minutes, then stopped the car on the roadside, got out and soon after we heard the report of the blast. It rumbled as thunder, not quite the same as other blasts we have heard. This is the 9th in a series of ten, another next week. It makes me shudder when I think of what misery we may face when men start dropping these terrific bombs on our cities. Some fanatics are now clamoring for their use in Korea.
>
> After we came back on Highway 91, we were stopped and a young man examined our car with an instrument to see if we had picked up any radioactive dust while traveling on the Highway. Found none so we missed a free car wash (which would have been appreciated). . . . Returned to St. George in a high wind which seems to always follow these explosions.[88]

Winds easily carried radioactive fallout the 135 miles to William Sleight's home in St. George. Atomic Energy Commission monitors picked up readings of six thousand milliroentgens in the town, where news bulletins broadcast the agency's sudden advice to stay indoors from 9:00 A.M. till noon. Monitoring crews stopped about one hundred cars heading north from St. George; many vehicles were washed down in an attempt at decontamination. The fallout was coming down so hard, AEC scientists later reported at a confidential government conference, that the commission's workers gave up on washing off the cars in St. George until the radioactive particles stopped falling.[89] The AEC, meanwhile, told area media that "radiation had not reached a hazardous level."[90]

---

85. Ernest Sternglass, *Secret Fallout* (New York: McGraw-Hill, 1981), pp. 1-5. See also articles by Herbert M. Clark in *Science*, May 7, 1954, pp. 619-622, and by Clark, et al., in *Journal American Water Works Association*, November 1954, pp. 1101-1111.

86. Ibid.

87. Ibid.

88. William Sleight, diary, made available to authors with permission of family through Citizens' Call organization.

89. *Chicago Tribune*, April 1-5, 1979, published as booklet "Radiation," p. 11.

90. *Washington County News* (Utah), May 21, 1953.

In St. George the blanket of fallout left a bad taste in many people's mouths—in more ways than one. Lifetime residents of the town reported, for the first time, an oddly metallic sort of taste in the air.[91] (This condition would surface again at Three Mile Island, twenty-six years later.)

Forty miles farther east, according to another secret AEC report, at least five residents developed symptoms matching signs of radiation sickness from high doses. The classified AEC report also said that in the town of La Verkin, twenty miles northeast of St. George, goats turned blue after clouds of fallout wafted through their grazing area.[92]

The day after Dirty Harry, downwind residents barraged the AEC with complaints. "Reverberations from the atomic tests in Nevada Tuesday echoed in Washington Wednesday as Southern Utah residents protested to Representative Douglas R. Stringfellow (R-Utah) about radiation contamination in the area," narrated *The* (Salt Lake) *Tribune*.[93] Congressman Stringfellow followed up by asking the AEC to stop the Nevada test program because of fallout. The AEC refused. (The next year Stringfellow lost his race for reelection.)

Two days after the Harry explosion, while AEC commissioners discussed the heavy fallout dumped on St. George and vicinity, an AEC worker tried to obtain names of milk producers in the area and failed. "It was just as well," he reported in an agency memo. "I was afraid it would create a disturbance."[94] Rulan (Boots) Cox, operator of Cox Dairy in St. George for thirty years beginning in 1949, had radiation monitoring equipment at his dairy the entire time of atmospheric nuclear testing upwind. He sent samples to federal addresses on a regular basis, but was never informed of results.[95]

New downwind samples of milk initially showed high levels of radioactivity. By the time the milk was boiled in Las Vegas and Los Alamos laboratories, AEC researchers found little radioactivity; the iodine 131 was being destroyed in the lab heating process.[96]

After the Harry test the AEC was faced with a new problem. Commissioner Henry D. Smyth, according to agency minutes, "was concerned about the public relations aspects of the tests, especially in view of the St. George, Utah, incident and the large number of shots already fired." The other AEC commissioner in attendance, Eugene M. Zuckert, also perceived nascent difficulties. "A serious psychological problem has arisen, and the AEC must be prepared to study an alternate to holding future tests at the Nevada Test Site. In the present frame of mind of the public, it would take only a single illogical and unforeseeable incident to preclude holding any future tests in the United States."[97]

The Pentagon, however, pushed hard for the AEC to stand firm. At a joint meeting in late May 1953, according to classified minutes, Defense Department representatives conveyed "the opinion that AEC is making a serious mistake in over-emphasizing the effects of fall-out resulting from recent tests." One general criticized official measures such as washing down cars and urging residents to stay indoors for a few hours after the Harry test; he complained that "the precautions taken by AEC were extreme and caused undue public concern."[98]

Meanwhile, on the morning of May 27, AEC chairman Gordon Dean met with the Commander-in-Chief. President Eisenhower, Dean recorded in his diary, "expressed some concern, not too serious, but made the suggestion that we leave 'thermonuclear' out of press releases and speeches. Also 'fusion' and 'hydrogen.'" In the wake of hydrogen explosions in the Marshall Islands during the past year, and with more sophisticated nuclear weapons tests scheduled, Eisenhower instructed the AEC's top executive to keep the public "confused as to 'fission' and 'fusion.'"[99]

---

91. Preston Truman, interview, February 1981. As state director of Citizens' Call and a lifelong resident of Utah, Truman said he had heard many accounts by St. George residents recalling a metallic taste after the Harry test.

92. *Deseret News,* September 5, 1979.

93. *The Tribune* (Salt Lake), May 21, 1953.

94. *Chicago Tribune,* April 1-5, 1979, "Radiation," p. 9.

95. Ibid.

96. *Deseret News,* September 5, 1979.

97. AEC Commissioners Meeting Minutes, May 22, 1953.

98. AEC-MLC Joint Meeting Minutes, May 28, 1953. At the same meeting Military Liaison Committee chairman Robert LeBaron said that the government "must avoid arousing public fears to the point of large-scale public opposition to the continental tests."

99. Gordon Dean, diary, May 27, 1953.

Fallout on Livestock

Downwind of the Nevada Test Site the epidemics of leukemia and cancer among residents would come later. Animals, however, were immediately affected. The AEC quietly paid a few hundred dollars to owners of some horses that suffered beta radiation burns in 1953.[100] But the concern about livestock burns was soon overshadowed as sheep began dropping dead—in unprecedented numbers and with unprecedented rapidity.

One hundred fifty miles from the test site, on Wheeler Mountain land owned by George Swallow in Nevada, about seventeen hundred sheep grazed on tender grass. It was lambing time in spring 1953. On the third Tuesday morning in May, George Swallow, his brother Dick, and a ranch hand named Lee Whitlock watched a pink fallout cloud (from the Harry detonation) drift overhead, toward the Utah line, Air Force jets following behind. Within a few weeks five hundred of the females in the flock of seventeen hundred sheep were dead. Sixty-five percent of new lambs were stillborn.[101]

The Swallows owned eleven sheep herds of the same size; the herd that sustained the high ratio of deaths and dead births was the one on Wheeler Mountain when the Harry blast fallout passed through.[102] George Swallow expressed his suspicions to the AEC. "We told Mr. Swallow that our experts have assured us that this sort of thing can't happen," AEC acting field manager Joe Sanders informed national headquarters.[103]

But the AEC's own files were filled with classified descriptions of similar incidents throughout Nevada, Utah, and Arizona. One Utah sheepherder reported twenty-five hundred stillbirths. Cattle and horses developed lesions and severe sores in large numbers.[104]

Dr. Stephen Brower was Iron County agricultural agent in southwestern Utah at the time. The Atomic Energy Commission stressed to Dr. Brower that the federal government had no intention of being held accountable for herd losses. Word first came from the chief of the AEC's Biology Branch of the Division of Biological Medicine, Dr. Paul B. Pearson.

Brower recalled that Pearson "told me . . . that the AEC could under no circumstances afford to have a claim established against them and have that precedent set. And he further indicated that the sheepmen could not expect under any circumstances to be reimbursed for that reason."[105]

In Cedar City, Utah, a U.S. Public Health Service veterinarian, Dr. Arthur Wolff, studied area sheep in June 1953. "My main concern was whether there was radioactivity involved," he recalled. "We autopsied a couple of animals, and I took some specimens back with me and took some [radiation] measurements. I was able to determine, yes, there was a relatively high level of radiation in the Iodine-131 in the thyroid and some radiation on the wool of these sheep.[106]

Cedar City sheepherder Kern Bulloch described what happened with his herd in 1953 this way:

> We were over at Coyote Pass right next to the bomb site just herding our sheep. One morning we were sitting in the saddle there, and some airplanes come up and one of them dropped a bomb. Jesus, it was bright! I put my hands up like that and you could doggone near see your bones. And then that cloud come right over top of us, it mushroomed right over our camp and our herd. And we were sitting there—'course we didn't know a thing about radiation or bombs or anything else. Pretty soon here comes some jeeps with Army personnel, and they said to us, "My golly, you fellas are in a hot spot." We didn't even know what they were talking about.
>
> Then we started driving the sheep back to Cedar [City], and we just started losing them. We got them in the yard there to get their lambs out, and gosh, every time you'd go in there, there'd be 20 or 30 dead sheep. The lambs were born with little legs, kind of potbellied. Some of them didn't have any wool, kind of a skin

---

100. *Deseret News,* February 15, 1979.

101. *Chicago Tribune,* April 1-5, 1979, "Radiation," p. 10.

102. Ibid.

103. Ibid.

104. Ibid.

105. *Forgotten Guinea Pigs,* p. vii.

106. *Deseret News,* February 20, 1979.

instead of wool. We figure we lost between 1,200 and 1,500 head close to half our herd.

Later, the scientists come, we took them up to a pile of bones and I remember putting a Geiger counter down. Somebody said, "Are they hot?" And one of the scientists said, "Hot? I'll say! This needle just about hit the post."[107]

Kern Bulloch remembered, nearly three decades later, "we just started to losing so many lambs that my father—[who] was alive at that time—just about went crazy. He had never seen anything like it before. Neither had I; neither had anybody else."[108]

Twenty-seven years passed before some semblance of the full story reached beyond the memories of downwind herders and officials privy to classified government files. In 1980 the U.S. House of Representatives Subcommittee on Oversight and Investigations provided the sort of overview kept from a national spotlight for decades.

The committee reported that, at the time of the two heaviest fallout tests in Nevada during the spring of 1953, there were 11,710 sheep grazing in a zone from 40 miles north to 160 miles east of the test site. "Of these sheep, 1,420 lambing ewes (12.1 percent) and 2,970 new lambs (25.4 percent) died during the spring and summer of 1953."[109]

This sheep mortality rate was considerably above normal.[110] But the government denied that there was anything amiss—refusing to admit radiation was involved. "It seemed like a policy decision had been made, and federal officials were there to implement it," Dr. Brower told us. "The government just wanted to cover up."[111]

Although the AEC profusely insisted in its public statements throughout the 1950s and beyond that fallout had nothing to do with sheep ills, a different assessment later came from Dr. Harold Knapp, a scientist who served with the AEC Fallout Studies Branch in the early 1960s. "The simplest explanation of the primary cause of death in the lambing ewes is irradiation of the ewe's gastrointestinal tract by beta particles from all the fission products that were ingested by the sheep along with open range forage," Dr. Knapp concluded. Radiation doses to the sheep internal tracts "are calculated to be in the range of thousands of rads, even though the external gamma dose to the sheep was within the 3.9 r limit per test series established by the Atomic Energy Commission as acceptable for persons living in areas adjacent to the test site."[112]

The 1980 House Oversight and Investigations Subcommittee report disclosed that its researchers had uncovered "substantial documentation from the files of the Government veterinarians and scientists assigned the task of investigating the 1953 sheep deaths, which revealed the Government's concerted effort to disregard and to discount all evidence of a causal relationship between exposure of the sheep to radioactive fallout and their deaths."[113]

Recently declassified minutes of a secret June 10, 1953, AEC meeting verify that the commissioners were aware that "sheep grazing in an area approximately 50 miles from the site were determined to have beta burns in their nostrils and on their backs and 500-1,000 out of a total of approximately 10,000 were reported to have died while being moved to grazing lands in Utah."[114]

But the AEC commissioners proved more concerned with publicity than health problems of either sheep or humans.[115] At a July 7 meeting Commissioner Henry Smyth observed that public concern could be allayed by

---

107. *Life,* June 1980, p. 36.

108. *Forgotten Guinea Pigs,* p. vii.

109. Ibid., p. 3.

110. Dr. Stephen Brower, interview, March 1981. When we spoke with him, Dr. Brower was a professor at Brigham Young University.

111. Ibid.

112. Dr. Harold Knapp, "Sheep Deaths in Utah and Nevada Following the 1953 Nuclear Tests," quoted in *Forgotten Guinea Pigs,* p. 4.

113. *Forgotten Guinea Pigs,* p. 4.

114. AEC Commissioners Meeting Minutes, June 10, 1953.

115. On October 26, 1953, the AEC convened a secret meeting at Los Alamos to take up the question of sheep deaths. The scientific method was not of paramount concern as the AEC's chief of the Weapons Radiation Effects Branch presided. Dr. George Dunning stressed to the assembled scientists the need for getting together a self-exonerating report for AEC commissioner Eugene Zuckert. As recorded by federal veterinarian Dr. Arthur Wolff, the influential Dr. Dunning informed the meeting's participants that a firm statement—concluding there was no connection between the nuclear tests and the sheep woes—would be necessary "before Commissioner Zuckert [would] open the 'purse strings' for future continental weapons tests." Scientists present tacitly agreed to go along with such a declaration, despite the opinions of some that a judgment would be premature, with the understanding it would be tagged "for internal use only" within the AEC. See *Forgotten Guinea Pigs,* p. 7.

comparing bomb fallout "to radiation incurred in the normal medical use of X-rays."[116] It was a public-relations angle that proved to be a favorite for the AEC, the Nuclear Regulatory Commission, and utilities operating nuclear power plants across the nation in future decades.

But the analogy—comparing X rays with radioactivity from nuclear fission—is highly misleading. An atomic bomb, or a nuclear reactor, produces radioactive alpha and beta particles that can be deadly if inhaled or swallowed even in minute quantities; the alpha and beta "internal emitters" are not present in the penetrating X rays used for medical purposes. The comparison with X rays also falsely assumes that bomb fallout or emissions from nuclear plants are evenly distributed in the population. A number of factors—including weather conditions and radioactive contamination of the ecological food chain[117]—can subject some animals or people to higher amounts of radioactivity.

Twenty-six years later the report by congressional investigators quoted from the AEC's conclusive press statement about the sheep, issued on January 6, 1954:

> On the basis of information now available, it is evident that radioactivity from atomic tests was not responsible for deaths and illness among sheep in areas adjacent to the Nevada Proving Grounds last Spring, the U.S. Atomic Energy Commission reported today.
>
> The AEC findings, reached as the result of extensive research studies, was concurred in by the U.S. Public Health Service and the Bureau of Animal Industry, U.S. Department of Agriculture. Prior to issuance by the AEC, the report was reviewed by the Department of Health, State of Utah. Special studies were conducted by veterinary and medical research scientists at Los Alamos Scientific Laboratory and Hanford Works and the University of Tennessee to determine whether radioactivity contributed to the deaths.[118]

But some of the AEC's own experts disagreed. Veterinarian Dr. Richard Thompsett, for example, reported that lesions on downwind sheep typified effects of beta radiation—and that the atomic tests had been a factor in the mass deaths of sheep.[119] Dr. Thompsett's report was never published. Dr. Stephen Brower recounted that Thompsett's "report was picked up—even his own personal copy—and he was told to rewrite it and eliminate any reference to speculation about radiation damage or effects."[120]

Follow-up research by scientists at the Los Alamos lab—C. Lushbaugh, J. F. Spaulding, and D. B. Hale—concluded that among sheep downwind from the Nevada Test Site "the skin lesion was remarkably similar, histologically, to severe beta ray burns as demonstrated experimentally." The researchers added, "It would appear from these gross observations that this and similar lesions seen in the field . . . confirm well enough to a presumptive diagnosis of a radiation-produced lesion."[121] Publicly the AEC stuck to its story—a story that would be repeated time and again to farmers and ranchers downwind from nuclear facilities.

In his role as county agricultural agent in southwest Utah, Dr. Brower accompanied sheep rancher Doug Clark to talk with federal administrators. "Doug raised some questions with the team of scientists, one of whom was a colonel," Dr. Brower remembered many years later. The colonel "seemed to be the leading spokesman to kind of press this issue that it couldn't have been radiation. Doug asked him some fairly technical questions about the effects of radiation on internal organs that he'd gotten from other veterinarians."[122]

In response the colonel called Doug Clark a "dumb sheepman" and told him he was "stupid—he couldn't understand the answer if it was given to him, and for just 10 or 15 minutes, just kind of berated him rather than

---

116. AEC Commissioners Meeting Minutes, July 7, 1953.

117. See *Washington Post,* November 11, 1979, for Dick Brukenfeld's article "A New German Study Challenges the NRC Assurances," on food chain concentrations of radiation.

118. "AEC Report on Sheep Losses Adjacent to the Nevada Proving Grounds," January 6, 1954; quoted in *Forgotten Guinea Pigs,* p. 4.

119. *Forgotten Guinea Pigs,* p. 6.; *Deseret News,* February 15, 1979.

120. *Forgotten Guinea Pigs,* p. 6.

121. *Deseret News,* February 15, 1979.

122. *Forgotten Guinea Pigs,* p. viii.

answer the question."[123]

A week after the Atomic Energy Commission's unequivocal public denial that sheep had been harmed by atomic test fallout, AEC officials faced angry livestock owners in a conference room of the Cedar City firehouse. The January 13, 1954, meeting included a dozen or so federal officials and a roughly equal number of area livestock owners.

"We know that practically all the sheep that range in that area had these effects," said a local rancher. "We fed these sheep corn and tried to keep them up. I couldn't keep my sheep up where they were able to raise a lamb. I had never seen it before.[124]

"We would like to have an answer for you," responded AEC biological medicine chief Dr. Paul Pearson. "We don't have any explanation for it. There have been instances of disease coming in that caused different effects, we don't know what happened."[125]

"There is very little protein in corn and they could be low in protein," interjected Leo K. Bustad, a General Electric Company envoy from the AEC-controlled Hanford Nuclear Reservation, prime production center for weapons-grade plutonium. "How was their flesh?"[126]

Refusing to be drawn into a discussion about his sheep's flesh with the GE representative, the rancher said that his sheep got all the protein they needed from grazing. "Range is white sage and black sage. . . . Sage is very high in protein."[127]

And so it went. "The body dose radiation that these sheep got is around five roentgens," explained GE's Bustad midway through the meeting. "You can get more roentgens from a fluoroscope or an X-ray machine than these sheep got through body radiation." Bustad failed to note that the sheep ingested radioactive particles into their bodies, which does not occur during an X ray. Nor did he mention that five roentgens is a hazardous dose in either case.[128]

A year later the Bulloch family filed suit in federal court, suing the U.S. Government for the loss of fifteen hundred sheep because of fallout. When the case came to trial in 1956, the federal government presented testimony that the sheep died of natural causes.[129] During initial investigations the Bullochs had heard researchers attribute the sheep deaths to radiation. "A lot of those scientists that checked the sheep and admitted it, when they got to court they had a different story," commented McRae Bulloch.[130]

The Bulloch family lost their court suit. Twenty-five years later no downwind rancher had been able to collect a penny from the federal government for a single dead sheep.[131]

Unwanted Controversy

Anxious to counter its increasing credibility problems, in 1954 the Atomic Energy Commission entered into an off-site radioactivity surveillance agreement with the U.S. Public Health Service.[132]

Not until 1979 did the terms of the AEC-PHS arrangement become public knowledge. After award-winning journalist Gordon Eliot White, Washington correspondent for the Salt Lake City daily *The Deseret News,* dislodged more than fifteen thousand A-test documents he reported that "PHS furnished trained personnel who worked under AEC funding and under strict AEC control." Their mission was not to ensure public health, but rather "to protect the test site from controversy."[133]

---

123. Ibid. It was, as Dr. Brower put it, "a tough kind of experience for Doug. I remember he left there to go out to his ranch to meet with the loan company to account for what sheep he had left, and within a couple of hours, he was dead from a heart attack. I think that . . . part of the stress that he experienced at that time was that abuse that he had received from these officials."

124. Minutes of livestock owners' meeting with AEC officials, Firehouse, Conference Room, Cedar City, Utah, January 13, 1954.

125. Ibid.

126. Ibid.

127. Ibid.

128. Ibid.

129. *Deseret News,* February 20, 1979.

130. *Life,* June 1980, p. 36.

131. Bruce Findley of Salt Lake City (current attorney for downwind sheep ranchers), interview, March 1981; *Deseret News,* February 20, 1979.

132. *Forgotten Guinea Pigs,* p. 18; see also pp. 19-22.

133. *Deseret News,* April 5, 1979.

The 1954 pact prohibited the PHS from any public release of its radiation data or "dissemination of information connected with activities under this agreement, except as prescribed by the AEC . . ." At the end of the year AEC tossed in a stipulation that any unauthorized release of information to the public could subject "the Public Health Service, its agents, employees, or subcontractors, to criminal liability" under the Atomic Energy Act.[134]

The AEC-PHS off-site monitoring agreement remained in effect not only during the last nine years (1954 to 1962) of atmospheric nuclear blasts at the Nevada Test Site, but also for the first eight years (1963 to 1970) of large underground nuclear bomb tests in Nevada.[135] Those underground detonations also spewed large quantities of radioactivity downwind for hundreds of miles.[136]

Despite the intense and pervasive downwind fallout from the Nevada Test Site in 1953 Washington remained enthusiastic for more continental nuclear weapons detonations. The prevailing sentiment at the federal level was aptly expressed in a letter to the acting chairman of the Atomic Energy Commission, Thomas E. Murray, written by AEC Biology and Medicine Advisory Committee head Dr. Elvin C. Stakman on March 25, 1954:

> Paraphrasing General Forrest's famous saying, "Victory goes to the nation that gits there fastest with the mostest and bestest weapons." This is no less true in the atomic age.
>
> It is therefore essential to continue the Nevada Proving Grounds in order to achieve maximum speed in the development of weapons. Speed is essential to national survival.
>
> In emergencies such as this some risks, immediate and long term, must be accepted. These risks should be frankly and publicly acknowledged. However, the policy of minimizing these risks must be continued in both the local and national interest.[137]

Perhaps some unlikely victims of the Nevada test program were the Hollywood cast and film crew of Howard Hughes's production *The Conqueror*. In 1954 John Wayne, Susan Hayward, and Agnes Moorehead, and producer-director Dick Powell filmed on the sandy dunes outside of St. George, Utah. They were there for three months.

A quarter century later John Wayne, Susan Hayward, Agnes Moorehead, and Dick Powell had all died of cancer. Wayne, a heavy smoker, succumbed to cancer of his lungs, throat, and stomach in 1979; Hayward died of skin, breast and uterine cancer in 1975; Moorehead passed away from uterine cancer in 1974. Another star of the movie, Pedro Armendariz, developed kidney cancer in 1960 and was later struck with terminal cancer of the lymphatic system. Dick Powell died from lymph cancer when it spread to his lungs in 1963.[138]

The coincidence of these cases was placed into a larger pattern when *People* magazine researched the subsequent health of the entire Hollywood entourage that had worked on location in St. George. They found that out of 220 people in the cast and crew, ninety-one had contracted cancer by late 1980, and half of the cancer victims had died of the disease.[139] (This survey did not include the couple of hundred local American Indians who served as extras in the film.)

"With these numbers, this case could qualify as an epidemic," remarked University of Utah radiological health director Dr. Robert C. Pendleton.[140] For two decades Pendleton had been warning that radioactive "hot spots" remained in numerous Utah locations, even after atmospheric testing had ceased.[141] Added Dr. Ronald S. Oseas of

---

134. Ibid. Summarizing the agreement, White's article added that PHS "was not permitted to set up a Nevada office until AEC approved the security arrangements, even though PHS was ordered only to measure readings outside the proving grounds. AEC retained the right of full access, at any time of day or night, to the PHS offices so commission officers could determine 'security obligations (to the AEC) are being met.' The ultimate responsibility for the off-site monitoring was retained by AEC . . ."

135. In 1970 the U.S. Environmental Protection Agency assumed operational authority for monitoring outside the Nevada Test Site. What agreements the EPA endorsed in secret covenants—with the AEC and its successor atomic military agency, the U.S. Department of Energy—remained a subject of speculation for anyone except those with high security clearances. Critics noted that EPA's radiation monitoring program remained heavily staffed by former AEC officials as the 1980s began.

136. Underground nuclear test leaks information and references are in Chapter Five.

137. Dr. Elvin C. Stakman to Thomas E. Murray, March 25, 1954.

138. *People,* November 10, 1980, pp. 42-47.

139. Ibid., p. 42.

140. Ibid.

the Harbor UCLA Medical Center: "It is known that radiation contributes to the risk of cancer. With these numbers, it is highly probable that the *Conqueror* group was affected by that additive effect."[142]

Ellen Powell, Michael Wayne, and Susan Hayward's son Tim Barker had accompanied their parents to the set in 1954. Tim Barker told of his mother's protracted cancer: "She was in a fetal position, and she had lost her swallowing reflex, she had pneumonia and she had lost her hair." In 1968 he had a benign tumor removed from his mouth. Michael Wayne later suffered from skin cancer. Barker echoed the sentiments of many residents downwind from the test site when he asked, "If the Government knew there was a possibility of exposure, why didn't they just warn us?"[143]

Federal nuclear authorities had long been aware of the deep resentment that had taken hold in numerous communities within a radius of several hundred miles of the Nevada Test Site. But the specter of culpability for the cancer deaths of such popular public figures caused concern at usually stolid government bureaus. At the Pentagon one official of the Defense Nuclear Agency responded to the news by murmuring, "Please, God, don't let us have killed John Wayne."[144]

141. *The Conqueror* health statistics were especially startling because no atom bombs were exploded in Nevada the year that the movie was filmed (1954); cast and crew were exposed to residual radioactivity left by Nevada atomic tests in previous years (1951-1953).

142. *People,* November 10, 1980, p. 44.

143. Ibid., p. 46.

144. Ibid.

4

Test Fallout, Political Fallout

Out in the Pacific, hydrogen bomb tests seemed far away from American communities. But the nuclear explosions there were producing unprecedented quantities of fallout—dropping on people around the world.

A 1951 two-page *Life* magazine photo spread hailing "Operation Greenhouse" at Eniwetok must have sounded rather glorious to most readers: "Finally at sunup one April morning a blinding flash and shattering rumble came from the tiny atoll. The AEC was busily engaged at its mid-ocean proving ground in testing its latest products. . . ."[1]

The first blast in May, code-named George and detonated from a tower on Eniwetok, proved to be a crucial building block for achieving the H-bomb. "Without such a test no one of us could have had the confidence to proceed further along speculations, inventions, and the difficult choice of the most promising possibility,"[2] Edward Teller later wrote. In the process thousands more American servicemen were exposed to atomic-fission products from nearby explosions.

After the George test, U.S. Navy seaman Artie Duvall was aboard a ship ordered to ferry scientists to the blast site. The scientists wore protective garb; the Navy seamen wore jeans, and many had their shirts off in the tropical sun. Duvall and his crew took sick and began vomiting. "It was like having some terrible flu," he remembered. They were ordered to sick bay. The next day, Duvall recalled, a wardroom briefing occurred, with an officer telling the men that they had "received a lethal dose of radiation." A physician recommended weekly blood tests—which were never conducted.[3]

Duvall developed skin cancer, and in 1962—unable to obtain dosimetry records—began a long battle with the government. A decade later he had a heart attack, followed by major heart surgery. He was forced to sell his house. The VA rejected his claim for service-connected benefits, telling him, "There is nothing that indicates that your heart condition is medically attributed by your physician to the history of radiation."[4]

Duvall reminisced, "We had no knowledge at all of atomic bombs. I had no fear at all of radiation. I didn't even really know what radiation was."[5]

At Eniwetok, when the military did raise the matter of health hazards of radiation, it did so in its customary fashion. Air Force Colonel Louis Benne—a decorated fighter pilot who received the Silver Star, Distinguished Flying Cross Air Medal with twelve oak-leaf clusters, and Purple Heart—recalled his introduction to radiation at Eniwetok as he lay dying from internal bleeding on May 11, 1978, at the age of fifty-six: "When we arrived at Eniwetok . . . or even before we left Hawaii . . . we got a briefing that said that a lot of people were concerned about the roentgens that we would be exposed to on these atomic shots . . . The Army said there was nothing to worry about because there was no doubt in their minds that five roentgens a month is nothing . . . and even 20 is nothing. . . . Well, the funny thing is, blowing of the wind shifted and everyone got about 10 to 15 roentgens, so they had to up the roentgens to 20 on the first shot and, of course, we still had some shots to go. So, anyway, Dorothy, it was a big joke."[6]

---

1. *Life*, June 25, 1951, pp. 28-29.

2. York, *The Advisors*, p. 77.

3. *Atomic Veterans' Newsletter*, November/December pp. 10-11. For evidence linking radiation to heart disease, see Arthur Elkeles, M.D, "Alpha-ray Activity in Coronary Artery Discase," *Journal of the American Geriatric Society*, May 1968, pp. 576-583.

4. Ibid., p. 11.

5. Ibid., p. 10.

6. *Atomic Veterans' Newsletter*, spring 1980, p. 2.

Of course to Dorothy Benne, who tape-recorded her husband's statement, it seemed a very sad joke.

Another Operation Greenhouse veteran, Vernon Lee Hawthorne, was still a teenager when he boarded an Army troopship for Eniwetok. By the time he died at age thirty from pancreatic cancer at a VA hospital in Amarillo, Texas, the years of suffering had taken a severe financial as well as emotional toll on his family. "The last year he was alive, we had a total income of $400," recalled his widow Bettye Hawthorne Fronterhouse. In the face of continued VA denials of claims for benefits, "my children and I came close to starving."[7] One son developed prostate trouble; another had four tumors removed including one from the jugular vein; the youngest son underwent surgeries for a two-pound mass tumor in his groin. Four of five grandchildren required treatment for anemia. A grandson developed a tumor in his scrotum like his father's, a granddaughter developed a tumor on her back. The ills had no precedent elsewhere in the family tree.[8]

Bettye Fronterhouse told a citizens' commission in Washington, "My husband should have had a right to know when he went there that he might die 10 years later from cancer at 30 years old and never have a chance to see his children grow and his grandchildren. Because we had plans for our future, but it was wiped out, taken away from us."[9]

Perfecting the H-Bomb

In the northern section of Eniwetok Atoll, on the island of Elugelab, the U.S. constructed a large laboratory building in 1952.[10] Placed in the lab was a bulky mechanism nicknamed Mike that included fission weaponry and deuterium frozen into liquid form. The cylindrical apparatus was twenty-two feet long, with a diameter of five and a half feet, weighing a total of twenty-one tons. On the first day of November 1952 the laboratory's contents exploded with a force of over ten megatons—nearly one thousand times more powerful than the atomic bomb dropped on Hiroshima. With the blast, proof existed that a hydrogen bomb was within reach. U.S. Government records listed Mike as the first detonated "experimental thermonuclear device."[11] The island on which it was situated disappeared.

The experience "so unnerved Norris Bradbury, the Los Alamos director," said a later narrative of the Mike explosion, "that for a brief time he wondered if the people at Eniwetok should somehow try to conceal from their colleagues back in New Mexico [at Los Alamos] the magnitude of what had happened."[12]

With the gigantic hydrogen explosions in the Pacific Ocean the fledgling Lawrence Livermore Laboratory in California was gaining great importance—as was one of its prime movers, Edward Teller. Fellow physicist J. Robert Oppenheimer, an opponent of H-bomb development and a rival of Teller's, came under growing attack.

America was at an apex of the cold war. The arms race between the U.S. and the Soviet Union, and the fears of internal subversion fomented by McCarthyism, made the AEC less prone than ever to tolerate dissension within its own ranks. That repressive atmosphere intensified in April 1953, when President Eisenhower signed an executive order launching an unprecedented far-reaching investigation into the "loyalty" of federal employees.[13] Two months later, with great fanfare, the government executed Ethel and Julius Rosenberg, convicted as spies who had conspired to give American atomic secrets to the Soviets.[14]

In 1954 the AEC held hearings on the matter of Robert Oppenheimer's security clearance. Oppenheimer's consultancy with the AEC was soon to expire, but this didn't prevent the AEC chairman, Lewis Strauss, from carrying on what many scientists considered a "witch hunt" against him.[15] On the basis of information supplied by

---

7. *Atomic Veterans' Newsletter,* November/December 1979, p. 8.

8. Michael Marchino, "A Wrongful Death," *Progressive,* November 1980, pp. 9-10.

9. *Citizens' Hearings,* pp. 24-26.

10. For a revealing planning document for the 1952 hydrogen tests at Eniwetok, see "Thermonuclear Research at the University of California Radiation Laboratory," Director of Military Application, AEC 425/20, Washington, D.C., June 13,1952; quoted in York, *The Advisors,* p. 82.

11. *Announced US Nuclear Tests,* p. 6.

12. McPhee, *Curve of Binding Energy,* p. 77. A key American designer of nuclear warheads, Theodore Taylor, later mused: "The theorist's world is a world of the best people and the worst of possible results." (McPhee, *Curve of Binding Energy,* p. 87.)

13. Douglas T. Miller and Marion Nowak, *The Fifties: The Way We Really Were* (New York: Doubleday, 1977), p. 405.

14. For accounts of the Rosenberg case that challenge the government's charges, see Walter Schneir and Miriam Schneir, *Invitation to an Inquest* (New York: Doubleday, 1965); Robert and Michael Meeropol, *We Are Your Sons* (Boston: Houghton Mifflin, 1975).

15. Carolyn Kopp, "The Origins of the American Scientific Debate over Fallout Hazards," *Social Studies of Science* (1979): 411 (hereafter cited as "Debate over Fallout Hazards").

the FBI, Oppenheimer was accused of guilt by association because of his long-known early contacts with Communist Party members in the 1930s.

A two-year-old statement to the FBI by Teller, questioning Oppenheimer's loyalty and character, had a major influence on the hearings. Teller, although not openly attacking Oppenheimer's loyalty, cited his opposition to development of the H-bomb—implying that Oppenheimer had a "defect" in his personality.[16] The AEC then filed a report stripping Oppenheimer of his security clearance. Chairman Strauss wrote the majority report echoing Teller's charge that Oppenheimer had "fundamental defects" in his character.[17]

The same year that Oppenheimer was purged from the AEC, America's nuclear weapons testers returned to the Marshall Islands with hydrogen explosives portable enough to qualify as bona fide bombs. From February to May six varieties of hydrogen bombs were detonated during "Operation Castle."[18] The first and largest, code-named Bravo, was fifteen megatons.

The American troops participating in Operation Castle were the first to get a close look at the H-bomb in action.

Marv Hyman was aboard the U.S.S. *Curtis* on March 1, 1954, when the Bravo shot inaugurated the hydrogen bomb. The ship's crew was kept below decks for three days as Bravo's fallout fell, Hyman recalled in 1980. "We were so well-indoctrinated, we were told not to say anything," recollected Hyman. But Navy denials did not change what had occurred. "I don't know how far away we were—they never told us. There was no way to get out of the fallout when the wind came right back at us. They set up a sprinkler system on deck."[19] Seawater was used.

"For three or four days we weren't allowed outside. They closed all the ports and hatches. Then they said it was 'low enough' to go out. They let us go on the islands in the Eniwetok and Bikini atolls and go swimming. I saw dead sea life all over, floating around by the millions." Later, sailing into San Francisco, the U.S.S. *Curtis* remained radioactive, Hyman said. "They wouldn't let us off the ship for three days."[20]

Navy seaman Robert Smith was twenty-three years old when he arrived at Bikini Island for Operation Castle. "We did not know nuclear weapons tests had already been conducted in this area. We even went swimming there," Smith recalled in 1979 from his home in Del, Oklahoma. "At the time, most of us did not even know what an H-bomb was."[21]

The Islanders

As the U.S. Government readied Operation Castle, it informed the chief of Rongelap Atoll about the nuclear tests scheduled for a farther west part of the Marshall Islands; no precautions were recommended. Eighty-six people were living on Rongelap when the Bravo H-bomb exploded. Winds were heading in their general direction.[22]

Like other people living on Rongelap, magistrate John Anjain noticed white flecks that looked like snow falling around them; soon the ground was covered with a layer of fallout over an inch thick.[23]

"We saw a flash of lightning in the west like a second sun rising," Anjain said as he talked of memories still vivid in 1980. "We heard a loud explosion and within minutes the ground began to shake. A few hours later the radioactive fallout began to drop on the people, into the drinking water, and on the food. The children played in the colorful ash-like powder. They did not know what it was and many erupted on their arms and faces."[24]

---

16. P. M. Stern, *The Oppenheimer Case: Security on Trial* (New York: Harper & Row, 1969). See also D. J. Keveles, *The Physicists* (New York: Knopf, 1978), pp. 380-382.

17. *Bulletin of the Atomic Scientists,* September 1954, pp. 275-277.

18. More than a quarter century after Operation Castle there were indications that the U.S. Government was not unreservedly proud of it. When, in cooperation with the nation's nuclear weapons design labs, the Department of Energy published an official list of American nuclear tests through the end of 1979, the listing of Operation Castle omitted "yield range" for four of the test series' six hydrogen blasts. The omissions occurred for hydrogen weapons tests code-named Romeo, Union, Yankee, and Nectar—which exploded at a combined power of over thirty-two megatons, according to a U.S. Government report declassified at the end of 1972. See *Announced US Nuclear Tests,* in comparison to "Joint Force Seven" cited in York, *The Advisors,* p. 86.

19. *Arizona Daily Star,* April 13, 1980.

20. Ibid.

21. *Atomic Veterans' Newsletter,* November/December 1979, p. 7

22. Giff Johnson, "Micronesia: America's 'Strategic Trust,'" *Bulletin of the Atomic Scientists,* February 1979, p. 11.

23. *Citizens' Hearings,* pp. 76-77.

24. Ibid.

On the neighboring Rongerik Atoll, U.S. monitoring equipment capable of measuring one hundred millirads per hour went off scale.[25] The Americans put on extra clothing and ducked inside a tightly closed building; within thirty-four hours, all twenty-eight Americans on Rongerik were evacuated.[26]

Back on Rongelap, which was closer to the Bravo blast, the people were not removed until more than two days had passed from the time the fallout first hit.[27] "Our people began to be very sick," John Anjain remembered. "They vomited, burns showed on their skin, and people's hair began to fall out."[28]

The AEC's own reports later conceded severe health damage, admitting to eighteen deaths among nineteen children in the Marshall Islands who received one-thousand-rad thyroid doses from U.S. hydrogen bomb tests in the area.[29] (Comparable dosages of radiation were absorbed by young children living in St. George, Utah, in 1953, according to secret estimates by top AEC officials—who calculated that thirty cases of cancer would be expected to develop among St. George residents as a result.)[30] Out of twenty-two Rongelap children exposed to the fallout from the Bravo test, nineteen have had thyroid nodules surgically removed.[31]

Nor was the damage confined to thyroids, as Anjain knew from grief-stricken personal experience. His son Lekoj, one year old when the fallout settled on Rongelap in 1954, was nineteen years old when he died of leukemia.[32]

In 1957, amid widespread publicity, Rongelapese were allowed to return to their atoll. But Rongelap women still experienced a stillbirth and miscarriage rate twice that of other Marshallese women who had not been exposed to the fallout. And radiation in their bodies increased rapidly. A 1961 Brookhaven study found body radiation levels had risen to sixty times normal for cesium; strontium 90 levels rose sixfold.[33]

Other Marshall Islanders were also affected. A day after the Bravo test mistlike fallout reached Utirik Atoll, about 275 miles east of the test site at Bikini. After two more days passed, the U.S. Navy evacuated Utirik's 157 residents.[34]

In a press release after the Bravo explosion the AEC declared: "During the course of a routine atomic test in the Marshall Islands, 28 United States personnel and 236 residents were transported from neighboring atolls to Kwajalein Island according to a plan as a precautionary measure. These individuals were unexpectedly exposed to some radioactivity. There were no burns. All were reported well. After completion of the atomic tests, the natives will be returned to their homes."[35]

The Marshall Islands were in the category of a protective "trust territory" arrangement engineered by the United States Government. The U.S. had signed a United Nations trusteeship agreement under which the American government had pledged to "promote the social advancement of the inhabitants, and to this end shall protect the rights and fundamental freedoms of all elements of the population without discrimination; protect the health of the inhabitants . . ."[36]

Some Rongelapese, like other Marshall Island natives, became bitter. "The American people used the Marshallese people as though they were animals," charged Mitsuwa Anjain, who was twenty-nine years old and mother of five when the Bravo fallout arrived at Rongelap. "While I am still alive, I can never forget what a horrible

---

25. Johnson, "Micronesia," p. 11.

26. Ibid.

27. Ibid.

28. *Citizens' Hearings,* pp 76-77.

29. *Chicago Tribune,* April 1-5, 1979, published as booklet "Radiation," p. 11.

30. Michael M. May, Director, Lawrence Livermore Laboratory to Glenn T. Seaborg (AEC chairman), November 29, 1965; reprinted in *Health Effects of Low-Level Radiation,* April 19, 1979, Vol. 2, p. 2120.

31. Giff Johnson, "Paradise Lost," *Bulletin of the Atomic Scientists,* December 1980, p. 28. The article quotes a 1977 federally funded study by Brookhaven National Laboratory, stating: "Recently about 50 percent of the exposed Rongelap people showed hypothyroidism without clinical evidence of thyroid disease, a finding that probably portends trouble ahead."

32. *Citizens' Hearings,* pp. 76-77.

33. Johnson, "Micronesia," p. 12.

34. Ibid., p. 11.

35. *Marshall Islands: A Chronology—1944-1978* (Honolulu: Micronesia Support Committee, 1212 University Ave., Honolulu, HI 96826), p. 4.

36. "United Nations Trusteeship Agreement for the United States Trust Territory of the Pacific Islands," Article 6; reprinted in Greg Dever, M.D., *Ebeye, Marshall Islands A Public Health Hazard* (Honolulu: Micronesia Support Committee), p. 25.

fate the American people inflicted on the Marshallese people."[37]

Almira Matayoshi was eighteen years old when the fallout rained on her home in Rongelap. We interviewed her in Hawaii in 1980, with the help of a translator. A friendly woman in her mid-forties, Matayoshi had lost four babies at birth after the bomb explosion—one of which came into the world with no arms or legs. "The people who are testing don't care about people on Rongelap and did not care then," she said. "I will not forget what happened to the people of Rongelap."[38] And Nelson Anjain, fifty-two, a Rongelap tribal chief, told us: "The U.S. has to think about what it did to the people of Rongelap. Department of Energy came to the islands, knew everything was contaminated, but did not tell us. . . . They come and check people but no report, no nothing."[39]

For 166 natives of the Bikini isles, where the United States detonated twenty-three atomic and hydrogen bombs over a period of a dozen years, a never-ending nightmare began with the first nuclear blast in 1946. At that time, reflecting the American government's promises, *United States News* reported: "Experts are sure the radioactive danger is temporary, and eventually the islanders will be permitted to return."[40]

Relocated to the barren Rongerik Atoll in 1946, the Bikinians lived through food shortages as they tried to adapt to new surroundings within one-half square mile of dry land. Malnutrition followed for years. In 1948 they were shuttled to Kili Atoll.[41]

During the 1970s, after a widely fanfared return of Bikinians to their home islands, high concentrations of radioactivity were still found to be present in the land and food of the atoll. The U.S. Government removed the 140 residents of Bikini in 1978 after determining that dangerous amounts of strontium 90 and cesium 137 were being absorbed into their bodies.[42]

In 1981 the New York Times News Service noted, "No one lives on any of the islands in the Bikini atoll." Elected Bikinian legislator Henchi Balos issued a March 1981 statement lamenting that "our land is radioactive." Said Balos: "We never wanted to leave. If we cannot go back to Bikini, the United States must pay for taking and destroying our homeland, for the hardship and suffering we have experienced and for its failure to care for us."[43]

The *Lucky Dragon*

GIs and natives of the Marshall Islands were not the only victims of Operation Castle. Twenty-three fishermen aboard the Japanese fishing boat *Lucky Dragon* were sailing eighty miles east of the Bravo shot when it was fired. Within days they were tormented by symptoms of acute radiation exposure—itching skin, nausea, vomiting. When they arrived back in Japan two weeks after the Bravo test, the entire crew remained sick; a Geiger counter revealed their bodies contained radiation from the hydrogen bomb sixteen days after it had exploded. The boat's rear crew compartment gave off readings of one tenth roentgen per hour.[44]

The tuna aboard the *Lucky Dragon* were extremely contaminated with radioactivity. This, as it turned out, was not unusual. In 1954 Japan monitoring programs showed that "a total of 683 tuna boats were found to have contaminated fish in their holds," nuclear physicist Ralph E. Lapp wrote in his book *The Voyage of the Lucky Dragon*. "Some 457 tons of tuna fish were detected above the 'worry limit' and were discarded, either by dumping at sea or by burial in deep ditches in land. About one out of every eight boats inspected had contaminated fish on board."[45]

As a nation dependent on fish for food and commerce, the high radiation levels in tuna caused outrage throughout Japan. And the conspicuous dousing of the *Lucky Dragon* with fallout had caused great publicity and political sensitivity. The U.S. Atomic Energy Commission responded with a public-relations sideshow. Dr. John Morton,

---

37. *Marshall Islands: A Chronology,* p. 4.

38. Almira Matayoshi, interview, May 1980.

39. Nelson Anjain, interview, May 1980.

40. *United States News,* February 1, 1946, p. 26.

41. Johnson, "Micronesia," p. 10.

42. Ibid., pp. 14-15. See also, Johnson, "Paradise Lost," pp. 25-26; *New York Times,* October 13, 1980.

43. *The Oregonian,* New York Times News Service, March 16, 1981.

44. Ralph E. Lapp, *The Voyage of the Lucky Dragon* (New York: Harper & Brothers, 1958), pp. 81-83.

45. Lapp, *Voyage of the Lucky Dragon,* p. 178.

director of the Atomic Bomb Casualty Commission, visited the stricken fishermen at the hospital and proclaimed them "in better shape than I had expected."[46] The Japanese considered Morton's remarks an insult.

After a second hydrogen bomb test AEC chairman Lewis Strauss returned from the Pacific test site and issued a statement to "correct certain misapprehensions" about the effects of the Bravo test. The exposed islanders and Japanese fishermen were recovering rapidly, Strauss claimed.[47]

Seven months after the Bravo test one of the *Lucky Dragon*'s twenty-three crew members died; the rest were still being hospitalized. Intensive care included frequent blood transfusions; low sperm counts indicated sterility. In 1955 the U.S. Government paid two million dollars in restitution for damage to the *Lucky Dragon*, its crew, and its cargo. The widow of *Lucky Dragon* fisherman Aikichi Kuboyama later told Ralph Lapp: "To a third person it might almost seem good to die if your death brings such sums of money. But I can't buy the life of my husband with money."[48]

Reflecting on the *Lucky Dragon* crew members three years after their encounter with radioactive fallout, Lapp observed: "The true striking power of the atom was revealed on the decks of the *Lucky Dragon*. When men a hundred miles from an explosion can be killed by the silent touch of the bomb, the world suddenly becomes too small a sphere for men to clutch the atom."[49]

But, in the midst of the controversy over the H-bomb test effects in spring 1954, AEC Chairman Strauss assured the American public there would be no significant impacts on the continental U.S. The "small increase" in radiation, he said, was "far below the levels which could be harmful in any way to human beings, animals and crops."[50]

The AEC chief's pronouncement provoked disbelief among independent scientists. Particularly disturbed was Dr. A. H. Sturtevant, chairman of the genetics department at the California Institute of Technology. In an address to the Pacific division of the American Association for the Advancement of Science, Sturtevant declared there was "no possible escape from the conclusion that bombs already exploded will ultimately produce numerous defective individuals." He further stated that an estimated "1,800 deleterious mutations" had already resulted from fallout.[51]

The AEC was stunned that the nuclear weapons testing program was being openly questioned by a prominent scientist like Sturtevant.

By early 1955 the AEC released a written response to Sturtevant's charges. Pointing to a "rather wide range of admissible opinion in this subject," the AEC dismissed the geneticist's assessment.[52] The AEC failed, however, to do any of its own calculations of genetic mutations—thus ignoring the scientific basis of Sturtevant's conclusions, which were derived from the work of the AEC's own Division of Biology and Medicine.

Comparing fallout hazards with other sources of radiation like medical X rays and "background radiation," the AEC concluded that fallout "would not seriously affect the genetic constitutions of human beings." With respect to the dangers to individuals from isotopes like radioactive strontium and iodine, the governmental report claimed that the levels of these nuclear products were too "insignificant" to pose any problem.[53]

Continuing Tests in Nevada

The furor in Utah that had resulted from fallout two years earlier prompted the AEC to exercise more caution as the continental atomic testing program—which excluded H-bombs during its first decade—restarted in February 1955 after a break of twenty months. But the AEC immediately received counterpressure. In a letter written three days after the first of fourteen nuclear shots slated for "Operation Teapot" at the Nevada site, Senator Clinton Anderson of New Mexico complained that he had been kept waiting for a week to witness the test series' premier blast, as one postponement after another was forced by poor weather conditions.[54]

---

46. Roger Rapoport, *The Great American Bomb Machine* (New York: Ballantine, 1971), p. 59.

47. "Statement by Lewis L. Strauss, Chairman U.S. AEC," AEC release, March 31, 1954.

48. Lapp, *Voyage of the Lucky Dragon*, pp. 192-193.

49. Ibid., pp. 197-198.

50. "Statement by Lewis Strauss," March 31, 1954.

51. A. H. Sturtevant, "Social Implications of the Genetics of Man," *Science*, September 10, 1954, pp. 406-407.

52. "A Report by the United States Atomic Energy Commission on the Effects of High Yield Nuclear Explosions," AEC release, February 15, 1955.

53. Ibid.

54. AEC Commissioners Meeting Minutes, February 23, 1955, pp. 117-118.

Senator Anderson was in the midst of a personal feud with AEC chairman Lewis L. Strauss.[55] As head of the congressional Joint Committee on Atomic Energy, Anderson could cause trouble. "I do not advocate taking any real risk with public health and safety," the senator said. But his message was clear: If the AEC was willing to let weather interrupt testing schedules at the Nevada Test Site, then the tests might be banished to the far-flung Pacific.[56]

AEC commissioner Willard F. Libby fumed that confining tests to the Pacific would "set the weapons program back a lot."[57] But disregarding weather conditions in Nevada would bring more fallout to the St. George area—"which they apparently always plaster," in the words of AEC Chairman Strauss.[58]

"I have forgotten the number of people at St. George," Strauss said. Informed that forty-five hundred people were living in the town, Strauss ruminated, "So you can't evacuate them."[59]

"St. George is hypertensified . It is not a question of health or safety with St. George, but a question of public relations," commented AEC fallout expert Dr. John C. Bugher. "You remember the uproar at St. George last series." After that experience, Dr. Bugher recollected, "We regarded southern Utah as a forbidden zone for future fallout in this series."[60]

But the AEC decided that the people of Utah were less important than the atomic testing schedule. Former Rear Admiral Strauss, into his second year as chairman, concurred with a suggestion by commissioner Thomas Murray to "get on with the test."[61]

"I don't think we can change them at this stage of the game," said Strauss, referring to Nevada testing criteria.[62]

A forty-three-kiloton blast, code-named Turk, proceeded as planned at the Nevada Test Site. So did ten more blasts in the Teapot series, totaling 114 more kilotons.

At an AEC meeting midway through Operation Teapot spirits seemed to have improved. "People have got to learn to live with the facts of life, and part of the facts of life are fallout," Commissioner Libby said.[63]

"It is certainly all right they say if you don't live next door to it," responded Chairman Strauss.[64]

"Or live under it," chimed in K. D. Nichols.[65]

Vowed Commissioner Murray: "We must not let anything interfere with this series of tests—nothing."[66]

At the site about eight thousand troops—from the Army, Navy, Air Force, and Marine Corps—participated in Operation Teapot, observing from trenches officially described as being one and a half to five miles from the atom bomb explosions. But Major Donald H. Anderson of Northridge, California, a twenty-year veteran of the Air Force, remembered being still closer—one thousand yards from ground zero—when the nuclear shot Bee was fired on March 22, 1955. Formerly trained as an instructor of the Armed Forces Special Weapons Project at the Sandia Base in Albuquerque, Anderson was among "about 200 or 300 of us" closest to the blast, listed at eight kilotons. "Upon detonation, we were in trenches 1,000 yards from ground zero."[67]

> After detonation, we had to dig our way out of the trenches which had collapsed on us. For about 10 or 15 minutes, I was blinded by the blast. . . . Then we were told we had to advance forward from the trenches to a location where toilet paper was lying on the ground. Not everybody who was in the trenches (about 200

55. Rosenberg, *Atomic Soldiers,* p. 71.

56. AEC Commissioners Meeting Minutes, February 23, 1955, pp. 117-118.

57. Ibid., p. 119.

58. AEC Commissioners Meeting Minutes, March 14, 1955, p. 122.

59. AEC Commissioners Meeting Minutes, March 14, 1955, p. 115.

60. Ibid., pp. 115-116.

61. Ibid., pp. 116-117.

62. Ibid.

63. AEC Commissioners Meeting Minutes, March 14, 1955, p. 121.

64. Ibid

65. Ibid.

66. Ibid.

67. *Atomic Veterans' Newsletter*, spring 1980, p. 14.

> or 300 people) advanced to the toilet paper marker which was about 200 or 300 yards from ground zero. About a dozen other people and I went down to it all the way. Then, an emergency jeep came up and an officer told us to get out of there—we did not belong there. He took our names and told us to report to an officer at camp. We had to go back for decontamination testing at Camp Desert Rock about 9 a.m. We reported to an officer who was threatening us with court martial because we did what we were instructed to do! No action was taken. Our film badges were not returned to us and we were not advised of the amount of radiation we had received.
>
> I believe it was the commander or his adjutant at Camp Desert Rock who talked to us and threatened us with court martial. At no time did they tell us there would be any possibility of subsequent illness as a result of complying with their orders to advance down to the toilet paper laid out on the ground. We were close enough to see parts of the tower that had been reduced to molten metal. . . . We were told that something went wrong with the detonation—that it was larger than expected.[68]

Major Anderson later developed cancer, which he linked to "the radiation exposure I received while in the military."[69]

An official report of the 1955 atomic exercises, issued by Marine headquarters, declared that "the realism engendered by coming face-to-face with an actual nuclear detonation adds a great deal to the benefits derived, and augments the total fund of training and experience of the Marine Corps."[70] As an additional note of envisioned battlefield "realism" some servicemen sat in tanks, moving toward the nuclear blast point after detonation—with radiation readings up to twelve roentgens metered in the tanks.[71]

As usual Las Vegas newspapers presented the nuclear tests in optimistic terms: "ATOMIC WARHEAD NEWEST YANK DEFENSE WEAPON"; "'BABY' A-BLAST MAY PROVIDE FACTS ON DEFENSE AGAINST ATOMIC ATTACK." Often the news stories glorified anticipated military benefits, with themes replayed by media across the country. In California the *Oakland Tribune* announced "ATOM BLAST TESTS SMOKE SCREEN TO CURB RADIATION." When the government unveiled a taller detonation tower—five hundred feet instead of the previous three-hundred-foot height—the *Las Vegas Review-Journal* reported, "Use of taller towers from which atomic devices are detonated at the Nevada Test Site introduces an added angle of safety to residents living outside the confines of the Atomic Energy Commission's continental testing ground, nuclear scientists believe."[72]

Military spokesmen continued their public reassurances. "The time after a detonation of nuclear devices is a period of caution, but a safe period if experienced personnel equipped with proper safeguards are used," Major Earl R. Shappell, a radiological safety officer, told reporters. "Our Army clearing teams can frequently move with impunity into the general firing area within hours following a blast."[73] A few days after Major Shappell's explanation the National Broadcasting Company telecast its first TV coverage of an atomic bomb test.[74]

Meanwhile millions of American schoolchildren were being taught to hide under desks in air-raid drills, as though such measures would provide appreciable protection in case of nuclear attack. Imagery of atomic holocaust became part of American life. According to authors Douglas Miller and Marion Nowak in their study of the fifties, "For kids, to whom the whole bomb-culture message was a thing to be inhaled like air, defense security could not help but get garbled up with terror."[75]

With few exceptions Americans remained frozen in silence as the nuclear age progressed. It was only in the later

---

68. Ibid.

69. Ibid.

70. U.S. Marine Corps, "Report of Exercise Desert Rock VI," 1955, p. V11-2.

71. Rosenberg, *Atomic Soldiers,* p. 71.

72. *Las Vegas Review-Journal,* March 29, 1955; *Las Vegas Sun,* March 13, 1955; *Oakland Tribune,* March 13, 1955; *Las Vegas Review-Journal,* March 11, 1955.

73. *Las Vegas Review-Journal*, March 27, 1955.

74. *Las Vegas Review-Journal*, March 29, 1955.

75. Miller and Nowak, *The Fifties*, p. 54. Added Miller and Nowak: "Adults, more accomplished at psychological defense, had an easier time of it. They could dodge the great fears and moral questions with more deftness than their offspring."

years of the 1950s, with Red-baiting on the wane and scientists beginning to speak out about biological dangers of fallout, that implications of the bomb were questioned.

Meanwhile, the Nevada testing continued, and atomic blasts became fairly common sights for people living throughout the West. One nuclear test explosion was visible from eleven western states.[76] The thick fallout clouds mostly moved through the targeted downwind corridors in rural areas of Nevada, northern Arizona, and Utah. But sometimes, with shifting winds at various altitudes, large cities were contaminated, as in March 1955 when an atomic shot sent radioactivity directly to Las Vegas.

Within six hours of that explosion "the cloud dropped invisible bits of matter that gave a total radiation of 174 milliroentgens in North Las Vegas," reported the Associated Press, which usually did not deviate from the official government perspective on nuclear events. "Normal background radiation is 2 milliroentgens, but the Atomic Energy Commission said the fallout was not harmful. The AEC has set a safety minimum of 3.9 roentgens, or 3,900 milliroentgens, per year for civilians offsite. Test personnel are allowed to absorb that much in a 13-week period."[77] The *Las Vegas Review Journal* stated flatly: "Fallout on Las Vegas and vicinity following this morning's detonation was very low and without any effects on health." A front-page follow-up article relayed the AEC's commendations for the "matter of fact manner" in which Las Vegans responded to the fallout dusting.[78]

The Fallout Debate

As the spring 1955 nuclear test series continued, a heated controversy arose. Alarmed by increasing radiation in their home state, two scientists from the University of Colorado Medical Center went public. "For the first time in the history of the Nevada tests, the upsurge in radioactivity measured here within a matter of hours has become appreciable," said Dr. Ray R. Lanier, director of the university's radiology department. University biophysics department head Dr. Theodore Puck joined with Lanier in the public statement issued March 12.[79]

Colorado's governor Edwin C. Johnson immediately asserted that the two scientists "should be arrested," adding: "This is a phony report. It will only alarm people. Someone has a screw loose someplace and I intend to find out about it."[80] He termed their statements "part of an organized . . . fright campaign."[81]

Meanwhile AEC media aides phoned Denver news outlets with a statement that the "trenchant reading in Colorado had absolutely no significance for public health."[82]

While insisting that "it is not our desire to alarm the public needlessly," Dr. Lanier said, "we feel it is our duty" to sound a warning. Drs. Lanier and Puck particularly infuriated the nuclear testing establishment when they publicly stressed that gamma-ray readings (and X-ray comparisons) did not provide the full health-hazard picture. Said Dr. Puck: "The trouble with airborne radioactive dust is that we breathe it into the lungs, where it may lodge in direct contact with living tissue." Thus, he explained, internal exposure from alpha or beta particles was "very different from having it lodge on skin or clothing where it can be brushed or washed off."[83]

The two Colorado scientists had dared to puncture the popularized myth that Geiger counter readings told the whole radiation danger story; that myth was based on the unspoken supposition that people would not breathe. Dr. Lanier also pointed out the absence of any "safe minimum below which danger to individuals or their unborn descendants disappears. Or at least we do not know what it is."[84]

At the same time, more than a few scientists, particularly those not on government payrolls, were voicing intensified concern about cumulative fallout effects. Dr. M. Stanley Livingston, chairman of the Federation of American Scientists and a physics professor at the Massachusetts Institute of Technology, supported the embattled

---

76. *Las Vegas Sun,* March 13, 1955.

77. *Los Angeles Times,* Associated Press, March 23, 1955.

78. *Las Vegas Review-Journal,* March 22, and March 24, 1955.

79. *Los Angeles Examiner,* March 13, 1955; *Los Angeles Times,* March 13, 1955.

80. *Los Angeles Examiner,* March 13, 1955.

81. *Albuquerque Journal,* March 22, 1955.

82. *Los Angeles Examiner,* March 13, 1955.

83. Ibid.

84. Ibid.

Colorado scientists in a television interview. Livingston said scientists were growing apprehensive "that we may soon reach a level of radiation in the atmosphere which would be dangerous genetically to the future of the race."[85]

But within the AEC the cold war made it very difficult for scientists to question the testing program. Oppenheimer's banishment had set a powerful example. "There developed what I consider to be a strange psychological frame of mind," Dr. Karl Z. Morgan, director of the Oak Ridge Health Physics Lab during that era, reflected in 1980. "It became unpatriotic and perhaps unscientific to suggest that atomic weapons testing might cause deaths throughout the world from fallout." Morgan found many of his AEC colleagues holding "onto untenable and extremely shallow arguments . . . comparisons with medical and natural background exposures as if they were harmless."[86]

The press gave only limited coverage to scientists who challenged the wisdom of atomic testing. Those complaining about radioactivity were routinely accused of ignorance, hysteria, or involvement in Communist manipulations.

The *Los Angeles Examiner* published a March 1955 column by International News Service writer Jack Lotto, headlining it "ON YOUR GUARD: REDS LAUNCH 'SCARE DRIVE' AGAINST U.S. ATOMIC TESTS." "A big Communist fear campaign to force Washington to stop all American atomic hydrogen bomb tests erupted this past week," Lotto reported. He repeated the persistent argument that during the past ten years the radiation dose from the testing "has been about the same as the exposure from one chest x-ray."[87]

In a *U.S. News & World Report* article called "The Facts About A-Bomb Fallout," AEC Commissioner Willard Libby cited "evidence" from AEC research which implied that bomb fallout would "not likely be at all dangerous."[88] Although the article did not explicitly claim to represent the AEC view, many scientists believed it had been approved in advance by the AEC.

That article caused a flurry of written protests from prominent scientists. Linus Pauling, a 1954 Nobel prize winner in chemistry, complained vigorously to Commissioner Libby.[89] Another Nobel laureate, geneticist Hermann Muller wrote to the AEC, saying that he was "shocked" by the article.[90] Bruce Wallace, of the Cold Spring Harbor Biological Laboratory, was "dismayed" that the AEC had misinterpreted his work in the magazine piece.[91] Dr. Curt Stern, of the University of California in Berkeley, warned the AEC that the article would only serve to increase distrust of AEC credibility.[92]

Major newspapers echoed the AEC's argument in the debate. One source of unequivocal disclaimers was nationally syndicated commentator David Lawrence. "Evidence of a world-wide propaganda is accumulating. Many persons are innocently being duped by it and some well-meaning scientists and other persons are playing the Communist game unwittingly by exaggerating the importance of radioactive substances known as 'fallout,'" Lawrence wrote in spring 1955. "The truth is there isn't the slightest proof of any kind that the 'fallout' as a result of tests in Nevada has ever affected any human being anywhere outside the testing ground itself."[93]

"The Nevada tests are being conducted for a humanitarian purpose—to determine the best ways to help civilian defense—and not to develop stronger weapons of war," Lawrence contended authoritatively in another column. "The big bombs are not tested in this country, but in ocean areas far away from this continent. The Communist drive, however, is to stop all tests, and many persons are being duped by the campaign into thinking all the tests held in Nevada are injurious and will hurt future generations. There isn't a word of truth in that propaganda."[94]

But profound issues of long-term atomic fallout effects could not be so easily dismissed.

---

85. *Albuquerque Journal,* March 14, 1955.

86. Karl Z. Morgan, "History of Developments in Nuclear Safety and the Development of International Standards," unpublished article submitted to Energy Department's Office of Consumer Affairs, December 1980, p. 2.

87. *Los Angeles Examiner,* March 24, 1955.

88. *US News & World Report,* March 25, 1955, pp. 21-26.

89. Linus Pauling to Willard Libby, March 30, 1955, Historian's Office, U.S. Department of Energy.

90. Hermann Muller to E. Green, March 29, 1955, A. H. Sturtevant Papers, California Institute of Technology, AHS-CIT, Archives Box 11, Folder 3.

91. Bruce Wallace to Hermann Muller, April 5, 1955, AHS-CIT, Archives Box 11,. Folder 3.

92. Curt Stern to John Bugher, March 28, 1955, GWB/BDR-CIT, Archives Box 96, Folder 1.

93. *Washington Post,* March 1955.

94. *Chicago Daily News,* March 25, 1955.

Cancer, Genetics, and Fallout

In the autumn of 1955 AEC Chairman Strauss was caught suppressing a scientific paper by Hermann Muller on the genetic effects of radiation. In 1927 Muller had been the first to discover that exposure of plants and animals to X rays causes an increase in genetic mutations. Twenty years later he received the Nobel prize for his work in genetics.

Muller's 1955 paper assessed the worldwide fallout exposure to people's gonads and the genetic damage this could cause. He submitted it for presentation at the first United Nations meeting on "peaceful uses of the atom," scheduled for Geneva later that year. In May the AEC accepted Muller's abstract. When he tried to submit his full paper in July, the renowned geneticist was told that it had been taken out of the program by the U.N. because of "space limitations."

Two months later *The Washington Post* revealed that the AEC, not the U.N. had excised Muller's paper. Then the AEC admitted to blocking the paper because Muller had mentioned the Hiroshima bombing, a subject "definitely inadmissible" at a conference about the "peaceful" uses of atomic energy. As AEC chairman, Strauss apologized for the "regrettable snafu" and promised to publish Muller's paper in printed proceedings of the event. A few weeks afterward, Strauss stated on the TV show *Face the Nation* that "some irresponsible statements that had been made on the subject were liquidated in the course of the conference."[95]

The Muller incident so enraged George Beadle, president of the American Association for the Advancement of Science, that he wrote a lengthy editorial in *Science* magazine titled "Liquidating Unpopular Opinion."[96] Prior to publication of his essay, Beadle sent a draft to Gerard Piel, publisher of *Scientific American*. After reading both the draft and the final version, which had been toned down, Piel wrote back remarking on "what skulking deceit and dishonesty had been involved in Admiral Strauss' handling of the matter."[97]

Beadle's *Science* editorial asserted that "Chairman Strauss has consistently maintained that fallout from tests of nuclear weapons have been so low that they could not bring harm to human beings. Muller has repeatedly presented reasons for believing such complacency to be unjustified . . . could it be that Muller's persistence in disagreeing with the chairman of the Commission was a factor in barring his report?"[98]

By the late summer of 1956 the issue of fallout was being covered on nation-wide television at the Democratic National Convention. The Democratic Party was campaigning to halt H-bomb tests. Presidential candidate Adlai Stevenson, relying on the information of AEC critics, cited the genetic and strontium 90 hazards from tests. Nuclear testing advocates Edward Teller and Ernest O. Lawrence responded with a joint statement depicting radioactive fallout as "insignificant."[99]

Institutional differences over dangers of fallout became quite clear during the election. On one side was the AEC and its scientists, such as Commissioner Willard Libby, Shields Warren, John Bugher, Teller, and Lawrence. The other side included several prominent scientists from the California Institute of Technology—Linus Pauling, E. B. Lewis, A. H. Sturtevant, and George Beadle. Although Stevenson lost the election, his campaign provided a national forum for the fallout debate.

Another event in 1956 also had major impact. British physician Alice Stewart found the first firm evidence that low-level radiation causes cancer in human beings. "At the time," Dr. Stewart told us, "radiologists considered low-level radiation to be in the range of fifty to one hundred rems. We were able to demonstrate that the flicker from one X-ray photograph to a fetus could initiate a cancer. This was a tiny fraction of the amount considered safe."[100]

Stewart's findings were received with disbelief by radiologists and the international nuclear industry. If she was correct, then physicians were causing cancer among children—and the nuclear industry was doing the same.

In 1958 Stewart and her colleagues at England's Oxford University published their classic paper on effects of

---

95. Kopp, "Debate over Fallout Hazards," p. 412.

96. George W. Beadle, "Liquidating Unpopular Opinion," *Science*, October 28, 1955, p. 813.

97. Kopp, "Debate over Fallout Hazards," p. 412.

98. Beadle, "Liquidating Unpopular Opinion," p. 813.

99. *New York Times*, June 21, 1956.

100. Alice Stewart, interview, November 1980.

fetal X rays, now one of the most often cited studies in the world.[101] Stewart found that X rays during the first three months of pregnancy increased the risk of cancer by ten times. With each X ray taken, there would be an increase in the cancer risk.

In June 1957 Linus Pauling estimated in a *Foreign Policy Bulletin* article that ten thousand persons had died or were dying from leukemia because of nuclear tests.[102] A month earlier Pauling's colleague E. B. Lewis had published a more detailed analysis in *Science*.[103] Using four sets of data, Lewis showed that there was no safe level of exposure; leukemia incidence seemed to be directly proportionate to the amount of the radiation dose. These articles documented the absence of any "safe" dose of radiation. And the pair of C.I.T. scientists also broke new ground by estimating the number of deaths from strontium 90 fallout.

The AEC countered Lewis in a later article in *Science* by Austin Brues, the commission's director of Biology and Medicine. Brues argued that the evidence wasn't strong enough to support Pauling or Lewis, calling their approach one of "superficial simplicity." Instead, Brues insisted, facts corroborated the existence of a "threshold" dose of radiation, below which no biological damage would occur.[104]

The Joint Committee on Atomic Energy hearings in 1957 proved to be a watershed in the fallout debate. Dr. Ralph Lapp cut short a trip to Japan to appear before the committee. His opening presentation pointed to "reckless and non-substantiated statements" made by the AEC.[105] He called attention to claims by the AEC's New York Health and Safety Lab chief Merrill Eisenbud, who had announced that "the total fallout to date from all tests would have to be multiplied by a million to produce visible deleterious effects in areas close to the explosion itself."[106]

Eisenbud took the stand in his defense, putting qualifications on his earlier statement. Eisenbud claimed to have been "talking about the immediate gamma radiation from the fallout which occurs in the eastern United States within a matter of a day or so after detonation in Nevada." He then accused Lapp of taking his statement "out of context."[107]

Lapp quickly responded from the audience by multiplying the amounts of radiation exposure calculated by Eisenbud to be present in the Troy/Albany area after the Simon bomb test in 1953 by a million times. It amounted to an average exposure of ten thousand roentgens. Stunned by this calculation, Senator Clinton Anderson asked if such a dose "would kill everybody in sight." Eisenbud, red-faced, answered with a meek "Yes."[108]

In 1958 the U.S. tested sixty-four weapons aboveground, the Soviet Union twenty-four, and Britain five. This was the highest rate since the first tests began.[109] After two and a half years a U.N. study by eighty-seven scientists confirmed allegations by critics of A-tests.[110]

Meanwhile strontium 90 levels in milk were rising dramatically, according to the AEC's own data. The northern Great Plains—particularly the Red River Valley dividing North Dakota and Minnesota—were fast becoming the most strontium-90-contaminated area in North America. Strontium 90 in the region's milk supply was far in excess of the AEC's own safe limit for human consumption.[111]

Reacting to the stepped-up nuclear testing, the National Council on Radiation Protection (NCRP) recommended doubling the "maximum permissible body burden" of strontium 90.[112] Other test advocates like Edward Teller began to contend publicly that radiation from fallout "might be slightly beneficial or have no effect at all."[113]

---

101. Alice M. Stewart, et al., "A Survey of Childhood Malignancies," *British Medical Journal* (1958): 1495-1508.

102. Linus Pauling, "How Dangerous Is Radioactive Fallout?" *Foreign Policy Bulletin,* June 15, 1957, p. 149.

103. E. B. Lewis, "Leukemia and Ionizing Radiation," *Science,* May 17, 1957, pp. 965-972.

104. Austin Brues, "Critique of the Linear Theory of Carcinogenesis," *Science,* September 26, 1958, pp. 693-699.

105. H. Peter Metzger, *The Atomic Establishment* (New York: Simon and Schuster, 1972), pp. 97-98.

106. New York *Daily News,* March 20, 1955.

107. Metzger, *Atomic Establishment,* pp. 97-98.

108. Ibid.

109. J. A. Young and R. W. Perkins, "Fallout from Nuclear Testing—A Position Paper with Recommendations to the EPA," Battelle Pacific Northwest Laboratories, Richland, Washington, September 19, 1979, Table 1.

110. United Nations, "United Nations Scientific Committee on the Effects of Atomic Radiation, 1958 Report," New York. See also *New York Times,* August 11, 1958.

111. AEC, "Strontium Program Quarterly Report," New York Operations Office, February 24, 1959.

112. Metzger, *Atomic Establishment,* p. 99.

113. Edward Teller, "The Compelling Need for Tests," *Life,* February 10, 1958, pp. 64-66.

During this period Dr. Karl Z. Morgan attended an NCRP meeting where Teller gave a speech about fallout. "To my amazement, and certainly to the amazement of others, Ed [Teller] was claiming that since naturally occurring radiation played a part in the evolutionary process, the increase in fallout would simply speed up the evolution."[114] Was Teller speculating that fallout would weed out the weak in the society to enhance the development of a superrace?

Linus Pauling was the first to sound the alarm concerning the dangers of carbon 14. This radioactive form of carbon exists in nature and is easily absorbed by plants and people. But the incremental increase of carbon 14 from test fallout concerned Pauling.[115] By 1958 he estimated that carbon 14 from "the bomb tests . . . will ultimately produce about one million seriously defective children and about two million embryonic and neonatal deaths, and will cause many millions of people to suffer from minor heredity defects."[116]

Pauling and others realized that it was not enough to exchange scientific papers with the AEC in order to stop the continuing radioactive fallout from testing. The circle of scientists necessary to alert the people of the U.S. and the world had to become much larger.

On April 23, 1957, Nobel peace prize winner Albert Schweitzer made a radio speech that inspired Pauling to take a first important step in recruiting scientists of the world. Schweitzer concluded his speech by saying that "the end of further experiments with atom bombs would be like early sunrays of hope longed for by suffering humanity."[117] AEC Commissioner Willard Libby responded with the standard AEC line: "Exposures from fallout are very much smaller than those which would be required to produce observable effects in the population."[118]

Three weeks after Schweitzer's speech Pauling addressed an audience at Washington University in St. Louis, the headquarters of the Committee for Nuclear Information—an active antitesting organization recently cofounded by Dr. Barry Commoner. That afternoon Pauling sat down with Commoner and Edward Condon of the committee and told them of his idea for a petition campaign to enlist American scientists in opposition to nuclear testing. With their help Pauling drafted "An Appeal by American Scientists to the Governments and People of the World," urging that "an international agreement to stop testing of nuclear bombs be made now."[119]

"Each nuclear test spreads the added burden of radioactive elements over every part of the world," read the petition. "Each added amount of radiation causes damage to the health of human beings all over the world and causes damage to the pool of human germ plasm such as to lead to an increase in the number of seriously defective children that will be born in future generations . . ."[120] Within two weeks the signatures of two thousand American scientists were collected and released in the midst of the 1957 hearings of the Joint Committee on Atomic Energy.

President Eisenhower, in a press conference shortly after Pauling publicized his appeal, implied that the scientists' petition was the work of an "organization" that didn't necessarily have the best interests of the nation in mind. When later asked to clarify his statement, Eisenhower backed off and replied, "I said that there does seem to be an organization behind it. I didn't say a wicked organization."[121]

Two days later Pauling told a reporter that "I would like to see signatures of thousands of Russian scientists, of scientists of all countries of the world to this appeal." The response was an immediate outpouring of signatures from scientists all over the globe. By January 1958 Pauling had collected 11,021 signatures from 50 nations—including 216 from the Soviet Union, 701 from Britain, and 1,161 from Japan.[122] Pauling personally delivered the petition to

---

114. Karl Z. Morgan, interview, November 1980.

115. Vast amounts of carbon 14 are produced by hydrogen bombs and large nuclear reactors. A beta-emitter with a half-life of about five thousand years, carbon 14, can be incorporated into the DNA of cells, creating significant biological damage. Another of the worrisome fallout isotopes is strontium 90, which is chemically similar to the nutrient calcium and therefore is taken up in soil, plants, and animals, as calcium is. The principal "pathway" for radioactive strontium is the ingestion of contaminated food, particularly milk, leafy vegetables, fruit, and root vegetables. Once it enters the body, strontium eventually lodges in the bone, particularly the growing bone tissue of children, where half of it remains for twenty-eight years. Once inside the bone tissue it emits beta particles, which can eventually lead to such diseases as leukemia or bone-marrow cancer.

116. Linus Pauling, *No More War* (New York: Dodd, Mead, 1958), pp. 74-75.

117. Albert Schweitzer, "A Declaration of Conscience," *Saturday Review*, May 18, 1957, pp. 17-20.

118. Pauling, *No More War*, p. 169.

119. Ibid., p. 160.

120. Ibid.

121. Ibid., p. 172.

122. Ibid., pp. 173, 174-178.

the United Nations secretary general, Dag Hammarskjold, on January 15, 1958. By the end of the year the U.S. and the Soviet Union agreed to a voluntary moratorium on testing—a move to enhance negotiations for a test ban treaty.

Attacks against Pauling and his so-called "organization" intensified. Syndicated columnist Fulton Lewis, Jr., estimated that such a petition drive would have cost $100,000, and he demanded to know who had funded the campaign.[123]

The Nobel prize winner was called before the House Un-American Activities Committee. According to Pauling, "the cost of gathering the 7,500 signatures of scientists outside the U.S. amounted to about $250.00 . . . for stationery, postage and secretarial help. . . . My wife and I have expended altogether about $600 on the appeal and petition."[124] Pauling's "organization" consisted of his wife and a circle of friends.

Congress was unable to prove that Pauling's petition was a Communist conspiracy. But Pauling's detractors in the government assured that he would no longer receive a penny of federal money for his research. More than two decades later Pauling had received no federal government funds for his work. However in 1962 Pauling received a second Nobel prize—this one the peace prize for his efforts to end nuclear testing.

Antibomb protests during the late fifties included small-scale sit-ins at missile bases, and refusals to participate in New York City air-raid drills. The most dramatic civil disobedience against nuclear explosions occurred as activists attempted to steer their ships into the Marshall Islands test zones. In 1958 four pacifists in a thirty-foot ketch—christened the *Golden Rule*—tried to set sail from Hawaii for Eniwetok; they were arrested by the U.S. Coast Guard. A similar expedition the same year, by the crew of the *Phoenix,* sailed toward the Bikini testing area; U.S. authorities halted that demonstration as well.[125]

Other tactics against the nuclear tests took hold, widening the pressure campaign participation beyond scientific experts and pacifists. Less than a year after its founding in November 1957, the National Committee for a Sane Nuclear Policy (SANE) had enlisted 130 chapters and twenty-five thousand members in opposition to the tests.[126]

With public mistrust of the AEC deepening, near the end of his presidency Dwight Eisenhower created the Federal Radiation Council to "advise the president with respect to radiation matters." Although appearing to represent public-health interests, the FRC was dominated by advocates of nuclear testing. Two out of six members were from the AEC and Department of Defense. The council's director, Paul Tompkins, came directly from the nuclear weapons program. One of the first acts of the council was to increase the amount of sanctioned strontium 90 exposures from testing by six times.[127]

On September 1, 1961, during the height of tensions over Berlin, the voluntary moratorium on testing was broken by the Soviet Union. The U.S. followed suit by resuming atomic tests later that month. During the next year the two countries conducted the most intense series of aboveground tests in history.[128] In 1962 more than one hundred nuclear weapons exploded and sent radiation into the atmosphere. By the summer of 1962, iodine 131 in milk across the United States was reaching dangerous levels.

As fallout quantities approached "safe" governmental limits, the AEC looked to the Federal Radiation Council for help. By September 1962 the council announced that the U.S. Government's radiation guidelines didn't apply to fallout[129]—in essence, giving the AEC a blank check to contaminate the earth as it deemed necessary. "I-131 doses from weapons testing conducted through 1962 have not caused undue risk to health," the council contended.[130] Two years later the panel secretly raised its guidelines for radioactive iodine by a factor of twenty, to accommodate "underground" nuclear tests.[131]

---

123. Ibid., p. 171. (The Fulton Lewis, Jr., broadcast was on February 12, 1958.)

124. Ibid., p. 175.

125. Miller and Nowak, *The Fifties,* pp. 63, 80, 413.

126. Ibid., p. 413.

127. *Background Material for the Development of Radiation Standards,* Federal Radiation Council Report No. 2 (Washington, D.C.: U.S. Government Printing Office, 1961). (Paul Tompkins was formerly deputy director of the AEC's Office of Radiation Standards.)

128. Young and Perkins, "Fallout from Nuclear Testing," September 19, 1979.

129. *Estimates and Evaluation of Fallout in the United States from Nuclear Weapons Testing Conducted Through 1962,* Federal Radiation Council Report No. 4 (Washington, D.C.: U.S. Government Printing Office, 1963).

130. *New York Times,* September 18, 1962.

131. Federal Radiation Council Report No. 5 (Washington, D.C.: U.S. Government Printing Office, 1964).

The Federal Radiation Council's director, Paul Tompkins, justified the increase by claiming "we had to take our choice between that much iodine or a predictable level of malnutrition from pricing the milk off the market. We made the choice . . ."[132]

In St. Louis, where fallout readings were very high during the 1962 tests, the Committee for Nuclear Information vocally denounced the persisting nuclear blasts. In an effort to blunt the criticisms the AEC transported a group of children from St. Louis to New York and measured them for radioactive iodine. The AEC's Merrill Eisenbud reported that "tests completed at the New York University Medical Center indicate that the amount of radioactive iodine entering the thyroid glands of children has not approached the danger level."[133] Eisenbud did not mention that iodine 131 has an eight-day half-life. By the time the children reached New York and were analyzed, almost all of the radioactivity had decayed—with the damage already done in the meantime.

In 1960, fifteen years after the first nuclear testing, the AEC had finally established a Fallout Studies Branch. Harold Knapp was working in the AEC general manager's office at the time. Asked to join the Fallout Studies Branch in 1962, Knapp's first task was to review the AEC's rebuttal to a series of criticisms by Ralph Lapp. Knapp found that the rejoinder, written by the prestigious General Advisory Committee of the AEC, "didn't answer anything" and was a "wholly inadequate response."[134] Particularly, Knapp found that the issue of radioactive "hot spots" raised by Lapp deserved further exploration.

AEC officials were continuing to assume uniform distribution of fallout—a woefully inaccurate assumption, ignoring variations in fallout patterns, owing to weather conditions and other factors. "For three months I held them off on a daily basis," while working to come up with a better response, Knapp recollected in a 1981 interview.[135] He found evidence that agreed with Lapp's claims about hot spots. The paper, sent to the Joint Committee on Atomic Energy, elicited praise for its candor.

Knapp decided to make a systematic and detailed analysis of the problem of fallout by first looking at radioactive iodine. To his surprise "no systematic approach to the study of fallout had been done before." The monitoring data were "spotty," and evidently there was no real consistent approach to the collection of radiation samples.

"They had inadequate measuring techniques. It takes four days for the radioiodine to build up to a maximum in milk. Within two weeks everything is gone. Either they would analyze the sample too soon or wait too long."[136]

In examining milk data for the 1953 tests, Knapp discovered, "by pot luck someone was measuring the right thing at the right time" for St. George, Utah. Knapp estimated that during the 1950s the dose to the thyroid from iodine 131 in cow's milk was ten times the Federal Radiation Council standards.[137]

Knapp's report was sent upstairs to Charles Dunham, director of the AEC's Division of Biology and Medicine. It was immediately classified.[138] Dunham sent the paper to Gordon Dunning, AEC deputy director for operational safety, who suggested that a special AEC committee, composed of "qualified scientists with specialized backgrounds,"[139] be established to comment on the report.

Four of five reviewers favorably commented on Knapp's paper and urged its release. The only unfavorable review came from the Nevada Test Site's off-site radiological safety officer, Oliver R. Placak.[140] Over Dunning's objections, the AEC assistant general manager for research, Spoford English, reluctantly okayed release of the Knapp report.

The basic point of Knapp's research was that after more than ten years of atomic weapons testing at the Nevada

---

132. U.S. Congress, House and Senate Joint Committee on Atomic Energy, *Environmental Effects of Producing Electric Power,* (91st Cong., 1st sess.), October-November 1969, Part 1, p. 409.

133. Metzger, *Atomic Establishment,* p. 107.

134. Harold Knapp, interview, February 1981.

135. Ibid.

136. Ibid.

137. Ibid.

138. Charles L. Dunham, "Draft Document Average and Above Average Doses to the Thyroid of Children in the United States from Radioiodine from Nuclear Weapons Tests," AEC Memo, October 24, 1962, files of House of Representatives Commerce Subcommittee on Oversight and investigations, Washington, D.C.

139. Gordon Dunning to N. H. Woodruff, AEC Memo Re: Knapp Paper, files of House Subcommittee on Oversight and Investigations.

140. U.S. Congress, House and Senate Joint Committee on Atomic Energy, *Fallout, Radiation Standards and Countermeasures,* (88th Cong., 1st sess.), August 1963, Part 2, pp. 914-1082.

site, the AEC had never actually bothered to methodically assess the impact of fallout on people living nearby. The Knapp report, issued in early 1963, warned that "At the Nevada Test Site, over 1,000 kilotons equivalent of Iodine-131 were released before we obtained any reliable data on Iodine-131 in milk in off-site communities following deposition from specific shots." The amount was more than five thousand times as much as had been released at a 1957 accident at the British reactor at Windscale, which caused a national emergency to be declared because of milk contamination.[141]

The broad outlines of the fallout disaster came into focus even while atmospheric nuclear testing persisted. Two decades later Robert Minogue, research director for the Nuclear Regulatory Commission, told us: "High AEC officials knew very well the biological effects of low-level radiation in the 1950s. They can't use ignorance as an excuse."[142] But, as grim evidence mounted, the nuclear policymakers tried to keep the truth from the public.

141. Harold Knapp, "Observed Relations Between Deposition Level of Fresh Fission Products from Nevada Tests and Resulting Levels of I-131 in Fresh Milk," AEC Report, March 1, 1963, files of House Subcommittee on Oversight and Investigations.

142. Robert Minogue, interview, February 1981.

5

Continued Testing: Tragic Repetitions

While the fallout debate raged during the mid-1950s, the U.S. nuclear weapons testing program continued to escalate. American servicemen and civilians were, more than ever, in the radioactive line of fire. The government gave scant priority to the health and safety of its own citizens.

The practice of exploding atomic weapons underwater was a case in point.

The first time the United States set off an atom bomb beneath the ocean surface, at the 1946 Baker test in the shallow Bikini lagoon, the military vessels had been shellacked with unexpectedly tenacious, and long-lived, radioactivity. The U.S. Government scuttled plans for a follow-up deep-water explosion to climax the first series of atomic tests at Bikini.

There was no official acknowledgment that dangers of sub-ocean-surface nuclear explosions had prompted the indefinite postponement.[1] However, an analysis published in *Science Digest* in summer 1947 said such detonations involve "some highly unpredictable phenomena." In fact, remarked author John W. Campbell, "no one has the slightest idea of what might happen if an atomic bomb were set off at a depth of half a mile in sea water."[2]

The Atomic Energy Commission, in a report to the National Security Resources Board, later conceded that "if a bomb is exploded in water, such as the [1946] Test Baker at Bikini, there will be considerable amounts of residual radioactivity, depending upon wind, currents, tides, and the size of the body of water."[3]

American military officers, briefed by the Armed Forces Special Weapons Project during the late 1940s, were warned that underwater nuclear tests entailed special risks. The secret handbook used in the course cautioned that radioactive mist from an underwater nuclear blast could be expected to spray "serious contamination over a large area."[4]

On pages marked "RESTRICTED" the government's own experts elaborated on the dangers. Dr. Herbert Scoville, Jr., who later became deputy director of the Central Intelligence Agency, wrote: "In an underwater detonation the nuclear radiation effects are quite different from those resulting from an air burst and are of considerably greater magnitude." Scoville recalled that the only underwater nuclear test up until that time, in the lagoon at Bikini, had left enormous quantities of radioactivity—"estimated to be equivalent to thousands of tons of radium shortly after the detonation. This is a billion times the radioactivity from a gram of radium. Such is the truly fantastic radioactivity associated with an atomic bomb detonation."[5]

And, Scoville pointed out, in Bikini's lagoon "intensities above tolerance were measured for almost a week." Even "nontarget vessels" were severely contaminated.[6]

But nine years later the United States exploded a thirty-kiloton nuclear bomb two thousand feet below the surface of the Pacific Ocean—just five hundred miles southwest of San Diego.[7]

---

1. Rather, the official explanation as *United States News* reported it was that the deep-water explosion set for Bikini was axed "chiefly because of the danger to military security in tying up the needed technical man power and equipment at this time." (*United States News,* September 20, 1946, p. 19.)

2. John W. Campbell, "Why Atom Test 3 Was Canceled," *Science Digest,* July 1947, p 7.

3. *The H Bomb,* p. 35.

4. Dr. Herbert Scoville, Jr., "Nuclear Radiation Effects of Atomic Bomb Detonations," "Medical Indoctrination Course," Armed Forces Special Weapons Project, Army Medical Center, Washington, D.C., undated, late 1940s, p. 4.

5. Ibid.

6. Ibid.

7. U.S. DOD, *Prototype Report, DOD Personnel Participation, Operation Wigwam* (Washington, D.C.: Defense Nuclear Agency, 1980), p. 12. Wigwam blast location was 28 degrees 44 minutes north latitude and 126 degrees 16 minutes west longitude.

Wigwam

For those who heard about the 1955 deep-water test ahead of time, it didn't sound like much to worry about. Government public-relations specialists saw to that. In the five months between President Eisenhower's approval of the detonation and the day it actually occurred, Pentagon image-makers busily prepared for the unusual nuclear blast, tagged "Operation Wigwam."

About sixty-five hundred people, almost all of them servicemen, were scheduled to be there, so secrecy was out of the question. But the AEC barred news correspondents from observing Operation Wigwam. And, although the bomb was thirty kilotons—more than twice the size of the Hiroshima atomic weapon—the government succeeded in depicting it as rather small. The *San Diego Evening Tribune* informed its readers that the Wigwam bomb was "thought to have had an energy equivalent of 1 to 5 kilotons, certainly smaller than 20 kt."[8]

Internal government documents about Operation Wigwam remained classified for more than twenty years. In 1980 the California-based Center for Investigative Reporting was able to study official records and films of the underwater test. The team of journalists concluded that "the planners' major concerns were for the scientific and military results of the test; concern for the possible hazards facing the thousands of men stationed at the blast site appears to have been secondary."[9]

When the A-bomb exploded on May 14, 1955, it sent huge shock waves and gigantic walls of seawater at thirty ships with more than six thousand servicemen aboard—many of whom had no idea they were participating in an atomic test. A confidential document declared that the men were subjected to "extremely hazardous respiratory conditions."[10] And the Center for Investigative Reporting found that nearly 40 percent of interviewed Operation Wigwam veterans recalled having no radiation-detection badges during the nuclear test.[11] Out of thirty-five Wigwam veterans located, seventeen had illnesses they attributed to radiation exposure during the blast.[12]

Twenty-four years after the Wigwam test Elroy L. Runnels faced television cameras in Honolulu and remembered: "We weren't told anything of the . . . gravity of the situation."[13] Two days after Runnels's filmed statement he was dead—a leukemia victim. He had been seventeen years old while aboard the U.S.S. *Moctobi* in the Operation Wigwam armada.

One of Runnels's last efforts, from his deathbed in late summer of 1979, was to file a class action lawsuit against the U.S. Government, charging it intentionally endangered him and the other servicemen involved in Operation Wigwam. And because the government continued to stay mum about possible risks, Runnels maintained, his leukemia "festered undetected until it had advanced to an acute, severely debilitating state."[14]

Elroy Runnels's charges exposed basic inconsistencies in the government's accounts of the nuclear test. Despite the Navy's contention that no servicemen were closer than five miles to the blast, the logs of Runnels's ship showed it as being well under a mile from the bomb detonation.[15] He was not informed that he had participated in a nuclear test until several weeks after Operation Wigwam was over.[16]

Nor was Operation Wigwam the last American underwater nuclear explosion. In the summer of 1958 two nuclear blasts went off beneath the sea at Eniwetok. And on May 11, 1962, a test code-named Swordfish exploded with a force of twenty kilotons, under the Pacific Ocean at a spot 360 miles southwest of San Diego. About five thousand Navy servicemen were at the Swordfish test, which subjected them to what the Defense Nuclear Agency has termed "extremely low-yield" radiation.[17]

---

8. Dan Noyes, Maureen O'Neill, David Weir, "Operation Wigwam," *New West,* December 1, 1980, p. 28.

9. Ibid., p. 27.

10. Ibid., p. 29.

11. ABC-TV, *20/20* program broadcast, March 5, 1981, transcript p. 7.

12. Ibid., p. 6.

13. Ibid., p. 3.

14. *Honolulu Star-Bulletin,* September 4, 1979.

15. *San Francisco Chronicle,* United Press International, September 7, 1979.

16. *Honolulu Advertiser,* September 7, 1979.

17. *The Oregonian,* Associated Press, December 13, 1979.

For the most part America's nuclear testers were content to detonate new warheads above sea level in the Pacific Ocean. In 1958—a dozen years after the first atomic test in the Marshall Islands—the United States was exploding massive thermonuclear (hydrogen) bombs amidst those scenic isles. One Eniwetok blast, dubbed Oak, went off with a force of 8.9 megatons on June 28, 1958. Two months later the last nuclear weapons test occurred in the Marshall Islands.

The Pentagon moved on to other parts of the Pacific Ocean—Christmas Island and Johnson Island areas—where in 1962 thousands more American servicemen were exposed to nuclear test radiation.[18] Over a span of more than sixteen years, beginning with Operation Crossroads in 1946, the United States exploded 106 nuclear weapons in various parts of the Pacific.

The "Clean" Bomb

At the Nevada Test Site atmospheric nuclear bomb tests continued until mid-1962.[19] Leukemia and cancer deaths rose noticeably as mushroom clouds continued to darken the horizon.

For residents downwind, radioactive fallout—as AEC Commissioner Willard Libby had predicted in closed session—had indeed become a fact of life. Living in rural range lands of Nevada's Railroad Valley north of the test site, Martin Bardoli was just beginning elementary school in 1956 when he was diagnosed with leukemia. He died before the end of the year.[20] Believing the fallout clouds were responsible, Martin's parents circulated a petition and sent it to their senators and the Atomic Energy Commission.

In a responding letter Senator George Malone warned against alarmism about fallout. And, the senator added, "it is not impossible to suppose that some of the 'scare' stories are Communist inspired."[21]

AEC chairman Lewis Strauss replied by quoting former President Truman: "'Let us keep our sense of proportion in the matter of radioactive fallout. Of course, we want to keep the fallout in our tests to the absolute minimum, and we are learning to do just that. But the dangers that might occur from the fallout involve a small sacrifice when compared to the infinitely greater evil of the use of nuclear bombs in war.'"[22] Such reasoning did not convince the bereaved parents.

Health matters remained low priority for the nation's nuclear weapons testers. When the AEC's Advisory Committee on Biology and Medicine convened in January 1957, panelists discussed how best to counter public statements being made by independent scientists failing to toe the government line on fallout dangers.[23]

Two months later the AEC distributed its assurances-filled *Atomic Tests in Nevada* booklet to thousands of downwind residents.[24] With two dozen or so atomic explosions during Operation Plumbbob slated to begin soon at the Nevada site, new methods of cultivating trust among residents went into effect.

Federal administrators discovered that "good public relations in the off-site area were more difficult to maintain" than during the test series two years earlier, an in-house government report lamented. But the U.S. Government's evaluators had some encouraging news. Innovations for gaining the confidence of residents seemed to pay off. "The

---

18. Among the megaton-range explosions at Johnson Island was the 1.4-megaton Starfish Prime blast set off via rocket at an altitude of 248 miles on July 8, 1962. "For some time thereafter," *Science* magazine reported nineteen years later, "physicists puzzled over a resulting series of odd occurrences. Some 800 miles away in Hawaii, streetlights had failed, burglar alarms had rung, and circuit breakers had popped open in power lines. Today, the mysterious agent is known as electromagnetic pulse (EMP). Physicists say a single nuclear detonation in near space would cover vast stretches of the earth with an EMP of 50,000 volts per meter." A few such nuclear detonations could shut down electrical power grids and communications systems for thousands of miles around. (William J. Broad, "Nuclear Pulse (1): Awakening to the Chaos Factor," *Science,* May 29, 1981, pp. 1009-1012.)

19. Even when the bombs weren't exploding, the radiation burden was being increased because of test-site activities. From 1955 to 1958, and again in 1962, the government conducted dozens of "safety experiments"—sometimes labeled "plutonium dispersal" in official logs—sprinkling deadly plutonium particles to the winds in the southern Nevada desert. At the time, the general public was unaware those tests were going on. The Environmental Protection Agency discovered in 1974 that soil in the two states contained the nation's highest plutonium concentrations. The thickest blankets of plutonium in Utah were found in northern parts of the state—including Salt Lake City. (U.S. Energy Research and Development Administration, *Final Environmental Impact Statement, Nevada Test Site, Nye County, Nevada* (Washington, D.C.: ERDA, September 1977), pp. 2-88 to 2-91; *Health Effects of Low-Level Radiation,* April 19, 1979, Vol. 1, pp. 65-66.

20. *Deseret News,* April 24, 1979; *Life,* June 1980, pp. 38-39.

21. *Life,* June 1980, p. 38.

22. Ibid., p. 39.

23. AEC Advisory Committee on Biology and Medicine Meeting Minutes, January 16-19, 1957, pp. 4-6.

24. AEC, *Atomic Tests in Nevada*.

single fact that off-site monitors (many with families) lived in communities went a long way in establishing good public relations."[25]

Amid customary heavy and laudatory publicity American troops maneuvered beneath mushroom clouds of the 1957 tests.

Stationed in southern Nevada, Marine Major Charles Broudy placed a long-distance call to his wife on July 4, 1957. Excitement and urgency in her husband's voice were apparent to Pat Broudy as she listened from their home in Santa Ana, California, about three hundred miles away.

"You've got to get the kids up and face the east tomorrow morning around four Nevada time," she would always remember his telling her. "You'll see a miracle."[26]

After the "miracle"—a massive atomic explosion named Hood that official logs peg at seventy-four kilotons—Charles Broudy returned home. An often-decorated pilot whose awards included a Distinguished Flying Cross, Broudy was a career Marine with a top-secret clearance. He said little about the nuclear tests.

Nineteen years later he was diagnosed with lymphoma, a radiation-linked cancer. "He suffered terribly," recounted his widow, "but was convinced that his government would take care of him in his final days and would take care of his family after his death."[27]

However, after the drawn-out death occurred, the Veterans Administration denied service-connected benefits to his widow and children. Pat Broudy undertook detailed research. Aided by Princeton University physicist Frank von Hippel, she found that the Hood shot had exposed her late husband to about seventy thousand millirads of radiation—more than five thousand times above the thirteen-millirad dose the government said his film badge read at the test blast.[28]

But the Veterans Administration continued to turn down the Broudy family's appeals. "I buried my husband and swore to avenge his death if it takes the rest of my life, and well it may," Pat Broudy said in 1981.[29]

In response to a growing public awareness of the threat of nuclear fallout, President Eisenhower introduced the notion of the "clean" bomb. At a press conference on June 5, 1957, he declared that "we have reduced fallout from bombs by nine-tenths." Nevada test detonations were continuing in order "to see how clean we can make them."[30]

A few weeks later, three top American atomic scientists, including Dr. Edward Teller, met with President Eisenhower to support the "clean bomb"' rationale for further nuclear testing. Teller told reporters the meeting occurred to inform Eisenhower "what we are accomplishing in the current weeks and what we hope to and plan to accomplish in the coming years, if we can continue to work."[31] Teller made the comment a few hours after a thirty-seven-kiloton nuclear bomb named Priscilla had exploded in Nevada.

"Clean bomb" verbiage sought to put a relatively pretty face on the testing program. "This was done to counter the increasing public protests in the late 1950s against radioactive contamination resulting from atmospheric nuclear test explosions," a later article in the *Bulletin of the Atomic Scientists* remarked. "In addition, the possible development of an 'absolutely clean' bomb was used as an argument against a nuclear test ban, then under negotiation with the Soviet Union."[32]

After his June 1957 meeting with Teller and other physicists, President Eisenhower shared his enthusiasm with the nation. "What they are working on is . . . the production of clean bombs," Eisenhower proclaimed. "They tell me that already they are producing bombs that have 96 percent less fallout than was the case in our original ones, or what we call dirty bombs, but they go beyond this. They say: 'Give us four or five more years to test each step of our development and we will produce an absolutely clean bomb.'" *The New York Times* headline, for the article conveying the President's statements, revealed one of the significant motives behind the announcement:

---

25. AEC, "Plumbbob Off-Site Rad-Safety Report," 1958, p. 19.

26. Pat Broudy to authors, January 2, 1981.

27. Ibid.

28. *Atomic Veterans' Newsletter,* p. 19.

29. Broudy to authors, January 2, 1981.

30. *New York Times,* June 25, 1957.

31. Ibid.

32. Wim A. Smit and Peter Boskma, "Laser Fusion," *Bulletin of the Atomic Scientists,* December 1980, p. 34.

"EISENHOWER WARY OF ATOMIC TEST BAN."[33]

But promises about cleanliness of nuclear bombs did not decontaminate the radiation still rising from Pacific Ocean and Nevada test sites in 1958—during which the U.S. exploded seventy-seven nuclear weapons. Even America's major metropolitan areas were not exempt from intensely radioactive fallout clouds. Rapid-fire atmospheric nuclear tests in Nevada, plus Russian atomic detonations, sent radiation readings to the highest ever recorded in Los Angeles by the end of October 1958. Government officials announced that the fallout on Los Angeles was "harmless." Yet privately the National Advisory Committee on Radiation termed the L.A. radioactivity "an emergency."[34]

Panel members met in secret session on November 10, 1958, to discuss the problem. "If you ever let these numbers get out to the public, you have had it," said Lauriston S. Taylor, head of the Atomic Radiation Physics Division of the National Bureau of Standards.[35]

The average radiation dose in Los Angeles hovered at the maximum levels deemed "permissible" according to federal guidelines—and some citizens received more than that amount. Taylor admitted that references to permissible levels "carry the implication that we know what we are talking about when we set them. But in actual fact, they really represent the best judgment we would exercise now in the total absence of any real knowledge as to whether they are correct or not."[36]

U.S. surgeon general Dr. LeRoy Burney commented, "If I were in Los Angeles, I would consider I was insulted for somebody in the Federal Government . . . to say, 'This is nothing to be alarmed about.'"[37]

The huddled government scientists observed that radiation dosages at least as high as those besetting Los Angeles had been found the previous year in Salt Lake City. But twenty years would pass before residents of either city learned about what was said at that closed governmental meeting.[38]

By the time the provisional nuclear test moratorium began in November 1958, the United States had set off 196 nuclear bombs, while the Soviet Union had detonated 55.

For nearly three years the world got relief from atmospheric nuclear tests—except for a few fired by France in 1960 and 1961. Amid growing world tensions—the Berlin and Cuban crises in particular—the Soviets resumed testing with a huge nuclear explosion in September 1961, and the U.S. soon followed that example.[39] But the movement for a formal test treaty continued.

Fallout in New York State

By 1963 an atmospheric nuclear test ban was in final stages of negotiation between the United States, the Soviet Union, and Great Britain. Carrying through promises of the 1960 campaign, President John Kennedy had made it respectable for people to question fallout from testing.

In a July 1963 speech televised to the nation Kennedy urged Senate ratification of the test ban treaty: "The number of children and grandchildren with cancer in their bones, with leukemia in their blood, or with poison in their lungs might seem statistically small to some, in comparison with natural hazards, but this is not a natural health hazard—and it is not a statistical issue. The loss of even one human life, or malformation of one baby—who may be born long after we are gone—should be of concern to us all. Our children and grandchildren are not merely statistics towards which we can be indifferent."[40]

On August 20, 1963, Edward Teller testified before the Senate Foreign Relations Committee in opposition to the test ban treaty. "From the present levels of worldwide fallout, there is no danger," he said. "The real danger is that

33. *New York Times*, June 27, 1957, cited in Smit and Boskma, "Laser Fusion," p. 34.

34. *Deseret News*, April 24, 1979.

35. Ibid.

36. Ibid.

37. Ibid.

38. Ibid.

39. For a list of nuclear tests by all nations, see Melvin W. Carter and A. Alan Moghissi, "Three Decades of Nuclear Testing," *Health Physics*, July 1977, pp. 55-71.

40. Ernest Sternglass, *Secret Fallout*, pp. 27-28.

you will frighten mothers from giving milk to their babies. By that, probably more damage has been done than by anything else concerning this matter."[41]

Across the Capitol, at a Joint Committee on Atomic Energy hearing, University of Utah scientists Robert Pendleton and Charles Mays presented evidence that because of the 1962 tests approximately a quarter-million young children in Utah may have been exposed to average thyroid doses of 4.4 rads. Their analysis had compelled the state of Utah to dump several thousand gallons of milk—which contained radioactive iodine levels eight times above the official Federal Radiation Council guidelines. Dr. Mays estimated that as a result of the Harry test in 1953, seven hundred infants in St. George received radiation doses to their thyroids 136 to 500 times higher than existing permissible levels.[42] Those doses could cause death, genetic mutation, brain damage, and hypothyroidism among other diseases.

Underscoring this point, witness Eric Reiss, cofounder of the St. Louis Committee for Nuclear Information, added that "in the period 1951-62, a number of local populations, especially Nevada, Idaho, and Utah . . . have been exposed to fallout so intense as to represent a medically unacceptable hazard to children who may drink fresh locally produced milk."[43]

On the next day a University of Pittsburgh Medical School professor of radiology, Dr. Ernest Sternglass, presented testimony. His work evoked the greatest amount of concern from the Joint Committee. In a 1963 paper in *Science* magazine,[44] Sternglass had calculated that the latest two years of nuclear testing fallout exposed everybody living in the Northern Hemisphere to a radiation dose of two hundred to four hundred millirads, roughly equivalent to a pelvic X ray. Citing Dr. Alice Stewart's findings of a 50 percent increase in childhood cancer risks from fetal X rays,[45] Sternglass estimated that there would be an additional eight hundred childhood cancer deaths in the U.S. from the 1961-1962 tests alone.

Sternglass had applied those estimates to the Troy/Albany area in upstate New York—where average radiation doses went as high as a few thousand millirads as a result of fallout from the 1953 Simon test in Nevada. Sternglass calculated a doubling in child cancer risks for the residents of Troy/Albany.[46]

Sternglass submitted his findings on fallout effects to *Science* magazine for publication. In its early days, *Science* had strongly questioned the atomic establishment. In 1955 the magazine vigorously attacked Lewis Strauss for scientific suppression and had published E. B. Lewis's papers opposing the "threshold" concept of radiation safety.

But now the editorship of *Science* had passed to Philip Abelson, a physicist deeply involved in the government's nuclear program from the Manhattan Project on. Abelson also served on the AEC's General Advisory Committee and on its Project Plowshare Committee, which was promoting "peaceful" uses of nuclear explosives. Not surprisingly, Abelson rejected Sternglass's article on fallout contending that "there is really no evidence of the functional relationship between the number of X-rays taken and cancer mortality."[47]

Sternglass soon resubmitted his paper with comments from Dr. Russell Morgan, one of America's foremost experts on X rays and the effects of low-level radiation. Morgan praised Sternglass's paper and voiced support for Alice Stewart's findings of definite links between X rays and cancer—findings which by then had been confirmed by Dr. Brian MacMahon of Harvard. Within a month after resubmission, *Science* was forced to accept Sternglass's paper.

But in March of 1964 the magazine printed a letter from James H. Lade of the New York State Health Department attacking Sternglass's findings. Lade wrote that "the cancer report files of this department reveal no increase in the incidence of cancer or leukemia over the past 10 years in children of the Albany, Troy and Schenectady areas—who were 15 years or younger in 1963—as compared with children of this age elsewhere in upstate New York."[48]

---

41. U.S. Congress, Senate Foreign Relations Committee, (88th Cong., 1st sess.), August 12-27, 1963.

42. *Fallout, Radiation Standards and Countermeasures,* June 1963, Part 1.

43. Ibid., August 1963, Part 2.

44. Ernest J. Sternglass, "Cancer: Relation of Prenatal Radiation to Development of Disease in Childhood," *Science,* June 7, 1963, pp. 1102-1104.

45. Stewart, et al., "Survey of Childhood Malignancies," pp. 1495-1508.

46. Sternglass, *Secret Fallout*, p. 21.

47. Ibid., p. 23.

48. J. H. Lade, "More on the 1953 Fallout in Troy," *Science*, March 6, 1964, pp. 994-995.

A key phrase in Lade's argument came when he said the Albany area's leukemia rate appeared normal "*as compared with children of this age elsewhere in upstate New York."* The entire upstate New York region had received heavy fallout on April 26, 1953, but measurements there had been classified as secret by the AEC. "Under these circumstances," Sternglass reasoned, "there would of course be little or no difference in leukemia rates between Troy, Albany, Schenectady and elsewhere in upstate New York." Lade's new information actually "showed that beginning in the fourth to fifth years after the 1953 rainout, the yearly number of reported leukemia cases quadrupled," according to Sternglass.[49]

Unable to pry loose any further data from New York State's uncooperative health department, Ernest Sternglass presented an update of his Troy/Albany paper to the Health Physics Society's annual meeting, held in Denver in June 1968. Reports of Sternglass's findings received wide publicity in the U.S. and abroad. A month after the annual meeting R. E. Alexander, chairman of the Health Physics Society public-relations committee, sent a letter to the society's board members, complaining that the "publicity about the paper of E. J. Sternglass . . . was damaging to the nuclear industry."[50] Continuing his research, Sternglass began poring through U.S. vital statistics for the three upstate counties in New York. While copying the numbers he noticed that births had increased by only about 50 percent while leukemia cases went up by more than 300 percent. What was even more striking, fetal deaths stopped declining while intense fallout was taking place; seven years after testing, fetal deaths resumed a downward trend. He then began a detailed comparison of actual measured fallout levels made public by the AEC, with fetal and infant death rates in New York State. "Each time the levels of the short lived isotopes, such as I-131 and Strontium-90, shot up to their highest peaks, there was a sharp rise in fetal mortality within a year."[51]

The first large jumps in fetal deaths were "followed by a second slower rise culminating between three and five years later," Sternglass discovered. The second peaks were especially high "probably because each of the enormous fusion bombs . . . produced hundreds of times as much Strontium-90 . . . in order to get a 'bigger bang for a buck,' as U.S. Secretary of Defense Charles Wilson put it. Edward Teller and his weapons engineers had surrounded the hydrogen bombs with cheap, abundant Uranium-238. As a result, the total explosive force could be doubled . . . but the levels of Strontium-90 in the bones of living creatures vastly increased."[52]

By fall 1968 Sternglass had estimated that atmospheric nuclear testing caused the deaths of 375,000 babies—in the United States alone—before their first birthdays between 1951 and 1966.[53]

Sternglass discussed his research with colleagues in the Federation of American Scientists. They agreed to hold a public meeting in Pittsburgh on October 23, 1968. Meanwhile, Sternglass submitted copies to *Science* and the *Bulletin of the Atomic Scientists*.

Pittsburgh television reporter Stuart Brown contacted *Science* editor Philip Abelson for his comments on the Sternglass paper. Contrary to the standard procedure of keeping editorial correspondence confidential, Abelson read statements from scientific reviews of Sternglass's paper responding to Lade on the Troy/Albany situation. Abelson then advised Brown against using Sternglass's findings on the air.[54] A few weeks later *Science* returned the Troy/Albany and infant-mortality papers with a rejection notice.

The *Bulletin of the Atomic Scientists*, after a review of Sternglass's infant-mortality paper, agreed to publish it in their April 1969 issue. Sternglass later learned from the magazine's managing editor, Richard S. Lewis, that the *Bulletin* withstood pressure "both before and after publication in the form of long distance phone calls from Washington from individuals who claimed to be long-term Government friends of the journal." The callers informed Lewis that publication of the Sternglass article was a "grave mistake."[55]

---

49. Sternglass, *Secret Fallout*, p. 43.

50. Ibid., p. 52.

51. Ibid., pp. 56, 57, 63.

52. Ibid., p. 65.

53. Ibid., p. 73.

54. Ibid., p. 75.

55. Ibid., p. 97.

Nuclear Experiments

In retrospect there is chilling irony in the atomic bomb's—and the nuclear industry's—origins. Stopping Nazi barbarism provided the initial rationale for the Manhattan Project, which developed the atomic bomb. At the Nuremberg trials some Nazi scientists and other functionaries were charged with grotesque experiments on humans; the Nuremberg judges rejected excuses and rationalizations.

But since then, in the United States, "we have already accepted the policy of experimentation on involuntary human subjects,"[56] concluded Dr. John W. Gofman, a pioneer in radiation research who codiscovered the fissionability of uranium 233 and helped isolate the world's first milligram of plutonium.

"In the mid-'50s—when the toxi[ci]ty of low-dose radiation was still uncertain—we were testing nuclear bombs in the atmosphere and launching the Atoms for Peace Program," Gofman recalled in a 1979 statement. "It should have been clear to me, even then, that both atmospheric bomb-testing and nuclear power constituted experimentation on involuntary human subjects, indeed on all forms of life."[57]

With extraordinarily blunt self-criticism Gofman—a physicist and medical doctor—went on: "I am on record in 1957 as *not* being worried yet about fallout and still being optimistic about the benefits of nuclear power. There is no way I can justify my failure to help sound an alarm over these activities many years sooner than I did. I feel that at least several hundred scientists trained in the biomedical aspect of atomic energy—myself definitely included—are candidates for Nuremberg-type trials for crimes against humanity through our gross negligence and irresponsibility." And, Gofman added, "Now that we *know* the hazard of low-dose radiation, the crime is not experimentation—it's *murder*."[58]

People viewing such an assessment as unfair or excessively strident might find it less so after visiting small towns like St. George, Utah, or Fredonia, Arizona, or Tonopah, Nevada. The pain, for many, has just begun.

Before dawn on January 27, 1981—exactly thirty years after the first mushroom cloud ascended from the Nevada Test Site—lifelong Utah residents gathered at the steps of the state capitol and lit candles in memory of dead relatives and friends. Around the state other memorial candles flickered in the darkness.

At the operations center for the Nevada Test Site daylight brought simply the beginning of another working day. An Associated Press reporter phoned for comment on the candlelight observances downwind. He took notes, and wrote in an article sent across the nation a few hours later: "The Department of Energy maintains there is 'no positive evidence' of a link between fallout and the cancer cases, said Dee Jenkins, test site spokeswoman."[59]

We called Dee Jenkins and asked for clarification. Had she been accurately quoted?

Yes, she replied. "There is no positive link between low-level radiation and cancer cases."[60]

We asked whether the downwind residents had received "low-level radiation" exposure during the atmospheric testing years.

"I'm not qualified to answer that question," she responded after a pause.[61] Our request for a clarifying official statement was never answered.

Three decades after the first fallout clouds from Nevada, in some respects not much had really changed at federal agencies making pronouncements about nuclear testing.

And, with some exceptions, American mass media have continued to be influenced by substantial pressures to treat nuclear weapons testers with deference.

In 1957 *The Reporter* magazine published an exceptional in-depth article, "Clouds from Nevada," by investigative reporter Paul Jacobs.[62] Raising basic questions about the safety of nuclear tests, the article was a

---

56. John W. Gofman, *An Irreverent, Illustrated View of Nuclear Power* (San Francisco: Committee for Nuclear Responsibility, Main P.O. Box 11207, San Francisco, CA 92401; 1979), p. 227.

57. Ibid.

58. Ibid., pp. 227-228.

59. *The Oregonian*, Associated Press, January 28, 1981.

60. Dee Jenkins, interview, February 1981.

61. Ibid.

62. Paul Jacobs, "Clouds from Nevada," *The Reporter*, May 16, 1957, reprinted in *Health Effects of Low-Level Radiation*, Vol. 1, pp. 45-64. Jacobs was one of the few people to write about the Nevada testing's destructive impact on downwind residents as early as 1957 for a national readership. Another was Ralph Friedman, a free-lance journalist who had written for the U.S. Army weekly *Yank* during World War II. *The Nation* published Friedman's reportage—headlining it "NEXT DOOR TO GROUND ZERO"—in autumn 1957. The federal government, Friedman concluded in his article, "has done a top-flight Madison Avenue public-relations job in playing down all issues relating to radiation." But, he noted, "AEC publicists have the painful task of double-dealing. They tell the isolated stockmen and miners that they have nothing to worry about . . . They then tell the people of the cities that the tests are 'safe' because

classic instance of prophetic journalism that—if heeded at the time of publication—would have prevented a great deal of fallout-induced harm yet to come. Twenty years later Jacobs set about working on a documentary film to update the story.

Jacobs died from cancer in 1978, before completion of the project.[63] Associates at New Time Films, based in New York, finished the movie, titling it *Paul Jacobs and the Nuclear Gang*.[64] The result was a devastating chronicle of life and death downwind from the test site.

To the nuclear industry, that was the problem. The movie was clearly dangerous. And so when the Public Broadcasting Service scheduled *Paul Jacobs and the Nuclear Gang* for national telecast, the Atomic Industrial Forum—an advocacy organization for nuclear energy corporations—swung into action. It mounted an intensive nationwide drive against the film, denouncing it as biased and unfit for broadcast. In addition stations in some localities received letters from regional reactor-committed electric utilities, urging that the film not be broadcast.[65]

"After the Atomic Industrial Forum wrote to PBS to protest, the censorship then took place on a local level," the film's associate producer, Penny Bernstein, told us.[66] When the evening scheduled for telecast came, public TV stations in nine of the nation's twenty-four largest television areas refused to air *Paul Jacobs and the Nuclear Gang*. Some, like the five public stations in New Jersey, said they could not find broadcasting time for the film—ever. Other stations postponed it to less popular time slots.[67]

In St. Louis, where public television station KETC scheduled the movie and then yanked it at virtually the last minute, a *Post-Dispatch* editorial expressed doubt that the program would have been treated the same way if it had down-played radiation risks. Most likely, the newspaper concluded, the TV station sought to avoid controversy "only because the show questioned the safety of radiation and because government and industry . . . have invested millions in promoting nuclear power (with its accompanying radiation) as safe."[68]

Paul Jacobs and the Nuclear Gang won the only Emmy award that the Public Broadcasting Service received for 1979. But as of late 1981 PBS—heavily reliant on government and corporate funding—had not provided any money to the documentary movie's producers for a follow-up film they had proposed.[69]

Underground Nuclear Tests

One of the most pervasive—and erroneous—beliefs about the U.S. nuclear testing program is that its radioactive fallout ended when the Limited Test Ban treaty took effect in 1963. When the nuclear tests went underground, people assumed the weapons-testing radiation threat disappeared. This comforting notion, carefully nurtured by the government, is false.

In 1979 the U.S. Government admitted that more than 35 of approximately 330 "underground" nuclear blasts sent radioactivity outside the boundaries of the Nevada Test Site, during the 1960s and early 1970s.[70] And the DOE's test site manager, General Mahlon Gates, said that the government still was not sure it had made public all the atomic tests that occurred in Nevada.[71] Prior to that announcement governmental spokespeople were admitting to only half as many underground test mishaps venting radioactivity off-site. "During 18 weapons tests which accidentally

---

the fallout comes to rest in 'virtually uninhabited desert terrain.'" (Ralph Friedman, "Next Door to Ground Zero," *Nation*, October 19, 1957, pp. 256-259.) When we asked Friedman what the response was to *The Nation* article, he replied: "None—as far as I could see." (Friedman, interview, March 1981.)

63. For a eulogy to Paul Jacobs see Saul Landau and Jack Willis, *In These Times,* April 11-17, 1979.

64. Jack Willis and Saul Landau, *Paul Jacobs and the Nuclear Gang*.

65. "PBS Stations Yield to Industry Pressure, Decline to Air Program on Effects of Nuclear Radiation," *ACCESS,* March 26, 1979; Penny Bernstein to authors, January 27, 1981.

66. Bernstein to authors, January 27, 1981.

67. "PBS Stations Yield to Industry Pressure."

68. *St. Louis Post-Dispatch,* March 3, 1979.

69. Bernstein to authors, January 27, 1981.

70. U.S. Congress, House Committee on Interstate and Foreign Commerce, Subcommittee on Oversight and Investigations, Testimony of General Mahlon Gates, U.S. DOE manager of the Nevada Test Site, and Richard E. Stanley, acting director of the U.S. Environmental Monitoring and Support Laboratory," Las Vegas, Nevada, April 23, 1979, unpublished transcript.

71. Ibid.

released radioactivity during the period, 1962-1971, very, very, small releases occurred," DOE media liaison David Miller said in December 1978.[72]

While understating the number of underground tests spewing radioactivity beyond site boundaries, officials were even more determined to belittle the severity of those ventings. "We didn't believe it was a health hazard then and don't believe it is today," Miller insisted.[73] But that kind of assurance sounded more than a little familiar. In St. George, Irma Thomas—who had lived through the atmospheric testing days as a middle-aged woman—told us the underground nuclear testing continued to infuriate her. "I don't trust all that stuff about how safe it is," she said. "We've heard that before."[74]

Across the Arizona border, in the town of Fredonia where the leukemia epidemic killed four people including her husband, Rose Mackelprang reacted to the underground testing with gentle anger: "I don't think that we really should have to have any more radiation, I think we have plenty without adding to it all the time. We have about all that we need."[75]

In 1980 we visited the Nevada Test Site, touring the windswept expanse of desert, accompanied by federal officials. Signs at heavily guarded checkpoints now say "U.S. Department of Energy." As always it is a military operation.

Amid the ugly pockmarks of the test site, where craters give off the appearance of a moonscape from the air, the austere yet ecologically intricate desert seemed transmuted, and profoundly violated.

For the record, Nevada Test Site representatives were resolute—speaking of preparedness, national defense, a strong "military posture." But an old hand at nuclear testing said, after asking us to turn off our tape recorder, "No head of state, in the world, has ever seen a nuclear bomb explosion. To me, that's scary." He added: "I don't think anyone who has ever seen a nuclear explosion has ever not asked the question—*My God, what have we done?*"[76]

When the 1980s began, nuclear detonations under the Nevada desert—ranging up to 150 kilotons each—were occurring at an average rate of once every three weeks.[77] After the Reagan administration gained power in 1981, it pledged to increase that pace.

A cone-shaped crater, measuring several hundred feet deep and a quarter-mile across, was left by the hydrogen "device" code-named Sedan. Eighteen years after it was created by the 104-kiloton thermonuclear blast, the crater—graced with an overlook platform and an explanatory sign—had become a monument to the destructive force of nuclear weaponry. But when it was detonated, as an experiment in possible excavation uses of nuclear energy, Sedan sent intense radiation all the way to the Eastern Seaboard. Probably little would have been learned about this planned disaster had not some University of Utah graduate students and their outspoken professor been visiting a canyon about twenty miles southeast of Salt Lake City.

On July 7, 1962, radiologist Dr. Robert C. Pendleton was with students on a field trip in Big Cottonwood Canyon. "We were measuring levels of radioactivity in different environmental situations," Dr. Pendleton remembered. "A cloud of radioactive material came over and all the measurements began to go nuts. I recognized that we were getting fallout and took the students off the hill and back down in the valley."[78] The fallout had multiplied normal radiation readings a hundredfold.[79]

There had been no warning from the government—only "the usual announcements that atomic shots were taking place," according to *Deseret News* environmental reporter Joseph Bauman.[80] Although the federal government was content to let the matter rest, Dr. Pendleton was not: "We found radioactive iodine in all of the children, milk and vegetation that we measured in the whole northern section of the state."[81]

---

72. *Washington County News* (Utah), December 14, 1978.

73. Ibid.

74. Irma Thomas, interview, February 1980.

75. Rose Mackelprang, speech to National Conference for a Comprehensive Test Ban, University of Utah, Salt Lake City, December 12, 1980.

76. DOE official, who requested anonymity, during tour of Nevada Test Site, interview, February 1980.

77. David Jackson, DOE spokesman, interview, September 1980.

78. *Deseret News*, May 23, 1979.

79. *The Tribune* (Salt Lake), May 17, 1980.

80. *Deseret News*, May 23, 1979.

81. Ibid.

Pendleton's determination to analyze impacts of the Sedan fallout caused the Utah Department of Health to divert thousands of gallons of milk—laced with radioactive iodine 131, a voracious destroyer of human thyroids—that would have been otherwise consumed by Utah residents.[82] The action partially deflected health damage to Utahns from the Sedan test fallout. But it angered the White House—which "responded by ordering the Public Health Service to clear its radiation reports through the White House press office," *The Deseret News* reported seventeen years later on the basis of newly declassified federal documents.[83]

As long-secret records came to light, the Salt Lake City newspaper published an interview with Dr. Pendleton about aftermaths of ostensibly nonatmospheric nuclear testing in July 1962. Radioactive iodine, cesium, and strontium increased "very markedly" after the Sedan blast, Pendleton recalled. "We told Governor George D. Clyde there was a risk, but the [U.S.] Public Health Service was telling the State Division of Public Health a different story." The federal policy of dismissing radiation alarms prevented use of precautions that could have helped guard people from exposure. As Pendleton observed, "Public relations statements that there was no harm in the fallout clouds were reprehensible."[84]

During the 1960s, as Pendleton continued warning of radiation damage from underground nuclear tests, official hostility toward him grew. The conflict escalated in 1963 with the publication of a *Science* magazine article on Utah's summer 1962 iodine 131 levels.[85] Pendleton and two colleagues pointed out that the thyroids of many thousands of Utah people were seriously threatened by nuclear detonations in Nevada the previous summer—with children in their first two years of life put at the greatest risk of all.

In 1964 a follow-up article in *Science* made clear that the country as a whole remained in jeopardy from ventings of underground nuclear tests.[86] Dr. Edward A. Martell, formerly employed by the U.S. Government to monitor fallout, documented findings that underground nuclear blasts were responsible for significant levels of iodine 131 in milk from the Pacific Northwest and the Midwest to the southeastern United States.

"Even underground tests which are largely contained below ground with only a limited release of radioactive gases and vapors cannot be overlooked as sources of Iodine-131," Martell wrote. He added: "Control of Iodine-131 fallout will be more effective if we control its sources rather than the distribution and consumption of fresh dairy products. . . . The high frequency of venting of radioactive products from previous underground tests suggests that either there was no serious attempt to contain them, or that containment is difficult and uncertain."[87]

To a casual observer the scientific debate over iodine 131 from underground testing might have seemed somewhat academic. But in a community like Pleasant Grove—located near Provo, Utah, in the fallout path of Sedan and other tests several years earlier—the issue appeared much less abstract. During the late 1960s seven children in that town of about five thousand people died from leukemia[88]—a rate more than ten times higher than the national average.[89]

Pendleton found himself faced with cuts in federal research funds because he was coming up with Utah radiation readings deemed "too high."[90] Some of the most ominous nuclear tests were being executed under the category of Plowshare explosions to develop nuclear technology for functions like excavation. "Surely each person to be showered with radioactive dust from engineering tests should be fully informed of this possible hazard, and should be given a chance to decide whether the risk is justified," Pendleton told a *Science Digest* interviewer in 1967. He went on, "While we are making such strong efforts all over the nation to clear up the air and remove pollution, we have an agency proposing to release massive quantities of radioactive air pollution to drift down over the inhabitants of the country without even asking a by-your-leave as to whether they may do so."[91]

---

82. *The Tribune*, (Salt Lake), May 17, 1980.

83. *Deseret News*, April 24, 1979.

84. *Deseret News*, January 27, 1979.

85. Robert C. Pendleton, et al., "Iodine-131 in Utah During July and August 1962," *Science*, August 16, 1963, pp. 640-642.

86. E. A. Martell, "Iodine-131 Fallout from Underground Tests," *Science*, January 10, 1964, pp. 126-129.

87. Ibid., p. 129.

88. *The Tribune* (Salt Lake), May 17, 1980.

89. Heath, "Subject: Leukemia."

90. *Deseret News*, January 27, 1979.

91. Nelson Wadsworth, "Underground A-Tests May Be Making Us Radioactive," *Science Digest*, September 1967, pp. 15, 17.

In 1981 we asked Robert Pendleton to comment on his two-decade altercation with nuclear weapons testing authorities. Continuing his research as director of the Radiological Health Department at the University of Utah, Dr. Pendleton seemed weary of the struggle. He declined to discuss past cover-ups and coercion directed against him.[92]

More Radiation Clouds

In the late 1960s and beyond, the kind of additional fallout that underground testing critics had labored to prevent did indeed occur—with several subsurface nuclear tests shooting radioactivity across the U.S. and into Canada.

From 1966 to 1975 the federal officer responsible for monitoring of off-site fallout from underground detonations was Colonel Raymond E. Brim, chief of operations for the Air Force Technical Applications Center. On December 8, 1968, a thirty-kiloton Plowshare blast named Schooner sent up a storm of radioactivity over the Nevada Test Site. As usual Brim's agency began to monitor the fallout.

"This effluent cloud was tracked continuously by Air Force planes until it reached the border of Canada where standing orders prevented tracking outside the United States," Brim revealed more than a decade afterward. "I remember a few days later an article appeared in the *New York Times* which reported an increase in radiation detected in Canada. When we read the article, we knew that it was the cloud we had tracked to the border."[93] But, at the time, Brim and his colleagues kept silent. And, with neither the U.S. nor Canadian governments willing to state definitely that the American test was the cause of increased radiation levels in Canada, the matter dropped, unresolved, from public sight.[94]

The Schooner test clouds also dropped radiation across the continent. "It didn't register anywhere east of the Mississippi because the AEC had no monitoring stations east of the river," according to Brim—who termed the government's strategy "a clever adaption of the switch-the-monitors-off ploy."[95]

While working for the Air Force, Brim went along with the Pentagon program and held his peace. During the first several years after retirement, however, Colonel Brim mulled the implications of underground testing radiation leaks. On August 1, 1979, he testified at a hearing of the House Subcommittee on Oversight and Investigations.

"There is indisputable evidence on record that shows that the people, not just of Utah and Nevada but of a much wider and more encompassing area of the United States, were unknowingly subjected to fallout of radioactive debris that resulted from ventings of underground and cratering tests conducted at the Nevada Test Site," Brim told the congressional panel. "Because of weather and wind patterns, this debris was frequently carried much farther than has been reported to the public."[96]

Although Brim's testimony came at an open hearing on Capitol Hill, *The New York Times, The Washington Post,* and the nation's other most influential newspapers did not print a word about it.

More than a year later, in January 1981, Brim declared flatly that "Americans were exposed to dangerous levels of radiation from 'safe' underground tests all through the 1960s and 1970s, and remain in danger today." In an article published by *The Washington Monthly* magazine, Colonel Brim charged: "Just as the risk of fallout continues, so does the conscious government effort to cover up the situation. Department of Energy officials fully understand that underground testing can't fully contain radiation, yet downplay the information or even withhold it from the public. Exactly as they did in the 1950s, officials refuse to reveal information necessary for those who live near radiation accidents to protect themselves."[97]

It was a strong statement from someone who—for nearly ten years—served as the Pentagon's top officer in charge of monitoring leaks from underground nuclear tests. "Today it seems incredible that straight-faced government spokesmen could proclaim that standing downwind of an open-air nuclear explosion was perfectly safe," Brim went on. "It seems equally incredible that people believed the claims. Yet that twin mentality continues to

---

92. Robert Pendleton to authors, January 19, 1981.

93. U.S. Congress, House Committee on Interstate and Foreign Commerce, Subcommittee on Oversight and Investigations, "Testimony of Raymond Brim, Retired Colonel, U.S. Air Force, Washington, D.C., August 1, 1979, unpublished transcript.

94. Ibid.

95. Raymond E. Brim and Patricia Condon, "Another A-Bomb Cover-up," *Washington Monthly,* January 1981, p. 48.

96. "Testimony of Raymond Brim."

97. Brim and Condon, "Another A-Bomb Cover-up," p. 45.

operate, with Washington making what will, in years to come, be considered preposterous claims about the safety of underground tests, and most people nodding their heads in agreement."[98]

The Nevada Test Site's current manager, Mahlon Gates, made a public appearance before a 1979 congressional hearing, ostensibly making a clean breast of past underground test radiation ventings. Colonel Brim observed, however, that Gates's "estimate of the *total* amount of radiation downwind of a test site in the period from 1951 to 1969 . . . worked out to less than a quarter of the radiation the Public Health Service recorded after a *single blast* on the same site."[99]

Indicative of the kind of present-day hazards—and governmental deceit—Brim alluded to was the underground nuclear test Baneberry. When it vented on the morning of December 18, 1970, Baneberry sent a mushroom cloud of radioactivity eight thousand feet into the air. Ten years later the U.S. Government's official log of nuclear tests was still claiming that only "minor levels of radioactivity" were detected off-site from the Baneberry explosion.[100]

But Colonel Brim, who was responsible for off-site monitoring during the Baneberry test, has pointed to evidence "that a dangerously high concentration of Iodine-131, a radiation byproduct, was found in the milk of Utah and Nevada cows which had eaten vegetation exposed to Baneberry's fallout. Deer and sheep as far as 400 miles from the test range had abnormal concentrations of iodine in their thyroid glands, and the thyroid of a fetus from one sheep contained five times more iodine than the thyroid of its mother."[101]

Favorable weather conditions mitigated the Baneberry fallout impact. Dr. Robert Pendleton calculated that if the accident had happened in summertime the result for Utah residents could have been "a very significant radiation dose to the thyroid."[102]

Baneberry radioactivity rode the winds to the Northwest, Midwest, and New England, also reaching Canada. The following spring Dr. Ernest Sternglass and associates accumulated data on where the fallout had descended. They compared the findings to U.S. Monthly Vital Statistics reports on mortality of infants born after the vented test blast. "In all of the states where the total radioactivity rose highest—Idaho, Montana, Oregon, Nevada, Washington, Nebraska, and as far away as Minnesota and Maine—infant mortality also rose sharply during the first three months after the test," Sternglass discovered. "Across the rest of the U.S., the pattern of general decline continued."[103]

The fetal deaths for Bannock County in southeastern Idaho, directly in the path of the December 1970 Baneberry fallout,[104] rose to their highest level in 1971, compared with any of the five previous or five following years.[105] That year there were twenty-one officially recorded fetal deaths in Bannock County—62 percent higher than the average annual total for the years 1966 to 1976.[106]

Was the Baneberry underground test venting a fluke unlikely to be repeated? The United States Government says yes. But a 1974 confidential U.S. military memo, written by nuclear testing program officer Captain William Gay, says otherwise. Made public through efforts by Senator Edward Kennedy in 1979, Captain Gay's memorandum stated that "on the basis of past experience at NTS [Nevada Test Site], a rather high incidence prevails for a release of radioactivity like Baneberry." The Gay memo added that "the risk is not like one in a million or so low as to be comfortable. Ventings have happened and will probably happen again."[107]

Captain Gay, director for tests in the Atomic Energy Commission's Division of Military Application, also wrote

---

98. Ibid., p. 46.

99. Ibid., p. 48.

100. *Announced US Nuclear Tests,* p. 30.

101. Brim and Condon, "Another A-Bomb Cover-up," p. 47.

102. *Deseret News,* January 27, 1978.

103. Sternglass, *Secret Fallout,* p. 181.

104. The Baneberry fallout split into three general trajectories after venting. The westernmost segment went over the Idaho Falls area of southeastern Idaho, passing directly over Bannock County. (*Deseret News*, January 27, 1978. See also, EPA, "Final Report of Off-Site Surveillance for the Baneberry Event, December 18, 1970," Western Environmental Research Laboratory, SWRHL-107r, February 1972, especially pp. 31, 51.)

105. Bannock County and overall Idaho fetal death statistics are contained in anthropology master's thesis by Edward B. Beldin, Idaho State University, "A Bioanthropological Approach to the Effects of Air Quality on Human Health, with Emphasis on the Incidence of Stillbirths in Two Southeast Idaho Cities," 1978.

106. Ibid. When put in ratio to live births, the Bannock County fetal deaths in 1971 were even more anomalous in comparison with preceding and subsequent years.

107. *Health Effects of Low-Level Radiation,* Vol. 1, p. 125.

in the memo: "Considering past experience, massive venting can be expected in about one [ratio blanked out by censors] events."[108] Even after the decision was made to declassify the document in 1979, the American people apparently could not be trusted to hear a candid official estimate of the chances for future disastrous ventings of underground nuclear bomb tests.

Irradiated Test Workers

Bennie F. Levy was thirty-two years old when he began working at the Nevada Test Site in 1951, the first year of nuclear explosions there.

Born and raised on an Arizona cattle ranch, he had left college to volunteer for the Air Corps soon after Pearl Harbor, helping to service B-24s and other Allied bombers at Pacific Ocean bases. After the war, he became an ironworker, on jobs at dam construction along the Colorado River, then electrical transmission lines in the Southwest. A member of the Structural Ironworkers Union, he was laboring on a dam project in the Pacific Northwest when he first heard about a big new source of employment.

"I was in Walla Walla, Washington, when I got a letter from a friend in September 1950 to come to Las Vegas, Nevada, that there was a big job breakin' here," Levy recalled in an interview.[109]

In autumn 1951 Levy's career as a Nevada Test Site ironworker got under way. "We were workin' a lot around radiation," he told us. "We asked, 'Is it safe to go in?' They say, 'Oh, yeah, it's safe, nothing wrong with it, it's safe.'"[110]

Levy and other ironworkers built towers the atom bombs would be perched on for detonation. In early 1952 he helped set up a test for the first time. "We got everything ready and then we came home." From the town of Henderson, nearly a hundred miles away, he watched the orange light glow of the atomic blast. "It was pretty. It was a pretty shot. They were all pretty."[111]

The work settled into a routine. After a nuclear detonation a few ironworkers would be directly involved in retrieving instrumentation from ground zero. On a rotating basis Levy and fellow ironworkers "were recovering the data for the scientists. And we'd go in anywhere from thirty minutes to an hour after the event, after the shot. And the fallout—we went right through it." Levy paused. "Of course we were 'rad-safed' with cotton coveralls and a little cap." How about protection for mouth and nose? "Never wore a respirator," he replied.[112]

During the early and middle 1950s Levy personally went on the reentry mission dozens of times—"at least thirty, forty, maybe more than that." And, as a matter of course, along with coworkers he ate lunch in "forward areas" hot with radioactive particles, including plutonium. "On occasion," he remembered, "monitors would come by with Geiger counters and get readings on my lunch pail or tools. This common occurrence leaves no doubt in my mind that I was breathing and swallowing radioactive debris all the time. We had no facilities to wash our hands or face, and we could not leave the contaminated areas for lunch as that would take an extra thirty minutes."[113]

Bennie Levy had been employed at the test site for about a year when—unbeknownst to him or his fellow workers, or the general public—Atomic Energy Commission policymakers met to discuss their working conditions. In the words of then-secret AEC minutes, "the commissioners expressed concern that workers might be exposed to radiation hazards for too long a time."[114] At a follow-up meeting two weeks later, AEC records show, the commissioners heard that "the means used to determine the intensity and duration of exposure are not always as reliable as might be desired and in general it cannot be said that exposure problems at the test site have been completely solved."[115]

But test site employees like Bennie Levy heard nothing of the sort from official quarters. They continued at their

---

108. Ibid.

109. Bennie Levy, interview, December 1980.

110. Ibid.

111. Ibid.

112. Ibid.

113. Ibid.

114. AEC Commissioners Meeting Minutes, September 23, 1952, p. 504.

115. AEC Commissioners Meeting Minutes, October 7, 1952, p. 536.

high-paying jobs, believing their work shored up national security. Yet Levy noticed a few odd things. "Although we were assured that there was no danger, I thought it was a bit curious that supervisors and AEC personnel did not remain in the area. I questioned them on various occasions and was told that they did not have to remain."[116]

When the nuclear testing program shifted underground in the early 1960s, Bennie Levy took part in drilling tasks. In the process, "I was involved in operations which caused me to be exposed on many occasions." Often the underground shots leaked badly, scattering radiation, "but we continued to work in these same areas as if there was no danger at all."[117]

And caverns left by the nuclear blasts seeped radiation for days—even years—afterward.[118]

Mounting cancer and leukemia deaths among test-site workers became conspicuous to those who had labored side by side. But the government conducted no health study of test-site employees. "In fact," according to Levy, "any suggestion that radiation had caused cancer was fought bitterly. In my own craft, the ironworkers, I do not need to be told that cancer has been caused by radiation. I have seen my fellow workers die before my very eyes."[119]

In the late 1970s, after more than twenty-five years of employment at the test site, Levy left the job and began to research the health of people with whom he had worked. Levy documented that, out of only 350 fellow ironworkers at the test site, two had died of leukemia.[120] Among 350 men, even a single instance of leukemia would have been unusual under ordinary circumstances.

By 1981 he had accumulated a list of 132 men who died of cancer or blood diseases, out of 3,100 construction-trades employees working in highly contaminated forward areas at the Nevada Test Site. Three men on the list—Clarence Crockett, Robert Sendlein, and Warren Snyder—died of multiple myeloma bone-marrow cancer during 1977 and 1978.[121] And in just three months of spring 1981 three who worked in the test-site drilling division died of brain cancer.[122]

Eighteen of the men on Bennie Levy's list died of leukemia, a rate of approximately five times the normal.[123] Two others—caught in thick radiation clouds after the Baneberry underground test venting—died of acute myeloid leukemia.[124]

In 1981 the U.S. Government was still denying that the Baneberry blast's radiation caused the leukemia that killed those two workers, test-site guard Harley Roberts and welder William Nunamaker. They had been among eighty-six workers taken to the site's center for treatment after being covered by radioactive clouds that erupted out of the shaft.[125] The two leukemia deaths, out of eighty-six individuals, vastly surpass normal rates of incidence.

"We just would like it to be on record that we know our husbands died of leukemia by radiation," widow Louise Nunamaker told a congressional subcommittee in 1979 as she sat next to Dorothy Roberts. "I saw a very well, healthy man die, a beautiful person that loved his country, served his country in the war and also was in the field from 1957. . . . I don't think anyone will know the hell we have been through with the testimony and [the government's] saying that the records of my husband have been destroyed and so forth and so forth. Things we know are untruths. It was very, very difficult for both of us."[126]

Bill Nunamaker, his widow recalled, "never said anything until his deathbed. He said, 'Mother, you know what I

---

116. Levy, interview, December 1980.

117. Ibid.

118. *Final Environmental Impact Statement,* Nevada Test Site, pp. 2-99, 2-106. In addition to leakage from "drillback" operations, the EPA has conceded that craters left by Sedan and other subsurface blasts have continued to seep radiation. (EPA, "Off-Site Environmental Monitoring Report for the Nevada Test Site and Other Areas Used for Underground Test Detonations," Las Vegas, 1977, 1978.)

119. Levy, interview, December 1980.

120. Joe Naves and Raymond Browers.

121. "Deceased Nevada Test Site Workers," list provided by Levy, 1981.

122. Levy, interview, June 1981.

123. The usual rate of leukemia among a comparable number of American males as determined for the Smoky bomb test participants study cited in Chapter 2, would be less than four cases—in contrast to the eighteen instances of leukemia found by Levy among test-site building-trades workers.

124. *Los Angeles Herald Examiner,* March 11, 1979.

125. Ibid.

126. U.S. Congress, House Committee on Interstate and Foreign Commerce, Subcommittee on Oversight and Investigations, "Testimony of Louise Nunamaker and Dorothy Roberts," Las Vegas, April 23, 1979, unpublished transcript.

died from. Go get them.'"[127]

Louise Nunamaker and Dorothy Roberts tried. When the DOE turned a deaf ear to their entreaties, they went to federal court with a lawsuit. But the two widows had meager financial resources to use against a courtroom adversary with virtually unlimited funds. When a reporter for the *Los Angeles Herald Examiner* asked the U.S. Justice Department's head attorney on the case, William Z. Elliott, how much the government was spending to defeat the Nunamaker/Roberts suit, he replied, "As much as it takes to win."[128]

No End in Sight

In autumn 1980 yet another underground test in Nevada sent radiation off-site.[129] For residents it was a bad case of deja vu.

Utah governor Scott M. Matheson was disgusted. "This lack of communication is too much like what occurred between the state of Utah and the Atomic Energy Commission . . . 30 years ago," the governor asserted in a letter to the U.S. Department of Energy. "I object to the disregard for the rights of Utahns to know when there is even the possibility of risk for increased radioactivity in our state as a result of nuclear testing in Nevada."[130]

Indeed, events had followed a classic pattern. The Energy Department waited twelve hours after detection of the September 25 radioactive leakage before alerting the Environmental Protection Agency, the federal department responsible for off-site monitoring of radiation.[131] Despite public assurances by DOE that radiation "is not expected to leave the Nevada Test Site," the EPA later reported finding radioactive xenon gas near the California border.[132]

Like Utah state officials, California authorities learned of the nuclear accident from the news media—about four hours after EPA was informed of the problem, and a full sixteen hours after on-site DOE personnel reportedly discovered the leak.[133] Meanwhile less than eighteen hours after the mishap the radioactive gas traveled forty miles in a southwesterly direction and reached Lathrop Wells, a small Nevada town about ten miles from the California line.[134]

EPA spokesman Chuck Costa acknowledged, when we interviewed him, that his agency did not have monitoring equipment available in California capable of detecting radioactive gases such as xenon. The only such EPA monitors were stationed in Nevada, he said. As for the delay in revealing the leak, Costa—EPA's deputy director for nuclear radiation assessment—said that "there was an obvious screw-up in communication over at DOE. They should have called us much earlier than they did."[135]

When we asked DOE for comment, the response was tight-lipped. "We feel that they were notified in what we considered to be a timely manner," test-site spokesman David Jackson said. "That was the way it was, and I have no further comment.[136]

The U.S. Government has remained especially anxious to retain its nuclear testing prerogative in Nevada. Federal officials would be hard pressed to find another state hospitable to such activities. After nuclear tests in 1969 and 1973 Colorado voters passed a referendum requiring ballot approval of any further atomic blasts within the state.[137]

---

127. Ibid.

128. *Los Angeles Herald Examiner,* March 11, 1979. In 1980 and early 1981 a total of 263 suits were filed in U.S. District Court on behalf of former Nevada Test Site workers, seeking compensation payments for cancer and other radiation-linked illnesses. (*San Diego Evening Tribune,* Associated Press, November 14, 1980; *Las Vegas Sun,* February 26 1981.) In 1980 the Nevada Test Site Radiation Victim Association came into existence with Bennie Levy serving as president. (NTSRVA, P.O. Box 18414-192, Las Vegas, NV 89114.)

129. *The Oregonian,* Associated Press, September 28, 1980.

130. *The Tribune* (Salt Lake), October 9, 1980.

131. DOE spokesman David Jackson and EPA official Chuck Costa, interviews, September 1980.

132. *The Oregonian,* September 28, 1980; Costa, interview, September 1980.

133. James Mahoney, California Department of Health Services, and Alvin Rickers, state of Utah, interviews, September 1980.

134. *The Oregonian,* September 28, 1980; Costa, interview, September 1980.

135. Costa, interview, September 1980.

136. Jackson, interview, September 1980. But nuclear health physics pioneer Karl Z. Morgan was far from complacent about the delay. "It's very important that appropriate monitoring be done. If you wait till the cloud has passed over, you miss entirely what was in it," Dr. Morgan said. (Morgan, interview, September 1980.)

In southern Mississippi two underground atomic explosions during the mid-1960s occurred near the town of Hattiesburg. A decade and a half later, an Associated Press dispatch noted, Governor Cliff Finch urged families nearby to evacuate "after the University of Mississippi reported that scientists had found radioactive and deformed toads, frogs, and a lizard above the Tatum Salt Dome, a shelf of salt used in the 1960s for nuclear explosions." Tests of one frog detected radioactivity one thousand times normal.[138]

At Carlsbad, New Mexico, a 1961 underground nuclear test, named Gnome, sent radiation airborne. Two years later, in congressional testimony, Dr. Eric Reiss said that the Gnome test "delivered sufficient fallout to the vicinity of Carlsbad, New Mexico, to cause thyroid dose levels of from 7 to 55 rads to children."[139]

There are strong indications the radioactivity caused second-generation genetic defects. Dr. Catherine Armstrong, a pediatrician in Carlsbad since 1950, told us that during thirty-one years of practice she noticed a startling upswing of serious congenital damage apparent at birth. That trend did not get under way until well after the underground atomic blast vented radiation in 1961.[140]

"Young people coming along are having a noticeable increase of congenital abnormalities, much more than we used to have in this area," Dr. Armstrong said in a 1981 interview. "Congenital heart diseases" have been far more prevalent, along with increased bone defects, severely immature livers, and jaundice among newborns in the Carlsbad community. Dr. Armstrong noticed that those problems became conspicuous during the mid-1970s—years when many area residents who were small children at the time of the Gnome nuclear test began raising families. "It’s got to be more than coincidental," she declared.[141]

As with every presidency since Franklin D. Roosevelt was in the White House, the administration of Ronald Reagan eagerly embraced nuclear testing as part of national defense. The desert of southern Nevada has become the place where America culminates work on the nuclear weapons development assembly line. Even without detonation in combat, those atomic warheads have been endangering the lives of many Americans and of future generations around the world.

"Our nuclear program was built in the name of national security—protecting the lives of Americans," Congresswoman Patricia Schroeder commented in 1980. "One can’t help but wonder, who was protected and at whose expense?."[142]

---

137. Anna Gyorgy and Friends, *NO NUKES: Everyone’s Guide to Nuclear Power* (Boston: South End Press, 1979), p. 443.

138. *Boston Globe,* Associated Press, May 26, 1979.

139. *Fallout, Radiation Standards and Countermeasures,* August 1963, Part 2.

140. Dr. Catherine Armstrong, interview, May 1981.

141. Ibid.

142. Patricia Schroeder, press release statement, April 12, 1980.

PART II

X Rays and the Radioactive Workplace

6

The Use and Misuse of Medical X Rays

During 1979 congressional hearings on medical and dental X rays, Congressman Albert Gore (D-Tenn.) recalled taking his young daughter to a hospital emergency room after she had inhaled some pillow stuffing. She was having trouble breathing. Recalled Gore: "The first thing the doctor said is, 'Let's have an X ray.'" Gore asked the doctor if the pillow stuffing would show up on the X ray. The doctor said it would not. Gore then asked why an X ray was necessary. The doctor said it would be good to have as a base against which to compare future X rays in case some pneumonia developed. Gore decided not to allow the X ray to be taken.[1]

Gore's action was a rare one. In 1979—the year of the accident at Three Mile Island—the American population received over 270 million individual X rays.[2] They constituted the largest single source of human-made external radiation doses to the American public. In 1980 some $6.7 billion was spent on radiology equipment, insurance, and personnel;[3] approximately 300,000 people are currently employed operating medical and dental X-ray equipment.[4] Yet the doses administered by this industry were hardly insignificant. In some cases they may have harmed rather than helped their patients.

There is no question that X rays can perform enormously important medical services, and that their use has made an inestimable contribution to human health. Surgical therapy; treatment of bone fractures; location of various cancers, internal diseases, and malformations—all have become possible with the use of X rays, and all have resulted in the alleviation of pain and the saving of lives on a mass scale. As a result, X-ray diagnosis has rightfully taken its place as a vital and necessary part of medical therapy throughout the world.

The problems arise when the technology is overused and its dangers are not fully appreciated by the medical profession or the public. Every indicator now points to new warnings that caution is advised, and that there are those—particularly pregnant women and their unborn children—who have already suffered from the misuse of this medical miracle.

The Dawn of the X Ray

X rays were discovered accidentally on November 23, 1895, by the German physicist Wilhelm Roentgen. Roentgen was working in a darkened room, trying to determine whether recently discovered cathode rays could travel through a glass vacuum tube. "Suddenly, about a yard from the tube," recounted Dr. Otto Glasser, Roentgen's biographer, "there was a weak light that shimmered on a little bench he knew was located nearby. It was as though a ray of light or a faint spark from the induction coil had been reflected by a mirror."

Not believing this possible, Roentgen repeated the process, and another faint light appeared, this time looking "like a faint green cloud." Excited, Roentgen soon found the fluorescence was caused by the rays striking a chemically treated screen. After extensive experiments he determined that the rays had a very short wavelength that gave them special penetrating power, enabling them to pass through various substances—including human flesh. Human bones, he found, cast a denser shadow than surrounding soft tissues—a property that would form the basis for

---

1. U.S. Congress, House Committee on Interstate and Foreign Commerce, Subcommittee on Oversight and Investigations, *Unnecessary Exposure to Radiation from Medical and Dental X-rays,* 96th Cong., 1st sess., July 24 and 31, 1979, pp. 86-87 (hereafter cited as *1979 X-ray Hearings*).

2. *1979 X-ray Hearings,* p. 79.

3. Joseph D. Calhoun, "President's Address," *American Journal of Roentgenology* 135 (September 1980): 636-646.

4. *1979 X-ray Hearings,* p. 71.

the global medical X-ray industry.[5]

Roentgen published his first article on the phenomenon in late December 1895. By February of 1896 American physicists were using X rays in clinical medicine. One patient—a young boy named Eddie McCarthy—had a broken forearm X-rayed. A young New Yorker named Tolson Cunningham had a bullet removed from his leg after it was located with a forty-five-minute X-ray exposure. Soon University of Pennsylvania professor Henry W. Cattell wrote in *Science* that "the manifold uses to which Roentgen's discovery may be applied in medicine are so obvious that it is even now questionable whether a surgeon would be morally justified in performing a certain class of operations without first having seen pictured by these rays the field of his work—a map, as it were, of the unknown country he is to explore."

Within months X rays were used to find a bullet in the brain of a twelve-year-old child, a severed drainage tube in a lung, and to photograph a broken hip joint. By the end of 1896 a Chicago electrical engineer named Wolfram C. Fuchs had performed more than fourteen hundred X-ray examinations, and doctors were regularly referring their patients to "specialists" with the simple, primitive machines they had bought or built themselves.[6]

Not surprisingly the early X-ray pioneers had little understanding of the potential dangers of radiation. They rarely bothered to protect their patients or themselves from overexposure. Machine operators often tested their equipment by placing their hands—time and again—in the beam. With fluctuating power ratios and errant beams, doctors, patients, machine operators, and bystanders alike were exposed. The X rays could even penetrate walls and irradiate people in other rooms.[7]

And the side effects were not long in surfacing. In 1896 Dr. D. W. Gage of McCook, Nebraska, writing in New York's *Medical Record,* noted cases of hair loss, reddened skin, skin sloughing off, and lesions. "I wish to suggest that more be understood regarding the action of the x rays before the general practitioner adopts them in his daily work," Gage warned.[8]

As the technology was refined and the equipment became more powerful, increasingly serious damage began to surface. A part-time machine demonstrator named H. D. Hawks was forced to quit his job after only four days because his hands began to redden and swell. The skin on his knuckles disintegrated from overexposure, fingernail growth halted, and the hair on exposed skin fell out.[9] Hawks's problems were minor compared with those of Clarence Madison Dally, a glassblower at Thomas Edison's Menlo Park laboratory and the first American X-ray worker known to have been killed by X-ray exposure. Dally frequently tested the output of radiation tubes by placing his hands directly in the beam. Though he was severely burned in 1896, Dally continued X-ray work for two more years. In 1902 his right arm was amputated at the shoulder to arrest the spread of skin cancer; two years later his left arm was amputated for the same reason. Dally died that October, prompting Edison to discontinue radiation research in his laboratory. By the 1930s so many people had fallen victim to the misuse of X rays that an entire book (entitled *American Martyrs to Science Through the Roentgen Rays*) was published by Dr. Percy Brown, a Boston radiologist who himself died of cancer in 1950.[10]

As the demand for X rays expanded, so did the number of people operating the machines. Radiology grew from a

---

5. Otto Glasser, *Dr. W. C. Roentgen,* 2nd ed. (Springfield, Ill.: Charles C. Thomas, 1958), p. 36.

6. Ruth Brecher and Edward Brecher, *The Rays: A History of Radiology in the United States and Canada* (Baltimore: Williams & Wilkins, 1969), pp. 9, 16, 63, 64.

7. Joel Griffiths and Richard Ballantine, *Silent Slaughter,* (Chicago: Henry Regnery Company, 1972), p. 39; Charles Panati and Michael Hudson, *The Silent Intruder: Surviving the Nuclear Age* (Boston: Houghton Mifflin, 1981), pp. 3-43.

X rays are produced by bombarding a tungsten target with high-speed electrons in a vacuum tube. They are invisible to the human eye, but they may be captured as a visible image on film. The making of film records of internal body parts by X-ray exposure is called radiography; the film image, a radiograph.

Advances in equipment design capability and procedures led to radiation's rapid growth in the medical field after 1920. Refinements—limiting source size, providing radiation shields and high voltage protection, and disposing of excess heat—allowed the number and types of radiologic examinations to increase. Present-day X-ray films and intensifying screens provide physicians with high-quality images of bones and internal organs, while delivering much less radiation to the patient.

Today, films are coated with chemical emulsions to enhance their sensitivity to X rays. The more sensitive a film, the smaller the dose of radiation needed to produce an image. Some of the newer sophisticated films are in the experimental stages or not yet widely used. Intensifying screens are thin sheets of plastic or cardboard coated with a substance that emits blue light when struck by X rays. This acts with the X rays to produce an image of a bone or internal organ with less radiation exposure. Rare-earth metals are used in the most sensitive intensifying screens.

8. Brecher and Brecher, *The Rays,* p. 88.

9. *Electrical Review,* 1896, p. 250.

10. Percy Brown, *American Martyrs to Science Through the Roentgen Rays* (Springfield, Ill.: Charles C. Thomas, 1936), p. 37.

specialty of only a few hundred practitioners in 1913 to a burgeoning profession with more than fifteen thousand people in 1981—roughly 6 percent of the nation’s physicians. To become certified radiologists, doctors generally complete a three-year residency following their medical-school training and internship. A one-year fellowship in a specialty may also be taken. They must then pass a national examination before practicing.[11] As an elite group of medical doctors with radiation training, they raised the use of diagnostic X rays to the status of a high-powered medical specialty.

Unfortunately the health of radiologists declined dramatically with the expansion of their trade. In 1946 a statistical study of obituaries in the *New England Journal of Medicine* by Dr. Helmuth Ulrich found the leukemia rate among radiologists to be eight times that of other doctors.[12] In 1956 the National Academy of Sciences (NAS) supported those findings in a report that concluded that radiologists lived 5.2 years less than other doctors.[13] In 1963 a study by Dr. E. B. Lewis found a significant excess of deaths from leukemia, multiple myeloma, and aplastic anemia among radiologists, and two years later two Johns Hopkins researchers discovered a 70 percent excess of cardiovascular disease and certain cancers among radiologists as opposed to the general population, and a 730 percent rise in leukemia deaths.[14] In 1981 Dr. Genevieve Matanowski, who is directing the continuation of the Johns Hopkins study, wrote that there is additional evidence that radiologists also suffer an increased risk of contracting multiple myeloma, and an increased chance of death from strokes and heart disease.[15]

And though they have become the human guinea pigs of the X-ray industry, radiologists unfortunately are not the only people administering X rays. In fact many medical practitioners obtain their M.D. certificates and go on to use X-ray machines extensively in their practices without even rudimentary training in radiology. Dr. Herbert Abrams, professor of radiology at the Harvard Medical School, has warned that the problem "can be traced to medical schools, where all too often one finds too few radiologists on the faculty, too little support of the department, too little time in the curriculum and too few radiology clerkships." The result, he warns, "may be a graduating class with limited knowledge of what radiology can do."[16] Indeed, Dr. Karl Z. Morgan, founder of the profession of radiation health physics, has stated: "If you ask many of these doctors what is a roentgen or a rad, they are not even able to give you the definition."[17] Surveys have shown, in fact, that nonradiologists who provided their own X-ray services ordered twice as many X rays as those doctors who referred patients to trained radiologists expert in the field, with a more complete understanding of the technology and its dangers.[18]

And if doctors are largely ignorant of the potential health effects of the X-ray machines in their offices, often the roughly 150,000 people who actually operate them understand the dangers even less. As of 1981 less than a third of the states in the U.S. required licensing of X-ray machine operators, and even those programs are by no means uniform. Most of the licensing only pertains to full-time X-ray equipment operators and does not cover people who operate the machines part time. Only California, of all the fifty states, requires that all X-ray machine operators be specially trained.[19]

Meanwhile the vast majority of the people administering X rays may not really know what they are doing. Congressman Bob Eckhardt, chairman of the House Subcommittee on Oversight and Investigations, found it "particularly disturbing, if not outright frightening . . . that in many states any person can walk off the streets and operate machines which are capable of inflicting great harm upon those exposed to them."[20] Daniel Donohue,

---

11. Brecher and Brecher, *The Rays,* p. 211.

12. Helmuth Ulrich, "Incidence of Leukemia in Radiologists," *New England Journal of Medicine,* January 10, 1946, Vol. 234, pp. 45-46.

13. NAS, *Pathologic Effects of Atomic Radiation,* Publication No. 452 (Washington, D.C.: National Academy of Sciences, 1956).

14. E. B. Lewis, "Leukemia and Ionizing Radiation," *Science,* 125(7255): 965, May 17, 1957. (The absence of chronic lymphatic leukemia deaths lead Lewis to suggest that the excess deaths were due to radiation exposure or some other factor acting in a similar manner.) Raymond Seltser and Phillip Sartwell, "The Influence of Occupational Exposure to Radiation on the Mortality of American Radiologists and Other Medical Specialties," *American Journal of Epidemiology* (January 1965): 2-22.

15. "Job Hazards of Radiologists Studied," *Washington Star,* February 23, 1981; "Radiologists Take X-ray to Heart, Disputed Study Suggests," *Medical World News* 22, No. 6 (March 16, 1981): 36.

16. Herbert L. Abrams, "The ‘Overutilization’ of X rays," *New England Journal of Medicine* 300 (May 24, 1979): 1213-1216.

17. *Citizens’ Hearings,* p. 93.

18. *1979 X-ray Hearings,* p. 75.

19. Arizona, California, Florida, Hawaii, Kentucky, Montana, New Jersey, New York, Vermont, West Virginia, and Puerto Rico have operating programs for licensing X-ray technologists. Delaware, Georgia, Indiana, Iowa, Michigan, and Minnesota have enabling legislation to begin licensing programs.

president of the American Society of Radiologic Technologists, has echoed the sentiment. After assisting in a training program he found that many prospective X-ray machine operators "were told never to adjust the controls of the equipment, but to increase the time of exposure when they X-rayed a larger patient. Many were told to experiment on their patient and to try different techniques . . . to learn how to use the equipment." Some, Donohue added, had been instructed "not to limit the beam of radiation in the area of interest." The technique of limiting tissue exposed is now seen as a basic safety practice in medical radiology.

Donohue found the experience deeply disturbing. "Most of these operators—which included nurses, medical assistants, secretaries, receptionists—who were employed and expected to perform radiological examinations as part of their job requirements were not provided radiation monitoring devices to determine their accumulated dosage, and were unaware that a potential hazard existed for either themselves or their patients."[21]

Herbert Abrams has added his opinion that improper focusing and shielding may be widespread among untrained X-ray operators.[22] And a nationwide evaluation by the Bureau of Radiological Health (BRH) has borne out that fear. In 1975 the BRH found that 63 percent of the noncredentialed operators tested failed to properly restrict the X-ray beam to the size of the film for a given examination and thus unnecessarily overexposed the patient. Forty percent of the credentialed technologists taking that same test failed. In some cases exposure levels varied from patient to patient by a factor of two thousand.[23]

In August 1981, under intense pressure from portions of the radiation health community, Congress passed a law requiring the states to establish federally approved programs for the training and licensing of radiological technologists. The programs are to be in place by 1985.

X Rays *in Utero*

Though the X-ray industry and its medical proponents emphasize that the doses from diagnostic radiation are small, considerable evidence has surfaced indicating that the health effects can be devastating, particularly to the unborn fetus.[24]

In fact, one of the world's first and biggest radiation surveys was conducted in the mid-1950s on the effects of X rays on unborn children, and it has had an important effect on all debate over safe radiation exposures since.

The study began in 1955, when David Hewitt, a statistician at England's Oxford University, noticed that in the preceding few years there had been more than a 50 percent increase in the number of British children dying of leukemia. His preliminary statistics convinced Dr. Alice Stewart of Oxford's Department of Preventative Medicine to search for a reason. Trained as a pediatrician and epidemiologist, Stewart began crisscrossing Britain, persuading local health officials to interview the mothers of each of the 1,694 children who died of cancer the previous two years. An equal number of healthy mothers and children were used as controls.

As the interviews began to accumulate, a cause for the excess cancers emerged. Stewart and Hewitt sifted through the data and found that twice as many cancer deaths occurred before the age of ten among children whose mothers had received a series of pelvic X rays while pregnant.[25] "It was quite by accident that we bumped into the radiation story," Stewart told us.[26]

The "accident" was not well received by either the medical community or the nuclear industry. An X-ray picture

---

20. *1979 X-ray Hearings,* p. 69.

21. *1979 X-ray Hearings,* p. 8.

22. Abrams, "'Overutilization' of X rays," p. 1213.

23. DHEW, *Bulletin of the Bureau of Radiological Health, Supplement no. 1* (Washington, D.C.: Department of Health, Education and Welfare, July 1976); U.S. Congress, Senate Committee on Commerce, Science and Transportation, *Radiation Health and Safety,* June 16, 17, 27, 28, 29, 1977, p. 49. The Bureau of Radiological Health is following up on facilities with readings above or below the average doses for certain examinations and has reported significant drops in patient doses. Use of gonad shielding is part of the educational programs for both medical and general audiences.

24. DHEW, *X-Ray Examinations A Guide to Good Practice* (Washington, D.C.: Department of Health, Education and Welfare, 1970), p. 6. The unborn face greater risk of radiation damage than adults receiving the same amount of exposure. The stage of pregnancy determines, in large measure, the type of fetal damage. During the first trimester risks of accidental miscarriage, congenital malformation, and brain damage predominate. From the ninth day through the sixth week of pregnancy, organogenesis—the period of organ and limb development—occurs. The greatest radiation-induced deformities can be produced because of the specialized rapid development and division of cells and tissues. Ear, nose, eye, and structural brain deformities can result.

25. Griffiths and Ballantine, *Silent Slaughter,* p. 41.

26. Alice Stewart, interview, November 1980.

of a fetus *in utero* had been secured as early as February of 1896—two months after Roentgen's discovery—and it had become common practice to use X rays to detect multiple births or abnormal conditions in the uterus, and to clarify the outlines of the mother's pelvis to aid in delivery.[27] Hewitt's and Stewart's findings jeopardized those practices and threw into doubt the entire foundation of the safety standards for radiation. Such doses from X rays were believed to be safe. At the time their study was issued, it was generally believed that the "threshold" below which radiation exposure was safe was roughly ten rads. The new findings indicated that a single rad of X-ray dosage to an infant *in utero* could lead to a higher chance of childhood leukemia.[28]

Dr. Stewart soon found herself under a barrage of criticism. She lost her staff and her funding for the Oxford survey. But she continued nonetheless. In 1958, with an expanded data base, she concluded that a fetus exposed in the first three months of development was ten times more likely to develop cancer than an unexposed fetus. The risk increased with the number of exposures, even a single X ray was found to contribute. Stewart also found that X rays to a woman who was not pregnant could also lead to damage in future offspring. Women carry their eggs from birth, and Stewart found the X rays would be particularly harmful if they affected the mothers' ovaries.[29]

In 1962 Stewart's embattled study received powerful confirmation from Dr. Brian MacMahon of the Harvard School of Public Health. A study of 700,000 children born between 1947 and 1964 was conducted in thirty-seven major maternity hospitals in the Northeast. MacMahon compared the children of seventy thousand mothers who had received pelvic X rays during pregnancy with the children of mothers who had not been X-rayed. He found that cancer mortality was 40 percent higher among the children with X-rayed mothers.[30] It was a stunning confirmation of Stewart's findings, a crucial turning point in the radiation controversy, and made essentially inescapable the conclusion that the human fetus was far more vulnerable to miscarriage, malformations, and cancer from X rays than anyone had previously believed possible. In 1963 MacMahon told a Joint Committee on Atomic Energy hearing on bomb fallout in southern Utah that "we must consider very seriously the possibility of cancer production by low doses of radiation such as encountered in x ray diagnosis and even fallout."[31]

Yet two decades after Stewart first published her findings, and fourteen years after MacMahon confirmed them, little had been done to warn the public. A 1976 telephone survey by the New York Public Interest Research Group indicated that women of childbearing age who underwent X-ray examinations were often not asked beforehand if they were pregnant.[32] At 1980 hearings for radiation victims, held in Washington, Dr. Karl Z. Morgan remembered how he and others had "fought for years to pass a recommendation . . . that women in the childbearing age should not be given x rays in the pelvic and abdominal region except during emergency situations and except during the ten-day interval following the beginning of menstruation." The failure of the X-ray industry to comply was, he said, "one of the biggest problems in reducing the harmful effects of radiation."[33]

In 1970, the last year in which the federal government analyzed X-ray records on a national scale, it found that 23 percent of the 3.5 million pregnant women in the United States were exposed to medical X rays—some eight hundred thousand women. In 9 percent of these cases—involving more than seventy thousand individuals—the fetus was exposed to the X-ray beam. Five years later a study of sixty-eight thousand single deliveries in sixteen hospitals during 1969 and 1970 estimated that pelvic X rays were given in 6.9 percent of the cases. Current estimates indicate that pelvic X rays are still given in about 6 percent of all live births in the United States, though some facilities administer them at a far higher rate.[34]

---

27. Brecher and Brecher, *The Rays,* p. 60.

28. Stewart, et al., "Survey of Childhood Malignancies," *British Medical Journal* (1958), p 1495.

29. Alice Stewart and George W. Kneale, "Radiation Dose Effects in Relation to Obstetrics, X Ray and Childhood Cancer," *Lancet* 1 (1970): 1185-1187.

30. Brian MacMahon, "Prenatal X-ray Exposure and Childhood Cancer," *Journal of the National Cancer Institute* 28 (1962): 1173.

31. *Fallout, Radiation Standards and Countermeasures,* U.S. Congress, Joint Committee on Atomic Energy, Subcommittee on Research, Development, and Radiation, August 20-22, 27, 1963, p. 595.

32. Deborah Van Brunt, *Consumer Perspectives on X Rays* (New York: New York Public Interest Research Group, November 15, 1976).

33. *Citizens' Hearings,* p. 88.

34. "Considerations of Possible Pregnancy in the Use of Diagnostic X Rays," FDA Publication 75-8029, Health Physics in the Healing Arts, 7th Mid-year Topic Symposium, Health Physics Society (Washington, D.C.: DHEW, December 1972), p. 599; J. A. Campbell, "X-ray Pelvimetry: Useful Procedure or Medical Nonsense," *Journal of National Medical Association* 68 (November 1976): 514-520; K. M. Kelly, et al., "The Utilization and Efficacy of Pelvimetry," *American Journal of Roentgenology* 125, No. 1 (September 1975): 66-74.

Unfortunately the practice of X-raying pregnant women already has had tangible effects. In January of 1957 Emma Rita Mihal, an Ohio housewife, visited an obstetrician and told him she was pregnant. "But," she remembers, "he insisted that I was not pregnant" and then ordered month-long radiation treatments for endometritis, an inflammation of the lining of the womb. A few weeks after completion of the treatment Mrs. Mihal returned to the obstetrician. The doctor, she said, "took the stethoscope and he listened, and then . . . he turned to me and said, ‘Mrs. Mihal, you are pregnant.’ . . . It was the last thing that man ever told me." Worried about what the radiation treatment might have done to her unborn child, Mihal visited her radiologist. "He took me by the shoulder and he said, ‘I want you to go home, your baby will be fine.’" But when Kathleen Mihal was born on September 19, 1957, she came into the world with the undersized head of a microcephalic. Radiation burns scarred her back.

Mihal recalled that her doctors "never told me I shouldn’t have another child. I did become pregnant again, and here again my other child is greatly damaged, because she has genetic damages. She was very sickly from the day she was born."[35]

Though the Mihals’ story was an extreme one, it and other cases ultimately could not be ignored. Additional studies have now linked X-ray doses to women *even before pregnancy* with significant rises among offspring in Down’s syndrome and fatal cancer before the age of fifteen.[36] Finally, in April of 1980, the Bureau of Radiological Health and the American College of Obstetricians and Gynecologists launched a massive public education program warning of the damaging effects of radiation (as well as certain drugs) on pregnancies.[37] The consumer education program is part of BRH’s nonpersonnel budget, which was cut in fiscal year 1981 from $6.3 million to $6.1 million. Projections for FY 1982 at the time of this writing put that budget at $5.9 million.[38]

Mammography and Other Problems

Unfortunately, children *in utero* have not been the only ones to suffer from the misuse of X-ray technology. One major program of X-ray diagnosis—mammography, aimed at tracking down breast cancer in women—has also resulted in disaster. Breast cancer is the leading cause of death among American women between the ages of forty-four and fifty-five. Apparently X rays have contributed to the problem rather than helping to solve it.[39]

An X ray of the breast can reveal tumors in their early stages, and thus can have beneficial results. But because the breast is highly radiation-sensitive, the mammogram itself can cause cancer. The danger can be heightened by the subject’s genetic makeup, preexisting benign breast disease, artificial menopause, obesity, and hormonal

---

35. *Citizens’ Hearings,* p. 35; Robert W. Gibson, et al., "Leukemia in Children Exposed to Multiple Risk Factors" *New England Journal of Medicine* 279, No. 17 (October 24, 1960): 906-909.

36. Griffiths and Ballantine, *Silent Slaughter,* p. 46; A. T. Sigler, et al., "Radiation Exposure in Parents of Children with Mongolism (Down’s Syndrome)," *Johns Hopkins Hospital Bulletin* 117 (December 1965): 374-399.

37. The FDA panel on X-ray pelvimetry approved the following statement on January 26, 1979:

"Pelvimetry is not usually necessary or helpful in making the decision to perform a cesarean section. Therefore, pelvimetry should be performed only when the physician caring for the patient feels that pelvimetry will contribute to the decisions concerning diagnosis or treatment. In those few instances, the reason for requesting the pelvimetry should be written on the patient’s chart. This statement does not apply to x-ray examinations for purposes other than measurement of the pelvis."

This statement was subsequently approved and adopted by the American College of Radiology in July 1980.

The American College of Obstetricians and Gynecologists has approved the following statement in June 1980, which is comparable to the panel statement:

"X-ray pelvimetry provides limited additional information to physicians involved in the management of labor and delivery. It should not be a prerequisite to clinical decisions concerning obstetrical management. Reasons for requesting x-ray pelvimetry should be individually established."

FDA’s public education campaign "X-Rays: Get the Picture on Protection" includes American College of Obstetricians and Gynecologists and FDA-approved materials on X rays and pregnancy. The information is available free from: X Rays, FDA, Rockville, MD 20857.

38. A revised FDA operating budget of $336 million for fiscal 1982 has been submitted to Congress by President Reagan. This is $16.9 million below the request submitted in January by the previous administration. The new proposed figures are:

Fiscal Year	*Budget*	*Paid Staff Years*
1981	$327 million	7,627
1982	$336 million	7,379

Source: FDA *Talk Paper,* March 10, 1981.

39. J. D. Boice, "Risk of Breast Cancer Following Low-Dose Radiation Exposure," *Radiology* 131 (June 1979): 589-597; G. W. Beebe, et al., "Studies of the Mortality of A-bomb Survivors, Report 6, Mortality and Radiation Dose, 1950-1974," *Radiation Research* 75 (July 1978): 138-201; F. A. Mettler, "Breast Neoplasms in Women Treated with X-rays for Acute Postpartum Mastitis," *Journal of the National Cancer Institute* 43 (October 1969): 803-811.

imbalances. Ironically, because the breast tissue of younger women is denser than that of older women, detection of their cancer through mammography is more difficult, if not impossible, in many cases.

The idea of using X rays to detect breast cancer gained credence in the 1930s. By the 1960s mammography was in common use, and a study begun in 1963 by the Health Insurance Plan of New York (HIP) concluded that mammography could reduce mortality rates among women.[40] In 1973 the American Cancer Society and National Cancer Institute cosponsored the establishment of the Breast Cancer Detection Demonstration Projects (BCDDP). Twenty-seven projects were established with the goal of examining a quarter million women. The project program included instruction in breast self-examinations, an initial clinical history, and a physical examination which included a thermogram (which uses an infrared camera to study body temperatures) and a mammogram X ray. The entire program was repeated each year for five years, with a five-year observation period after screening. By 1976 about eighteen hundred cases of breast cancer had been detected.[41]

But the program took on the aura of a fad. In 1974, after Betty Ford and Happy Rockefeller suffered mastectomies, the interest in methods of preventing breast cancer soared. Rose Kushner, executive director of the Maryland-based Breast Cancer Advisory Center, found that "women all over the country were inundated with information about this life-saving machine, and waiting lists for mammograms were often months long. Omitted from this flood of media coverage, however, was the behind-the-scenes conflict among scientists about the potential danger of exposing healthy breasts to a known carcinogen: x ray."[42]

In January of 1975 Dr. John C. Bailar III published an article in the *Annals of Internal Medicine* warning that the Health Insurance Plan study, which had prompted so much faith in mammography, had not in fact demonstrated any increase in survival rates among the women under fifty who had been given the X rays.[43] Drs. Irwin Bross and Leslie Blumenson of Buffalo's Roswell Park Memorial Laboratory soon estimated that based on dosage levels, twice as many deaths as cures could result from mammographic screenings.[44] By early 1977 Bross had become an outspoken critic of the program, calling it a "disastrous mistake" that would "produce the worst . . . epidemic of cancer in medical history." At a meeting sponsored by the National Cancer Institute, Bross accused the American Cancer Society and the American College of Radiology of subjecting a quarter million American women to X-ray dosages equivalent "to death warrants with a 15-year delay in the execution."[45] Dr. Rosalie Bertell, a mathematician and an expert in radiation and the causes of cancer, later explained that a basic arithmetical error had been made in the design of the mammography program, which may well have resulted in serious health effects to early participants in the program. Some changes were made after the error was pointed out, she said, but had the program continued as originally planned, it might have caused up to twelve breast cancers for every one it picked up. "A lot of this I blame on the nuclear establishment," she said, "which has gone out of its way to convince everybody that low level radiation is no hazard. The nuclear physicist gives cancer risk per year, whereas health professionals give reproductive lifetime (30 year) or lifetime (70 year) risk. A physician using a physicist's estimates and not noting the timeframe difference will underestimate the risk." The medical profession, she said, was also accepting the word of the weapons industry about the magnitude of the risk per year, even if corrected for longer time spans, letting nuclear physicists determine what doses of radiation were safe, and what were not. Thus, she charged, "the doctors have abdicated responsibility in this area."[46]

The medical establishment gradually responded to the criticism. In August of 1976 the National Cancer Institute set interim guidelines for X rays at the screening centers, warning that "we cannot recommend the routine use of mammography in screening [women without demonstrable symptoms] ages 35 to 50."[47] In 1977 the federal

---

40. S. Shapiro, et al., *Changes in Five-year Breast Cancer Mortality in a Breast Cancer Screening Program*, presented at the Seventh National Cancer Conference (Philadelphia: J. B. Lippincott, 1973), pp. 663-678.

41. Winifred F. Malone, "National Cancer Institute Guidelines for Mammography," presented at Ninth National Conference on Radiation Control, Seattle, Washington, June 19-23, 1977, p. 51.

42. *1979 X-ray Hearings*, p. 115.

43. John C. Bailar, "Mammography, A Contrary View," *Annals of Internal Medicine* 84 (1976): 77-84.

44. I. D. Bross and Leslie Blumenson, "Screening Random Asymptomatic Women Under 50 by Annual Mammographies: Does it Make Sense?" *Journal of Surgical Oncology* 8, No. 5 (1976): 437-445.

45. I. D. Bross, "Written Statement Submitted for the NIH/NCI Consensus Development Meeting on Breast Cancer Screening, September 14-16, 1977, at the Invitation of Dr. Donald Frederickson," p. 1.

46. *Citizens' Hearings*, p. 85.

government recommended that women below the age of fifty be X-rayed only if they or a member of their immediate family had a history of breast cancer. The American Cancer Society has suggested that women under thirty-five be given mammographies only if there is clear evidence of a need for it.[48]

Nonetheless the controversy continued. Leonard Solon, director of New York City's Bureau of Radiation Control, worried in 1976 that inadequate training was leading to faulty administration of mammograms.[49] In 1977 the BRH found that roughly 35 percent of the mammograms being taken had technical problems affecting their usability.[50] Bross warned that "the irresponsible or incompetent use of x ray" could not be stopped if health agencies waited for the medical profession to give the word. "If one million women each receive 1,000 millirem of x rays, between 50 and 200 can be expected to develop breast cancer as a result," he said. "The risk for radiation-induced breast cancer is higher than for all other radiation-induced cancers, including thyroid, lung, leukemia, and bone tumors."[51]

Though infants *in utero* and women have proved extremely sensitive to X rays, the problem is not restricted to them. In the early 1960s one of the largest radiation-related population studies ever done was begun at Johns Hopkins University. Known as the Tri-State Leukemia Survey, the study covered some six million subjects in New York, Maryland, and Minnesota who had undergone diagnostic X rays. By 1972 results of an analysis by Dr. Bross and Nachimuthu Natarajan indicated that children with chronic diseases were also at special risk from low levels of X ray. The study also lent crucial confirmation to the problem of *in utero* X rays, showing that children of mothers X-rayed during pregnancy suffered 1.5 times the leukemia rate as children of mothers not X-rayed. In certain selected sub-categories of children, exposed groups are 5 or even 25 times as likely to develop leukemia as is the general population.[52] Dr. Rosalie Bertell, in examining the data, added that "young adults with asthmas, severe allergies, heart disease, diabetes, arthritis and so on, were about 12 times as susceptible to radiation-related leukemia as were healthy adults." She measured the equivalence in effect of X ray and natural aging. Although the aging acceleration had been recognized as radiation-related, the effect had gone unmeasured. Nor had there been a full accounting for what X rays might be doing to the gene pool. "I think we need to face up not only to the long-term effects on the individual of exposure to radiation," she warned, "but on the long-term effects to the species."[53]

---

47. Diane Fink, "Letter of Screening Guidelines to Breast Cancer Center Directors," August 1976.

48. "Modification #1, Operational Memorandum #6," Breast Cancer Detection Demonstration Project, National Cancer Institute, May 5, 1977.

During a 1977 lecture Dr. Richard G. Lester of the University of Texas Department of Radiology discussed the statistical limitations of the screening program. There is a sharp increase in the incidence of breast cancer among women between the ages of forty to forty-five. The BCDDP program established the screening program at age thirty-five because proponents "believed, despite the fact that it was more recognized that the HIP Study showed no improvement in survivorship under the age of 50, that techniques had improved enough so that such an improvement would be demonstrated."

In October 1975 the National Cancer Institute initiated three committees to review the use of X-ray mammography for women under age fifty. One group, headed by Dr. Lester Breslow of UCLA, was to estimate the benefits of adding mammography to history and physical examination in the HIP breast-cancer screening project. The Breslow report, presented in July 1976, recommended that routine mammographic screening in women less than fifty years of age be discontinued; the amount of radiation in mammography for women in all ages be standardized at the lowest level possible for diagnostic quality; and additional randomized clinical trials involving women under fifty be carried out to more clearly define the value of mammography in relation to other means of detecting breast cancer.

A second group, under the direction of Dr. Louis Thomas, a NCI pathologist, reviewed the pathology data from the HIP survey. The third group, under Dr. Arthur Upton, was asked to lead a group evaluating the relation between the benefit and risk of mammographic screening for the detection of breast cancer. The Upton report found that although the risk of a mammogram increasing an individual's risks of developing breast cancer was small, the total risk to a large population of healthy women was not justified.

49. Leonard Solon, "The Options: New York City Mammography Regulations," presented at the Eighth National Conference on Radiation Control, Springfield, Illinois, May 2-7, 1976, p. 241; M. J. Homer, "Mammography Training in Diagnostic Radiology Residency Programs," *Radiology* 135, No. 2 (May 1980): 529-531.

In a letter to the *American Journal of Roentgenology* ("National Conference on Breast Cancer: Adequacy of Mammography Training," 133, No. 1 [July 1979]: 161) Dr. Marc J. Homer of the New England Medical Center Hospital stated: "Not too long ago I prepared for my oral boards in radiology. Though subjects as esoteric as congenital hypophosphatemia and the Mounier-Kuhn syndrome were covered . . . I was never required to learn mammography. Though last year I saw more breast cancers on my viewbox than all the colon, stomach, and kidney cancers combined, I never had to interpret a single mammogram as a resident . . . Anything less than a resident learning the technical and interpretative aspects of mammography is inadequate and will only serve to keep mammography as a 'second class radiology examination.'"

50. Ronald G. Jans and Thomas R. Ohlhaber, "Breast Exposure: Nationwide Trends—Progress to Date," presented at Ninth Annual National Conference on Radiation Control, Seattle, WA, June 19-23, 1977, p. 222.

51. Bross, "Written Statement," p. 2.

52. I. D. Bross and N. Natarajan, "Leukemia from Low Level Radiation: Identification of Susceptible Children," *New England Journal of Medicine* 287 (1972): 107-110; S. Graham, et al. "Methodological Problems and Design of the Tri-State Leukemia Survey," *Annals of the New York Academy of Science*, 107: 557-69 (1963).

53. *Citizens' Hearings*, p. 83; R. Bertell, "Radiation Exposure and Human Species Survival," *Environmental Health Review*, June 1981, pp. 43-52.

In May 1977 the outspoken Bross coauthored an article in the *Journal of the American Medical Association*, blaming doctors for excess cancers and increased risks of genetic damage because of misuse of X rays. Within weeks he was notified that federal funding for his work on the Tri-State Survey was being terminated. The National Cancer Institute, which supported the survey for a decade, put two of Bross's best-known opponents on its review committee. Said Bross: "We became the most recent victims of a pattern of censorship and repression that has been going on in the United States ever since the furor over fallout from weapons."[54]

Why So Many X Rays?

Proponents of atomic power and weaponry have long been concerned that indications that small doses of X rays may be harmful would reflect badly on the viability of atomic reactors and the safety of bomb testing. Dr. Stewart's initial study, for example, was the first major epidemiological indication that low-level fallout could be far more dangerous than the currently accepted limits. In fact, even as late as 1979, during the accident at Three Mile Island, nuclear proponents were arguing that exposure levels from the plant were comparable to a single X ray, and thus safe. But Dr. Stewart's study, and a host of others, had indicated that even a single X ray could have disastrous effects on an infant *in utero* and other susceptible members of the community. As Dr. Allan Reiskin, professor of radiology at the University of Connecticut, told a congressional subcommittee in the wake of the accident, "these comparisons are inappropriate because they fail to recognize dramatically different distribution of radiation energies, different dose rates, different types of radiation, and different types of population that are irradiated."[55]

Another reason for an excess of X rays may be that they add to the income of doctors and medical institutions. X-ray equipment is costly and as the state of the art quickly changes, older but still usable models become obsolete. Doctors who invest thousands of dollars in X-ray machines may well be inclined to use them more than absolutely necessary in an attempt to recoup their investment. Perhaps the technology most vulnerable to this kind of financial consideration is the new "computerized axial tomography scanning" machine—the CT scanner. This device was introduced in 1973 and can perform precise examinations of the brain and, more recently, the whole body. It contains an X-ray tube and an electronic detector situated on a circular track. While rotating, the scanner can take thousands of radiographs in a few minutes and create a computer-processed cross-section view of the patient's body on a video screen. A visual slice can be taken of any body part.[56]

The CT scanner can be enormously useful—and also enormously expensive, costing up to $1 million to buy and $500,000 per year to maintain. A body scan can cost $250 (CT radiation therapy can run as high as $36,000 per patient) and by the early 1980s more than two million Americans were undergoing CT examinations each year.[57] Unfortunately the radiation doses are not inconsiderable, ranging as high as forty-five hundred millirems for some scans.[58]

The question must inevitably arise as to whether the machines once bought might be overused for financial reasons. That question has also arisen in the field of dental X rays. The average skin dose per dental X-ray film is about 910 millirems, nearly triple the whole body dose from background radiation. Though the dose to the bone is much lower—four millirems—a full mouth series can involve sixteen or more individual X-ray films and can deliver a substantial dose of radiation to the mouth.[59] A 1976 telephone survey of five hundred New York dentists by the New York Public Interest Research Group found that 89 percent of them ordinarily included a full set of full-mouth X rays during a patient's first visit to the office. Nearly half the dentists repeated X rays of the mouth at least once a year.[60] According to radiological health specialist James L. Walker, many dentists "feel that the dental x-ray is a

---

54. I. D. Bross and N. Natarajan, "Genetic Damage from Diagnostic Radiation," *Journal of the American Medical Association* 237 (May 30, 1977): 2399; and U.S. Congress, House Interstate and Foreign Commerce Committee, Hearings on Effect of Radiation on Human Health, January-February 1978 (Vol. I): p. 995.

55. *1979 X-ray Hearings*, p. 10.

56. K. Z. Morgan, "The Need for Radiation Protection," *Radiologic Technology* 44, No. 6 (1973): 385-395; OTA, *Policy Implications of the Computerized Tomography (CT) Scanner* (Washington, D.C.: Office of Technology Assessment, August 1978), pp. 15-20.

57. Michael Goldstein, "CT Benefits and Cost in Therapy," *Journal of the American Medical Association* 244, No. 12 (September 19, 1980).

58. OTA, *Policy Implications*, p. 39.

59. DHEW, *Population Exposure to X rays U.S. 1970* (FDA) Publication 73-8047 (Washington, D.C.: Food and Drug Administration, November 1973), Appendix III; ICRP, *Protection of the Patient in X-ray Diagnosis*, Publication No. 16 (New York: Pergamon Press, 1970).

60. Deborah Van Brunt, *Consumer Perspectives.*

tiny, tiny exposure and it's not really a hazard."[61]

Unfortunately, many of the technicians administering dental X rays are no better trained than those working in doctors' offices. And though lead "bibs" have been recently introduced to protect patients in some dentists' offices, sensitive organs such as the thyroid, salivary glands, active bone marrow, and lymphatics are still being exposed. Scatter radiation may also affect other parts of the body, including the gonads, a particularly important problem among children.[62]

Experts at the 1981 National Council on Health Care Technology Conference on Dental Radiology agreed that dentists rely too much on X rays. Conference participants concluded that X rays should be administered only when clinically indicated, i.e., after the patient's mouth has been visually examined and there appears to be a definite need for more information.[63]

Another form of exploratory X ray under scrutiny is the use of chest X rays to find cancers and tuberculosis. As early as 1965 the Public Health Service called for an end to routine chest X rays as a means of detecting tuberculosis. PHS argued that tuberculosis was on the decline and that 95 percent of the people with active TB had been identified without X-ray screening. PHS also learned that chest X-ray units—many of which were mobile, moving around in vans—produced higher levels of exposure than other radiological equipment, and that a large segment of the population was receiving unnecessary amounts of radiation with little return. Nonetheless X-raying of children with mobile units continued essentially unabated until 1972, when the PHS again called for an end to the practice, this time in conjunction with the American College of Radiology and the American College of Chest Physicians.[64]

Chest X rays remain a part of many routine health physicals and screening programs aimed at finding heart and breathing diseases. Serious questions have been raised by the Medical College of Pennsylvania about their effectiveness in promoting early treatment of lung cancer.[65] But in 1977 thirty-seven million chest X rays were performed in hospitals across the country. In February of 1978 President Jimmy Carter approved a directive recommending, among other things, that routine X-ray screening of patients who showed no particular symptoms should be discontinued, except in specific circumstances of high disease risk because of social or economic factors.[66]

In April of 1979 the Joint Commission on Accreditation of Hospitals announced that it no longer required or recommended routine laboratory or X-ray examination upon admission to the hospital. In February of 1981, as part of the Reagan reductions in domestic expenditures, the federal government saved four million dollars and perhaps numerous lives by eliminating its program of routine chest X rays for some 160,000 government employees in thirty-seven agencies.[67]

But X rays continue to be prescribed and shot all over America in what Irwin Bross has described as a "mindless" fashion.[68] Ironically, one of the chief contributors to this ongoing exposure is the American insurance program. Medical malpractice liability varies from state to state. Numerous insurance companies require an X ray before they will reimburse a patient for treatment. The Social Security Act requires an X ray to be submitted as proof of need for chiropractic treatment.[69]

---

61. Susan Lockamy, "X-Rays: Many Tidewater Dentists' Machines Exceed FDA Levels," *Virginian-Pilot,* August 20, 1979.

62. S. Julian Gibb, "Radiation Risks in Dental Practice," prepared for the Council on Dental Materials, Instruments, and Equipment, American Dental Association, p. 12; Panati and Hudson, *Silent Intruder*.

63. *Washington Star,* July 2, 1981; National Council on Health Care Technology, Conference on Dental Radiology, Arlington, Virginia, June 29-July 1, 1981.

64. Valerie Britain, "Mass Chest X Rays Are on the Way Out," *FDA Consumer,* February 1973.

65. W. Weiss, et al., "The Philadelphia Pulmonary Neoplasm Research Project, Thwarting Factors in Periodic Lung Cancer," *American Review of Respiratory Diseases* 3, No. 30 (March 1975): 389-397.

66. *Federal Register,* February 1, 1978, pp. 4377-4380. Recommendation #3 of "Radiation Protection Guidance to Federal Agencies for Diagnostic X Rays": "Routine or screening examinations in which no prior clinical evaluation of the patient is made, should not be performed unless exception has been made for specified groups of people on the basis of a careful consideration of the magnitude and medical benefit of the diagnostic yield, radiation risk, and economic and social factors. Examples of examinations that would not be routinely performed unless such exception is made are: a) chest and lower back x-ray examinations in routine physical examinations or as a routine requirement for employment; b) tuberculosis screening by chest radiography; c) chest x rays for routine hospital admission of patients under age 20 or lateral chest x rays for patients under age 40 unless a clinical indication of chest disease exists; d) chest radiography in routine prenatal care; e) mammography examinations of women under age 50 who neither exhibit symptoms nor have a personal or strong family history of breast cancer."

67. "X'ing Out Unneeded X Rays," *FDA Consumer,* April 1981, p. 19.

68. I. D. Bross, "An Action Program to Protect the Public Against the Mindless Use of Diagnostic Radiation and Other Technology," June 17, 1977.

69. *1979 X-ray Hearings,* p. 162; U.S. Congress, House Interstate and Foreign Commerce Committee, Subcommittee on Oversight and Investigations, *Report on Unnecessary Exposure to Radiation from Medical and Dental X-rays,* Committee Print 96-52, August 1980, pp. 3-7.

Perhaps the worst problem resides in the medical malpractice laws. These vary from state to state, but in general they are a strong incentive to doctors to give numerous X rays far in excess of real medical need, in the hopes of establishing a record with which to defend themselves in case of a lawsuit. This "defensive medicine" can be carried to extremes. Dr. John McClenahan, a Pennsylvania radiologist, describes the syndrome thusly: " If a tennis player suffers elbow pain after a truck scratched the fender of his car, a radiologist will be called on to take pictures of not only the elbow, but of a shoulder . . . a forearm, a neck, chest and, after the diarrhea ensuing as the result of stress imposed by the accident, of the patient's entire gastro-intestinal tract."[70] Though radiologists and doctors may find such treatment excessive, few would risk losing an expensive lawsuit by refusing to use it. A 1973 survey by the Federal Commission on Medical Malpractice found that more than half the doctors polled admitted to engaging in some form of defensive medicine, and four years later an American Medical Association poll found 75 percent of the doctors contacted were ordering extra X rays to protect themselves from lawsuits.[71]

Radiation Therapy

X rays and other forms of radiation have been used in medicine for purposes other than taking diagnostic pictures. In the early days of radioactive science it was widely believed that radium had immense curative properties, in large part because its rays affected tissue growth. Injection of radioactive materials into some tumors and growths can reduce and destroy them; radiation can also be used to destroy cancerous cells in the body, and arrest the spread of the disease. Great care must be taken to ensure that all the cancerous growth is destroyed and that none of the surrounding tissue is harmed. The size, type, and location of the cancer dictates exactly the form of therapy used.[72]

But the use of radiation as a medical treatment has often been misunderstood and abused. Large amounts of radium, used as a source of gamma rays, have been used to treat lupus, eczema, psoriasis, and other skin diseases, and for removing benign skin tumors and moles. Such radiation treatments were administered from the 1920s through the 1950s, and were also deemed acceptable for treating enlarged thymus and thyroid glands, enlargement and inflammation of tonsils and adenoids, deafness due to hypertrophy of lymphoid tissues around eustachian tubes, ringworm of the scalp, cervical and other types of inflammation, tuberculosis of cervical nodes, asthma, whooping cough, and even breast problems after birth.[73] Throughout the 1950s American children and adults were even allowed to have their feet X-rayed in shoe stores to determine their proper size. The practice may well have damaged millions of people's feet, and scatter radiation from the relatively cheap machines may have done other damage as well.[74]

Some of the more primitive applications of radiation persist. In 1981 we discovered pamphlets from two operating Montana "health spas" advertising the benefits of radon gas in curing "arthritis, sinusitis, migraine, eczema, asthma, hay fever, psoriasis, allergies, diabetes and other ailments." The pamphlets claimed that by sitting in abandoned mine shafts and breathing radioactive gases, people's pain will disappear, joints will loosen, and skin lesions will heal. Unfortunately, the pamphlets do not mention that it has been well established for at least a decade that radioactive gas in uranium mines is a cause of a fivefold increase in lung cancer among miners.[75]

The toll from misdirected medical uses of radiation through the decades is impossible to fully document. But there have been tragic victims. One, a man named Joe Victor, told his story at the 1980 Citizens' Hearings for Radiation Victims in Washington. "I was burned by x rays on my face," he told a packed hearing room. "I have had more than twenty operations to remove the irradiated and malignant skin that the radiation caused . . . I will be disfigured for the rest of my life."

---

70. John McClenahan, "A Radiologist's View of the Efficient Use of Diagnostic Radiation," presented at the Seventh Annual National Conference on Radiation Control, Springfield, Massachusetts, April 27-May 2, 1975, p. 72.

71. *Medical Economics,* September 30, 1974, p. 75; "Fear of Lawsuits Boosts MD Bills," *Buffalo Courier,* March 29, 1977.

72. Brecher and Brecher, *The Rays,* pp. 137-160.

73. E. L. Saenger, et al., "Neoplasia Following Therapeutic Irradiation for Benign Conditions in Childhood," *Radiology* 74 (June 1960): 880-884; L. H. Hemplemann, et al., "Neoplasms in Persons Treated with X-rays in Infancy: Fourth Survey in 20 Years," *Journal of the National Cancer Institute* 50, No. 3 (September 1975) 519-530; NAS, *A Review of the Use of Ionizing Radiation in the Treatment of Benign Diseases* (Washington, D.C.: National Academy of Sciences, September 1977).

74. Karl Z. Morgan and J. E. Turner, *Principles of Radiation Protection* (New York: John Wiley & Sons, 1967), p. 49.

75. Merry Widow Health Mine (P.O. Box 3444, Basin, MT 59631), pamphlet; and Sunshine Health Mine (Box E, Boulder, MT 59632), pamphlet.

At the end of World War II, as a handsome young Marine, Victor underwent radiation therapy for a facial rash called "barber's itch." When the rash recurred in 1947, he again underwent therapy. Five years later an X-ray technologist told him he thought Victor had been overexposed. And when he visited a radiologist at a Veterans Administration hospital in Boston, Victor was bewildered when "doctors congregated around me. The one in charge asked the others a lot of questions about how they would diagnose my problem, and then he turned to them—I'll never forget it, he was very dramatic about it—and said, 'This is what happens when you guys are careless with x rays.'"

Later Victor called the radiologist who had treated him and was told not to worry. But within ten years of his "treatment," Joe Victor developed skin cancer on his nose, chin, neck, and eventually on his chest. Huge pieces of flesh had to be removed from his face. Though skillfully done, the reconstruction was patchy, discolored, scarred, and incomplete. His nose was reshaped, his upper lip partly cut away, and he was left unable to close his mouth. Scars left on his neck resembled those of a burn victim, and his chest was permanently disfigured. "I considered getting married," Victor testified. "But aside from the problems my condition created in relationships with women, I was also worried that all this radiation would affect any kids I had. I would be afraid they would be deformed.

"What's happened, to put it bluntly, is that my life's been ruined," Victor added. "They tell me in the hospital now how I'm so well adjusted. But you never really adjust."[76]

At the time Joe Victor was irradiated for a skin rash, faith in radiation as a diagnostic aid and medical cure was nearly boundless. X-ray therapy for a wide range of noncancerous illnesses of the head, neck, and upper chest during childhood has, according to some studies, resulted in a significant excess of both malignant and benign thyroid tumors.[77] X rays used to treat illnesses related to the thyroid directly have also resulted in that sensitive gland's being exposed. Because much of the treatment was done in private doctors' or radiologists' offices, there are no firm records on how many people received such treatment and who they were. But the National Cancer Institute estimated the number to be as high as four million.[78]

Meanwhile the use of radioactive substances to treat a wide range of diseases—and particularly cancer—is becoming increasingly sophisticated. There continues to be widespread debate over the advisability of such therapy, and the possibilities of natural, alternative cures. There has also been some tragic fallout.

In the late 1970s James L. Kline of Hagerstown, Maryland, suffered an overdose of radiation which was given him as a precaution after the surgical removal of his prostate gland. The radiation burned away his buttocks and destroyed his right hip, leaving him, in the words of his lawyer, "hopelessly and totally disabled." Bedridden since May 1978, Kline recently won a two-million-dollar malpractice settlement.[79]

Despite Kline's case and a growing controversy over the uses and abuses of radiation, portions of the medical profession remain enthusiastic. "Recent advances in radiation therapy allow the maximum potential cure with the minimum of side-effects, such as nausea, vomiting, skin reactions and scarring," says Dr. Luther W. Brady, Jr., of Philadelphia's Hahnemann Medical College and Hospital. "With a growing number of early cancer patients, radiation therapy techniques are emerging that are as viable now as radical therapy."[80]

But the question remains whether this early enthusiasm for yet another use of radiation may someday result in a long list of tragic, unexpected side effects, as has the use of medical X rays.

---

76. *Citizens' Hearings,* p. 80

77. B. J. Duffy and P. J. Fitzgerald, "Cancer of the Thyroid in Children: A Report of 28 Cases," *Journal of Clinical Endocrinology and Metabolism* 10 (October 1950): 1296-1308; T. Winship, "Symposium of Thyroid Tumors: Carcinoma of the Thyroid in Children," *Transactions of the American Goiter Association,* 1951, p. 364; T. Winship and W. W. Chase, "Thyroid Carcinoma in Childhood, a Report of 275 Cases," *Surgical, Gynecology and Obstetrics* 101 (August 1955): 217-224; E. M. Uhlmann, "Cancer of the Thyroid and Irradiation," *Journal of the American Medical Association* 161 (1956): 504-507.

78. Margaret H. Sloan, "Thyroid Irradiation Followup Studies," presented at the Ninth Annual Conference on Radiation Control, Seattle, Washington, June 19-23, 1977, p. 369.

79. Chip Brown, "Maryland Cancer Patient Gets $3 Million in Malpractice Claim," *Washington Post,* February 26, 1981. The award was eventually lowered to $2 million. Loretta Tofani, "Malpractice Award Is Cut to $2 Million," *Washington Post,* February 27, 1981.

80. Lawrence Galton, "New Victories for Radiation Therapy," *Parade Magazine,* March 1, 1981.

7

Nuclear Workers: Radiation on the Job

While the use of radiation in medicine has led to some unpleasant surprises, its presence in the workplace has served as a sort of early-warning system to the general population. "Since workers are first exposed and most heavily exposed," writes Dr. Irving Selikoff, "the workers give us first indication. Most things that cause cancer in society are discovered in the workplace."[1] Ever since Czech miners began digging for uranium four centuries ago, evidence has been piling up to indicate that radioactivity has been killing and debilitating people who work with it. Unfortunately the nuclear industry and its supporters in government have consistently resisted that conclusion, even to the point of suppressing numerous broad-based studies they themselves commissioned and then quashed when the conclusions went the "wrong" way.

The key point of debate has centered on how much radiation was really considered safe. Since 1898, when Pierre and Marie Curie began working with radium in a run-down shed outside Paris, millions of people have worked in diverse industries that use radioactive materials in such varied applications as the making of false teeth and numerous industrial products, the painting of watch dials, the shooting of X rays, and the building of atomic bombs and power plants.

Because it cannot be smelled, tasted, seen, heard, or felt, early physicists assumed that radiation was not dangerous unless it produced immediate, visible effects, such as skin burns. Soon it began to dawn on those close to the field that there might be other effects, and standards began to come into existence in succeeding years on a hit-and-miss basis. The first exposure standards, set in the 1920s, allowed workers to receive as much as 730 rems per year—146 times the current U.S. limit.[2] By the 1940s it was widely acknowledged that radiation did cause cancer. But the prevailing scientific view at that time was that there was a safe "threshold" of exposure below which radiation caused no harm. If that particular "harmless" dose could be found, then a permanent standard could be set.

While the search for the threshold went on, it became well known that radium-dial painters who had ingested bits of radium in their work were suffering agonizing deaths from cancer. In 1941 a standard that limited radium ingestion was set based on their experience.[3] By 1959 industry-wide concern over genetic damage and other radiation-related disease had grown to the point where an across-the-board limit of five rems per year was set for all radiation-related work. The formal limit persisted through 1981, but various loopholes in the standards allowed a worker to legally receive as much as forty-two rems per year. And in the late 1970s industry and its supporters began a concerted move to raise exposure limitations in the workplace.[4]

Meanwhile, by 1980, EPA estimates put the number of Americans working with radiation at 1.5 million. At least eight federal departments, two independent scientific advisory committees, and fifty states have some authority over

---

1. D. Zinman, B. Wyrick, and B. Hevisi, "Job-Related Diseases Kill 300 a Day," *Newsday*, February 9, 1977.

2. David M. Scott, "A Review of Radiation Protection Principles and Practices and the Potential for Worker Exposure to Radiation," a research report for the National Institute for Occupational Safety and Health (NIOSH), March 30, 1980, pp. 10-13 (hereafter cited as "Scott/NIOSH Report").

3. Ibid.

4. According to Volume 10 of the Code of Federal Regulations, Part 20 (10 CFR), a radiation worker can receive three rems per quarter or twelve rems total body exposure in a given year using the 5(n-18) age averaging formula. By adding the thirty-rem bone or thyroid dose permitted under these regulations, the forty-two-rem figure is arrived at. In 1977 the International Commission on Radiological Protection (ICRP) issued worker exposure recommendations in their Publication No. 26 (ICRP No. 26, Pergamon Press) which would have the effect of increasing single organ exposures significantly. For example, the current thyroid dose of thirty rems would be raised to fifty rems in cases where radiation is deposited in one organ alone. ICRP No. 26 in terms of regulations would raise twenty-three out of forty-nine maximum permissible concentrations of airborne radioactivity in the workplace—such as strontium 90, which would be increased by a factor of seventeen.

worker protection.[5] As an editorial in the prestigious journal *Health Physics* put it in August 1980: "Policies vary from location to location. Regulations and regulatory guidance are in such a hopeless muddle that it is impossible to derive consistent practices. Thus many exposures . . . go unrecorded or unrecognized."[6]

Perhaps more important for the general public, the debate over what is thought to be a "safe" dose of radiation rages on, with people who work with radiation serving as society's guinea pigs. By the mid-1970s the federal government and the broad mainstream of independent radiation specialists had agreed that it was simply impossible to set a 100 percent safe level of exposure. The extreme vulnerability of children, the potential for genetic damage, and variations in individual susceptibilities made even the tiniest bit of exposure potentially lethal. As the studies of Hewitt, Stewart, and Kneale had shown in England, small doses of X ray had already proven far more dangerous than previously believed.

And now, with billions of dollars invested, radiation and its dangers became the core of yet another debate, this time with the health of workers at center stage, but with serious implications for the well-being of the global community at stake.

The Mancuso Report

At the heart of the conflict sits a quiet, unassuming health-research pioneer named Dr. Thomas Mancuso. A spry man in his late sixties, Mancuso walks daily to an office cluttered with computer printouts at the University of Pittsburgh. The printouts form the basis of Mancuso's research in occupational health, a field he has helped nurture since seventeen years of service as director of the Ohio Department of Industrial Hygiene in the 1940s and 1950s. During those years Mancuso helped write one of the nation's first occupational disease codes, and he pioneered a method of studying long-term health effects based on Social Security data, which has essentially revolutionized occupational cancer research. Given a career award by the National Cancer Institute as one of America's top researchers, Mancuso linked heightened cancer rates to work in the rubber, chemical dye, asbestos, chromate, and beryllium industries.[7]

Because of his unique prestige and unquestioned scientific integrity, Mancuso was approached in 1964 by the Atomic Energy Commission to study the potential health effects of work in their facilities at Oak Ridge, Tennessee; Savannah River, South Carolina; Los Alamos, New Mexico; and Hanford, Washington.

The AEC was then under fire from opponents of bomb testing and, as AEC adviser Brian MacMahon put it, "much of the motivation for starting this study arose from the 'political' need for assurance that AEC employees are not suffering harmful effects." Though they knew Mancuso's study would be extensive, AEC administrators expected it to prove nothing. Some referred to it as "Mancuso's folly" and openly viewed it as a public-relations sham.[8]

But what Mancuso actually found turned out to be more than they bargained for. His investigation—which constituted one of the largest and probably the most reliable of all the epidemiological studies on the health effects of radiation—proved conclusively that exposure levels in industry were far too high, and that the health effects of emissions from nuclear power plants and fallout from nuclear bombs may be far worse than suspected. When Mancuso's first results were finally published in 1977, the industry response changed rapidly from bemused tolerance to outright suppression, including attacks on Mancuso's findings and reputation, and an attempt to physically remove the data from his possession.

Trouble had surfaced even before 1977. Mancuso's methods were necessarily slow, but the AEC desperately wanted to have something with which to assure the public their industry was safe. In the early 1970s, after about a decade, the commission was looking for ways to phase Mancuso out. Mancuso, however, continued to resist pressure to force publication of his preliminary findings, essentially because he knew it could take up to thirty years for cancers to surface in affected workers. His data only began in the mid-1940s, and Mancuso wanted to wait before

---

5. Robert Alvarez, "Statement before the House Government Operations Subcommittee on Energy, Environment, and Natural Resources, July 14, 1978" (available from the Environmental Policy Center, 317 Pennsylvania Ave. SE, Washington, D.C. 20003).

6. Ronald Katheren, "What Is Occupational Exposure?" *Health Physics,* 39, No 2 (August 1980): 141.

7. Thomas F. Mancuso, "Methods of Study of the Relations of Employment and Long-term Illness by Cohort Analysis," *American Journal of Public Health,* 1959.

8. Thomas F. Mancuso, interview, October 1980; Professor Brian MacMahon, letter to Leonard Sagan, AEC contract officer, November 8, 1967.

terming any findings "conclusive."[9]

Then, in the summer of 1974, the situation changed abruptly. The problem focused on the massive AEC installation at Hanford, Washington, where a reactor complex—which produced the plutonium for the bomb dropped on Nagasaki—a waste dump, and other nuclear facilities were operating. As one of the oldest and largest nuclear facilities in the world, Hanford was—and is—a keystone to the American nuclear weapons program.

The controversy began there when Dr. Samuel Milham, an epidemiologist with the Washington State Department of Health, noticed a 25 percent cancer excess among Hanford nuclear workers when compared with the rates among the state's nonnuclear workers. Milham also found four cases of multiple myeloma, when less than one would normally be expected.[10] It was the same disease found among GIs who first went into Hiroshima and Nagasaki after the bombings.

When the AEC got wind of Milham's findings, Mancuso's contract officer called on Mancuso to issue a statement attacking Milham and contending that his own figures showed there was no problem at Hanford. Mancuso was stunned. He knew Milham to be a reliable researcher, and he had no intention of publishing any of his own data at that point. His initial findings were proving negative, but he felt that publishing anything then—especially in light of what Milham had found—was "premature."[11]

That, apparently, was intolerable to the AEC. In less than a year Mancuso got word that his funding would be gradually shut off, and that by 1977 he would be compelled to turn over his enormous store of data to the federal government. The 18-month "grace period" was essentially to allow Mancuso time to organize his files, and to ease the political impact of an action the authorities hastened to describe as strictly "administrative."[12]

Meanwhile the AEC commissioned Battelle Northwest, a think tank with extensive Hanford contracts, to reassess Milham's findings. According to AEC records, the study found precisely what the government did not want to hear—"that there is a relationship between cancer as a cause of death and the total dose of external radiation received."[13] Alex Fremling, manager of the Hanford Research Lab, lamented that "the message is clear that Battelle's data suggests that Hanford has a higher proportion of cancer deaths for those under 65 than the U.S." But, Fremling continued, "even more disturbing from our standpoint" was the fact that "the analysis tends to show a much higher incidence of certain types of cancer" even among those exposed to levels of radiation believed to be "safe." Thus, Fremling concluded, "we hoped to get a good answer to the Milham report, and instead it looks like we have confirmed it."[14] The Battelle study was quickly buried.

But Thomas Mancuso persisted. In the wake of the Milham affair he turned to Dr. Alice Stewart, the internationally recognized British X-ray researcher and a member of his advisory committee. With the help of statistician George Kneale, Stewart carefully examined Mancuso's data at their office at England's University of Birmingham. In the summer of 1976 they showed definitively that there were indications of 5 to 7 percent excess in radiation cancer deaths among Hanford workers at exposure levels as much as thirty times *below* what had been considered safe.[15]

The Mancuso-Stewart-Kneale findings were shattering not only to the industry, but to public perceptions of what

---

9. In a draft memorandum from Sidney Marks, Mancuso's AEC contract officer, dated February 20, 1973, Marks stated that "unless an immediate replacement [for Mancuso] is found, a public charge may be made that the AEC is stopping the program out of fear that positive findings will emerge." Marks continued by adding ". . . overtures to possible candidates must be carried out in a clandestine atmosphere . . ." to phase out the uncooperative Mancuso.

10. Samuel Milham, Jr., "Increased Cancer Mortality Among Male Employees of the Atomic Energy Commission, Hanford Facility, Washington, June 1974," unpublished manuscript.

11. Mancuso interview.

12. U.S. Congress, House Committee on Interstate and Foreign Commerce, Subcommittee on Health and the Environment, *Effect of Radiation on Human Health,* 95th Cong., 2nd sess., January 24-26, February 8, 9, 14, and 28, 1978, Serial No. 95-179, Vol. 1, p. 523.

13. Draft AEC Memorandum, from Alex Fremling, AEC Director of the Hanford Research Laboratory, July 17, 1975.

14. Ibid.

15. Thomas F. Mancuso, Alice M. Stewart, and George W. Kneale, "Radiation Exposures of Hanford Workers Dying from Cancer and Other Causes," *Health Physics Journal* 33, No. 5 (November 1977): 369-384; Mancuso, et al., "A Reanalysis of Data Relating to the Hanford Study of the Cancer Risks of Radiation Workers," *International Atomic Agency Symposium Proceedings on the Late Biological Effects of Ionizing Radiation,* Vienna, Austria, 1978, IAEA-SM-224/510; Stewart, et al., "Hanford IIb, The Hanford Data—a Reply to Recent Criticisms," *Ambio* 9 (June 1980): 66-73; Kneale, et al., "Hanford III, a Cohort Study of the Cancer Risks from Radiation to Workers at Hanford (1944 to 1977 deaths) by Method of Regression Models in Life-Tables," *British Journal of Industrial Medicine* (in press), summer 1981; Mancuso, et al., "Hanford IIIb, Delayed Effects of Small Doses of Radiation Delivered at Slow Dose Rates," *Proceedings of a Symposium on Industrial Cancers,* Cold Spring Harbor, Banberry Center, Long Island, N.Y., March 1981.

might be a safe dose of radiation from reactors, bomb tests, or a nuclear war. As described by the 1980 *Encyclopaedia Britannica*, the survey had become "the largest study of a normal adult population exposed to low-levels of ionizing radiation" in the world.[16] Because it was a largely homogeneous sample of relatively healthy white males whose exposure and health histories had been carefully recorded, there was little reason to doubt its conclusions. And the study had shown, quite simply, that human beings were up to thirty times more sensitive to radiation-induced cancer than previously believed.

Now the AEC turned the tables on Mancuso. Having demanded that he publish his preliminary findings to attack Milham, the AEC now exerted enormous pressure to keep Mancuso's final statistics out of print. "They were clearly unhappy," Mancuso told us. "They urged us not to publish. . . . My job in their eyes was simply to transfer the data to them."[17]

By the fall of 1977 Mancuso's research funds had run out. In November he published his paper in *Health Physics*, creating a firestorm of controversy. Though he continued to draw a salary from the University of Pittsburgh, Mancuso had no funds with which to continue his research. Though it was a bare fraction of what was needed, Mancuso began cutting into his personal retirement money to continue working on the Hanford study. Meanwhile the federal government persisted in its attempts to take the data away from him.

But it also had come under public attack for its treatment of Mancuso. Under pressure, Dr. James Liverman, who had been director of the AEC's Division of Biology and Medicine, explained that Mancuso was being fired because of his "imminent retirement" from the University of Pittsburgh. On that basis, he said, the Mancuso study was being moved to the government-controlled Oak Ridge Associated Universities. Liverman failed to note, however, that Mancuso had a full eight years left in his position with the University of Pittsburgh. Liverman arranged for the Hanford portion of the Mancuso study to be handed over to Battelle Laboratories, where the same former AEC official who had tried to use Mancuso to attack the first warning signals of a problem at Hanford would now be in charge of further investigations into the situation at Hanford.[18] Liverman also charged that an early peer review of Mancuso's work had been critical of him, when in fact it had lauded his capabilities and recommended that the study be continued under his control.[19]

By January of 1978 the public furor over Mancuso's findings and other radiation-related issues had led to a congressional investigation and to hearings in front of the House Commerce Subcommittee on Health and the Environment. The hearings marked a major watershed in the controversy over the health effects of radiation, signaling the first major congressional attention given not only the Mancuso report but also the facts of high exposures to the 250,000-plus military personnel used as "guinea pigs" during atomic bomb tests.[20]

In the course of the hearings Congressmen Paul Rogers (D-Fla.) and Tim Lee Carter (D-Tenn.) charged that the justifications for the decision to fire Mancuso were "not supported" and the decision to transfer Mancuso's study to Oak Ridge was "highly questionable at best." The whole process, they said, reflected "serious mismanagement and is of highly questionable legality."[21]

Nonetheless the attacks continued. Mancuso kept the study going with private donations and his retirement money until August of 1979, when labor-union pressure forced the National Institute of Occupational Safety and Health to reinstate the study. But in the spring of 1981 the Reagan administration notified Mancuso his funding would once again be cut off.

Responses to the Mancuso Report

Mancuso's critics—including his former project manager—have consistently conceded that his data indicate an excess of bone-marrow and pancreatic cancers among the Hanford workers. But the critics contend that a carcinogen

16. Karl Z. Morgan, "The Hazards of Low-Level Radiation," *Encyclopaedia Britannica*, 1980 edition.

17. Mancuso interview.

18. U.S. Representatives Paul Rogers and Tim Lee Carter, letter to James Schlesinger, secretary, Department of Energy, May 4, 1978 (hereafter cited as "Rogers, Carter letter to Schlesinger").

19. Ibid.

20. "Statement of Donald M. Kerr, acting assistant secretary for defense programs, Department of Energy," *Effect of Radiation on Human Health*, January 26, 1978, pp. 331-404.

21. "Rogers, Carter letter to Schlesinger."

other than radiation must be involved.[22]

The prime basis for that contention comes from a government-sponsored investigation into the Japanese casualties at Hiroshima and Nagasaki. According to official interpretations of that study, dose estimates from the Japanese bombings would indicate that similar effects surfacing in the Mancuso data were "impossible" given the reported levels of radiation at Hanford. But the bomb study itself has since come under devastating reevaluation, and it may in fact confirm rather than deny Mancuso’s conclusions.[23]

The study was begun in 1950 under the auspices of a high-level U.S. Government group called the Atomic Bomb Casualty Commission (ABCC). Beginning its work a full five years after the bombings, the ABCC was dominated by members of the Atomic Energy Commission. Though the board was originally composed almost entirely of Americans, the Japanese government has recently taken an increasingly important role. Essentially the ABCC undertook to reconstruct the bombings of Hiroshima and Nagasaki through computer models designed to estimate the doses received by local victims and to apply that to what could be learned about their health histories after the bombings. The study has served in part as the basis for the five-rem annual exposure standards in the workplace, and as the pace-setter for calculating all other dose levels for the general public. Moreover, it has been used as the scientific litmus test for all other radiation studies.

Unfortunately the ABCC study has been seriously flawed. Its dose estimates result from computer models built around atomic tests conducted in the U.S.; the blasts at Hiroshima and Nagasaki were not monitored, and the actual doses they delivered are not precisely known. The ABCC study is considered in the scientific community to be a "high-acute dose" study, for the obvious reason that the people of Hiroshima and Nagasaki were hit with a massive "burst" of radiation. But the results of the ABCC study have consistently been applied to long-term exposures of low doses of radiation, which may well be an entirely different type of medical response. The Mancuso study is acknowledged as the largest of the "low-dose" studies because the workers involved were exposed over long periods of time to measured low-level exposures.

The ABCC has also been highly secretive about its data, with access given only to a select group of scientists—leading to the criticism that only those friendly to the nuclear industry have been allowed to use this seminal information. Japanese scientists have also charged that the data have been kept from them and systematically dominated by Americans who might have an interest in discouraging compensation claims from Japanese victims of the bombing.[24] Indeed, in 1957 Dr. John Gofman, a leading atomic scientist and survivors tried to collect compensation."[25]

Additional scientific questions about the study have been raised over the nature of the populations of the two afflicted cities. The systematic analysis of what happened to them did not begin until 1950, and thus there is little base-line data about what occurred in those crucial five years after the bombs were dropped. Nonetheless, for statistical purposes the ABCC began its studies by assuming that the Hiroshima and Nagasaki populations of 1950 could serve as a viable test sample.[26]

But Dr. Alice Stewart has challenged that assumption. Aberrations inflicted among the survivors of the bombings had, she said, created a population that was both atypical and prone to diseases caused by bone-marrow scarring and other effects that might not turn up in the ABCC calculations. After an in-depth independent study she concluded that a more realistic appraisal of the Hiroshima-Nagasaki populations might well reveal that the radiation effects of the bombings were ten times more serious than what the ABCC was saying—and thus the entire issue of what constituted a "safe" radiation dose was very much in doubt. "The A-bomb survivors are a highly abnormal population," Stewart told us in a 1980 interview. "It seems incredible that radiation standards for workers and the general public would be based on A-bomb survivors when we now have data on normal, healthy workers from the Mancuso study."[27] scientist that data were being manipulated to prepare "for the time when

---

22. George Hutchinson, Charles Land, Brian MacMahon, and Seymour Jablon, "Review of Report by Mancuso, Stewart and Kneale of Radiation Exposure of Hanford Workers," *Health Physics Journal* 37 (August 1979): 207-220; Ethyl S. Gilbert and Sidney Marks, "An Analysis of Mortality of Workers in a Nuclear Facility," *Radiation Research* 79 (1979): 122-148.

23. "New A-Bomb Studies Alter Radiation Estimates," *Science* 212 (May 1981) (hereafter cited as "New Studies Alter Estimates").

24. Frank Barnaby, *Bulletin of the Atomic Scientists*, December 1977, p. 50.

25. John W. Gofman, interview, February 1981.

26. See Gilbert W. Beebe, et al., *Life Span Study Report 8, Mortality Experience of Atomic Bomb Survivors, 1950-74*, Technical Report TR 1-77, Radiation Effects Research Foundation.

27. Alice M.Stewart, interview, September 1980; Alice M. Stewart, "Delayed Effects of A-Bomb Radiation—a Review of Recent Mortality Rates and Risk Estimates for Five Year Survivors," submitted to the *British Journal of Epidemiology*, May 1981 (available through the Environmental Policy Institute, 317 Pennsylvania Ave. SE, Washington, D.C. 20003).

The flow of new scientific evidence seems to be going Dr. Stewart's way. In August 1981 Iwanami Shoten of Tokyo and Basic Books of New York jointly published *Hiroshima and Nagasaki: The Physical, Medical and Social Effects of the Atomic Bombings,* the first comprehensive survey of the damage done by the nuclear attacks. Compiled by a team of Japanese scientists and social workers, the massive volume delineated the "irreversible injury" to human cells, tissues, and organs which still plagued bomb victims, causing a rise in deaths from leukemia and on-going suffering from other blood diseases, cataracts, genetic damage, nervous system disorders, and a general loss of disease-resistance. According to the study, which received worldwide attention, the overall toll from the bombs was far more serious than previous surveys had indicated.[28] at that time a strong industry supporter, was told outright by a military

Similar revisions with specific focus on radiation damage were already being fiercely debated. In 1980 a key high-level study group—the National Academy of Sciences Advisory Committee on the Biological Effects of Ionizing Radiation (the BEIR committee)—used ABCC data to conclude that workplace cancer risks from radiation had been overestimated by a factor of two. The committee's chairman, Dr. Edward Radford, disagreed, arguing that exposure levels to workers should in fact be tightened by a factor of ten. Nationally known as a leading expert in the radiation field, Radford was subsequently excluded from key final BEIR committee deliberations.

But in early 1981 supporters of relaxed standards in the workplace and elsewhere were given a devastating shock. Researchers at the Lawrence Livermore Laboratory in California and at the Oak Ridge National Laboratory in Tennessee were forced to conclude that the doses received by the people of Hiroshima thirty-five years earlier had been seriously misinterpreted. "Some of the most important data on the effects of nuclear radiation on humans may be wrong," wrote *Science* magazine. The amount of neutron radiation delivered by the bombs had been grossly overestimated, perhaps by a factor of ten. Thus the people of Hiroshima and Nagasaki may have suffered cancer and other radiation side effects from doses far smaller than previously believed. That meant the radiation itself was far more deadly. "The new findings are far from welcome," one consultant told *Science*. All the revisions were "moving in the wrong direction" because they now indicated that low doses of radiation could kill far more people than anyone had previously thought possible—the very conclusion to which Thomas Mancuso's work had been pointing since 1977.

The impact of the new findings was hard to overstate. "The implications are far-reaching for health regulation and nuclear power in this country in general," said David Auton, a physicist with the Defense Nuclear Agency. Standards for neutron radiation in particular might have to be tightened by a factor of ten and on crucial jobs, the nuclear industry might have to hire ten times as many people. Exposure levels for people living near nuclear power plants would have to be reevaluated, as would potential casualty statistics for a nuclear war. The new data said Dr. Arthur Upton, former director of the National Cancer Institute, greatly strengthened the argument that there is no "safe" level of exposure to radiation.[29]

Death in the Mines

Though the Mancuso and Hiroshima/Nagasaki studies based their conclusions on data dating to the 1940s, deaths from radiation exposure among workers have occurred for four centuries, since the beginnings of the uranium-mining industry. As early as the sixteenth century, miners in the Erz Mountain region of what is now Czechoslovakia complained of a chest disease they called "mountain sickness." The ore they dug was pitchblende—uranium—which served as a pigment in pottery and lent sparkle to ornaments used by European royalty. The disease it brought caused deep, stabbing pains, difficult breathing, and an early death.

By the 1870s pioneer health researchers had identified the disease as lung cancer. An early epidemiologist named Arnstein recorded a 40 percent cancer death rate among Czech uranium miners. In 1939 a researcher named Peller reported that the lung-cancer death rate among those miners was twenty times higher than that among control subjects in Vienna. J. A. Campbell, an Englishman, found that mice exposed to dust from those mines developed

---

28. The Committee for the Compilation of Materials on Damage Caused by the Atomic Bombs in Hiroshima and Nagasaki, translated by Eisei Ishikawa and David L. Swain, *Hiroshima and Nagasaki The Physical, Medical and Social Effects of the Atomic Bombings* (New York: Basic Books, 1981). See also, Herbert Mitgang, "Study of Atom Bomb Victims Stresses Long-Term Damage," *New York Times,* August 6, 1981, p. A8.

29. "New Studies Alter Estimates."

lung tumors at a rate ten times normal.[30]

The source of the problem was radon gas, which is naturally emitted in small quantities from uranium ore. This gas, in turn, decays into heavy isotopes called "radon daughters," including isotopes of polonium, bismuth, and lead. Unlike the gas that carries them, some of these isotopes have extremely long half-lives. They emit dangerous alpha particles; minuscule amounts of them can cause cancer when they are introduced into the body. Underground, the radon gas from uranium ore is trapped long enough for its "daughters" to be deposited as solids in the earth. But when the ore is exposed to air, as it is when mined, the gas escapes. Miners without adequate protection inevitably inhale that gas—and its lethal alpha-emitting "daughters."[31]

Such dangers were already well known in the 1940s and 1950s, when the pressure to build atomic bombs and fuel reactors sent prospectors into the western hills to find uranium. Much of it was discovered on Indian land. Soon hundreds of miners—many of them Native Americans—were at work digging out the radioactive ore.

But precious few of them were warned of any special dangers in the mines. Working conditions were, as one researcher put it, "medieval," probably not significantly better than in the Czech mines of the 1500s. One particular problem arose when mine owners used explosives to loosen ore. "When the blast was made it got all smoky," miner James Bennally told a crew from the New York-based Eleventh Hour Films. "We would enter the mines while the smoke was still in the air and take out the ore. They never told us about protective equipment. We went in in our own clothes." The miners were paid seventy-five cents an hour; they drank water that seeped through the radioactive ore they dug. They were sometimes given masks to wear, but even at that, said Bennally, "we still got dust through the nose. There was a bitterness in it which we breathed and tasted. We were not aware of the grave illness that might occur." The effects, however, were real enough. "Across my rib-cage it is constantly hurting," said Bennally. "The doctors do not tell me what is happening. But I know the hurt is there."[32]

---

30. Joseph Wagoner, interview, October 1981. See also, Wagoner, "Uranium Mining and Milling: The Human Costs," remarks at the University of New Mexico Medical School, Albuquerque, N.M., March 10, 1980; and Wagoner, "Uranium: The United States Experience" (Washington: Environmental Defense Fund, 1525 18th St. NW, 20036); and Glen Peterson, "Lung Cancer Rate Among Uranium Miners Five Times Higher than National Average," *National Health Federation Bulletin,* March 1980.

31. Radon 222 is a gas found in uranium-containing ores. It has a half-life of 3.9 days. As radon 222 decays, a series of radioactive elements called radon daughters are formed. Radon daughters, including polonium, lead, and bismuth, emit alpha radiation, which can become attached to dust or water particles in the mines and then inhaled by miners. Once inhaled, the alpha radiation is delivered through the respiratory system where the particles are deposited.

Lung diseases among uranium miners have been documented since the 1500s. Cancer was first identified in 1879. Since then, studies of German, Czech, Yugoslav, and U.S. miners have demonstrated that exposure to radon daughters is associated with increased risk of lung cancer for workers in underground mines generally and uranium mines specifically.

Studies of miners in the United States began in the early 1960s, nearly twenty years after large-scale uranium mining began for the nuclear weapons program. A review of environmental records shows that many miners were exposed to radon levels greater than one working level (WL) (1.3 X 10ˆ5 MeV of alpha radiation from radon daughters per liter of air). In 1955 health officials and scientists recommended that radon levels in mines be no greater than 1 WL. As late as 1968 nearly 30 percent of underground uranium mines still had radon daughter exposures to higher than 1 WL. Proceedings are currently under way to reduce mining exposures to 0.7 working level month (WLM) from the current 4 WLM (a working level month is 173 hours per month exposure to an air level of 1 WL).

During the 1960s researchers found the U.S. uranium miners suffering from shortness of breath, persistent cough, pneumoconiosis, wheezing, and chest pain. Pulmonary emphysema, fibrosis, and chronic bronchitis were also linked with chronic exposures to airborne radiation in the mines. In 1976 an epidemic of nonmalignant respiratory diseases among U.S. miners was confirmed when 80 such deaths were observed when 24.9 deaths were expected.

Excess lung-cancer mortality among U.S. uranium miners with three or more years of underground experience was reported in 1962. One year later 47 cancer deaths (contrasted to 16.1 expected cancer deaths) were reported among miners who received chronic radon daughter exposure in the 1 to 2 WL range. In 1964 a tenfold excess of respiratory cancer surfaced among white miners with five or more years of underground exposures. A 1950-1978 follow-up of white underground U.S. uranium miners found 205 lung-cancer deaths when 40 were expected. Follow-up done on 780 American Indian miners found 11 deaths when 2.6 lung-cancer deaths were expected.

Early epidemiologic studies found that the histologic cell type of lung cancer among U.S. miners was the small cell undifferentiated type, very different from the type found in the general population. Later studies, however, have found three types—epidermoid, small cell undifferentiated, and adenomatus—prevalent among uranium miners. The early studies also indicated that uranium miners who smoked were more apt to develop cancers than nonsmokers. Recent studies of lung cancer among nonsmoking Indian miners and follow-ups of the early epidemiologic studies, however, show that smoking serves only to shorten the lung-cancer latency period—the same types of cancer were found among both smokers and nonsmokers, the nonsmokers' cancers appearing approximately two to five years after those in smokers were diagnosed.

References: V. E. Archer, J. D. Gillam, and J. Wagoner, "Respiratory Disease Mortality Among Uranium Miners," in *Annals, New York Academy of Sciences* 271 (1976): 280; D. A. Holaday, et al., *Control of Radon and Daughters in Uranium Mines and Calculations on Biological Effects,* PHS Publication No. 494 (Washington, D.C.: U.S. Government Printing Office, 1957); F. E. Lundin, et al., *Radon Daughter Exposure and Respiratory Cancer Quantitative and Temporal Aspects,* NIOSH and NIEHS Joint Monograph No. 1 (Springfield, Va.; NTIS, 1976); V. E. Archer, et al., "Hazards to Health in Uranium Mining and Milling," *Journal of Occupational Medicine* 4 (1962): 55-60; J. K. Wagoner, et al., "Cancer Mortality Patterns Among U.S. Uranium Miners and Millers, 1950-1962," *Journal of the National Cancer Institute* 32 (1964): 787-801; J. K. Wagoner, et al., "Mortality of American Indian Uranium Miners," *Proceedings,* XI International Cancer Congress, 1975.

32. *In Our Own Back Yard,* transcripts, Eleventh Hour Films, 29 Jones St., New York City 10014.

The dust Bennally and his fellow miners breathed was laced with radon. Ventilation systems that had been installed in Czech mines as early as the 1930s, and that were being operated at a relatively low cost in France, were nowhere to be found in the U.S.[33] In fact the National Council on Radiation Protection had recommended mine-worker exposure standards as early as 1941. At that time the Atomic Energy Commission was the sole purchaser of uranium in the U.S. It also operated some of the mines directly. Under federal law it was responsible for working conditions in those mines. And at the end of the 1940s, as the nuclear arms race accelerated demand, the AEC's Office of Raw Materials Operations recommended taking control of exposure levels underground. "Since we were the only customer for the ore," said Dr. Merrill Eisenbud, who was head of that office at that time, "we should see to it that the standards that already existed could be met." Soon after issuing that recommendation, the functions of Eisenbud's office were inexplicably removed from his department in New York to Washington.

Then, despite the billions of government dollars spent to develop atomic weaponry, the AEC claimed it lacked the funding to enforce mine safety, and turned the job over to the states and the mining companies.[34] The companies did little. And when the states tried to intervene, they were charged with bureaucratic meddling and endangering the national security. One Colorado inspector commented that in the 1950s "anybody that said a thing against uranium mining was suspected of being a communist."[35]

In 1967 Eisenbud helped develop a machine that could identify miners who had already suffered heavy radon exposures, thus aiding them in getting early treatment. The machines were available for use in both Denver and Salt Lake City. But the AEC and the Public Health Service declined to use them, claiming that funds for a testing program were not available. Eisenbud found that "hard to believe . . . because we were talking about a very small amount of money."[36]

And by that time evidence was beginning to pile up that the mines were creating an epidemic of lung cancer. Colorado and other states began to fear a landslide of compensation claims that could cost taxpayers and industry millions. Their fears were substantiated by a PHS study that had begun in 1950, when the service began collecting data on uranium miners and how they were dying. In 1960 the PHS handed the figures to Joseph Wagoner, a recent doctoral graduate of the Harvard School of Public Health. Wagoner told us in an extensive Washington interview that by 1964 "we showed twelve lung cancers in this group where just 2.8 were expected. We then updated the analysis one more year, and showed twenty-two lung cancers where there should have been only 5.7. When we went through 1965 we found thirty-seven lung cancers where there should have been just seven. And through 1978, with that same group, we now show 205 lung cancers where there should have been only forty. In other words there has been a consistent fivefold increase in lung cancer among this group right down the line."[37]

Still, however, the AEC refused to take responsibility for the enforcement of mine-safety regulations. Backed by the pronuclear Joint Committee on Atomic Energy (JCAE), which had effectively blocked any congressional attempts to regulate the mining industry, the AEC sailed along with little regard for the health of its miners—until 1967. Then, at a stormy JCAE hearing session, Secretary of Labor Willard Wirtz charged that "the best available evidence is that over two-thirds of the approximately 2,500 underground miners are working under conditions which at least triple their prospects for dying from lung cancer if they continue this work and these conditions remain unchanged." Year after year of "debate and discussion had produced nothing."[38]

The JCAE continued to insist that more study was needed. But one of its members complained that people were now "saying that the Joint Committee was for love, motherhood, apple pie and lung cancer."[39] During the Nixon administration it tried to recapture lost ground by staging more hearings, hoping to restore its public image and forestall enactment of new regulations. This time the JCAE focused on the possibility that cigarette smoking rather than radon was at fault. But the PHS statistics indicated otherwise. Robert Finch, Nixon's secretary of health,

---

33. H. Peter Metzger, *The Atomic Establishment* (New York: Simon and Schuster, 1972), p. 120.

34. U.S. Congress, Senate Committee on Labor and Human Resources, Subcommittee on Health and Scientific Research, and the Committee on the Judiciary, *Health Impact of Low-Level Radiation, 1979*, 96th Cong., 1st sess., June 19, 1979, pp. 19-23 (hereafter cited as *1979 Radiation Hearings*.)

35. Metzger, *Atomic Establishment*.

36. *1979 Radiation Hearings*, pp. 19-23.

37. Wagoner interview.

38. Metzger, *Atomic Establishment*, pp. 131-133.

39. Ibid.

education, and welfare found the thesis "not persuasive." Undersecretary of Labor James Hodgson noted that "European pitchblende miners were dying of lung cancer before the introduction of tobacco to Europe."[40]

By 1971, despite continued resistance by the JCAE, federal standards for radon gas levels in uranium mines were created. But for many they were too little, too late. In 1979 Merrill Eisenbud, long a nuclear supporter, told a Senate hearing that the plague of lung cancer among American uranium miners was "totally avoidable." There was, he said, "a total failure of initiative with respect to the radon exposure problem, and I believe the fact that the Atomic Energy Commission did not take the steps it took everywhere else in this program to safeguard the employees, is uniquely responsible for the death of many men who developed lung cancer as a result of the failure of the mine operators, who must also bear the blame, because they too had the information, and the Government should not have had to club them into ventilating their mines."[41]

Dr. Joseph Wagoner, however, felt even the new standards were far from adequate. And enforcing them was yet another story. Mine owners were deliberately deceiving the government about the levels of exposure, and they were getting away with it. The radon levels were being measured by setting collection bags on ventilation shafts. The air in the bags would then be tested for radon. "But," Wagoner told us, "the government had only a single inspector [per mine]. So all the companies had to do was find out when the inspector was coming and have somebody run in front of the guy and get to the bags and reduce the concentration."

Wagoner also told us that the companies would time their blasting schedules to circumvent the measurements. The government would often monitor mine air in the morning and evening. So the companies "were sending the workers out of the mines at lunch break, shutting off the ventilation and blasting inside the mine to loosen the ore. When the workers came back at one o'clock in the afternoon, they were getting walloped with seventeen working levels," which was seventeen times the legal standard. The miners left work having been hit with extreme doses, which were never recorded in company files. It was "false bookkeeping, pure and simple."

In 1980 Wagoner quit the Public Health Service after twenty years. He told us that fall that uranium mining as practiced in the U.S. remained the moral equivalent of "genocide." His last official act, he said, "was to recommend that the current standards in the mines are so totally inadequate that they are causing a doubling of lung cancer among miners. Fully 40 percent of the mines are working in violation of those standards, which are inadequate anyway."[42]

Conditions in the uranium mills—where the raw ore is crushed and treated to extract the uranium—may not be any better. In the late 1970s two mill workers joined a major suit by sixty-five miners, charging working conditions had destroyed their health. The men reported regularly eating lunch in areas thick with uranium dust. Some were given cloth respirators, but they became caked with dust and were so rarely cleaned by the company that many workers simply stopped wearing them. Dust was so pervasive that a cleanup operation at one abandoned mill recovered $100,000 worth of uranium dust between two layers of roofing.[43] In another case the Colorado Bureau of Investigation confirmed that a mill owner—the Commonwealth Edison Company of Chicago—had regularly falsified exposure levels to avoid cleaning up their operations or paying compensation to workers.[44]

Neither the miners nor the mill workers were generally informed of the special dangers of radiation. Again that policy had tragic costs. In 1979 a Utah miner named George Val Snow told hearings on low-level radiation chaired by Senator Edward Kennedy that of the forty-two miners with whom he had worked, twenty-two were already dead of various causes. He had worked in the Marysvale mine from 1950 to 1960; his father and brother, both victims of lung cancer, were among the dead. Snow told of a game the workers would play to see whose breath was most radioactive. The company, Snow said, "had a Geiger counter out to measure the ore to see whether it was ore or waste. As we would come out at night we would blow on it to see who could put it furthest up on the scale. Sometimes we could put it clear off scale."

But despite four centuries of experience with death in the mines, and decades of knowledge that radon gas caused

---

40. Ibid., p. 140.

41. *1979 Radiation Hearings,* pp. 19-23.

42. Wagoner interview.

43. *High Country News,* September 5, 1980.

44. Peggy Strain, "Edison Unit's Uranium Mill Health Data Falsified: Study," *Chicago Sun-Times,* September 28, 1980.

lung cancer, no one had told George Snow or his coworkers there was ever a danger. Said Snow: "We were not concerned that there was anything wrong."[45]

The Radium-Dial Painters

Other workers also have been uninformed about their exposures to radiation—and have paid a fearsome price. Among the first were several thousand Americans—most of them women—hired to paint radioactive radium onto watch faces, making them glow in the dark.[46]

Radium is a by-product of uranium ore, found in nature. In the 1920s company managers told many employees that ingesting radium would add to their vitality, curl their hair, improve their complexions, and make them sexually attractive. The dial painters thus eagerly licked their paintbrushes to give them the fine point they needed to paint the watch dials. Many also applied the radioactive substance to their rings, buttons, and belts. One man even painted his teeth to make them glow—an act that anticipated the current widespread use of uranium in the manufacture of false teeth and ceramic tooth caps.

By 1924 news that four employees of the U.S. Radium Corporation had died of necrosis of the jaw—a rare degenerative disease—reached the Board of Health of Orange County, New Jersey. Eight other women were seriously ill, and local dentists were reporting still more cases. But when Katherine Wiley of the National Consumers League approached the company, she was told the problem was due to poor dental hygiene.[47]

The company, however, had already secretly hired Dr. Cecil Drinker of Harvard to study the plant. Drinker found radium paint spattered throughout the work area, on employees' clothes and even on their underwear. He also learned U.S. Radium had ordered its workers to stop licking their paintbrushes, a clear indication they knew something was wrong. Drinker's report clearly implicated radium as the source of the necrosis epidemic.[48]

The company responded with hostility. Katherine Wiley was given an edited version of Drinker's report, which said "every girl is in perfect condition." Drinker protested and was threatened with a lawsuit. When he later published his full paper anyway, U.S. Radium brought in Dr. F. B. Flinn of Columbia University. Flinn gave the company a clean bill of health. But in 1925 Dr. Harrison Martland, a local health official, confirmed five deaths from radium poisoning and estimated the average radium-dial painter might well ingest, over a five-year period, one thousand micrograms of radium—ten thousand times the 1981 standard.[49] In light of Martland's findings, Flinn repudiated his own study.

Ensuing studies continued to confirm the worst, with indications of increased bone cancer, cancer of the colon, diseases of the blood-forming organs, respiratory problems, and necrosis of the jaw. One study showed that the exhumed bones of former dial painters exhibited such high levels of radium that they photographed themselves on unexposed film.[50] And as the victims themselves began complaining of their diseases and filing lawsuits, media coverage led to increased public pressure on the companies to tighten up their procedures. That slowed, but did not stop, the epidemic. Because it emits alpha radiation, radium can be lethal when ingested in sufficient amounts. But radium also emits penetrating gamma rays, and working with it outside the body can lead to exposures that cause a wide range of diseases, including breast cancer and multiple myeloma, which continued to surface even in the "modernized" dial plants.[51]

Finally, faced with a raft of lawsuits, one operation—the Illinois-based Radium Dial Company—went out of business in 1934. Soon thereafter, however, a "new" company called Luminous Processes emerged as the owner of Radium Dial's plant and paymaster of its employees. Joseph Kelley, Sr., former president of Radium Dial, now

---

45. *1979 Radiation Hearings*, pp. 48-50.

46. Scott/NIOSH Report, p. 8.

47. Roger J Cloutier, "Florence Kelley and the Radium Dial Painters," *Health Physics Journal* 39, No. 5 (November 1980): 711-717.

48. Ibid.

49. Harrison S. Martland, "Occupational Poisoning in the Manufacture of Luminous Watch Dials," *Journal of the American Medical Association* 92 (1929): 466-477.

50. Cloutier, "Florence Kelley and the Radium Dial Painters."

51. Baverstock, et al., "Risks of Radiation at Low Dose Rates," *Lancet* 21 (February 21, 1981): 430-433; Jack Cuzick, "Radiation-Induced Myelomatosis," *New England Journal of Medicine* 304, No. 4 (January 22, 1981).

became president of Luminous Processes, whose practices were remarkably similar to those of Radium Dial. Investigative reporter Anna Mayo reported in *The Village Voice* that Luminous had grown, by the 1970s, into a multinational concern with offices in Manhattan, Switzerland, and Hong Kong.[52]

But despite its expansion Luminous apparently maintained many of its traditional modes of production. In 1976 the NRC fined Luminous for sloppy practices at its Illinois factory. In 1978 the commission ordered the plant shut. Luminous responded by hastily ordering its equipment trucked to Georgia, where it had a plant free of NRC jurisdiction. The commission caught the trucks and confiscated the equipment. The Georgia plant was closed soon thereafter; local officials were still reporting high radiation levels on site in 1980.[53] Mayo later visited the Illinois site and reported that seven of the ten former Luminous workers she interviewed there were suffering from breast cancer and tumors on their feet.[54]

In the mid-1970s luminous watch-dial production shifted from radium to the use of thin glass slivers filled with tritium, a radioactive isotope of hydrogen capable of glowing without an electric source. Though the process was generally believed to be safer than painting with radium, the American Atomics Corporation of Tucson in 1979 contaminated an entire neighborhood with tritium, including the kitchen of the Tucson public school system. Meanwhile radioactive materials continue to be used in a wide range of light sources including some coffeepots, hand-held calculators, and nightlights.

The Manhattan Project

Although several radium-dial workers won compensation claims in court, publicity of the primitive conditions in which they worked did little to better the lot of workers elsewhere in the nascent nuclear industry. While the people of Hiroshima and Nagasaki were the most obvious victims of the atomic attack, Americans also died from those bombs—many from the work of producing them.

Part of the problem was a cavalier attitude among scientists toward the potential dangers of radiation. In the 1930s, for example, Dr. J. Robert Oppenheimer would occasionally drink a solution of highly radioactive sodium 24 and then, to the amazement of onlooking graduate students, send a Geiger counter off-scale with his hand.[55] In 1944 Dr. John Gofman, then a young graduate student working on the Manhattan Project, which produced the first atomic bomb, was heavily dosed when he was ordered to perform by hand a highly dangerous task involving plutonium that should have been handled only by machine. Gofman told us that in another instance the chief concern of safety personnel at the Berkeley Laboratory in California was the stacking of cardboard boxes that "might fall and hit someone." The room in which they were stacked, however, was highly radioactive, and the people in it were being severely exposed—with no particular concern on the part of the safety teams.[56] In another case Dr. Karl Z. Morgan, an original member of the Manhattan Project Health Physics Group, could not convince plant engineers to separate the workers' drinking-water system from the industrial-process system. Thus a leak or a mistaken turn of a valve could result in plant workers drinking radioactive water.[57]

Another Los Alamos scientist named Harry Daglian caused his own death in a process he called "tickling the dragon's tail." By arranging a wall of tungsten-carbide bricks around a uranium or plutonium source, Daglian could determine how much material was needed to cause a chain reaction. But on August 21, 1945, Daglian accidentally caused a plutonium source to go critical. The air in his laboratory turned blue and radiation seared Daglian's flesh. He died a horrifying death. Less than a year later Daglian's boss, Louis Slotin, suffered a similar fate.[58]

The haphazard practices inevitably carried over to the workers at Los Alamos, many of them enlisted GIs. One, a

52. Anna Mayo, "We Are All Guinea Pigs," *Village Voice,* December 25, 1978, p. 18.

53. Environmental Radiation Surveillance Report, Georgia Department of Natural Resources and Environmental Protection Division, summer 1979 to summer 1980, pp. 177-186.

54. Mayo, "We Are All Guinea Pigs."

55. Rapoport, *The Great American Bomb Machine,* p. 122.

56. Gofman interview.

57. Karl Z. Morgan, interview, October 1980.

58. Karl F. Hubner and Shirley Fry, "The Medical Basis for Radiation Accident Preparedness," *Proceedings of the REAC/TS International Conference,* Oak Ridge, Tenn., October 1979, p. 17.

GI named Ted Lombard, remembered that he and his coworkers often handled dangerous materials with their bare hands, and without proper monitoring. "Contamination was rampant," he said. In certain shops "the fumes and dust were constantly in the air . . . The dust was on the floor. Uranium chips would be in your shoes. You went to eat with the same clothes and sat on the beds."[59]

By the summer of 1945 Lombard was complaining of stomach problems. In December the Army gave him a medical discharge. His health deteriorated, with the tissue in his lungs becoming fibrous and his skin developing sores that would not heal. The worst of it, however, came with his children and grandchildren. "I have a daughter, 31 [who] appeared to be healthy until we looked back," Lombard said to the 1980 Citizens' Hearings for Radiation Victims in Washington. "It's a slow, insidious thing. Now she's in a wheel chair with neuromuscular, undiagnosed, multi-type seizures, lack of antibodies, lack of digestive enzymes. . . . My youngest son is a deaf mute, subject to multiple seizures, blood conditions and other undiagnosed problems. He's mentally retarded too. Another son has migraine headaches . . . is aphasic and has blood problems. The two grandchildren are starting to show signs of digestive problems and blood conditions."[60] Lombard has filed a claim with the Veterans Administration. The VA has acknowledged his exposures at Los Alamos but refuses to provide his medical records.

Evidence has also surfaced that operation of Los Alamos may have harmed the entire community. A 1979 study by the New Mexico tumor registry showed that from 1969 to 1974, breast cancer in white females in Los Alamos County was more than twice the national average. Cancers of the stomach, pancreas, bladder, and rectum were three times the state average. Cancer of the colon was more than double the state average.[61] The only long-term health survey of Manhattan Project workers at Los Alamos was conducted by Dr. George Voeltz, director of Health Effects Research at Los Alamos. Voeltz concluded, after contacting twenty-six employees, that "no medical findings were reported which could be attributed definitely to plutonium."[62] But his findings have been disputed. Dr. Edward Martell, a radiation researcher for the National Center for Atmospheric Research in Boulder, examined Voeltz's data and concluded that "with equal justification one may state that most of the serious medical findings in this group can be attributed to plutonium."[63]

In 1974 Voeltz began a larger study of 224 workers exposed to plutonium at Los Alamos. Ted Lombard was not in either of Voeltz's samples. But in a form letter to prospective participants for his second study, Voeltz revealed the results he anticipated: he asked former workers to "please cooperate to help us prove that exposures to low-levels of plutonium are not harmful."[64]

The Portsmouth Naval Shipyard

No such bias was apparent in the work of Dr. Thomas Najarian, a blood specialist at Boston Veterans' Hospital. In the fall of 1977 Najarian was examining a former nuclear welder named Adolph Pohopek, who was suffering from leukemia. Pohopek had worked at the Portsmouth Naval Shipyard in New Hampshire, and asked Najarian if radiation exposure at the shipyard might have had anything to do with his leukemia.

Portsmouth, which is about sixty miles north of Boston along the Atlantic coast, has been building warships since 1800. It constructed the first American military submarine in 1917. Between 1954 and 1977 a total of sixty-three atomic subs were either built, overhauled, or repaired at Portsmouth. The General Dynamics Corporation operates the yard on government contract, and roughly a third of the 24,525 workers listed as having worked at PNS have been exposed to radiation, among them Adolph Pohopek.[65]

Pohopek told Najarian that numerous Portsmouth workers seemed to die unusually young, and that working

---

59. "Statement of Ted Lombard," *Citizens' Hearings*.

60. Ibid.

61. "Cancer Rate Elevated in Los Alamos County," *Albuquerque Journal*, October 12, 1979.

62. Ibid.

63. Ibid.

64. Ibid.

65. "Epidemiologic Study of Civilian Employees at the Portsmouth Naval Shipyard, Kittery, Maine," National Institute of Occupational Safety and Health, released December 3, 1980 (hereafter cited as "NIOSH/PNS Report").

conditions in the yards were not all they should be. Pohopek then gave Najarian the names of fifty people who had recently worked at Portsmouth. Najarian found that ten of them were already dead, and he asked the VA for funds to do some follow-up research. The VA turned him down, saying exposures at Portsmouth were too low to have caused any of the deaths.[66]

But Najarian persisted. Using his own money for postage and paper, he mailed questionnaires to about forty past and present Portsmouth workers. Within a week the head of the VA's research division in Washington called Najarian, demanding to know who was funding his research and asking for all his correspondence with naval personnel. When Najarian asked that the request be put in writing, he never heard from the VA official again.[67]

When the questionnaires themselves began coming in, they revealed what Najarian considered an alarmingly high rate of leukemia deaths. In mid-November of 1977 Najarian asked *The Boston Globe* for help. Although the Navy had refused to give Najarian any of its records, he and an investigative team from the *Globe* were able to gather some seventeen hundred death certificates relating to Portsmouth workers. The Navy also refused to release any worker exposure records. But with the help of statistician Dr. Theodore Colton, Najarian was able to isolate those workers whose families could confirm that they were exposed to radiation at Portsmouth. In June of 1978 Najarian and Colton published a paper in *Lancet,* indicating a leukemia rate among exposed Portsmouth workers that was four times normal.[68]

The study was soon attacked by Admiral Hyman Rickover, chief of the Navy's nuclear programs and pioneer of the atomic submarine. A hard-driving perfectionist who was former President Jimmy Carter's mentor while Carter was in the Navy, Rickover has an almost legendary reputation for turning out the best-trained personnel in the nuclear field. In 1958, under his watchful eye, an enlarged version of the nuclear sub reactor opened at Shippingport, Pennsylvania, as the world's first commercial demonstration reactor to produce electricity. Rickover also had a great stake in the Portsmouth operation, and vigorously defended the record of the nuclear Navy. In 1978 he told a congressional hearing that "we have had no accidents which caused people to be injured or which had a radiobiological effect on the environment." But he scrupulously added that "I do not include the long-term effects of low-level radiation."[69]

And that was precisely what was at issue. Rickover, after congressional pressure, soon agreed to have the Center for Disease Control (CDC) evaluate Najarian's findings. The CDC turned the study over to its subagency, the National Institute for Occupational Safety and Health, which asked—among others—Dr. Thomas Mancuso to serve on its independent scientific "watchdog" panel which had been mandated by Congress.

Controversy soon clouded the study. Mancuso refused an appointment to the watchdog panel after NIOSH refused to guarantee him access for an on-site evaluation of the data sources. In December 1980 several NIOSH researchers concluded that "excesses of deaths due to cancer and due specifically to cancers of the blood and blood forming organs were not evident" at Portsmouth.[70] But on January 5, 1981, the *Globe* reported that five of six advisory committee members they polled felt that the NIOSH data had in fact revealed "a trend toward higher leukemia rates among workers who received higher doses of radiation." One panel member, Dr. George Hutchinson, who is generally known to be pronuclear, conceded to the *Globe* that "there is a trend of leukemia with dose"—that the evidence indicated the more radiation the Portsmouth workers received, the more likely they were to contract leukemia.[71]

In fact NIOSH submitted its final report for publication without giving its full congressionally mandated advisory committee a chance to discuss its conclusions. Committee member Irwin Bross threatened to sue NIOSH to get them to send him the data, and then charged that the numbers "flatly contradict statements made by CDC/NIOSH." Bross found a large excess of lung cancer linked to radiation exposure.[72]

---

66. "Statement of Thomas Najarian," *Effect of Radiation on Human Health,* February 28, 1978, p. 1236.

67. Ibid.

68. Thomas Najarian and Theodore Colton, "Leukemia among Shipyard Workers," *Lancet,* June 1978.

69. "Statement of Hyman Rickover, Adm. H.G., Deputy Commander, Nuclear Power Naval Sea System Command, USN, Department of Defense," *Effect of Radiation on Human Health,* p. 1272.

70. "NIOSH/PNS Report," p. 31.

71. N. Breslius, "Questions Raised in Shipyard Cancer Study," *Boston Globe,* January 5, 1981, p. 22.

72. Irwin D. J. Bross, director of biostatistics, Roswell Park Memorial Cancer Research Institute, memorandum to "Competent and Responsible Members of the Oversight Committee," January 26, 1981.

Though controversy still rages over the Portsmouth studies, there seems little doubt in the minds of the people working there that something might be seriously wrong. In January of 1979 Dr. John Cobb of the University of Colorado Medical School, a member of the NIOSH advisory panel, visited Portsmouth to evaluate the situation for NIOSH director Dr. Tony Robbins. When he got there, Cobb found "antagonistic" and "explosive" differences between the unions and the Navy over health and safety issues, and that the unions felt "the Navy would lie, cheat and do anything to cover up their deficiencies in management."[73]

Cobb also discovered "that there could be an incentive for workers to keep their recorded radiation exposure lower than actual exposure," and that the Navy would often issue "waivers" to workers to keep them working in radioactive areas even after they had exceeded exposure limits. Cobb said he "was told that workers were led to believe that radiation exposure would not harm them."[74] Because radiation work brought higher pay, employees were reluctant to wear film badges for fear of being put in lower-paying jobs if they "burned out."

Enrichment and Reactors

Labor anger and questions of radioactive workers' safety are also epidemic in America's uranium enrichment industry. Enrichment—the process of turning milled uranium ore into high-grade reactor fuel and weapons material—involves huge quantities of energy, thousands of workers, and billions of dollars in taxpayer investments and subsidies.

These are three major enrichment plants in the U.S.—at Paducah, Kentucky; Piketon, Ohio; and Oak Ridge, Tennessee.

At Paducah, which is operated under government contract by the Union Carbide Corporation, a worker named Joe Harding has charged that company management put a tight lid on all discussions of plant safety. Words like *radiation* were banned from conversation, he said. "Before you worked there, the FBI ran a security check. And after you were hired, the FBI would keep an eye on you."[75]

Through his eighteen and a half years at Paducah, Harding, a maintenance worker, regularly breathed radioactive gases "so thick you could see the haze in the air when you looked at the ceiling light, and you could taste it coated on your teeth and in your throat and lungs. After a couple hours of work the uranium dust on the floor was so thick you could see your tracks when walking around." Leaks were rampant, Harding added, and protective clothing was minimal. "There was no particular lunch room or lunch hour. You just sat down somewhere, blew away the uranium dust and had your lunch."[76]

According to Dr. Karl Z. Morgan, working in air laden with uranium hexafluoride gas, prevalent at the enrichment plants, can contaminate the lungs and entire gastrointestinal tract and can give the body heavy doses of alpha, beta, and gamma radiation. Serious beta radiation to the skin can also result. There is a double risk because the hexafluoride, which is combined with the uranium, is itself highly corrosive and toxic.[77]

By late February of 1980 Harding—at age fifty-nine—had lost 95 percent of his stomach and suffered from chronic lung problems and skin sores that would not heal. There was a large tumor wrapped around his spine in the abdominal cavity, and fingernail-like growths protruded from his joints. Despite confinement to a wheelchair, Harding spent the last years of his life speaking out against conditions at Paducah. When he had started work at age thirty-one, he said, he was a strong, vigorous man who was "never sick" and "could eat anything." His plant supervisors had told him "you will not get any more radiation in this work than you get from wearing a luminous dial wristwatch."[78]

Three decades later, an eighty-pound cripple racked with constant pain, Harding extracted a promise from the DOE that his case would be fully evaluated. But after he died, his widow, Clara, was told her husband had rarely

---

73. John C. Cobb, *Report of Visit and Recommendations Regarding Studies of Cancer Incidence at Portsmouth Naval Shipyard,* NIOSH Report, January 30-31, 1979, p. 5 (hereafter cited as *Cobb/NIOSH Report*).

74. Ibid., p. 6.

75. Joe Harding, interview with Pierre Fruling, published in newsletter, "Uranium Killed Joe" (available from the National Committee for Radiation Victims, 317 Pennsylvania Ave. SE, Washington, D.C. 20003).

76. Ibid.

77. Karl Z. Morgan, letter to Robert Hagar, Esq., February 4, 1981 (hereafter cited as Morgan letter).

78. Joe Harding interview.

been monitored for radiation "because of the low potential for exposure" among workers in his field.[79]

The DOE records did reveal that at one point in Harding's career he had produced a urine sample which showed ten times the allowable limit of radiation. But a sample taken the next day was said to have shown a dramatic drop in radiation levels. According to Dr. Morgan it takes several days for uranium to pass through the body, and thus "either the second sample taken of Mr. Harding's urine was mistakenly analyzed, or it was falsified."[80]

Ironically, though no reliable studies have been done of worker health at Paducah, the Kentucky Health Department has found that the counties around the plant have the highest cancer rate in the state, well above the national average. Breast cancer among women and prostate cancer in men were the most prominent. Communities near the plant showed excesses of colon and lung cancer among both sexes—diseases commonly linked to radiation.[81]

Unfortunately conditions at Paducah do not appear to be unique. According to Dennis Bloomfield, president of the Oil, Chemical and Atomic Workers local union at Piketon, one incident there spread so much contaminated dust that workers were forced to destroy their shoes for fear of carrying radiation home to their families. "The lunch table we were eating on was so contaminated it had to be destroyed," he said.[82]

In 1979 Bloomfield's union waged a long and bitter strike for improved health and safety conditions at the plant. Among other things it demanded that monitoring of worker conditions be taken out of the hands of the DOE and given to the Occupational Safety and Health Administration (OSHA), which the union hoped would offer better protection for its workers. According to a 1980 GAO report the DOE had inspected all three enrichment plants only a total of three times in the five years from 1975 to 1980. Neither the NRC nor OSHA were allowed to monitor radiation exposures inside any of the enrichment plants, and the GAO noted that by and large company management was very slow to respond to worker complaints of unsafe conditions.[83] Finally, after the workers' costly strike, Goodyear—which operates Piketon under federal contract—gave in to some of the union's demands. The DOE, however, still dominates access and monitoring of working conditions at all enrichment facilities.

Because of such lack of controls, many American enrichment workers live in fear of what their jobs might be doing to them. Two such Piketon employees—Mike and Kathy Schuller—were interviewed by British television in 1980. They were both contaminated after having been told by Goodyear that their particular jobs were safe from radioactivity. When Kathy complained, she was told "either you do it, or you get sent home."[84] Pregnant at the time, she told the TV crew, "I kind of worry about what is going to happen to my unborn child." Kathy said she "will feel better after it gets here, and that it's got everything—all ten fingers and ten toes."[85] On December 18, 1980, the Schullers' son was born with only one hand.

Fears like those of the Schullers are also starting to surface in the nuclear power field. Since 1957, when operations began at the first commercial demonstration power reactor at Shippingport, Pennsylvania, a burgeoning industry has evolved employing more than eighty thousand people. In 1972 the EPA predicted annual exposure levels per worker would not exceed .225 rem by the year 2000. Within six years the reported average exposures at atomic reactors had more than tripled that EPA prediction.[86] Ironically efforts to reduce exposures to the general public may be partly at fault. By trapping radiation on site that would normally be vented, levels within the plant go up—at peril to the employees.

And during crisis situations at a plant conditions become even worse. Utilities often hire "jumpers," short-term workers who handle high-exposure jobs, where legal limits of exposure are quickly consumed. The practice is sometimes called "body banking," whereby unskilled and often uninformed laborers are sent into "hot" areas at high

---

79. Department of Energy, letter to Clara Harding, January 1981 (available from Robert Hagar, Mrs. Harding's attorney, 1471 N. Capitol St., NW, Washington, D.C.).

80. Morgan letter.

81. *Sun Democrat* (Paducah, Ky.), November 2, 1977, p. 1.

82. Dennis Bloomfield, interview, *For My Working Life,* film transcript, copyright ATV, April 28, 1981 (hereafter cited as *ATV Transcript*).

83. Sheila Hershow, "Atomic Plant Probe Confirms Charges Aired Six Years Ago," *Federal Times,* August 25, 1980, p. 13.

84. *ATV Transcript*.

85. Ibid.

86. Scott/NIOSH Report, p. 30.

hourly wages for brief but dangerous stints. In 1971 the Nuclear Fuel Services reprocessing facility at West Valley, near Buffalo, New York, used nearly one thousand jumpers to handle an emergency. According to Dr. Marvin Resnikoff, a professor of physics at the nearby Rachel Carson College, the jumpers were often "high school graduates with minimal job experience, unable to find employment in the depressed job market in Buffalo. They were given extremely limited information regarding radiation hazards."[87] Though federal standards dictated that they not work with radiation for at least three months after their initial employment, many of the jumpers returned to NFS within days bearing false identification, and were sent back in for more doses. Former President Carter served as a jumper after a nuclear accident at Chalk River, Canada, in 1952. Carter got a year's dose in less than ninety seconds.[88]

One of the problems that makes "body banking" and all other nuclear work even more dangerous is that few if any of the workers involved may be getting reliable exposure records from their employers. Much of the monitoring relies on the use of dosimeter "badges," which are usually worn while a person works in a hot area. The badges are generally built around a special film designed to record gamma radiation.

But other lethal forms of radiation escape the badges. And even for gamma radiation they may not be reliable. A 1980 study by the Nuclear Regulatory Commission found that 80 percent of all radiation monitoring devices tested failed to come within 50 percent accuracy. Conducted by the University of Michigan, the study covered fifty-nine processing firms and involved a sample of about 90 percent of the radiation-dosimetry industry. By mixing in "control" badges with those coming from work sites, the Michigan researchers found that a large part of the dosimetry work being done at American nuclear sites was unreliable at best. When test badges were exposed to levels of radiation corresponding to a major nuclear accident, the extreme doses went undetected.[89] The response by the Health Physics Society, which sets monitoring standards, however, was not to improve the technology—but rather to relax the dosimetry standards, making it easier for the industry to pass future tests.[90]

Meanwhile preliminary indications from reactor work are not encouraging. According to death certificates obtained by the union representing workers at the Shippingport and Beaver Valley I reactors in Pennsylvania, multiple myeloma and leukemia rates among former workers at those two plants are far above normal state rates.[91] Indications are also strong that there may have been serious damage incurred by workers at Three Mile Island (TMI). According to the Kemeny Commission, which was established by President Carter to study the accident, workers at TMI were exposed to levels that "exceeded the limits of the licensee's measurement capability of one thousand rads per hour." During the accident several repair parties entered these high-radiation areas without knowledge of radiation protection supervisors. According to an NRC report on the accident, "items of protective clothing were not worn, resulting in several instances of head contamination." Sample containers of highly radioactive water were "handled directly without the use of remote tools or shielding."[92]

---

87. Marvin Resnikoff, "On the Job at NFS—Occupational Hazards in the Reprocessing Business," Sierra Club Radioactive Waste Campaign, Buffalo, N.Y.

88. Jimmy Carter, *Why Not the Best?* (New York: Bantam, 1976), p. 60.

89. "Performance Testing of Personnel Dosimetry Services, Report of a Two Year Pilot Study, October 1977—December 1979," NUREG/CR 1304 (Washington, D.C.: U.S. Nuclear Regulatory Commission).

90. Ibid.

91. *Deaths Among Operating Engineers Who Worked at the Shippingport Site*

1 accident (crushed chest)
9 cancer: 5 non-bone-marrow related cancers
4 bone-marrow related cancers
2 bone-marrow leukemias
2 multiple myelomas
12 heart and other diseases

22 deaths total among operating engineers at Shippingport (1970-79)

92. J. G. Kemeny, et al., *The President's Commission on the Accident at Three Mile Island, the Need for Change: The Legacy of TMI,* Washington, D.C., 1979, Appendix iii, Nos. 4 and 18. (hereafter cited as *Kemeny Report*).

Rocky Flats

Problems among workers in the reactor industry are just starting to surface, but such complaints have long been common at the Rocky Flats plutonium factory near Denver. Rocky Flats is the "Grand Central Station" of the nuclear weapons industry. It recycles fissionable materials from "obsolete" bombs, and it also produces plutonium "triggers" for new ones. Its core is an elaborate system of ventilated stainless-steel glove boxes where workers smelt, press, machine, polish, and measure the plutonium for America's nuclear bombs.

Rocky Flats was operated under government contract by Dow Chemical from the time it opened in 1953 until 1975, when management was taken over by Rockwell International. Dissatisfaction with both Dow and Rockwell has been widespread, and numerous fires and spills have plagued the plant. At least 325 workers are known to have been seriously contaminated in that period. One 1958 survey of an on-site cafeteria showed contamination in fifty of fifty-four areas above "allowable tolerances" for plutonium.[93] In 1965—a year in which at least forty-five workers were contaminated with plutonium—a local union attempted to establish a management-worker safety committee. Dow Chemical management refused to cooperate. In October of that year a fire contaminated an entire production crew of twenty-five workers with up to seventeen times the maximum allowable exposure.[94]

Since the plant opened, thousands of people have been employed at Rocky Flats. But no reliable independent health survey of the work force has ever been published. And some of the indications that have surfaced are not encouraging and have resulted in fierce court battles that may have a profound impact on all radiation-related work to come.

Don Gabel, for example, began work at Rocky Flats fresh out of high school in 1969. A significant part of his day was spent operating a furnace that treated plutonium. In one case a pipe leaked nitric acid laced with plutonium onto his head. Despite assurances from his boss, Gabel became concerned about the effects of working near so much radiation. In one case the pipe that he worked near for long periods of time was tested and "pegged the needle off the dial."[95]

In 1979, after a decade in the plant, Gabel began to suffer from serious headaches, then seizures. Doctors found a malignant brain tumor, which could not be removed. Gabel finally had to move his wife and three children to the Los Alamos Laboratory in New Mexico, hoping to be saved by experimental treatment. It failed. In the fall of 1980 Don Gabel died at the age of thirty. An ensuing autopsy revealed significant quantities of plutonium and americium in his lungs, liver, and bones.

Three months before his death Gabel filed a workers compensation claim against Rockwell International. His wife is pursuing the battle.

The case of Dan Karkenan, a college-trained professional who began work at Rocky Flats in 1968, was never resolved. Karkenan was a mechanical engineer who helped in the cleanup and reconstruction of Rocky Flats after a fire on May 11, 1969, seriously contaminated the plant and sent an uncertain amount of plutonium into the areas south of the plant.

By the spring of 1975 Karkenan began showing symptoms of numbness in his fingers and toes, followed by a loss of coordination and then paralysis in his arms and legs. Doctors were unable to diagnose Karkenan's disease, but he and his family were convinced it could be traced to his work during the cleanup after the 1969 fire, when the entire Rocky Flats area was heavily contaminated.[96] Just before Karkenan died in 1976, he asked his wife Miriam to have tissue samples examined as a part of his autopsy—as was later done with Don Gabel. But when she authorized the autopsy, Miriam Karkenan was told by the hospital that permission was required from Rockwell before her husband's tissues could be analyzed for radioactivity. After three months of wrangling with the company, she obtained permission—and was then told by the hospital that the tissues had been discarded. Karkenan continued to pursue her husband's records from Rockwell International and in late 1979 was sent a "report" ostensibly detailing her husband's exposure history. The document discussed Dan Karkenan's "on-the-job" exposures in 1977, 1978, and 1979—three years after he was already dead.[97]

---

93. Rapoport, *Great American Bomb Machine,* p. 24.

94. Ibid., p. 25.

95. Don Gabel, interview with film makers of *Dark Circle: A Documentary on Nuclear Weapons and Nuclear Power,* produced by the Independent Documentary Group (395 Elizabeth St., San Francisco, CA 94114; 1981) (hereafter cited as *Dark Circle*).

96. *Citizens' Hearings*.

97. Ibid.

One landmark case of immense potential impact has been won—against Dow Chemical for its operation of Rocky Flats. It involves the family of Leroy Krumback. Krumback worked with plutonium at Rocky Flats from 1959 through 1974, when he died at age sixty-five of colon cancer. His widow Florence was never told how much exposure her husband was getting, but remembered him coming home often with his hands rubbed raw from Clorox scrubs designed to remove contamination, and with descriptions of how his eyes, nostrils, and feet had been contaminated as well. Florence Krumback's attempts to receive compensation for her husband's death dragged on fruitlessly until 1979, when a young lawyer named Bruce DeBoskey joined her case.

His involvement was well timed. By 1980 public sentiment in Denver and surrounding communities had swung sharply against Rocky Flats. Colorado's governor Richard Lamm had urged President Carter to move the plant to another state, and a business group, organized in part by a local contractor named Rex Haag, was actively working to shut Rocky Flats down.

In February, Dr. Alice Stewart testified at Krumback's compensation hearing. Krumback's records showed he had received 45.67 rems of whole body exposure, which Dow Chemical claimed was a safe dose. But Stewart calculated that the actual "effective" dose was much higher because Krumback had received a substantial portion of it while over the age of forty, when his sensitivity to radiation was greater. His "effective" dose, said Stewart, was more like 222 rems, far more than enough to cause his cancer.[98]

At another hearing in August of 1980 Dr. Karl Z. Morgan found it "unthinkable" that records showed Krumback had on ten separate occasions been allowed to exceed his quarterly exposure limit. "I am appalled at what happened," said Morgan, who had worked for twenty-eight years as a top health officer at Oak Ridge National Laboratory. He commented that he would have shut down Oak Ridge if similar exposures had been shown there. He estimated the effective plutonium dose to Krumback's colon in the thousands of rems, and agreed with Dr. Stewart that the plutonium exposure was more than sufficient to cause Krumback's cancer.[99]

With the unexpected addition of testimony from Drs. Stewart and Morgan, Dow Chemical saw what had seemed like a routine suit—destined for denial—turn into a watershed battle. On June 3, 1981, the tide turned toward the nuclear workers. Colorado granted Florence Krumback a twenty-one-thousand-dollar settlement, which seemed bound to open the door for a whole backlog of suits like those of the Gabel family. The sum was a small fraction of the medical expenses from Leroy Krumback's illness. But Florence Krumback hoped her victory would help force the industry to make the changes in the radioactive workplace. "If it saves one life," she said, "then it will be worth it."[100]

---

98. Alice M. Stewart, testimony before the Colorado Workers Compensation Department hearings, *Krumback v. Dow Chemical*, February 1980.

99. Karl Z. Morgan, testimony before the Colorado Workers Compensation Department hearings, *Krumback v. Dow Chemical*, August 1980.

100. Pamela Avery, "Rocky Flats Cancer Death Blamed on Radiation," *Rocky Mountain News*, June 4, 1981, p. 4.

While the commercial reactor industry is undergoing a serious decline, well hidden from the public eye is the proposed massive expansion of nuclear weapons production. Insofar as military strategic policy serves as the vehicle of the nuclear arms race, the plants that make fissionable material, manufacture bomb components, and assemble them make up the engine. Because several of these weapons plants have reached the end of their productive cycle of thirty years, the federal government is already moving to commit the nation to another thirty years of large-scale nuclear weapons material production.

PART III

The Industry’s Underside

8

Bomb Production at Rocky Flats: Death Downwind

Kristen Haag was born in 1967. Rex, her father, was a well-to-do contractor in suburban Denver who did all he could to show his blue-eyed daughter the world. "She had a happy childhood," he said. "She rode horses, she rode motorcycles. She went to Hawaii, she went to the mountains. She was just a beautiful, high-spirited girl that everybody loved, that never really lacked for anything."

In March of 1979, at age eleven, Kris bumped her knee. In early May doctors found a malignancy; she was diagnosed as having bone cancer. Her leg was amputated, and she began undergoing chemotherapy. "It didn't slow her down much," Haag said. "She swam. She got her swimming certificate, her life-saving at the end of the summer." Kristen asked her parents to get her amputated leg analyzed, "so other children won't get what I've got."

Kris Haag died before the year ended. Her parents agonized over where her disease could have come from and then heard about a fire at the Rocky Flats plutonium facility, six miles from their home. "When she was just two years old I built her a sandbox in the backyard," her father told us. "I later found out that was the year they had the big fire at Rocky Flats."

In talking with us and with a film crew from *Dark Circle,* a documentary on nuclear hazards, Rex Haag outlined his fear that the same factory whose sloppy practices had killed Leroy Krumback and his coworkers inside its walls had also claimed his daughter six miles away. "The plutonium that went out with that fire must've carried right into her sandbox. It just tears me up to think about it now. We were right downwind."[1]

So was Denver.

Like the dozen-odd other facilities in the American nuclear weapons production chain, Rocky Flats has been plagued not only with hazardous working conditions, but with accidents and uncontrolled radiation emissions that have threatened the health of millions of downwind Americans like the Haag family.

At Rocky Flats two major fires and a wide range of accidents and unexpected leaks have led to charges that the plant has seriously contaminated the nearby countryside; has caused a plague of reproductive problems, mutations, and death among farm animals downwind; and has led to an escalated cancer rate among human residents in the Denver area. It has also raised serious questions about the entire process of producing nuclear bombs.

Bombs Away

The American handling of atomic weapons in peacetime has been riddled with mishaps. The most spectacular accidents have come in the mere transport of the bombs from one place to another.

In early 1958, for example, a B-47 crashed into a fighter plane and jettisoned a nuclear weapon into the sea off Savannah Beach, Georgia. The bomb was never found.

Later that year another B-47 accidentally dropped an atomic bomb while flying over Florence, South Carolina. When it hit the ground, an explosion with the power of several hundred pounds of TNT blasted out a crater thirty-five feet deep and spread a ring of plutonium around the area. Local residents preparing for a family picnic heard it coming and barely had time to duck for cover. "It blew out the side and top of the garage just as my boy ran inside with me," said Walter "Bill" Gregg, whose family was injured in the blast. "The timbers were falling around us. There was a green, foggy haze, then a cloud of black smoke. It lasted about thirty seconds. When it cleared up, I looked at the house. The top was blown in and a side almost blown off." The government later dragged Gregg's

1. Rex Haag, quoted in *Dark Circle,* and Rex Haag, interview, May 1981.

compensation claims through the courts. He finally won fifty-four thousand dollars, but was left deeply embittered by the experience.[2]

In 1961 two more American atomic bombs were dropped over Goldsboro, North Carolina, by a crashing B-52. One deployed a parachute, which eased its fall to earth; the other broke apart on impact. Another B-52 with four hydrogen bombs aboard crashed into an ice floe near Thule, Greenland. The entire plane and its cargo apparently disintegrated, leaving a radioactive hole nearly half a mile long in its wake. With abundant apologies to the Danish government, which rules Greenland, the military was forced to ship 1.7 million gallons of contaminated ice and snow back to the United States for disposal. In January of 1966 yet another B-52 crashed into its refueling tanker and spewed three hydrogen bombs onto the fishing village of Palomares, Spain. A fourth bomb dropped into the Mediterranean. TNT exploded in two of the bombs and spread plutonium over a square mile, forcing the U.S. to destroy local crops and remove tons of radioactive topsoil back to South Carolina for burial.

In all, the U.S. military admits to twenty-seven accidents involving nuclear weapons—which it terms "Broken Arrows." Independent critics charge the figure is more like 125.[3]

If the handling of nuclear bombs has been less than perfect, so has their production. In 1963, for example, a fire at the AEC's Medina works in San Antonio touched off 120,000 tons of explosives and sent a uranium cloud into the environs of one of Texas's largest cities. At least two major explosions also ripped through the AEC's Burlington, Iowa, bomb-assembly plant. And the AEC's hydrogen-bomb fabrication plant at Pantex, Texas (near Amarillo), was severely damaged by a freak hailstorm, despite its supposed invulnerability to enemy attack.[4]

Significant quantities of radiation have also leaked into the environment. In 1974 the operators of the huge Savannah River weapons facility at Aiken, South Carolina, accidentally released some 435,000 curies of radioactive tritium in a single day—the largest single tritium emission ever reported in the U.S. Studies of the local water system show serious contamination, and there are preliminary indications of an escalated cancer rate among people living near the plant.[5]

Overall, the American nuclear weapons production program has been plagued with mismanagement, cost overruns, sloppy handling of radioactive materials, and low worker morale.

All of which may have found its ultimate expression at the Idaho Nuclear Engineering Laboratory (INEL), a vast outpost where research-and-development projects are conducted for the military, spent nuclear submarine fuel is recycled, and military radioactive wastes are stored.

INEL has a bleak history. In 1960 three technicians were killed there when a fuel rod blew out of a small test reactor, piercing the body of one and pinning him to the reactor containment, high above the core. The other two men were hopelessly contaminated, and pieces of their bodies had to be buried in lead caskets. An NRC official later indicated that the "accident" may have been caused deliberately by one of the technicians in a bizarre suicide-murder plot stemming from a love triangle at the plant.[6] In subsequent years INEL has been plagued with sloppy handling of nuclear wastes. Concentrated uranium was accidentally dumped on a nearby road. Far more serious, INEL management from 1952 to 1970 deliberately dumped some sixteen billion gallons of liquid wastes into wells that feed directly into the water table below. Radioactive contamination has been found 7.5 miles away, angering local farmers and raising questions about the long-term fate of the huge Snake River Aquifer, a major underground water source for much of the American Northwest.[7]

An even more severe accident, however, occurred during the 1978 World Series. With the Yankees leading the Dodgers 7-2, the plant supervisor was engrossed in the game on a portable TV set he had sneaked, against regulations, into the facility. Had he not been so involved in watching New York win yet another World Championship, he might have noticed that an abnormal buildup of radioactivity was occurring in a small uranium-

---

2. Clyde W. Burleson, *The Day the Bomb Fell on America* (Englewood Cliffs, N.J.: Prentice-Hall, 1978), p. 13. The Savannah Beach incident appears on p. 16.

3. David E. Kaplan, "Where the Bombs Are," *New West,* April 1981, p. 80.

4. Rapoport, *Great American Bomb Machine,* pp. 22-23.

5. Robert Alvarez, *Report on the Savannah River Plant Study* (Washington, D.C.: Environmental Policy Institute, 1980) (hereafter cited as *Savannah River Study*).

6. Stephen Hanauer, NRC, interview, June 1981.

7. *High Country News,* February 8, 1980, p. 10, see also, *Progressive,* October 1980, and J. T. Barraclough, et al., *Hydrology of the Solid Waste Burial Ground, as Related to the Potential Migration of Radionuclides, Idaho National Engineering Laboratory,* Open File Report #76-471 (Idaho Falls: U.S. Geological Survey, Water Resources Division, August 1981) (hereafter cited as *Hydrology*).

processing column nearby. No one was checking the plant's monitoring devices. One recording chart had run out of paper two weeks earlier. Meanwhile the solution in the processing column was dangerously unbalanced. As the game was getting under way, uranium concentrations in the column were sixty times what they should have been.

Suddenly, at 8:45 P.M., high-radiation alarms began ringing around the plant. The panicked supervisor abandoned the Yankees. Operators in the control room fled to a sheltered area.[8] Fortunately the column was brought under control. But official figures showed that at least eight thousand curies of radioactive iodine, krypton, and xenon had been released into the atmosphere, more than enough to threaten the health of anyone downwind.[9]

The supervisor was later fired. An investigation of worker alienation and low morale at INEL concluded that the situation was bad, with no easy solutions available. As a health physicist who worked on the study told *The Idaho Statesman:* "It's a generic question that I have no answer for."[10]

Disaster at Rocky Flats

Two decades before that incident a devastating but little-known fire at Rocky Flats laced the Colorado winds with deadly plutonium.

Built in the early 1950s at a cost of $240 million, the huge factory produces plutonium triggers for hydrogen bombs. It sprawls at the eastern edge of the Rocky Mountains, its tall stacks jutting out of the flatlands. Steady winds rush through the canyons and into those plains, often reaching blasts of up to eighty miles per hour—and quite often heading toward Denver, sixteen miles to the east/southeast.

In fact the air currents are so powerful that in the late 1970s the Department of Energy chose a patch of land just west of the plutonium plant as its prime national site for testing windmill components.

As a key link in the cold war rush to nuclear supremacy Rocky Flats was built under great secrecy. The handling of large quantities of plutonium at the plant was not made public until 1955, two years after it had opened. There was no public input into choosing the site. The military, said Dr. Tony Robbins, former director of the Colorado Department of Health, "made a decision to place a plant with a large quantity of plutonium and a lot of other trace elements pretty much within the Denver metropolitan area." The siting was "clearly a mistake."[11] Approximately 600,000 people live within twenty miles of the plant.

A major component of the Rocky Flats operation is the glove box production line. In it lumps of plutonium are measured, machined, milled, and shaped to use in bomb triggers. The material is kept in airtight boxes and manipulated by workers from the outside who use rubber gloves fastened to the boxes, thus avoiding any contact with the toxic metal inside.

But plutonium can catch fire spontaneously in air. In the evening of September 11, 1957, some of the "skulls" on the glove box line of Room 180 in Building 771 ignited. The fire was found by two plant production men shortly after 10:00 P.M.

The area was designed to be fireproof. But it was soon a radioactive inferno. Firemen switched on ventilating fans, but that backfired, spreading flames to still more plutonium. They then sprayed carbon dioxide into the area. That also failed. Meanwhile the filters designed to trap plutonium escaping up the stacks caught fire. The shift captain and other observers reported a billowing black cloud pouring some 80 to 160 feet into the air above the 150-foot-high stack of Building 771.

As the crisis intensified, plant officials struggled to find a solution. They knew water would destroy millions of dollars' worth of complex equipment. They also knew the intense heat might flash the water into enough steam to blast into an explosion and send even more plutonium particles flying toward Denver. But when the carbon dioxide failed, there was no alternative. In the early hours of the morning water began pouring into the blaze. Fortunately it worked. The fire went dead roughly thirteen hours after it began.[12]

---

8. *Idaho Statesman,* April 25, April 26, and May 22, 1979. The bulk of the "World Series" story appears in the May 22 edition.

9. DOE, *Radioactive Waste Management Information: 1978 Summary and Record-to-Date* (Washington, D.C. July 1979), p. 12 (DOE, Nuclear Fuel Cycle Division, Idaho Operations Office, prepared by E.G. & G. Idaho).

10. *Idaho Statesman,* May 22, 1979.

11. Rocky Flats Action Group, *Local Hazard, Global Threat Rocky Flats Nuclear Weapons Plant* (Rocky Flats Action Group, 2239 E. Colfax, Denver, CO, 1977), p. 3 (hereafter cited as *Local Hazard*).

12. Carl Johnson, "Comments on the 1957 Fire at the Rocky Flats Plant, in Jefferson County, Colorado," report to the Conference on the Relation of Environmental Pollution to the Cancer Problem in Colorado, at the American Medical Center Cancer Research Center and Hospital in Lakewood, Colorado, September 1980 (hereafter cited as "Comments"); and Rapoport, *Great American Bomb Machine,* pp. 27-28.

The damage was extensive. Initial AEC reports contended that there was "no spread of radioactive contamination of any consequence." Seth Woodruff, manager of the Rocky Flats AEC office, told the local media that "possibly" some radiation had escaped. "But if so," he emphasized, "the spread was so slight it could not immediately be distinguished from radioactive background at the plant.[13]

But—as at Three Mile Island twenty-two years later—there was no reliable equipment operable at the time to monitor the amount of radiation that actually went out the stacks. Not until a week after the fire were working gauges installed. Then, in a single day, emissions registered sixteen thousand times the permissible level—a full fifty years' worth of the allowable quota.

Some fourteen to twenty kilograms were estimated to have burned in the fire, enough to make at least two bombs equivalent to the one dropped on Nagasaki.[14] And that may not have been the worst of it. According to a study based on figures from Dow Chemical, which operated Rocky Flats at the time, some thirteen grams of plutonium were routinely deposited daily on the first stage of filters in Building 771. According to government documents obtained in a lawsuit against the plant, the 620 filters in the building's main plenum had not been changed since they were installed four years before the fire. Thus a pair of local researchers theorized that as much as 250 kilograms of airborne plutonium could have gone out the stacks from the burning filters alone.[15]

Such an enormous release of plutonium struck some in the Denver area as beyond plausibility. But a much lower estimate of 48.8 pounds of plutonium—one tenth of the 250-kilogram figure—was calculated as enough to administer each of the 1.4 million people in the Denver environs a radiation dose one million times the maximum permissible lung burden.[16] "I find the high release estimates hard to believe," we were told by Dr. John Cobb of the University of Colorado Medical School. "But even if only one gram of plutonium escaped, as the plant operators say, that would be cause for concern."[17] Nor was plutonium the fire's only by-product. The water used to extinguish it became infused with radioactivity. In this case some thirty thousand gallons of it escaped unfiltered, thus spreading its contamination into local streams and the water table.

Through the whole crisis there had been no warning to local schools, health departments, police, or elected officials that something extraordinary and dangerous was happening at Rocky Flats. There were no backup plans for evacuation, no notification to area farmers or ranchers to safeguard their health or that of their animals.

And though some of the buildings were heavily contaminated, bomb-trigger production was back under way within a few days. Over the next thirteen months, Rocky Flats's operators recorded twenty-one fires, explosions, spills of radioactive material, and contamination incidents inside the plant.[18]

More Fires

A continent and an ocean away, in countryside that could hardly have been less like the flatland at the foot of the Rockies, Britain was also facing a disaster from bomb production. Amid the cold, deep lakes and lush farmlands of the English north country, fire struck the plutonium production reactor at Windscale in early October 1957—less than a month after the first fire at Rocky Flats. Windscale was designed to produce plutonium for bombs. Rocky Flats made such plutonium—once it was chemically processed—into triggers.

On October 7 uranium fuel pellets in the Windscale reactor caught fire. Attempts to quench them failed.

Though the plant was a military facility, word of the accident soon spread. The public was told the radiation releases were harmless, and there was no danger of an explosion. Both statements were false. Radiation monitors at

---

13. *Denver Post,* September 12, 1957.

14. Johnson,"Comments."

15. For the 250-kilogram estimate, Johnson in "Comments" cites R. W. Woodward, "Plutonium Particulate Study in Booster System No. 3 (Building 771) Filter Plenum" (Golden, Colo.: The Rocky Flats Plant, January 27, 1971); and H. Holme and S. Chinn, "Pre-Trial Statement," Civil Action Nos. 75-M-1111, 75-M-1162, and 75-M-1296 (Denver: U.S. District Court for the District of Colorado, 1978). See also, J. B. Owen, "Reviews of the Exhaust Air Filtering and Air Sampling, Building 771," unpublished manuscript, Rocky Flats Plant, Golden, Colorado, March 14, 1963.

16. Rocky Flats Action Group, *Local Hazard,* p. 3; see also, F. W. Krey and E. P. Hardy, *Plutonium in Soil Around the Rocky Flats Plant* (New York: AEC Health and Safety Library, 1970), p. 36; Carl Johnson, et al., "Plutonium Hazard in Respirable Dust on the Surface of Soil," *Science,* August 6, 1979, pp. 488-490; and Jack Anderson, "Colorado Plant Eyed as Radiation Source," *Washington Post,* March 25, 1979, p. D25.

17. John C. Cobb, interview, May 1981.

18. Rapoport, *Great American Bomb Machine,* p. 28.

the plant site and in the countryside showed high levels of contamination. As at Rocky Flats, carbon dioxide could not extinguish the fire.

On its fifth day plant officials prepared to use their last resort—water.

At 9:00 A.M. two plant technicians and a local fire chief dragged a hose to the top of the containment dome and aimed it at the flaming core within. Plant workers and firemen ducked behind steel barriers and braced themselves for the worst. As water surged through the hose, radioactive steam poured out the stacks and into the wind. There was no explosion. The core was soon flooded; danger of a meltdown was over.

But by Monday, October 14, a ban on the sale of milk had been enforced over a two-hundred-square-mile area. Thousands of gallons of contaminated milk were dumped into the Irish Sea. Hundreds of cows, goats, and sheep were confiscated, shot, and buried. Farmers who slaughtered their animals for meat were told to send the thyroid glands to the government for testing.

Workers at the nearby Calder Hall reactor were ordered to scrub down with stiff brushes to remove contamination from their skin. Coal miners working in nearby shafts were replaced with "fresh" workers who had not been exposed to the radiation that had filtered through the mine ventilation systems. And in London, three hundred miles away, radiation monitors noted significantly increased levels.

Despite the national emergency that had been proclaimed, British officials told the public it was unlikely "in the highest degree" that anyone had been harmed by the accident.[19] But several months later British officials conceded to a United Nations conference at Geneva that nearly seven hundred curies of cesium and strontium had been released, plus twenty thousand curies of I-131. The admitted iodine dose represented more than fourteen hundred times the quantity American officials later claimed had been released during the 1979 accident at Three Mile Island.[20]

Like its ally across the Atlantic, the British government studiously avoided systematic follow-up studies on the health of area residents. When a local health officer named Frank Madge used a Geiger counter to confirm abnormal radiation levels in mosses and lichens, officials from the British Atomic Energy Authority actively discouraged publication of his findings.[21]

A study of health data in downwind European countries later indicated a clear impact of the accident on infant-mortality rates. It was, Dr. Ernest Sternglass told us, "as if a small bomb had been detonated in northern Great Britain."[22]

Eight years and eight days after the accident at Windscale—on October 15 1965—yet another major fire at Rocky Flats contaminated twenty-five workers with up to seventeen times the maximum permissible dose.

In 1968 a truck carrying contaminated soil to an off-site burial ground was found to be leaking, forcing plant operators to repave one mile of road. It was a modest measure at best, considering that the half-life of plutonium is more than twenty-four thousand years, while the "full-life" of asphalt paving is far less.[23]

Then, on Sunday, May 11, 1969—at a time when little Kristen Haag was likely to be playing in her sandbox six miles downwind—plutonium stored in a cabinet at Rocky Flats ignited. The flames leapt into the glove boxes of Buildings 776 and 777. At 2:27 P.M., when the fire alarms sounded, the blaze was out of control.

According to veteran reporter Roger Rapoport, author of *The Great American Bomb Machine:* "When company firemen reached [Building] 776-777 they found tons of flammable radiation shielding feeding the blaze. The fire-fighters donned respirators and charged into the dense smoke." Once again plant officials hesitated to use water. But when the carbon dioxide supplies ran out—after ten minutes—they had no choice. At times the smoke billowed so thickly that firemen were "forced to crawl out along exit lines painted on the floor." After four hours the fire was under control. But isolated areas continued to burn through the night.

The AEC first estimated the damage at three million dollars. It soon proved to be more like forty-five million dollars, ranking it as the most expensive industrial fire in American history at that time. It would take two years and

19. John G. Fuller, *We Almost Lost Detroit* (New York: Reader's Digest Press, 1975), p. 86. The Windscale story is told on pp. 71-87.

20. Virginia Brodine, *Radioactive Contamination* (New York: Harcourt Brace, 1975).

21. Ibid.

22. Ernest Sternglass, interview, October 1980. High cesium levels in people eating fish caught "in the path of the Windscale effluent" are noted in E. D. Williams, et al., "Whole Body Cesium-137 Levels in Man in Scotland, 1978-9," *Health Physics Journal* 40 (January 1981): 1-4. The contamination seems to be coming from ongoing operations at the Windscale reprocessing facility.

23. Rapoport, *Great American Bomb Machine,* pp. 31-36.

hundreds of regular and part-time employees to clean up the mess. One regular plant janitor refused to help in the cleanup for fear of radiation poisoning. He was fired.

Far from letting a major radioactive fire slow down bomb production, Rocky Flats operators continued full-speed construction of a seventy-four-million-dollar addition designed to increase plant capacity by half.[24]

Nor were the fires the only source of contamination. Dow records showed that at least one thousand barrels of contaminated lathe oil were burned in the open air during their operation of the plant, sending unknown quantities of uranium into the air. And despite assurances to the public that no radioactive waste was being stored on site, more than fourteen hundred barrels of it were found there.

When AEC officials decided to move those barrels in the spring of 1970, a Dow report confirmed that "ten percent of the drums had holes apparently caused by rust and corrosion. . . . Many of the liquid drums developed leaks during handling or after exposure to air and sun."[25]

One Dow study indicated that up to forty-two grams of plutonium had been carried off by winds blowing through the drum storage area.[26]

Another Dow report conceded that normal plant operations were resulting in the daily release of millions of individual particles of plutonium, each of which could lodge in a human or animal lung, or be ingested with local-grown food and feed. Such particles are known to cause serious internal damage.

DOE monitoring records kept from 1970 to 1977 indicated that levels of airborne plutonium were higher in the Rocky Flats area than at any of fifty other stations around the U.S. Dust samples downwind showed plutonium concentrations 3,390 times what might be expected from fallout. Evidence also surfaced that the nearby town reservoir had been contaminated.[27]

Constant mishaps at Rocky Flats led to a growing distrust among area residents. As early as 1969, in the wake of the fire that spring, a group of scientists from local industries and universities asked DOE and the AEC to monitor the soil downwind. Their request was refused.

So Dr. Edward Martell, a nuclear chemist working at the National Center for Atmospheric Research, with considerable experience from the bomb-testing era, decided in the fall of 1969 to conduct some tests of his own. His findings confirmed some of the community's worst fears. Abnormal plutonium levels were clearly evident in soil to the east and southeast of the plant.

Martell quickly came under attack from plant supporters. But when the AEC did its own study of downwind soil, it also had to admit to significant contamination. "We find his results are accurate," conceded a ranking military spokesman. "We don't disagree with his new data. As far as measurements, sampling techniques, and knowledge of science, we think Martell is a very competent scientist." The AEC did, however, question Martell's health conclusions. "While it is true," they said, "that some plutonium is escaping from the plant, we don't believe it presents a significant health hazard to Denver."

Dr. Arthur Tamplin—at the time a leading AEC health researcher—strongly disagreed. The Martell study "shows about one trillion pure plutonium oxide particles have escaped from Rocky Flats," he warned. "These are very hot particles. You may only have to inhale 300 of them to double your risk of lung cancer." Tamplin calculated that if plutonium had been spread as Martell suggested, lung-cancer rates in Denver could rise, over time, 10 percent. An additional two thousand Coloradans could fall victim to Rocky Flats.[28]

---

24. Ibid.

25. Ibid., p. 25.

26. S. E. Hammond, "Industrial-Type Operations as a Source of Environmental Plutonium" (Golden, Colo.: Dow Chemical Company, 1970).

27. Carl Johnson, "Cancer Incidence in an Area Contaminated with Radionuclides Near a Nuclear Installation" (report presented at a session sponsored by the Occupational Health and Safety, Environment, Epidemiology, and Radiological Health sections of the American Public Health Association at the 107th Annual Meeting, New York, November 9, 1979) (hereafter cited as "Cancer Incidence"). For a notation of contamination in the Broomfield Reservoir, see also Rocky Flats Action Group, *Local Hazard,* pp. 4-5.

28. Rapoport, *Great American Bomb Machine,* pp. 38-39.

A Grim Harvest

To Lloyd Mixon, Rocky Flats is an unwelcome newcomer. "I can walk out the back door twenty feet and see where I was born," he told us from his thirty-acre farm in Broomfield. "I was here a long time before that plant was." Six miles to the east, Mixon can see the tall stacks of the plutonium factory, with the winds blowing toward him "right down out of the canyon."

In 1975 he told a joint congressional-gubernatorial commission that bizarre problems had begun surfacing among his animals, problems in quantities he had never seen before. There was a calf born hairless with a body full of a watery substance and a liver "three times normal." There were pigs and fowl with mutations. There was another calf born dead with tissue that tested similar to cows exposed to radiation under experimental conditions.

Mixon later told the crew from *Dark Circle* that pigs had been born on his farm whose "nose and mouth [are] twisted, where they're not able to nurse." Some, he added, had been born with five toes instead of the normal four. Others had hips and ears badly deformed, "with eyes that were not like they're supposed to be."

"We've had chickens with no eyes," he added, "you break open the shell, they've got beaks like needles." Mixon continued, "We've had them where their legs have been so badly twisted and turned that they were unable to kick out of the shell. We had a chicken hatch with the brains right on top of his head."

State health inspectors told Mixon his problems stemmed from poor feed and hygiene. "They brought down what was supposed to be an expert, and he didn't even know how long it took for the eggs of different birds to hatch," said Mixon. But those birds that had allegedly been deformed because of poor food and hygiene had been kept in sanitary wire cages and fed commercial grain. "According to the ticket on the feed we buy, it has everything adequate in it. So it's caused from something else." Inbreeding was also suggested, but in one case "the female came out of Pennsylvania and the male came out of Texas. There's no way they could be related."

There were also charges of mismanagement. "I've had livestock ever since I've been three years old," Mixon said. "My people back years and years have had livestock."

Mixon's anger was reminiscent of the days when the AEC had scorned sheep farmers whose animals had died in bomb fallout. And his experiences matched those of a growing roster of farmers near nuclear facilities whose animals seemed to serve as a bellwether for bad news to come from radiation. In Pennsylvania, New York State, Vermont, New Hampshire, Arkansas, and Colorado farmers have complained of bizarre deformities, reproductive problems, and unexplained deaths among their animals—problems that seem to have no other possible cause except nearby nuclear facilities. In nearly every case "experts" from state agriculture departments have discounted the claims, blaming other factors ranging from weather to bad feed to inbreeding to mismanagement.

But Lloyd Mixon blamed Rocky Flats. "We used to have several different varieties of pheasants," he told *Dark Circle*. "We got where they wouldn't produce. The eggs were infertile. So we just went out of it. Then we had some lambs born with the guts, or the insides hanging out. [Some would] be alive. We've had some born dead that way. We've had kid goats born with growths on them. . . ."

And, he told us, there've been "geese who would walk across the yard and all of a sudden, they'll stiffen up and die. There've been deformities in cats, and they've stopped reproducing the way they should. We've lost a couple of dogs with cancer."

The health department, Mixon added, won't release any data on other cases. But Mixon has received numerous calls from neighbors, including one who complained of eleven colts, all born in the same season, all born blind. And there was general agreement that wildlife had disappeared from the area. "You don't see a rabbit around here anymore," he said. "And people that try to raise them . . . they just stop reproducing."[29] Mixon noted that many of his neighbors prefer to keep quiet about what is happening for fear of undercutting the value of their property and their produce.

One of his neighbors who did agree to talk with us—anonymously—told us she had lost so many colts to stillbirths and deformities that she went out of the horse-raising business altogether. "The animals aren't what they used to be and nobody's is getting any better," she said.[30]

Unfortunately the problems do not seem to be limited to animals. In the late 1970s Dr. Carl Johnson began

29. Lloyd Mixon, "Statement," *Hearings of Governor Lamm's Task Force on the Rocky Flats Plutonium Facility* (Boulder, Colo.: April 1975); in *Dark Circle*, and interview, May 1981.

30. Anonymous, interview, April 1981.

finding abnormal cancer rates among human beings downwind from Rocky Flats.

The stolid, conservative Dr. Johnson is former director of the Health Department of Jefferson County, which encompasses Rocky Flats. He is also an officer with the Army Reserve and maintains a top-secret "Q" clearance. As a public-health officer Johnson became disturbed by the constant malfunctioning of the nuclear industry and began his own studies to confirm or deny what the AEC and DOE were telling—and not telling—the public about Rocky Flats.

Dividing the downwind area into four zones and correcting for age, race, sex, and ethnicity, Johnson found male cancer rates in the zone closest to the plant to be 24 percent higher than in the zone farthest away. Intermediate zones showed excess rates of 15 percent and 8 percent. Female cancer rates were 10 percent higher in the near zone as opposed to the farthest one, with intermediate zones showing excesses of 5 percent and 4 percent. The excess cases for both sexes involved cancers of the lung and bronchus, upper respiratory tract, colon, rectum stomach, gonads, liver, thyroid, and brain as well as leukemia, lymphoma, and myeloma.

There were other alarming statistics as well. Johnson’s studies of people forty-five to sixty-four years of age in eight census tracts near the plant showed a doubled lung-cancer and leukemia death rate over subjects living in "relatively uncontaminated" zones. In essence Johnson found 491 excess cancer cases when the DOE said there would be less than one.

A separate study of a large suburban area near Rocky Flats found a congenital malformation rate of 14.5 per 1000 births as opposed to 10.4 per 1000 for the rest of the county, and 10.1 for the state overall.[31]

Johnson’s findings raised public awareness of Rocky Flats and helped fuel a movement to close the plant. His findings also put him in a difficult political position. Local real-estate interests began applying pressure to have Johnson fired from his job as Jefferson County health director. In May of 1981 they succeeded.

Meanwhile autopsy reports on workers at Rocky Flats showed plutonium concentrations in all organs of their bodies. And a study for the EPA by Dr. John C. Cobb of the University of Colorado School of Medicine indicated preliminary evidence of excess plutonium levels among other local human autopsy specimens plutonium that was traceable by its isotope-ratios to Rocky Flats. But in an interview Cobb warned us that plutonium might not necessarily be the chief culprit in any area health problems that might surface. "I’m not sure plutonium is the right thing to look for," he told us. "They also burned thousands of gallons of oil with uranium chips in it out there. A combination of the uranium in the cutting oil might be more important than the plutonium."[32]

Whether it was uranium or plutonium, or both, Lloyd Mixon had been directly exposed. "I had some tumors taken off my chest," he told the *Dark Circle* crew. "I’ve had my thyroid taken out. I’m tired quite a bit of the time, more than what was usual, and [I’ve] got a numbness in my left side, my shoulders. They found a growth on my right arm between my elbow and my shoulder. . . . My daughter was born with a hole in her heart," he said. Mixon also noted that his neighbors complained of being perpetually overtired, numbness in their hands, and other inexplicable health problems.

There was also talk of "children being born retarded," he told us, "of them with mental problems."

Few of his neighbors, he said, would point an accusatory finger at Rocky Flats. But, he asked us, "if it isn’t that place, what is it?"[33]

For Rex Haag there wasn’t much doubt. He had lived within six miles of the plutonium factory, and as a contractor had built another five dozen houses nearby "without the least bit of knowledge of that being a dangerous area."[34]

After Kristen Haag’s death from bone cancer, the body was cremated. At her father s request, her ashes were sent away for testing. When the results were slow in coming back, Johnson called the laboratory, where a technician told him "there was some problem because there appeared to be a large amount of plutonium 238" in the ashes.

---

31. Johnson, "Cancer Incidence"; and Carl Johnson, "Evaluation of Cancer Incidence for Anglos in the Period 1969-1971 in Areas of Census Tracts with Measured Concentrations of Plutonium Soil Contamination Downwind from the Rocky Flats Plant in the Denver Standard Metropolitan Statistical Area," 5th International Congress of the International Radiation Protection Association, Jerusalem, Israel, March 9-14, 1980.

32. John C. Cobb, et al., "Weapons Grade Plutonium in Humans Near Rocky Flats," abstract submitted for a poster session at the AAAS Annual Meeting, Toronto, Canada, January 1981; and Cobb, interview, April 1981.

33. Mixon in *Dark Circle*, and interview.

34. Haag in *Dark Circle*.

And when the official report finally arrived months later, it cited what Johnson termed "rather high" levels of plutonium 238.[35]

Rex Haag soon helped organize a business coalition to help close Rocky Flats. People justify the operation of the plant "in the name of national interest, or national security," he said. "But I wonder if the same people who are saying that, if it were *their* child, if they could actually sit there and say the same thing."[36]

Lloyd Mixon had similar questions. "I've been hearing a lot more problems lately," he told us. "In a few years things are gonna get a lot worse."[37]

35. Johnson in *Dark Circle*, and interview, July 1981.

36. Haag in *Dark Circle*.

37. Mixon interview.

9

Uranium Milling and the Church Rock Disaster

Church Rock, New Mexico, would seem an improbable spot for a nuclear disaster. A dusty cluster of industrial machinery set in the arid mesas of the great Southwest, its most distinguishing feature might be considered a large pond of murky liquid, unusual in such dry terrain. Church Rock also hosts a series of underground uranium mine shafts, a mill, and a scattered community of Navajo families who survive by herding cattle, goats, and sheep.

A deep gully leads from the mine site into the Rio Puerco, which once flowed only when fed by spring rains. Now it is wet year round, bolstered by water pumped from the mine shafts to keep them from flooding. That water flowing from the mine is laced with radioactive isotopes. And the pond hides a burden of contaminated waste.

The 350 families who water livestock in the Rio Puerco rely on their small herds to eke out a meager existence. Many are members of the Dine—Navajo—Nation, with incomes in the range of two thousand dollars per year. During the hot days of the desert summer local children would play in the stream as their parents tended the goats, sheep, and cattle.

A Wall of Radioactive Water

In the early morning hours of July 16, 1979—fourteen weeks after the accident at Three Mile Island—all of that changed. The dam at Church Rock burst sending eleven hundred tons of radioactive mill wastes and ninety million gallons of contaminated liquid pouring toward Arizona. The wall of water backed up sewers and lifted manhole covers in Gallup, twenty miles downstream, and caught people all along the river unawares. "There were no clouds, but all of a sudden the water came," remembered Herbert Morgan of Manuelito, New Mexico. "I was wondering where it came from. Not for a few days were we told."[1]

No one was killed in the actual flood. But along the way it left residues of radioactive uranium, thorium, radium, and polonium, as well as traces of metals such as cadmium, aluminum, magnesium, manganese, molybdenum, nickel, selenium, sodium, vanadium, zinc, iron, lead and high concentrations of sulfates.[2] The spill degraded the western Rio Puerco as a water source. It carried toxic metals already detectable at least seventy miles downstream.[3] And it raised the specter that uranium mining in the Colorado River Basin may be endangering Arizona's Lake Mead, and with it the drinking water of Las Vegas, Los Angeles, and much of Arizona.

Except for the bomb tests, Church Rock was probably the biggest single release of radioactive poisons on American soil. Ironically it occurred thirty-four years to the day after the first atomic test explosion at Trinity, New Mexico, not far away.

The source of the catastrophe was uranium mill wastes. Usable uranium is extracted from the sandstone in which it is usually found by grinding it fine and leaching it with sulfuric acid. The acid carries off the desired isotopes. But the leftover waste sands—"tailings"—still contain 85 percent of the ore's original radioactivity, and 99.9 percent of its original volume. There are now some 140 million tons of them scattered around the West. NRC commissioner

---

1. Kathie Saltzstein, "Navajos Ask $12.5 Million in UNC Suits," *Gallup Independent*, August 14, 1980 (hereafter cited as "Navajos"); for a general analysis of the relationship between Indians and uranium development, see Joseph G. Jorgenson, et al., "Native Americans and Energy Development" (Cambridge, Ma.: Anthropology Resources Center, 1978); for a broad range of information on the issue of uranium mining and milling, contact the Black Hills Alliance, Box 2508, Rapid City, SD 57709.

2. Edwin K. Swanson, "Water Quality Problems in the Puerco River," paper presented at the American Water Resources Association Symposium, Water Quality Monitoring and Management, Tucson, Arizona, October 24, 1980.

3. Edwin K. Swanson, interview, May 1981.

Victor Gilinsky and others consider them "the dominant contribution to radiation exposure" of the entire nuclear fuel cycle.[4] The acid milling liquids—called "liquor"—also dissolve dangerous traces of thorium 230, radium 222, lead 210, and other isotopes. Because of their high radioactivity the tailings and liquor both must be isolated from the environment—but nobody has yet demonstrated a method with any long-term success.

At Church Rock several hundred million gallons of the liquor were being held in a large pond so the liquids could evaporate off and the solid tailings be stored. The whole complex was owned by the United Nuclear Corporation (UNC), a Virginia-based firm with assets in the hundreds of millions of dollars and influence in the New Mexico state government. Its dam and pond at Church Rock were opened with the understanding that they would operate just eighteen months; twenty-five months later, at the time of the accident, no alternative sites were being developed.

The UNC dam wall was an earthen structure with a clay core, twenty-five feet high and thirty feet wide. On the morning of the accident a twenty-foot-wide section of it gave way, wreaking havoc downstream. In the desert, water is synonymous with life. In contaminating the Rio Puerco, UNC had threatened the basis of existence for all of the people who lived downstream. For the first time they confronted the terrors of radioactivity. "Our hearts have been broken," said Bodie McCray of Tsayotah. "We don't sleep worrying about it. I worry about our children and their children."

Indeed the hundreds of families living near the spill now had to live with the same kinds of uncertainties just beginning to plague the people of central Pennsylvania. "Ever since the accident we've been wanting the truth," said Kee Bennally, a silversmith playing a lead role in the multimillion-dollar lawsuit against UNC. "They say it's not dangerous and in a couple of days they say it is dangerous. It's been really confusing, especially for the old people. They don't know anything about this, the contamination, the radiation. . . ."[5]

What made the Church Rock disaster especially tragic was that it could have been avoided. Soon after the spill an angry U.S. representative Morris Udall (D-Ariz.) told a congressional hearing that "at least three and possibly more Federal and state regulatory agencies had ample opportunity to conclude that such an accident was likely to occur." Even before the dam had been licensed "the company's own consultant predicted that the soil under this dam was susceptible to extreme settling which was likely to cause [its] cracking and subsequent failure."[6]

Cracks had developed in the dam the year it opened, said Udall. Aerial photographs revealed that liquor, which was supposed to be kept away from the dam face, was lapping against it. State-required seepage devices and monitoring wells had never been built or inspected for.[7]

UNC's chief operating officer, J. David Hann, countered Udall by blaming the accident on "a unique rock point, beneath the breach." Because the dam had been built partly on bedrock and partly on softer ground, that rock point "served as a fulcrum, resulting in transverse cracking." The breach was "like many things you undertake," Hann told the congressional hearing. "They have a risk, and we undertook this. There was a circumstance that was not foreseen at the time."[8]

But coming in the wake of Three Mile Island, and in light of considerable evidence of impending disaster, Hann's arguments seemed to carry little weight. In a special report the U.S. Army Corps of Engineers charged that if the dam had been built to legal specifications, according to approved design, "it is possible that the failure would not have occurred."[9] And a spokesman from the New Mexico State Engineer's Office added that a "consensus" of engineers who reviewed the accident agreed that "had the drain zone been constructed according to the approved plans and specifications, and had the tailings beach been in place as recommended by [UNC's] engineers, it is likely that failure would not have occurred."[10]

---

4. Victor Gilinsky, "The Problem of Uranium Mill Tailings," paper presented at the Pacific Southwest Minerals and Energy Conference, Anaheim, California, May 2, 1978 (Washington, D.C.: NRC Office of Public Affairs), No. S-78-3, p. 3 (hereafter cited as "Problem"). See also, EPA, *Environmental Analysis of the Uranium Fuel Cycle, Part I—Fuel Supply,* EPA-520/9-73-003-B, Washington, D.C: EPA Office of Radiation Programs, 1973, p. 26.

5. Chris Shuey, "Calamity at Church Rock, New Mexico," *Saturday Magazine, Scottsdale Daily Progress,* Part 1, February 14, 1981, p. 3 (hereafter cited as "Calamity").

6. U.S. Congress, House Committee on Interior and Insular Affairs, Subcommittee on Energy and the Environment, *Mill Tailings Dam Break at Church Rock, New Mexico,* 96th Congress, October 22, 1979, pp. 1-4 (hereafter cited as *Church Rock Hearings*).

7. Ibid.

8. Ibid., p. 120.

9. Ibid., p. 3.

10. Ibid., p. 42.

At the time of the disaster the dam was carrying a load of tailings liquor at least two feet higher than allowed for in its designs. The company had also failed to tell the state that cracking had been observed. "There were significant warnings appearing before the dam broke," said William Dircks, director of the NRC's Office of Nuclear Material Safety and Safeguards. "I think that is the troubling part of it."[11]

Ultimately, for the company, the accident would mean a loss of some revenue and bad publicity. For the people downstream life itself was at stake. "Somehow," complained Frank Paul, vice-president of the Navajo Tribal Council, "United Nuclear Corporation was permitted to locate a tailings pond and a dam on an unstable geologic formation. Somehow UNC was allowed to design an unsafe tailings dam not in conformance to its own design criteria. Somehow UNC was permitted to inadequately deal with warning cracks that had appeared over two years prior to the date the dam failed. Somehow UNC was permitted to continue a temporary dam for six months beyond its design life. Somehow UNC was permitted to have a tailings dam without either an adequate contingency plan or sufficient men and material in place to deal with a spill. Somehow UNC was permitted to deal with the spill by doing almost nothing."[12]

Ironically the Church Rock dam was a "state-of-the-art" structure. Paul Robinson, an Albuquerque-based expert on mining issues, warned the Udall hearings that "UNC-Church Rock was the most recently built and the most carefully engineered tailings dam in the state." Similar dams owned by Anaconda, Kerr-McGee, UNC-Homestake Partners, and Sohio were "disasters waiting to happen."[13]

Thorium and Other Damage

Soon after the spill UNC sent small crews downstream with shovels and fifty-five-gallon drums to begin cleaning up. Bitter complaints from local residents and the state soon forced UNC to expand its crews to thirty to thirty-five workers. "We have removed more than 3500 tons of potentially affected sediment from the streambed to a distance of more than 10 miles from the mill," Hann told the Udall hearings. "The combination of these clean-up efforts, and natural effects, such as rain, have largely restored normal conditions in the area."[14]

But an Arizona water-quality official complained in an interview with us that the rains had merely transported the pollutants into his state.[15] And Robinson pointed out that UNC had in fact removed just 1 percent of the tailings and liquid known to have spilled from the dam. More than eighteen months after the accident indications were strong that radiation and other pollutants had penetrated thirty feet into the earth. A report by a Cincinnati-based firm brought in as a consultant by the EPA warned that at least two nearby aquifers had been put "at risk."[16]

Furthermore when the spill overflowed the banks of the Rio Puerco, it left behind a series of pools. When ordered by the state to monitor them, UNC chose to look for their uranium content.

But uranium was precisely what the company had been working to remove in the milling process. "It was a subterfuge on the company's part," said Dr. Jorge Winterer, an M.D. working with the Indian Health Service in Gallup at the time of the spill. "There were children up and down the river playing in those stagnant pools, and they were deadly poisonous. But UNC chose to monitor them for the element they knew was least likely to be there."[17]

In fact the NRC's William Dircks told the Udall hearing that those pools showed levels of radiation one hundred to five hundred times natural background. What UNC might have missed were substantial quantities of thorium 230 and radium 226. Both are alpha-emitters and are extremely dangerous if ingested or inhaled.

Thorium 230, for example, has a half-life of eighty thousand years and is believed by some to be as toxic as plutonium. A silver-white metal, thorium tends to deposit in the liver, bone marrow, and lymphatic tissue, where even minute quantities can cause cancer and leukemia. If inhaled as dust it can cause lung cancer. According to a study by Winterer, under some circumstances thorium can become "trapped" in the body, making it "a permanent

11. Ibid., p. 39.

12. Ibid., p. 8.

13. Ibid., pp. 225-232.

14. Ibid., pp. 120-121.

15. Swanson interview.

16. Paul Robinson, interview, February 1981; and Shuey, "Calamity," Part 2, February 21, 1981, p. 5.

17. Jorge Winterer, interview, October 1980.

source of radiation" there, and thus doing untold damage to the human organism.[18]

Winterer soon came under personal attack in the wake of his candid comments. UNC was a power in state politics. It had twenty-three hundred employees and an annual budget within New Mexico of $140 million.[19] When Winterer contradicted assertions from his superiors that there were no health effects from the spill, he was threatened with legal action. And when he began holding seminars in the local library on the dangers of radiation, Winterer was told by a former friend that he and his family "would be a lot better off if we got out of New Mexico right away."[20]

Jorge Winterer was not the only one concerned about UNC's assessment of the spill. Dr. Thomas Gesell, a health physics professor at the University of Texas School of Public Health, and a staff member of the Presidential Kemeny Commission on the effects of the accident at Three Mile Island, also testified at the Udall hearings. Gesell said UNC's monitoring data were self-contradictory and out-of-phase with the state's. One UNC report had listed background levels as being *lower* after the spill than before it. Some company reports on downstream radiation levels claimed findings 150 times lower than the state's.[21]

Meanwhile contamination had apparently spread to local animals. One veterinarian told a documentary crew from Eleventh Hour Films that abnormal radiation levels had been found in the tissues of goats and sheep that were drinking Rio Puerco water.[22] A study of eleven animals by the Center for Disease Control confirmed the problem. The CDC warned that kidneys and livers of local livestock might concentrate high doses and should not be eaten.

The CDC also warned locals not to drink water from the river, and to avoid its banks during windstorms, when radioactive particles might be more easily inhaled. The CDC emphasized that radiation levels in local animals did not exceed New Mexico standards. But it was important to exercise caution because "the health risks of low doses of radiation" were "not completely understood."[23]

A year after the spill Cubia Clayton of the state's Environmental Improvement Division confirmed that the Rio Puerco was still too dangerous for human or animal consumption. Clayton stated that it was "obvious" that "there has been some buildup of radiation" in some of the animals tested.[24]

Ironically some of those animals had drunk *upstream* of the spill, indicating the stream—fed by water pumped out of the uranium mines—may well have been contaminated even before the accident.

Soon after the dam break, two West German radiation biologists, Bernd Franke and Barbara Steinhilber-Schwab, sharply criticized the CDC report for downplaying the potential dangers of the accident and for sampling too few of the local livestock. They urged chromosome checks on area residents and called for the establishment of cancer and birth registries as well as intense ongoing radiation monitoring in the area. They also warned that thorium and other isotopes from the spill could enter the human body not only through eating contaminated animals, but also when radioactive dust settled on vegetables.[25]

Dr. Carl Johnson, director of Colorado's Jefferson County Health Department, further warned that detectable radiation levels in the tissues of children might only surface "over a period of many years." Dangerous levels of thorium, radium, and other isotopes could build up through the ingestion of contaminated food, air, and water. Thus he too urged careful monitoring of local children, plus a shutdown of the mines and mills until the public had determined that "a satisfactory method for preventing a subsequent incident" had been found.[26]

But the UNC mine and mill were back in operation in less than five months. The same pond was in use. Some changes were made in the dam, but constant seepage—up to eighty thousand gallons of contaminated liquid per

---

18. Jorge Winterer, *Potential Health Impact of United Nuclear-Church Rock Spill* (Gallup, N.M.: Physicians for Social Responsibility: fall 1979).

19. *Church Rock Hearings,* pp. 9-11.

20. Winterer interview.

21. *Church Rock Hearings,* pp. 9-11.

22. Allan Shauffler, interviewed for *In Our Own Back Yard*.

23. *Albuquerque Journal,* July 17, 1980.

24. *Gallup Independent,* June 16, 1980.

25. Bernd Franke and Barbara Steinhilber-Schwab, press statement, Albuquerque International Airport, Albuquerque, N.M., July 24, 1980. The question of contamination in local humans did come up when seven local residents were sent to Los Alamos for testing. Seven months later reports indicated no contamination. But it was soon discovered that the equipment used to measure the radiation levels was not capable of recording small doses—doses that were nonetheless large enough to do harm. See Shuey, "Calamity," Part 2, pp. 5-6.

26. Carl Johnson, letter to Lynda Taylor, July 14, 1980.

day—had become a mainstay.[27]

UNC had promised to provide local residents and their animals with clean drinking water. But an Arizona newspaper confirmed that the company was delivering just half the promised amounts.[28] A request by some of the downstream residents for emergency food stamps to replace their lost livestock was denied by the government.

And at least one family was forced to eat a sheep known to have ingested radioactive residues. "If you come to Lupton, you will see a lot of shepherds running along the side of the wash trying to keep the sheep out," said Navajo shepherd Tom Charlie.

The UNC had put up signs saying "contaminated wash, keep out. But our cows, sheep and horses can’t read that. Most of us can’t read, write or speak English. The signs do no good. If [neighbors] know we are from the Rio Puerco wash, they won’t shake our hands," he added. "They think we have a high level of radiation. They ran from me. They are afraid of us. That’s why people look at us, that’s why no one comes to help us. It is wet now, but on days when it dries up, the wind will come along. The dust settles on the grass. The sheep eat it. We eat the sheep. We wonder what that does to our lives."[29]

Tailings Forever

Church Rock was the biggest tailings spill on record, but it was not the only one. And though the Navajo and other New Mexicans nearby were the most directly affected, people as far away as Los Angeles had cause for concern.

As Congressman Udall put it, Church Rock fit a pattern of "sloppy and haphazard" handling of mill tailings throughout the nation. Other spills, he said, had dumped "millions of gallons of hazardous liquids" and jeopardized the water supply of much of the West.[30] In fact NRC statistics acknowledged at least fifteen accidental releases of tailings solution from 1959 to 1977, including seven dam breaks, six pipeline failures, and two floods. In at least ten of the events radioactivity reached a major watercourse.[31] One accident cited by Udall sent twenty-five thousand gallons of slurry directly into the Colorado River. A flood washed some fourteen thousand tons of tailings directly into Utah’s Green River.[32]

At Durango, Colorado, a huge hundred-foot-high tailings pile sits just sixty feet from the Animas River, a tributary of the Colorado. The state Department of Health has found abnormal radium levels in water thirty miles downstream.[33] According to Washington-based uranium expert David Berick operators of the Durango mill "just took the residues and threw them in the river. There’s really no way of knowing how much of it went how far downstream."[34]

Because the milling process renders many of the isotopes in the tailings highly soluble, they can be washed into streams and water tables by rain. A 1979 Oak Ridge National Laboratory study noted groundwater contamination at two New Mexico tailings piles.[35] Company records admit to severe groundwater contamination at Colorado’s Uravan mill.[36] One tailings dam near Wyoming’s Sweetwater River failed six times between 1957 and 1979 and was reporting a daily seepage rate of 1.7 million gallons.[37] And a major 1976 EPA study indicated that some 200,000

---

27. Robinson interview.

28. Shuey, "Calamity," Part 2, p. 6.

29. Saltzstein, "Navajos." In a July 1981 letter to authors, Edwin Swanson said the state of Arizona asked UNC to post signs along the river as far as Navajo, Arizona, but that the company did not do it.

30. *Church Rock Hearings,* p. 1.

31. Ibid., p. 9.

32. William Sweet, "Unresolved: The Front End of Nuclear Waste Disposal," *Bulletin of the Atomic Scientists,* May 1979, p. 45

33. Jack Miller, "Environmental and Health Effects," Uranium Information Network, unpublished. For this finding Miller cites the Colorado Department of Health, *Uranium Wastes and Colorado’s Environment,* second edition (Denver: Colorado Department of Health, August 1971), p. 10.

34. David Berick, interview, March 1981.

35. D. G. Jacobs and H. W. Dickson, *A Description of Radiological Problems at Inactive Uranium Mill Sites and Formerly Utilized MED/AEC Sites* (Oak Ridge, Tenn.: Oak Ridge National Laboratory, February 1979), p. 5.

36. *High Country News,* February 22, 1980, p. 1.

37. Ibid., December 14, 1979, p. 10.

kilograms of dissolved uranium had been introduced to subsurface water by seepage and "direct injection" at mills belonging to Anaconda and Kerr-McGee. The study warned the problem was widespread: "The stark contrast between a typical 20-year mill life and an 80,000-year half life for the dominant radionuclide (thorium 230) necessitates a much greater forward look than is now evident in waste disposal practices and preservation of ground-water quality."[38]

Nor has the problem stayed underground. As early as 1964 the Federal Water Pollution Control Administration told a congressional hearing that fish caught downriver from the Naturita and Uravan uranium mills showed higher radium concentrations than those caught upriver. Downriver hay samples also showed contamination, as did cows' milk. "In this case," said the authorities, "the prime source of radium intake for the cows is believed to be from eating hay irrigated with contaminated river water."[39]

As for Church Rock, Edwin Swanson, a water-quality expert for the state of Arizona, told us traces of the spill—though dilute and possibly undetectable—would eventually reach Arizona's Lake Mead, 470 miles downstream.[40]

And though most of America's uranium mills seem far removed from major population centers, concern is growing for such crucial water sources as Lake Mead, which supplies southern California, Las Vegas, and parts of Arizona with much of their drinking water.

The huge reservoir sits downstream from numerous uranium mining and milling operations. The distances are sometimes great, but so are the half-lives of many of the isotopes slowly making their way downriver. As early as 1972, H. Peter Metzger, writing in *The Atomic Establishment,* warned that bottom sediments in Lake Mead were showing three times the concentration of radium as similar sediment samples taken upstream of the uranium mills.[41]

The implications of a contaminated Lake Mead, and of a radioactive western water system, are catastrophic. But the uranium problem involves an immense volume of tailings and is not limited just to water quality.

According to the Government Accounting Office (GAO) at least twenty-two uranium mills had shut down on the continental United States by 1978. They left behind some twenty-five million tons of tailings in "unattended piles and ponds" in eight western states plus Pennsylvania and New Jersey. Another sixteen mills were in operation, with an additional 115 million tons on site—bringing the total to 140 million tons. In the early 1980s another six to ten million tons of tailings were being produced per year. Based on high growth estimates, the NRC in 1981 predicted another 109 mills could be operating by the year 2000 producing 470 million more tons of tailings and scores of acid ponds like the one at Church Rock.[42] One estimate from Los Alamos Laboratory put the total far higher, predicting 900 million tons of tailings by the year 2000 in New Mexico alone.[43] Such a total would involve some twenty trillion cubic feet of tailings.

And the piles threaten air as well as water, a problem considered by many experts—including NRC Commissioner Gilinsky—even more serious than the better-known "high-level" wastes from reactors and bomb factories. The reason is radon gas, the same deadly substance that has caused a five-fold increase in lung cancer among uranium miners. Because radon is a gas, it is possible, as Gilinsky said, "for large populations thousands of miles away from the source to be exposed, albeit to an extremely low dose."[44]

In fact the NRC has attempted to present long-term calculations for New Mexico tailings-gas emission levels in

---

38. Robert F. Kaufman, et al., "Effects of Uranium Mining and Milling on Ground Water in the Grants Mineral Belt, New Mexico," *Ground Water* 14, No. 5 (September-October 1976). See also, EPA *Radioactivity in Drinking Water,* EPA #570/9-81-002 (Washington, D.C.: EPA, January 1981).

39. U.S. Congress, Senate Committee on Public Works, Subcommittee on Air and Water Pollution, *Radioactive Water Pollution in the Colorado River Basin,* 89th Congress, May 6, 1966, pp. 101-104.

40. Swanson interview.

41. Metzger, *Atomic Establishment,* p. 164. For this information Metzger cites: DHEW, U.S. PHS, *Waste Guide for the Uranium Milling Industry,* Technical Report W62-12 (Cincinnati: PHS, 1962); PHS, Region VIII, *Radiological Content of Colorado River Basin Bottom Sedimentation,* Report PR-10 (Denver: PHS, June 1963); and *Radioactivity in Water and Sediments of the Colorado River Basin, 1950-1963,* Radiological Health Data and Reports (Washington: U.S. Government Printing Office, November 1964).

42. GAO, *The Uranium Mill Tailings Cleanup: Federal Leadership At Last?,* EMD-78-90, (Washington, D.C.: GAO, June 1978) (hereafter cited as *Tailings Leadership*); and, NRC, *Final General Environmental Impact Statement on Uranium Milling,* Vol 1, NUREG-0706 (Washington, D.C.: NRC Office of Material Safety and Safeguards, September 1980), pp. 3-15 (hereafter cited as *GEIS-Milling*). See also, GAO, *The U.S. Mining and Mineral-Processing Industry: An Analysis of Trends and Implications,* ID-80-04 (Washington, D.C.: GAO, October 1979).

43. David R. Dreesen, *Uranium Mill Tailings: Environmental Implications,* LASL 77-37 (Los Alamos, N.M.: Los Alamos Scientific Laboratory, February 1978).

44. Gilinsky, "Problem," p. 2.

such distant locations as Los Angeles, Chicago, Miami, Washington, D.C., and New York City.[45] NRC staff member Reginald Gotchy told us that despite its short half-life (3.8 days) radon gas from a tailings pile in New Mexico can carry to the East Coast of the United States. On its way contamination would appear "on grain grown in the Midwest" and elsewhere. "This stuff," he said, "goes everywhere." Gotchy hastened to add that he and the NRC consider the doses "minuscule."[46]

But in 1977 Dr. Chauncy Kepford, a chemist based in State College, Pennsylvania, testified during hearings on the license for Three Mile Island Unit 2 (which caused the 1979 accident) that the quantity and health effects of radon tailings emissions had been vastly underestimated. Kepford stated that the NRC had failed to account for continued emissions over the full decay chains of the elements involved. Assuming a stable human population and society, he estimated that tailings from the fuel needed to operate TMI-2 for just one year could cause a million cancer cases over time.[47]

In 1978 Dr. William Lochstet of Pennsylvania State University argued that the operation of a single uranium mine could result in 8.5 million deaths over time.[48] And Dr. Robert O. Pohl of Cornell told the NRC that the potential health effects from mill tailings could "completely dwarf" those from the rest of the nuclear fuel cycle and add significantly to the worldwide toll of death and mutations.[49]

The essence of those conclusions was substantiated, surprisingly, from within the Nuclear Regulatory Commission itself. In the fall of 1977 Dr. Walter H. Jordan of the commission’s Atomic Safety and Licensing Board wrote an internal memorandum arguing that the NRC "had underestimated radon emissions from tailings piles by a factor of 100,000."

Because of the long half-lives of the isotopes in the solid tailings, radiation will continue to be emitted from the tailings piles for billions of years. Said Jordan: "It is very difficult to argue that deaths to future generations are unimportant."[50]

In estimating the long-term effects of radon gases, the NRC assumed the tailings piles would be covered with dirt. The belief is that covering the piles will trap the gas and force it—after its relatively short half-life—to deposit its radioactive "daughters" in the form of less mobile solids.

But questions have been raised about how long dirt covering the piles would last through the millennia the tailings will be radioactive. Or if the piles can actually be covered at all. In some instances they are a hundred feet high and more, and cover hundreds of acres of ground. Huge strip-mining operations would be required just to get enough soil to do the job.[51]

The NRC has also considered returning the tailings to the mines from which they came. In some instances the procedure may be viable. But many workers would be contaminated in the process, and much fuel consumed. One estimate for removing the Durango tailings involves 65,860 trips with twenty-five-ton dump trucks. Returning the 140 million tons of tailings now lying around the U.S. would require more than 5.5 million such truck trips.[52]

In the meantime NRC Commissioner Gilinsky has warned that "none of the abandoned sites can be considered to be in satisfactory condition from the long-term standpoint."[53] In fact most of the piles continue to lie exposed to the winds and rain. Residents of Durango, Colorado, have experienced plumes of dust towering thousands of feet in the air, covering cars and houses with radioactive dust. Children have played in the "dunes." The piles were "the

---

45. NRC, *Radon Releases from Uranium Mining and Milling and Their Calculated Health Effects,* NUREG-0757 (Washington, D.C.: Office of Material Safety and Safeguards, February 1981), p. 7-3 (hereafter cited as *Radon 0757*).

46. Reginald Gotchy, interview, April 1981.

47. Chauncy Kepford, *Comments on NUREG-00332* (State College, Pa.: Environmental Coalition on Nuclear Power, 1977), p. 8; and Chauncy Kepford, interview, June 1981.

48. William Lochstet, "Radiological Impact of the Proposed Crownpoint Uranium Mining Project," August 1978, unpublished manuscript.

49. Robert O. Pohl, "In the Matter of Public Service Company of Oklahoma, Associated Electric Coop., Inc. and Western Farmers Coop., Inc. (Black Fox Station Units 1 and 2," testimony before the Atomic Safety and Licensing Board, Docket Nos. STN 50-556 and STN 50-557.

50. Walter Jordan, "Errors in 10 CFR Section 51.20, Table S-3," memorandum to James R. Yore, NRC, September 21, 1977; and Walter Jordan, letter to Congressman Clifford Allen, December 9, 1977.

51. NRC, *Radon 0757*, p. 4-7.

52. *High Country News*, May 16, 1980, p. 6.

53. Gilinsky, "Problem," p. 5.

biggest, best sandpile in the world," Greta Highland of Durango told the *High Country News*. "After school my friends would sneak into the mill yard and play in the tailings."[54]

But the consequences may be lethal. High levels of background radiation from thorium, for example, have been linked to spontaneous abortion and mental retardation.[55] Leukemia and lung-cancer rates in south Durango, near the piles, have been reported higher than the rest of the town and the state.[56]

And Monticello, Utah (population: 1900), has also reported problems. From 1949 to 1960 the town hosted a large uranium mill, which processed weapons material for the AEC. In the mid-1960s four young residents died of leukemia. A fifth began a long battle against it. In a normal town Monticello’s size just one case would be expected every twenty-five years.

A preliminary study by the Center for Disease Control concluded that "there appears to be no relationship" between the mill and the leukemias. But the authors conceded that such a high leukemia incidence "would be expected to occur in fewer than one of 1,000 towns this size or smaller during the same period of time." The report also said that gamma readings at the perimeter of the tailings areas "ranged up to twenty times background" and that "a nuisance and possibly a hazard also existed due to blowing of the tailings as they dried out."[57] All five of the young victims had grown up within a half mile of the mill. "For a place this small, it had to be something," said Dale Maughan, whose son Alan died of leukemia in 1966, at age sixteen.[58]

The damage has not been limited to humans. Farmers near the Cotter mill at Canon City, Colorado, have also complained of unexplained problems with their animals, problems reminiscent of those reported by Lloyd Mixon at Rocky Flats. Local residents Clarence Ransome and Wanda Bosco told us the illnesses among their livestock included diarrhea, weight loss, hair falling out, and difficulties in reproduction. Tests discovered contamination in at least one local well and in alfalfa being raised nearby. Bosco told us the problems with her animals disappeared when they were given uncontaminated water trucked in from town.[59]

The presence of uranium mining and milling has also been linked to high birth-defect rates in the states of New Mexico, Arizona, Colorado, and Utah. Overall conclusions are tenuous, complicated by a wide range of social and environmental factors. But Dr. Alan Goodman, director of Program Development for the Area Health Education Center at the University of New Mexico’s School of Medicine, has cited "a disturbing pattern" of sex ratio changes and birth defects that correspond to "the same patterns of uranium mining and milling on the Colorado Plateau. I’m not saying that they are caused by uranium, but one would have to be a fool not to see that there is a possibility that they are related."[60]

Particular attention has been focused on the twenty-thousand-person community of Shiprock, New Mexico, where an abandoned 1.7-million-ton tailings pile covers seventy-two acres in the heart of town. According to Dr. Leon Gottleib, a pulmonary specialist long associated with the Indian Health Service, during the rainy season, water leaching through the tailings pile carries radioactive particles into the nearby San Juan River. "Children swim in the contaminated river; cattle drink from the river; and contaminated fish inhabit these waters," he told us in a letter. In windstorms, radioactive particles are blown into school and residential areas, as well as onto grazing and garden land.

In January 1981 Dr. Evelyn Odin, a Shiprock pediatrician, told *The Albuquerque Tribune* that she had been

---

54. *High Country News,* May 16, 1980, p. 6.

55. N. Kochupillai, et al., "Down’s Syndrome and Related Abnormalities in an Area of High Background Radiation in Coastal Kerala," *Nature* 262 (July 1, 1976): 60-61.

56. *High Country News,* May 16, 1980, p. 6.

57. Peter McPhedran and John R. Crowell, "Leukemia in Monticello, Utah," EPI-67-48-2, Memorandum to the Director, National Communicable Disease Center, Atlanta, July 5, 1967. See also, John R. Crowell and Clark W. Heath, Jr., "Leukemia in Parowan and Paragonah, Utah," EPI-67-70-2, memorandum to the Director, National Communicable Disease Center, Atlanta, April 26, 1967. In a June 1981 interview, Peter McPhedran told us a more detailed study of Monticello "looked like a good idea, but nobody asked us to pursue it any further." As a result, he said, the study was dropped. Area drinking water had not been studied.

58. Bill Curry, "Small Utah Town, 4 Leukemia Deaths," *Washington Post,* July 16, 1978. In a March 1981 interview Alan Maughan’s mother told us she was certain the tailings piles had caused her son’s death. Dr. Carroll Goon, whom we also interviewed, said the large number of leukemia cases surfacing at the same time did seem extraordinary, but that there was no conclusive proof they had been caused by the tailings. There has been, he said, "nothing like it since" in Monticello.

59. "Bad Water Tough on Families," *Rocky Mountain News,* June 26, 1978, p. 8; and Clarence Ransome and Wanda Bosco, interviews, June 1981.

60. Christopher McLeod, "Uranium Link: New Studies Reveal High Birth Defect Rate in Southwest," Pacific News Service, April 1, 1981.

disturbed by the number of babies being born prematurely with small heads. One child, she said, was born with its esophagus and trachea joined together; another was born without an abdominal wall and with its intestines hanging out.

Dr. John Ogle, also of Shiprock, hesitated to blame the defects on radiation. But he told the *Tribune* that "my gut feeling is that the incidence here is too high." Ogle said in six months he had seen three infants born with heart diseases two with cleft lips and palates, two with skull defects, two with Down's syndrome one with a section of backbone missing, and several with thyroid conditions.[61] A study by Sarah Harvey, director of the Community Health Representative Program, found a doubling of spontaneous abortions, stillbirths, and congenital abnormalities among children of uranium-mining families as opposed to nonminers. Her survey has formed the basis for an investigation of the area partially funded by the March of Dimes.[62]

Problems in the Shiprock area may be compounded by the fact that numerous local residents have built their homes with radioactive rock from the mines, or with tailings from the mills. The use of tailings as a building material was widespread throughout the 1950s and early 1960s. Despite repeated warnings from independent experts, the AEC did not investigate the possibility that such use of tailings could harm people.[63]

The carelessness has had a direct cost. In Grand Junction, Colorado, more than six thousand structures—including several schools—are now known to have tailings deposits in the building materials or in the landfill under them. Streets and sidewalks were also laid with them. In all at least 270,000 tons of tailings were used, resulting in dangerous radiation levels in many Grand Junction houses. A state- and federal-funded program that has thus far cost taxpayers at least $6.5 million has brought "remedial action" to only seven hundred sites. Costs have been estimated at fifteen thousand dollars per home and seventy-five thousand dollars per commercial building.[64]

For some the cleanup may have come late. A 1978 study by the state of Colorado indicated cancer rates in Mesa County, where Grand Junction is the prime population center, showed an acute leukemia rate twice the state average. More women were suffering from the disease than men, an indication of radiation poisoning.[65]

At Edgemont, South Dakota, an EPA study found sixty-four "hot spots" related to a nearby tailings pile.[66] In 1978 the Neil Brafford family was forced to abandon their home there when they learned it had been built on tailings. The basement in which their young son Chris lived showed radiation levels thirty-nine times normal background. Brafford had bought the house from a mill worker and only later discovered tailings had been used as backfill. "We don't know how much he used," Brafford explained, "but we do know that we're never going to live here again."[67]

When they moved out, Brafford's young daughter stopped suffering from a long bout of diarrhea, which had begun when the family moved in. Laboratory tests showed that young Chris Brafford had broken chromosomes. He was also suffering from aching bones, a symptom of potential leukemia. In May of 1981 the Braffords filed a forty-million-dollar lawsuit against the Susquehanna Corporation, owners of the nearby tailings pile.[68]

Canonsburg

Ironically one of the worst tailings problems occurred in a community east of the Mississippi—Canonsburg, Pennsylvania, twenty miles southwest of Pittsburgh. As early as 1911 the Standard Chemical Company was importing carload after carload of radioactive ore from a mine at Montrose, Colorado, to extract uranium. At the time, it took about five hundred tons of ore to produce a single gram of radium—a gram that sold for up to $150,000.

---

61. Burt Hubbard, "Navajos Build Radioactive Homes; Offspring May be Bearing Burden," *Albuquerque Tribune*, January 27, 1981, p. A-2. The problems in Shiprock were also confirmed by Dr. Leon Gottleib, who worked in the area for many years, in an April 1981 interview and in an August 23, 1981 letter.

62. Lynda Taylor, Southwest Research Institute, interview, June 1981.

63. Metzger, *Atomic Establishment*, p. 164.

64. GAO, *Tailings Leadership*, p. 8; and *GEIS-Milling*, p. 2-2. See also, Joanne Omang, "EPA Proposes Rules for Cleaning Up Old Uranium Mills' Radioactive Waste," *Washington Post*, April 17, 1980.

65. "Mesa County Leukemia, Cancer Incidences High," *Rocky Mountain News*, United Press International, March 2, 1978.

66. *High Country News*, April 4, 1980, p. 13.

67. Neil Brafford, interview, July 1980.

68. Andrew Reid, interview, March 1981. Reid is lead attorney in the Braffords' lawsuit.

There were few questions asked. In 1914 company president Joseph M. Flannery told a local newspaper that radium would cure "such things as insanity, tuberculosis, rheumatism and anemia, and a lot of cancers." Flannery and at least two other principals in the company eventually died of radiation sickness.[69]

Standard Chemical and the companies that followed it quit the radium business in Canonsburg in 1942. But by then the push was on to build the atomic bomb. The government contracted in secret with the Vitro Corporation to extract leftover uranium from the discarded ore.

When Vitro finished operations in the late fifties, it was ready to go into the waste-storage business. At least 160,000 tons of radioactive residues were strewn around Canonsburg, some of them lining the bottom of a three-acre lagoon where local children regularly waded in the summer and skated in the winter.

In the early sixties the AEC allowed the lagoon to be filled in with tailings. It was an extraordinary decision, since—contrary to regulations—the government did not own the site. Health physicist Robert Gallagher, who performed a preliminary survey there, called the move "incredible." He charged that the AEC approval was either "a special favor or an oversight of gigantic magnitude."[70] As for the fill job, Joseph Swiger, project manager for the dumping, termed it "the worst and sloppiest job I've ever worked on." It was "morally objectionable," he told *The Pittsburgh Press,* "because the material was hazardous."[71]

In 1967 the site was sold for $130,000 to a local entrepreneur named Vaughn Crile, who was never warned that there might be a radiation problem. Crile built an industrial park on top of the tailings and brought in fourteen tenants along with his family business. The DOE surveyed the site in 1978 and found that the 125 workers there were being exposed to radon concentrations fourteen times above the level officially considered safe.[72]

The news was not well received by Crile's tenants. At least eight had left by early 1981. Workers were hesitant to take jobs there, and at least one claimed the place had ruined his health.

He was George Mahranus, a mechanic at the park for eight years, who finally quit in fear. "Towards the end," he told us, "I could hardly lift anything, couldn't pull on the wrenches. I got a soreness in my joints. Most of my hair fell out. My front teeth came loose on me. I never felt like this before in my life." Mahranus, who was in his forties, spent most of his working days on the plant floor, fixing tires and engines. "The radiation never occurred to me till they started drilling at the site to test for it," he said. "Then I decided to get the hell out of there." With just ten teeth left in his mouth and an unexplained lump behind his ear, Mahranus was apprehensive of doctors confirming his worst fears. "I do feel better since I left there," he told us. "But now I can't sit long and my fingertips go numb on me. I always did hard work. But now there's no way for me to go out and put in eight hours. It would kill me."[73]

Park owner Vaughn Crile was skeptical of Mahranus's claims, but was also deeply bitter toward the government, which he said had cost him thousands of dollars. "They should relocate us, but they're so ungodly slow," he complained.[74]

At least eighteen other radioactive "hot spots" were identified around town including a ballfield and an American Legion park. A spot near the lagoon registered five hundred times normal background levels.

Some locals complained that their gardens would not grow; others were warned not to eat the vegetables that did come up. A rain barrel at one Canonsburg home showed radiation levels eight thousand times background, while materials used to build one house registered 240 times the normal radium count. At least 150 homes were marked for decontamination.[75]

But, as at Grand Junction, the cleanup orders may have been too late. Epidemiologist Evelyn Talbott of the University of Pittsburgh studied the area. She told us preliminary figures indicated a lung-cancer rate twice normal among men over forty-five, and three times normal among men over seventy.[76]

Informal studies indicate things may be even worse. Agnes Engel, a mother of two in her late thirties and a

---

69. Ben A. Franklin, "U.S. Testing Workers for Effects of 13 Years Amid Atomic Wastes" *New York Times*, May 5, 1979, p. A-1.

70. *Pittsburgh Press,* January 23, 1980, p. C-1.

71. Ibid., January 21, 1980, p. A-8.

72. Franklin, "U.S. Testing Workers."

73. George Mahranus, interview, April 1981. See also, Albert Neri, "Radioactive Park Site Has Mechanic 'Scared,'" *Pittsburgh Post-Gazette,* March 19, 1979.

74. Vaughn Crile, interview, April 1981.

75. *Pittsburgh Press,* March 2, 1979, and June 22, 1980, p. A-10.

76. Evelyn Talbott, interview, October 1980. See also, *Pittsburgh Press,* July 30, 1980, p. B-3.

lifelong resident, surveyed 150 of her neighbors. She found an astonishing fifty-three of them complaining of thyroid problems. Like scores of other local children, Engel had been drawn to the contaminated lagoon when she was young. Before it was filled in, she told us, "there were cattails and frogs there. It was an irresistible attraction."

But there had been no warning of the radioactive chemicals at the lagoon's bottom. Engel has since suffered from multiple health disorders including strange bleeding problems, a thyroid condition at age seventeen, a minimally brain-damaged son, a hysterectomy at thirty-five. "My two sisters have also had similar problems," she told us. "And there are so many other women here who've had them . . . so many strange things. . . . "[77]

---

77. Agnes Engel, interview, October 1980. See also, *Pittsburgh Post-Gazette,* March 19, 1979; and Agnes Engel, *Residential Research Survey of Thyroid Disorders* (Strabane, Pa.: U.C.A.R.E., March 21, 1979).

10

Tritium in Tucson, Wastes Worldwide

Like Agnes Engel of Canonsburg, Tom Charlie downriver from Church Rock, and the Haag and Mixon families near Rocky Flats, radiation has affected the life of Rita Linzy. A mother of two and a lifelong resident of Tucson, Linzy knew little of the intricacies of atomic power until one of her near neighbors accidentally leaked radioactive tritium, introducing it into food being served to forty thousand local schoolchildren. It happened in the summer of 1979. During the incident—which Linzy called "our Three Mile Island"—her hair fell out and scores of her neighbors began wondering if their health had been damaged.[1]

The source of the contamination was American Atomics, a ten-million-dollar-a-year operation employing some two hundred workers in midtown Tucson. The company made a business of buying tritium from the federal weapons program and inserting it into thin glass slivers used in digital watches. The tritium makes the slivers glow without electricity.

As it functioned quietly in Tucson, American Atomics was just one of seventeen thousand medical, academic, industrial, and military organizations licensed to handle radioactive isotopes in the United States. Those licensees range in size from megacorporations like General Electric and Westinghouse to small colleges and hospitals that handle tiny quantities of isotopes for research and medical purposes.[2] Literally hundreds of millions of items containing some quantity of radioactivity are produced in the U.S. each year, including luminous timepieces, static eliminators, false teeth, welding rods, eyeglasses, electron tubes, fluorescent lamp starters, ceramic tableware, and some smoke detectors.[3]

Many of the factories that produce these items are legally permitted to release large quantities of radiation in the course of normal operations. Cobalt 60 fabrication plants, for example, are allowed to expose the public to twenty times more radiation than a commercial reactor.[4]

Many of the small radiation by-product plants are also located in thickly populated areas. American Atomics sat just a few hundred yards from a trailer park, a church, a day-care center, a potato chip warehouse, several homes, and the central kitchen for the Tucson public school system. The plant regularly leaked large quantities of tritium gas into the atmosphere—285,000 curies of it in 1978 alone, according to company records. In September of that year a maintenance worker opened the wrong valve and sent into the Tucson air a single "puff" of twenty-one thousand curies, a sizable dose. The public was not informed.[5]

But tritium can be deadly. A radioactive form of hydrogen, it has a half-life of twelve years. Because it gives off relatively small amounts of beta (electron) radiation, it is considered less dangerous than many other isotopes. However tritium behaves chemically and biochemically like ordinary hydrogen. When ingested, it can incorporate itself into all forms of body cells, including those of the reproductive system. Researchers theorize that because of its ability to act like regular water, tritium can incorporate with the DNA in living cells, multiplying the prospects for damage leading to genetic mutations and cancer[6]

---

1. *Arizona Daily Star*, June 3, 1979.
2. Clair Miles, NRC, interview, February 1981.
3. Buckley, et al., *Environmental Assessment of Consumer Products Containing Radioactive Material,* NUREG CR-1755 (Washington, D.C.: NRC).
4. 10 Code of Federal Regulations, Part 40. As of December 1979 the public exposure limit at "nuclear fuel cycle" facilities such as power reactors and fabrication plants was set at twenty-five mrem. But the limits at "by-product" facilities, waste dumps, weapons plants, and certain industrial facilities was set twenty times higher—at five hundred millirem.
5. *Arizona Daily Star*, April 15, 1979, and January 4, 1981.
6. H. Kasche, et al., "Dose Estimations for Tritium and C-14 Released in the Nuclear Fuel Cycle—A Biological and Radiobiological Evaluation," University of Bremen, SAIU, available through Environmental Policy Center.

Tritium in the Cake

In addition to tritium, at least one worker at American Atomics was also contaminated with "hot" oil. Other workers charged the company regularly falsified quality-control data and deliberately mislabeled radioactive cargo to avoid air-freight restrictions. In all, the company seemed a tragic throwback to the days of radium-dial painting—a practice tritium slivers made obsolete.[7]

Finally, American Atomics employee Elaine Hunter blasted the company in a letter printed in the local *Arizona Daily Star*. She was quitting work at American Atomics, she said, "not in fear of radioactivity," but "in disgust and anger that those greedy men were making a fast buck while jeopardizing the physical and emotional well-being of those involved with the fabrication of their product.[8]

Meanwhile plant neighbors complained of emission alarms that rang constantly. In August of 1978 the Arizona Atomic Energy Commission (AAEC) inspected American Atomics and warned of large losses of tritium because of sloppy handling. The findings were delivered to AAEC director Donald C. Gilbert, who let them sit on his desk for seven months. The reason for the inaction, Gilbert later told *Daily Star* reporter Jane Kay, was that he had been assured by Harry H. Dooley, Jr., that the situation was being corrected. Dooley was an AAEC commissioner—and a vice-president of American Atomics. The obvious conflict of interest apparently bothered no one at the AAEC. Only when Director Gilbert was fired in March of 1979 during a commission shake-up did the report find its way to the public.[9]

Four days after Gilbert's departure AAEC inspector Lynn FitzRandolph was sent to American Atomics. He cited the company with four counts of violating state regulations, and recommended that the plant be closed. The company was "out of control," FitzRandolph later explained. "I came away with pretty good ideas the tritium was going up the stacks and into the sewer." FitzRandolph was scorned at the time by some of his scientific peers, who told him his demands for strict enforcement were "ridiculous."[10]

But in the spring of 1979 the *Star* also reported the company had been dumping radioactive liquid "down the drain," directly into the city sewer system, without filtration or monitoring. American Atomics replied that the total radioactive content was "very low."[11]

But routine tests in early June at the Tucson school system's central kitchen, near the plant, found food with radiation counts 2.5 times above permissible levels. The kitchen regularly fed approximately forty thousand students. Water in cake that had been served to twenty-eight thousand pupils contained fifty-six thousand picocuries per liter; federal standards allowed only twenty-thousand picocuries. Vegetation outside the kitchen tested at levels thirty-six times the legal limit. Radiation, said acting AAEC director Kenneth Geiser, was "in the humidity in the air. Everywhere. And all the time. Cake or bread left on a table gets kind of soggy; it picks up moisture like a sponge—and tritium with it."

Tucson was shocked. The school board was soon forced to bury seventeen thousand cases of food. In all some $300,000 in perishables and $90,000 in canned goods were destroyed, at taxpayer expense.[12]

Meanwhile urine tests of people living near the plant revealed at least six cases of abnormal levels of tritium. Six-year-old Tony Bruckmeier tested at 89,100 picocuries per liter, a level termed by Gail Schmidt of the Bureau of Radiation Health as "small but not negligible."[13] Though federal officials emphasized the levels were not likely to be

---

7. *Arizona Daily Star,* July 18 and July 20, 1979.

8. Elaine Hunter, letter to the *Arizona Daily Star,* April 15, 1979.

9. Jane Kay, *Arizona Daily Star,* interview, January 1981.

10. *Arizona Daily Star,* February 11, 1980, and October 4, 1979.

11. Ibid., May 14, 1979.

12. Ibid., June 2, 1979; and Associated Press, October 25, 1979, as seen in *New York Times,* October 26, 1979.

13. Gail Schmidt, interview, June 1981. Dr. Schmidt told us that EPA standards for tritium in drinking water are twenty thousand picocuries per liter, constant intake of which could result in a whole-body dose of four millirems a year. The NRC standard for tritium in urine among nuclear workers is twenty-eight million picocuries per liter. Schmidt calculated that if the tritium levels in Tony Bruckmeier's urine had come from a single exposure, they would reflect a whole-body dose of roughly 0.37 millirems. If they reflected a whole year's constant exposure, Schmidt estimated the dose at roughly 8.9 millirems. In a June 1981 interview Dr. Alan Moghissi, principal adviser for Radiation and Hazardous Materials to the EPA's Office of Research and Development, told us that if he were the parent of a child who had suffered such exposure, he "would not be concerned." Moghissi, who worked extensively on the Arizona Atomics case, said the highest environmental doses were estimated at ten to seventeen millirems. "There is no such thing as zero danger," he told us. But Tony Bruckmeier's apparent dose was "comparable to what one would receive on a round-trip air flight from New York to Tucson."

harmful, local residents had their doubts. Mrs. Gloria Mendoza, who had lived in the neighborhood more than a quarter century, showed levels of 71,700 picocuries per liter. The AAEC, she told the *Star*, "told us to see our own physicians or call the Health Department. They told me it was nothing to be alarmed about. But I've had blisters inside my mouth, and the doctors say they haven't seen anything like it since World War II. It's all cracked and constantly purplish red."

"They told us they were making little components," said Joe Valenzuela, a grandfather and amateur gardener who lived in the same house for thirty years. "They never said they were using radioactive materials. No one knew. . . . The prevailing winds are south to southwest, and we're right here," he continued. "We have no defense against this. The employees work eight hours and wear coats and gloves. But my wife is here 24 hours. What about her kitchen?"[14]

When news of the contamination became public, parents began forbidding their children to come into the area—even to visit grandparents. Neighbors began leaving fruit on trees they had tended for years rather than risk eating radiation. Backyard swimming pools were also abandoned when they showed high tritium levels—one with 413,000 picocuries per liter, twenty times EPA drinking standards. But American Atomics continued to manufacture tritium slivers. "The safeguards are there," said company president Peter J. Biehl. "The performance here is super, and we're within the established standards. If we were a safety hazard we'd shut down."[15]

They did. Faced with the possibility of an official hearing, American Atomics surrendered its licenses to handle radioactive materials. The Tucson City Council and Pima County had already voted to deny the company permission to relocate within their borders.

The company then abandoned its factory, leaving behind tritium and other contaminated wastes. A break-in, fear of fire, and other problems at the deserted site brought on still more anger and anxiety in Tucson. Finally, on September 26, Arizona governor Bruce Babbitt used emergency powers to seize the leftover tritium. The American Atomics experience, he said, had been "a complete failure of regulation."[16] On September 28, six National Guardsmen packed several hundred thousand tiny glass vials filled with tritium into thirty-eight barrels and trucked them to a former military depot at Flagstaff, where they were buried.

The experience left bitter memories in Tucson—and more. During the height of the crisis health officials assured local residents any ingested tritium would be eliminated from the human system in three to six months.

But in the spring of 1981 a study of fifty former American Atomics workers showed a majority with tritium levels still ten times above normal. The ex-employees had not been exposed to high tritium concentrations for at least twenty-one months.

Dr. Michael Gray of the Arizona Center for Occupational Safety and Health reported that a survey showed a "long residency period in the system of very low concentrations of tritium." Some of the workers, he said, produced urine samples containing tritium levels twenty times above normal. Rates of decay found in the survey suggested that tritium "can reside in the body" not just for the three to six months promised during the crisis, but "for up to ten years."[17]

That was bad news for the people of Tucson, who banned all radioactive production from their town in the wake of the scandal. "It never entered my mind that they would even think of putting a plant in this area when they knew it could contaminate a neighborhood," Rita Linzy told the *Star* at the height of the American Atomics crisis. She was then suffering from an undiagnosed ailment that left her feeling tired and feverish, and made her hair fall out. Her dog's hair was also falling out.

When we interviewed her eighteen months later, she told us she was feeling better, and that there was no firm evidence that her ailment—or her dog's—had been caused by radiation. But she was still worried. "I don't know if the illness was from the plant or not," she said. "If any damage was done, we won't know for twenty years. And there won't be anything we can do about it."[18]

---

14. *Arizona Daily Star*, June 3, 1979, and June 12, 1979.

15. Ibid., April 15, 1979.

16. U.S. Congress, House Committee on Interior and Insular Affairs, Subcommittee on Energy and the Environment, *Nuclear Regulatory Commission's Agreement States Program*, 96th Cong., 1st sess., July 19, 1977, pp. 2-6 (hereafter cited as *Agreement States Hearings*).

17. *Arizona Daily Star*, March 5, 1981.

18. Ibid., June 3, 1979, and Rita Linzy, interview, January 1981.

A World of Waste

The closing of American Atomics in Tucson did not end the problems it created. The leftover tritium had to be trucked to a burial ground. Though no accidents marred that particular trip, other shipments haven't fared so well. Every year the NRC and Department of Transportation (DOT) log several thousand movements of radioactive wastes, fuel, ore, medical isotopes, and the like over American roads, rails, waterways, and airways. In 1979, when the American Atomics tritium was moved to Flagstaff, 122 nuclear-related transport accidents were reported, including at least seventeen that resulted in environmental contamination.[19]

How many more went unreported remains unknown. But in November of 1980 the GAO warned that with DOT's "limited staffing and funding resources" the agency could not "determine the extent of problems involved in transporting hazardous materials" let alone solve them.[20]

The problems seemed epidemic, from faulty vehicles and untrained drivers to inadequate safeguards and sloppy packaging. Nevada's governor Robert List, for example, complained to a 1979 House Interior Committee hearing that "simple tape" had been used to seal a metal container carrying liquid wastes from a Michigan reactor into his state. The tape had been painted over to conceal the problem. But the cask was dripping and may have contaminated roads for more than a thousand miles. Three months earlier hospital wastes being trucked into Nevada caught fire.[21]

These incidents and scores like it prompted List and the governors of South Carolina and Washington to announce they would accept no more low-level wastes into their states after 1987. Numerous municipal governments—such as New York City—have banned the transport of radioactive material through their streets altogether.

No such problems existed for the Tucson tritium, which got to its burial ground under the aegis of a state emergency. But once there it became part of a much bigger problem—the disposal of atomic wastes, generally considered the Achilles' heel of the nuclear industry. The issue has become so hard-fought that in 1980 the voters of Washington State overwhelmingly approved a referendum to ban all further shipments of radioactive waste into the state. And Ronald Reagan—whose campaign platform included the strengthening of states' rights—instructed the federal Justice Department to overturn the act and force the state to continue accepting radioactive wastes against its will.[22] In June 1981 the federal district court in Seattle ruled against the state.

What has people upset is an enormous and uncertain legacy of permanently toxic and potentially explosive garbage. It comes from two sources—the military and the commercial uses of the atom—and it breaks into three categories—low-level, transuranics, and high-level waste.

For three decades the weapons program was the principal source of radioactive waste. With their plutonium-producing reactors, uranium enrichment plants, bomb fabrication complexes, and research laboratories, the armed forces by the late 1970s were producing some seventy million gallons of high-level wastes per year, plus thousands of cubic yards of less toxic low-level solid trash. The military also had 460 buildings and sites in need of decontamination and, in many cases, burial.[23]

Overall, as the 1980s began, the weapons program remained the leading producer of radioactive wastes *by volume*. But because of the extreme intensity of the poisons in a power reactor core, the commercial nuclear program by 1977 had outstripped the military program in its production of nuclear wastes by *quantity of radioactivity*.[24] Both programs continue to produce both high-level and low-level wastes.

The latter are low in radioactivity, low-emitter items like tools and clothing contaminated during site work, test tubes, detergents, worn-out machinery, experimental carcasses, and the like. One 1979 DOE estimate of the total quantity of this material put it in the range of 2.5 million cubic meters, with 10 million cubic meters predicted by the year 2000. Much of it so far has been stored in metal barrels or dumped in trenches.[25]

---

19. "Nuclear Shipments: Accidents on the Rise," *The Guardian,* December 3, 1980.

20. GAO, *Programs for Insuring the Safe Transport of Hazardous Material Need Improvement,* CED/81-5 (Washington, D.C.: GAO, November 4, 1980).

21. *Agreement States Hearings,* pp. 6-12.

22. "U.S. Disputes Washington State Law on A-Waste," *Washington Post,* Associated Press, April 14, 1980.

23. Marvin Resnikoff, "Nuclear Wastes—The Myths and the Realities," *Sierra,* July/August 1980, p. 32 (hereafter cited as "Realities").

24. Ibid.

25. DOE, *Spent Fuel and Waste Inventories and Projections,* ORO-778 (Oak Ridge, Tenn.: Oak Ridge Operations Office, August 1980), p. 6 (hereafter cited as *Spent Fuel*).

In March of 1981, under the Reagan administration, the NRC "solved" part of the low-level storage problem by allowing hospitals and research institutions to simply burn their wastes in the open air or dump them down drains leading into public sewer systems. Research labs and hospitals regularly produce 200,000 to 400,000 gallons of liquid wastes each year, plus large numbers of contaminated animal carcasses and soiled equipment. Their radiation will now go directly into the environment.[26]

This method of waste disposal is not new. Government figures indicate that in the 1940s and 1950s the AEC dumped at least fifty thousand barrels of wastes directly into the Atlantic and Pacific oceans, and the Gulf of Mexico. Government officials claimed that the barrels were dumped far from heavily populated areas on shore, and that only a small number leaked once they hit bottom.

But testimony from military personnel and employees involved in the actual operations indicate many thousands of additional barrels may have been involved.[27] And a 1981 investigative report by *Mother Jones* magazine indicated a very high percentage of those barrels were leaking. In fact some of them had actually been shot with holes by ships' captains when the barrels were slow to sink after being thrown overboard.[28] Many of the barrels were also much closer to shore and in shallower water than the government said. And as early as 1975 two EPA scientists in a deep-diving submarine reported traces of radioactive cesium leaking from containers dumped 120 miles off Ocean City, Maryland. Fish caught at another site two hundred miles out showed significant levels of radioactive americium in their bodies.[29]

Divers at a dump site off San Francisco have found abnormal giant sponges similar to ones growing near nuclear outtake pipes at reactors in Japan. And a suppressed EPA report confirmed that small marine life was feeding near numerous broken barrels; they could, in turn, introduce the radioactivity into the ocean food chain.

The ocean dumping program was not limited to low-level wastes. In 1958 the military threw an entire atomic reactor vessel, containing thirty thousand curies of radiation, into the Atlantic. It later tried to retrieve the vessel, but could not find it.[30]

Both liquid and solid high-level wastes can be laced with plutonium, thorium, radium, strontium, cesium, and a broad spectrum of other dangerous isotopes. Many of them have long half-lives, are extremely toxic, and, in some cases, explosive. With its half-life of 24,800 years, plutonium must be stored to virtual perfection for 248,000 years before scientists estimate it may be safe to handle. Thorium, with its eighty-thousand-year half-life, will remain deadly even longer.

In both cases ingestion of even minuscule particles can result in cancer. And the storage of plutonium has become an even more pressing issue because it can be made into bombs. Public fears that it might be stolen and used by small nations or terrorist groups are well justified, and have already prompted one major international incidence of extreme violence—the June 1981 Israeli raid on an Iraqi reactor. More—possibly worse—events of its kind seem inevitable.[31]

Thus far the U.S. military has stored the worst of its wastes at the Hanford, INEL, and Savannah River sites. At each location there have been disastrous contaminations of land and water. At Hanford at least 430,000 gallons of caustic liquids have leaked from storage tanks, including 115,000 gallons over a single 50-day period in 1973. Though the wastes must be safely contained for millennia, numerous tanks at Hanford under ten years of age have leaked profusely.[32]

When a Hanford safety engineer named Stephen Stalos complained about the problem to his superiors, he was

---

26. Environmental Policy Center, "Biomedical Waste Disposal Regulations Adopted," in *Radioactive Readings* 2, No. 4 (March 20, 1981).

27. Barry Hagar, Chief Counsel, Subcommittee on Environment, Energy and Natural Resources, of the U.S. House Government Operations Committee, interview, February 1981; and Douglas Foster, "You Are What They Eat," *Mother Jones,* July 1981.

28. Ibid.

29. "Pilot Recalls Navy Sank Nuke Waste," *Sacramento Journal,* Associated Press, January 3, 1981, p. 12.

30. Foster, "You Are What They Eat."

31. It was the potential of using plutonium in bombs that prompted the Carter administration to prohibit the export of reprocessing technology. With characteristic inconsistency Carter continued to promote the sale of reactors at the same time, thus making the production of more plutonium inevitable anyway. In 1975, at the trial of community activist Sam Lovejoy, who toppled a weather tower in Montague, Massachusetts, to help stop a nuclear project, Dr. John Gofman asked in reference to the plutonium question: "Is there anything you'd like to guarantee will be done 99.9999% perfectly forever?" From Green Mountain Post Films, *Lovejoy 's Nuclear War,* Turners Falls, MA., 1975.

32. *Seattle Post-Intelligencer,* June 15, 1979, p. 1.

told no public report would be made because "such an admission would give bad publicity to the nuclear industry." Another Hanford worker, Allen Wegle, warned in a U.S. Senate hearing that radioactive liquids leaked at Hanford in the 1950s are "just reaching the Columbia River at this time."[33] Though the speed with which Hanford contaminants are moving toward the Columbia is a matter of some dispute, their long half-lives and the quantities poured into the soil make their arrival there at some point in the future a virtual certainty.

And if the Columbia is contaminated, the hundreds of thousands who live along it and who eat fish from it will be put at serious risk. Those who depend on the huge Snake River Aquifer, which has already been contaminated with wastes from Idaho's Nuclear Engineering Laboratory, have similar worries.[34]

Residents on and near the Savannah River, which has been contaminated by the government's huge weapons and waste storage facility at Aiken, South Carolina, are in the same position. Wastes there are stored within thirty feet of a huge aquifer that underlies parts of South Carolina, Georgia, and Florida. One hundred eleven waste accidents have been reported by the DOE at Aiken, and approximately one thousand square miles around the plant have been contaminated by plutonium from a weapons production reactor and reprocessing plants there.[35]

At Hanford dust made radioactive by wastes dumped on the ground has been carried by windstorms into the surrounding desert. Traces of some contaminants have been found at a nearby schoolyard. Contamination has also been detected in mice, snakes, wasp's nests, and coyote trapped nearby.[36]

Leaks at Maxey Flats, Kentucky, have also proved devastating. Maxey Flats handles "transuranic" wastes—materials contaminated by elements such as plutonium, which have a higher atomic weight than uranium. When it was first built, government officials assured local residents that the Maxey Flats burial ground would retain all plutonium and other dangerous isotopes on site forever. But in just ten years detectable quantities of the two hundred pounds of plutonium there had moved hundreds of meters. Tritium was found in streams three miles away. The site was closed in the 1970s.[37]

So far numerous experiments with various means of disposing of rad-wastes have been tried—all without proven success. In the wake of such failure the official focus has been on downplaying the potential dangers—especially in the case of commercial reactor waste. A standard industry claim has been that the fuel for operating a one-thousand-megawatt reactor for a year comes to about two cubic meters. As a public-relations gimmick various utilities have handed out small plastic pellets, which they compare to the size of each person's yearly share.

But the comparisons are deceptive.

First, they ignore the fact that mining and milling the fuel for one average reactor for one year will create roughly 180,000 metric tons of uranium mill tailings—of the type that poured out of the Church Rock dam, and that are sitting in piles throughout the West. According to the NRC's Ross Scarano 1.6 metric tons of tailings occupy a cubic meter of space. Those 180,000 metric tons of tailings created to fuel a reactor for a year will occupy roughly 100,000 cubic meters of space—a long way from the two cubic meters of "rear-end" wastes advertised by the industry.[38]

As for those smaller volumes of "rear-end" wastes that come directly from the reactors, they make up in intensity what they may lack in size.

Longtime nuclear advocate Bernard Cohen, of Pittsburgh, argues that those yearly rear-end wastes "would fit comfortably under a dining-room table."[39]

But anyone eating at that table would have a hard time walking away. The heat and radiation generated by spent fuel demand that it be diluted and spaced apart to avoid a chain reaction. Dr. Marvin Resnikoff of the State

---

33. U.S. Congress, Senate Subcommittee on Environment and Public Works, 96th Cong. 1st sess., September 11 and December 11, 1979, Serial #96-H27, p. 210.

34. Lonnie Rosenwald and Rod Gramer, "So What if the Water's Nuked?" *Progressive,* October 1980; and J. B. Robertson, et al., *The Influence of Liquid Waste Disposal on the Geochemistry of Water at the National Reactor Testing Station, Idaho. 1952-1970,* UC-70 (U.S. Geological Survey, 1970); and Barraclough, *Hydrology.*

35. Alvarez, *Savannah River Study*.

36. *Seattle Post-Intelligencer,* May 3, and June 15, 1979.

37. Marvin Resnikoff, *West Valley: A Challenge for the 80's* (Buffalo: Sierra Club Radioactive Waste Campaign, Box 64, Station G, Buffalo, NY 12224).

38. Ross Scarano, NRC, interview, July 1981.

39. Bernard Cohen, "The Disposal of Radioactive Wastes from Fission Reactors," *Scientific American* 236 No. 6 (1977): 21. Dr. Cohen has one of the most active scientific imaginations on the nuclear scene. See also, "The Role of Radon in Comparisons of Effects of Radioactivity Releases from Nuclear Power, Coal Burning and Phosphate Mining," *Health Physics Journal* 40, No. 1 (January 1981): pp. 19-27.

University of New York at Buffalo estimates those "two cubic meters" would require ten thousand times that much space for safe storage. Any "dining-room table" they'd fit under would need a top the size of a football field and legs ten feet high.[40]

At West Valley, New York, an attempt at commercial reprocessing of spent fuel has left a radioactive legacy that may eventually cost state and federal taxpayers $1.5 billion to clean up—if it can be done at all.[41] In addition to trenches of high-level wastes a "toxic stew" of 560,000 gallons of cesium, strontium, plutonium, and other isotopes is sitting in a leaking tank there. At one point so much potent residue settled out of the liquid that some experts feared it might eat through the vat, releasing large quantities of high-level radiation.[42]

Nearby farmers may already have felt the effects of West Valley's operations. Floyd Zell, who keeps 130 Holsteins four miles east of the plant, told us that while it operated, his dairy herd experienced breeding problems, and that a number of calves were born with deformities he has not seen since the plant shut in 1972. Several he described as "grotesque monsters," including one born blind with its front legs bowed "like it was straddling a barrel." Another came into the world with its tail protruding from the midback, directly opposite the umbilical cord. "Underneath the tail," said Zell, "was the rectum and vulva. Then, down the spinal column, its two hind legs were real miniature, about half the size they should have been. They were tucked way under."[43]

Emil Zimmerman, who keeps seventy Brown Swiss cows one mile east of the plant, charged that fallout from West Valley "took twenty-five hundred dollars per year out of my pocket" while the plant operated. A father of three who has worked the same farm since 1943, Zimmerman said that when West Valley began operations, he was getting a 45 to 50 percent "first service" success rate with artificial insemination of his cows. The last three years it operated the rate dropped to 35 percent, but then jumped to 65 to 75 percent after it shut. Zimmerman said his cows' abortion rate doubled after the plant opened, then dropped back to normal after it closed. He also blamed the reprocessing center for the birth of several "monster calves," some abnormally large, some whose bones "literally fell apart." The problems peaked in the early 1970s, he said, then declined to the point where, in the last few years, he has had no abnormal births at all.[44]

Nuclear Fuel Services, a subsidiary of Getty Oil, owns West Valley. It refuses to accept the burden of cleaning it up. In the fall of 1980 President Carter signed a bill authorizing $300 million in tax money to begin the job. It probably will not be enough.

Other commercial reprocessing and storage sites at Morris, Illinois, and Barnwell, South Carolina, have also been costly failures. And without reprocessing of fuel, or proven storage sites, atomic wastes are backing up at reactor sites all across the U.S. As a result scores of spent fuel assemblies are now being stored in "swimming pools" at the plants. In some cases operators have obtained permission to stack in three times as many fuel assemblies as the pools were originally designed to hold. By inserting control rods and lacing the liquids with neutron-absorbing boron, reactor operators contend they can store the spent fuel safely.

But any geological disruption or structural failure or cooling system breakdown could cause a catastrophic radiation release. There are those who believe the pools themselves are at least as dangerous as the reactors nearby.[45]

Near Lewiston, New York, there are those who believe rad-wastes have already begun to take their human toll. Lewiston was the site of the Lake Ontario Ordnance Works, a military facility. It is sixty miles from West Valley and just ten from the infamous Love Canal.

Between 1944 and 1950 the operators of the ordnance works left 20,489 tons of radioactive waste—most of it

---

40. Resnikoff, "Realities."

41. Marvin Resnikoff, interview, June 1981. Dr. Resnikoff told us costs for waste solidification at West Valley are estimated at $385 million, and for exhuming the low-level burial grounds there at $1 billion. To recoup some of the costs the state of New York has sued Nuclear Fuel Services and Getty Oil. See *NYSERDA v. NFS and Getty Oil,* Civ. 81-18E, Western District of Federal District Court, New York.

42. Minna Hamilton, Sierra Club, interview, May 1981.

43. Floyd Zell, interview, June 1981.

44. Emil Zimmerman, interview, June 1981.

45. In a June 1981 interview, Gordon Thompson of the Union of Concerned Scientists told us he felt that a coupling of cooling systems and the proximity of the storage pools to the reactors made the odds on an accident in those pools "at least as high" as in the reactors themselves. "The danger is very real," he said.

According to the DOE, in 1980 there were some 7460 metric tons of uranium in spent fuel assemblies in the U.S., with a predicted 90,000 tons to be on hand by the year 2000. (*Spent Fuel,* p. 3.)

from the Manhattan Project—strewn around a fifteen-hundred-acre site. Some of the wastes were packed into a reinforced concrete water silo, making it one of the world's most concentrated deposits of radium. But eight thousand tons were also just dumped on the ground, exposed to the elements and likely to be washed into nearby creeks, three of which empty into Lake Ontario.

The Department of the Interior has also confirmed that during the course of plant operations, radioactive liquids were intentionally spilled on the ground after storage tanks were full. "There is no question the material was handled just like any other ore," the DOE's Robert Ramsey told *The New York Times*. "There was just very little regard given to the fact that it was radioactive."[46] Similar attitudes were also in force at a Manhattan Project site in nearby Tonawanda where some thirty-seven million gallons of radioactive chemical wastes were dumped into unmonitored wells.[47]

In early 1981 a report from the New York State Assembly cited "an incredible occasionally surreal history of federal mismanagement" at Lewiston and other toxic dump sites in the area. The mismanagement at Lewiston was "manifested by sloppy and deficient record-keeping procedures, inadequate mapping of buried wastes, and technological primitivism. . . ." Because of high rainfall and poor drainage, it was "clear that the [Lewiston] site should never have been chosen for the storage of radioactive materials in the first place." Federal officials knew of the problems, but "ignored them."

The key determinants of the program were "expediency and economy," and it featured "the dumping of radioactive wastes in open and often unmapped pits in rusting barrels stacked along the roadside, and in inadequate structures originally designed for different purposes. Inevitably these practices and others resulted in the contamination of the . . . site and in the leaching of radioactive contaminants off the site and onto land outside the control of the Federal Government."[48] And, in fact, spot readings at the site showed radiation levels one thousand times above normal.[49]

No official health studies have been done on the area. But informal surveys by local citizens have indicated a frightening aftermath. Dr. Resnikoff reported finding fifteen deformities among twenty deer captured near local dump sites. Initial autopsies of some of them indicated high levels of radium and cesium in their livers.[50]

A local reverend noted twelve new cases of cancer among his eight-hundred-member congregation in the last three months of 1979. And a survey by local resident Donna Siock of eleven households on a street bordering the former ordnance works uncovered nineteen cases of major illness, including respiratory ailments, blood disease, and cancer.[51]

Nearby dump sites also host large quantities of high-level toxic chemicals, so few people in the area believe their health problems are strictly attributable to radiation. But few doubt its lethal contribution. "I think that place is an obscenity," Lewiston resident Danielle DeGolier told us. Of seventy-one people in the immediate vicinity, she said, thirty-three had cancer. Eleven homes in the near periphery reported nine cases of cancer. The nearby elementary school had already suffered four cases of childhood leukemia.

"The World Health Organization says eighty to ninety percent of cancers are environmentally induced," DeGolier told us. "We've got radiation here and every other pollution you can think of. Ten years from now, this place will make Love Canal look like a drop in the bucket."[52]

---

46. Ralph Blumenthal, "Atom Wastes of War Haunt Niagara Area from 'Grave,'" *New York Times,* June 23, 1980 (hereafter cited as "Haunt").

47. New York State Assembly Task Force on Toxic Substances, *The Federal Connection: A History of US Military Involvement in the Toxic Contamination of Love Canal, and the Niagara Frontier Region* (Albany: Task Force on Toxic Substances, January 29, 1981), p. 120.

48. Ibid., pp. i and viii.

49. Blumenthal, "Haunt."

50. Marvin Resnikoff, "Radioactivity Measurements of Four Deer Liver Samples," Sierra Club Radioactive Waste Campaign, March 30, 1981.

51. Blumenthal, "Haunt." See also, Ralph Blumenthal, "Big Atom Waste Site Reported Found Near Buffalo," *New York Times*, January 31, 1981.

52. Danielle DeGolier, interviews, March and April 1981; see also, *Maclean's Magazine* 94, No. 7 (February 16, 1981): 12.

Catastrophe at Kyshtym

In the fall or winter of 1957-1958—within months of the fires at Rocky Flats and Windscale, and while wastes were simmering at Lewiston and Tonawanda and still piling up at INEL, Savannah River, and Hanford—a massive explosion blew apart a radioactive-waste dump in the Ural Mountains of the Soviet Union.

The blast sent huge quantities of radiation into the air. It killed hundreds—possibly thousands—of people. It made permanently unlivable an area at least fifty kilometers square. And it ended forever any possible illusions about the dangers of radioactive waste.

When it happened, Soviet authorities quickly muzzled news of the disaster. So did the Central Intelligence Agency, which knew about it within the year, but kept it secret from the American public for two decades. Word of the explosion finally leaked into the western press in 1976, when emigre scientist Dr. Zhores Medvedev published "Two Decades of Dissidence" in the British journal *New Scientist*. The article was primarily about Soviet science. But in the course of his discussion Medvedev devoted a section to the Kyshtym accident, which he attributed to sloppy Soviet handling of rad-wastes.

"There was an enormous explosion, like a violent volcano," Medvedev explained. "The nuclear reactions had led to an over-heating in the underground burial grounds. The explosion poured radioactive dust and materials high up into the sky." The human fallout was "terrible. . . . Tens of thousands of people were affected, hundreds dying, though the real figures have never been made public. The large area, where the accident happened, is still considered dangerous and is closed to the public."[53]

Medvedev's passing descriptions drew outraged attacks from an unexpected quarter—Sir John Hill, head of the United Kingdom Atomic Energy Authority. Hill called the story "rubbish," "pure science fiction," and "a figment of the imagination." In a letter to *The Times* (London), Hill charged that "there may have been some other accident, but at a time when the public are concerned about the problems of nuclear waste I feel I should make it absolutely clear that in my view the burial of nuclear waste could not lead to the type of accident described."[54]

Medvedev was bewildered by the response. The accident was well known in the Urals. Having been exiled from Russia for his "western" views, he was now being blasted in the West for mentioning something he had assumed was common knowledge.

But within a week after the controversy began, news stories appeared in *The Denver Post, Los Angeles Times,* and elsewhere, acknowledging that an accident had taken place. The articles relied on "American intelligence experts"—the CIA—who asserted the accident was caused by a runaway reactor. The agency knew otherwise, but its "experts" said estimates of "hundreds of deaths and thousands of injuries" were "hard to believe."[55]

A month later a Russian emigre named Lev Tumerman wrote the *Jerusalem Post* that in 1960 he had driven through the Urals and had seen a road sign that "warned drivers not to stop for the next 30 kilometers and to drive through at maximum speed. On both sides of the road as far as one could see the land was 'dead'; no villages, no towns, only the chimneys of destroyed houses, no cultivated fields or pastures, no herds, no people. . . . nothing. The whole country around Sverdlovsk was exceedingly 'hot.' An enormous area, some hundreds of square kilometres, had been laid waste, rendered useless and unproductive for a very long time, tens or perhaps hundreds of years."

As for the crucial question of what had actually caused the accident, Tumerman said, "I cannot say with certainty" whether waste was the culprit. "However," he added, "all people with whom I spoke—scientists as well as laymen—had no doubt that the blame lay with Soviet officialdom who were negligent and careless in storing nuclear wastes."[56]

Ironically Tumerman was an avid supporter of nuclear power and had written to the *Post* in part to assure the Israeli public that the catastrophe had not been caused by a reactor.

Now, still under attack, Medvedev began a painstaking survey of Russian scientific literature. Though explicit mention of the accident was banned, scores of scientists had gone to the Urals to study its aftereffects. One of Kyshtym's great ironies was that despite official secrecy far more will be known to future generations about the

---

53. Zhores Medvedev, "Two Decades of Dissidence," *New Scientist*, November 4, 1976, pp. 264-267; see also, Zhores Medvedev, "Facts Behind the Soviet Nuclear Disaster," *New Scientist*, June 30, 1977, pp. 761-764 (hereafter cited as "Facts").

54. Zhores Medvedev, *Nuclear Disaster in the Urals* (New York: Vintage, 1980) pp. 5, 6, and 14.

55. Ibid., pp. 6-7.

56. Ibid., pp. 11-12.

radiation damage surrounding it than about either Windscale or Rocky Flats, where official scientific follow-up was virtually nonexistent.

Medvedev knew that his former colleagues had written more than a hundred studies involving lakes and the fish in them, insects, mammals, birds and vegetation that were "somehow" exposed to heavy doses of radiation in late 1957 or early 1958. By identifying the types of plant and animal life, the weather patterns, and other key features of the area, Medvedev pieced together an indisputable portrait of the "vast nothing" created by the catastrophe.

With the 1979 publication of his *Nuclear Disaster in the Urals* even John Hill capitulated. "As a piece of scientific detection work," Hill conceded in *New Scientist,* "Medvedev's book . . . makes a very strong case for the occurrence of a major nuclear accident in the southern Ural region."[57]

In late 1979 a special report from the Oak Ridge National Laboratory confirmed that a system of fourteen lakes had been contaminated by the Kyshtym blast. About thirty small towns listed in Soviet maps before the accident were gone from contemporary maps.[58]

After being forced by a Freedom of Information suit to release some of its documents, the CIA also confirmed the accident. As early as 1959 the agency had obtained eyewitness accounts confirming that "all stores in Kamensk-Uralskiy which sold milk, meat and other foodstuffs were closed as a precaution against radiation exposure, and new supplies were brought in two days later by train and truck. The food was sold directly from the vehicles, and the resulting queues were reminiscent of those during the worst shortages during World War II. . . . The people in Kamensk-Uralskiy grew hysterical with fear, and with incidence of unknown 'mysterious' diseases breaking out. A few leading citizens aroused public anger by wearing small radiation counters which were not available to everyone. . . ."[59]

One eyewitness reported a "terrific explosion" that made the ground and buildings shake, and that resulted in all the leaves on nearby trees being covered with "a heavy layer of red dust. . . . Very quickly all the leaves curled up and fell off the trees" and leafy green vegetables also "curled up and died."

The agency learned of a hospital "completely filled with victims of the explosion. . . . Some were bandaged and some were not. . . . The skin on their face, hands and other exposed parts of the body was sloughing off."

Meanwhile homes had been burned to prevent people from reentering them, and many local citizens "were allowed to take with them only the clothes in which they were dressed." There was also "common knowledge" that the area "had an abnormally high number of cancer cases."[60]

"One of the current topics of conversation at the time," said another source, "was whether eating fish or eating crabs from the radioactive rivers of the area was more dangerous. . . . Hundreds of people perished and the area became and will remain radioactive for years."[61]

Once news of the accident leaked out, official American response was restrained. "We've handled tens of thousands of pounds of this stuff now for better than 30 years," said John O'Leary, then the Carter administration's deputy secretary of energy. "You can say they had an accident there. But what does that say? It says they were careless."[62]

U.S. experts and analysts generally theorized the Urals catastrophe had been caused by a chemical or steam explosion, and that it could not happen here. "They don't know what they're doing and we do," said one Ford administration official. American wastes "leak, but they don't explode."[63]

---

57. Ibid., afterword.

58. J. R. Trabalka, et al.,*Analysis of the l957-58 Soviet Nuclear Accident*, ORNL-5613 (Oak Ridge: Oak Ridge National Laboratory, December 1979), pp. 12-17. This report also contains an interesting discussion of speculative causes of the accident, on p. 41.

59. Central Intelligence Agency, *Accident at the Kasli Atomic Plant,* Report #CS 3/389, 785 (Washington, D.C.: CIA, March 4, 1959). In citing this and other CIA reports by date and number, we are trying to best approximate their exact source. But given the heavily censored and rough photocopied state of the documents in our possession, some of the dates and/or numbers here may not correspond properly to the quoted material. The information itself, however, seems incontrovertible. See also Medvedev, *Nuclear Disaster in the Urals,* and "Facts."

60. Central Intelligence Agency, *Miscellaneous Information on Nuclear Installations in the U.S.S.R.,* Report #CS K-3/465,141 (Washington, D.C.: CIA, February 16, 1961); and *Mysterious Explosion in Chelyabinsk Oblast/Possible Radioactive Fallout Causing Destruction of Trees and Vegetation/Many People Burned as Result of Explosion,* Report #3,202,034 (Washington, D.C.: CIA, January 17, 1962).

61. Central Intelligence Agency, *1958 "Kyshtym Disaster"/Nuclear Accident Involving Plutonium Wastes from Military Nuclear Reactors*, Report #B-321/06645-77 (Washington, D.C.: CIA, March 25, 1977). These documents were made public as a result of a Freedom of Information suit.

62. Richard Corrigan, "Nuclear Disaster—Could Whatever Happened There Happen Here?" *National Journal*, August 19, 1979, p. 1329.

63. Ibid.

A special 1972 AEC report warned otherwise. Entitled "WASH-1520," the study said a waste-dumping trench at Hanford—labeled Z-9—had been pumped with wastes containing plutonium. The plutonium had clustered. About one hundred kilograms of it—enough for at least ten Nagasaki-sized bombs—had accumulated in about eighteen hundred cubic feet of soil. That, warned "WASH-1520," led to a situation where "it is possible to conceive of conditions which could result in a chain reaction."[64]

The report emphasized that the chances of that were minimal. But Congress hastily voted two million dollars, and the trench was dug up.

How close we came to a Kyshtym at Hanford is unknown. A better question might be how close we *will* come at Hanford, at those reactor site "swimming pools," at Lewiston, at West Valley, at Savannah River, and at INEL. The United States, John O'Leary assured the *National Journal*, has developed "elaborate standards" for dealing with radiation. But, he conceded, "tomorrow morning you could have a very bad accident because of stupidity."[65]

Kyshtym was "a tragedy of extraordinary dimensions," added Richard Pollock of Ralph Nader's Critical Mass Energy Project, which had sued for the release of the CIA documents. The explosion of nuclear wastes had underscored the dangers of both weapons production and the "peaceful atom." Pollock called for a moratorium on nuclear reactor construction, and asked: "Will U.S. energy policy makers be willing to accept the risk of hundreds of square miles of heavily contaminated cropland or metropolitan areas as the price for electricity? Will we be willing to write off a New York or Chicago or a Seattle or Miami as the Soviets have with cities in their country?"[66]

---

64. Medvedev, *Nuclear Disaster in the Urals*, pp. 152-153.

65. Corrigan, "Nuclear Disaster."

66. Richard Pollock, in *Nader Group Discloses Federal Report Confirming Soviet Nuclear Accident in 1957-58* (Washington, D.C.: Critical Mass Energy Project, P.O. Box 1538, Washington, D.C. 20013; February 14, 1980).

PART IV

The "Peaceful Atom"

11
The Battle of Shippingport

Dwight Eisenhower stood in the Oval Office of the White House and waved what his press secretaries had dubbed a "neutron wand." The date was May 23, 1958, a year in which the United States would detonate seventy-seven atomic tests, but one that would also see the first tentative test ban agreement. The ceremonial shaft, which had been topped with a futuristic phosphorescent bulb, passed through an electric eye as Eisenhower waved it. The President thus tripped a circuit that fired up America's first commercial atomic reactor—at Shippingport, Pennsylvania, three hundred miles west of the White House.

Shippingport, he said, "represents the hope of our people that the power of the atom will ease mankind's burdens and provide additional comforts for human living."[1] The global impact was hard to overstate. Shippingport embodied a fervent promise that the technology that had obliterated Hiroshima and Nagasaki would at last serve some useful peacetime purpose.

Eisenhower had set the stage four and a half years earlier. In December of 1953, just prior to the first hydrogen bomb blasts in the Marshall Islands, Eisenhower told the United Nations that America was committed to turning its nuclear sword into a plowshare. Atomic power would generate electricity to help build a better world. "The United States," he said, "pledges before you—and therefore before the world—its determination to help solve the fearful atomic dilemma—to devote its entire heart and mind to find the way by which the miraculous inventiveness of man shall not be dedicated to his death, but consecrated to his life."[2] As Eisenhower introduced the "peaceful atom," nuclear weapons testing continued in Nevada and in the Pacific.

Nuclear reactors had been in use in the U.S. since the early 1940s. Their chief function had been to generate plutonium for use on Nagasaki, and in later tests. But as a by-product these reactors also generated large quantities of heat. By harnessing this heat to boil water, steam would be created to turn turbines and generate electricity. Given the apparently infinite power of the atom, there seemed no reason why nuclear electricity could not also be infinitely inexpensive, or—as its supporters would later put it—"too cheap to meter." A new industry had been born.

But America's private utilities were skeptical. With a few exceptions its generally conservative executives were worried about the dangers of a nuclear accident and the risks of sinking so much capital into an untested technology. It was only with government-insurance guarantees, fuel subsidies, and lavish research-and-development help that commercial atomic power moved ahead. Even at that, private utilities did not become heavily involved until faced with the threat of being squeezed out of business by federal competition in the form of the Tennessee Valley Authority and other government-owned utilities. To this day TVA remains the nation's single largest reactor buyer. As Sam Day, former editor of the *Bulletin of the Atomic Scientists,* told us: "The private electric companies did not jump into nuclear power. They were kicked in."[3]

Gofman and Tamplin

One enthusiastic backer of the peaceful atom, however, was Duquesne Light. As its Shippingport turbine approached full capacity, Duquesne executives saw the fulfillment of a dream. "We went out and found the best

1. Harry Black, *Pittsburgher Magazine*.

2. Dwight Eisenhower, "Address Before the General Assembly of the United Nations on Peaceful Uses of Atomic Energy," New York City, December 8, 1953. (In Public Papers of the Presidents.)

3. Sam Day, interview, June 1981. See also, Irwin Bupp and Jean-Claude Derian, *Light Water* (New York: Basic Books, 1978), p. 35.

contractors," said the company's Earl Woolever more than a decade later. "We built the station following the most exact requirements in less than four years."

In general the plant, located thirty miles northwest of Pittsburgh, seemed to operate trouble-free. Built with strict supervision from the legendary Hyman Rickover, and in the backyard of the giant Pittsburgh-based Westinghouse Corporation, which would become a center of the nuclear industry, Shippingport seemed destined to set the tone for all commercial reactors to follow. "We never had any trouble with it," Woolever boasted to *The Pittsburgher Magazine* years later. It "ran like a top."[4]

The apparent success at Shippingport was heartening news to the nascent reactor industry. Despite his Republican philosophy of a free-market approach, Eisenhower was pouring billions of tax dollars into the development of atomic power. Kennedy and Johnson would follow (by 1980 the Department of Energy would estimate that government subsidies to commercial atomic power would total thirty-nine billion dollars.[5]) The AEC's early predictions that there would be twelve hundred reactors in the United States by the year 2000—two dozen for each state of the Union—began to gain credibility.[6]

In the early sixties, as the test ban treaty took hold, scientists who had devoted long years to fighting for it went back to their laboratories with a sense of pride, accomplishment, and relief. For most of them there was no hint of any further controversies over radiation.

But the furor over bomb testing and the accompanying fallout had sown the seeds of distrust. As early as 1956, just three years after Eisenhower's "Atoms for Peace" speech, the United Auto Workers (UAW) intervened against the construction of the Fermi fast breeder reactor, proposed for the town of Monroe, forty miles south of Detroit.

Led by Walter Reuther and his assistant Leo Goodman, the UAW challenged Detroit Edison's plan as being ill-conceived and untested. The union took the utility all the way to the Supreme Court before losing 7-2. But Justices Hugo Black and William O. Douglas issued a minority opinion full of portent. Allowing an unproven technology to go ahead with such force, they said, was "a light-hearted approach to the most awesome, the most deadly, the most dangerous process that man has ever conceived."[7]

In the early 1960s, as the debate over fallout peaked in the last days of atmospheric testing, the Atomic Energy Commission undertook its first systematic investigation of the health effects of atomic radiation. Nearly eighteen years after the bombings at Hiroshima and Nagasaki, the commission in May of 1963 announced the establishment of a "comprehensive, long-range program exploring in greater breadth and depth . . . man-made environmental radioactivity and [its] effects upon plants, animals and human beings."[8]

The program would be conducted at the Lawrence Livermore Laboratory under the direction of Dr. John Gofman. Gofman seemed the perfect choice. He had been a graduate student under Glenn Seaborg, an atomic pioneer later to become chairman of the AEC. Gofman himself was a brilliant nuclear chemist whose pioneering research helped make possible the discoveries of plutonium and an isotope of uranium, without which atomic reactors would not have been possible.

Gofman had since become a medical doctor and a nationally known health researcher, holding a number of prestigious awards for his work on heart disease.

Most important of all—from the AEC's standpoint—Gofman was an atomic loyalist. During the days of the test ban campaign he had served on the commission's "Truth Squad," which toured the country in the path of Linus Pauling and others, attacking their antitesting opinions.

But soon after taking charge of the AEC's radiation health program, Gofman was submerged in controversy. Summoned to Washington to "discuss radioactive iodine," he found himself in the midst of a heated discussion about Harold Knapp, an AEC scientist whose study of fallout in southern Utah had shown levels of radiation far in excess of commission standards. The real purpose of the meeting, Gofman said later, was to find a way to suppress Knapp's findings, which would, "in effect, make the AEC reports over the past ten years look untrue."[9] After dissecting

---

4. Black, *Pittsburgher Magazine*.

5. Joanne Omang, "Study Says A-Power Has Gotten $40 Billion in U.S. Subsidies," *Washington Post*, December 26, 1980.

6. AEC, *Nuclear Power Growth, 1974-2000,* WASH-1139 (Washington, D.C.: AEC, February 1974).

7. Fuller, *We Almost Lost Detroit,* pp. 118-119.

8. AEC, San Francisco Operations Office, "Biomedical Studies Planned for AEC's Livermore Laboratory," press statement, May 31, 1963.

Knapp’s research, Gofman and three other committee members could find nothing wrong with it. They recommended publication of his paper.

AEC commissioner James Ramey responded by trying to cancel the entire Lawrence Livermore health program. He failed to kill the whole project, but did succeed in reducing its budget.

Soon thereafter Gofman was joined in his research work by Dr Arthur Tamplin. Tamplin had come to Lawrence Livermore from the Rand Corporation. With his doctorate in biophysics he was a veteran of high-level research on the space program and nuclear weaponry. He had welcomed the shift to health work. "Instead of finding out better ways to kill people," he remembered, "I was now finding ways to save their lives."[10]

They began researching the anticipated health effects of Operation Plowshare, a peaceful atom offshoot. It was aimed at using nuclear explosions to dig canals, tunnels, harbors, fuel-storage caverns, river diversions, and the like.

But the program ran afoul of the dangers of radiation. An attempt to use hydrogen bombs to build a port in northern Alaska was scrapped when it was shown the fallout would threaten nearby Eskimos. Plans for blasting natural-gas storage domes into Pennsylvania and Colorado mountainsides were also stopped by citizen opposition.

Inside the AEC, Gofman and Tamplin were coming to some hard conclusions. "By 1967," they later wrote, "we had become thoroughly convinced that the entire approach to the handling of public health and safety aspects of nuclear energy development was erroneous." They expressed their belief that projects such as those envisioned in Operation Plowshare would make "an irreversible contribution of pollution of the earth" and should be abandoned.[11]

For their trouble Gofman and Tamplin soon became known to the AEC hierarchy as "the enemy within." In 1969 they lived up to that reputation by urging a tenfold reduction in the AEC’s maximum permissible radiation doses to the general public from nuclear reactors.

The recommendation stunned backers of the peaceful atom. Gofman’s and Tamplin’s findings had enormous weight; they resulted from six years’ work by men recognized as experts in their field, conducting a major project initiated by the AEC itself.

Before 1969 only a tiny handful of scientists had considered the issue of leaking reactors at all. The leaks in general came from the breakdown of fuel sheathing in the controlled but superhot reactor core. As cooling water flows around the core, it picks up radioactive isotopes, itself becomes radioactive, and carries that through the maze of pipes and valves around the plant.

Some of the emitters then escape through the plant stacks as gases and particulate matter, in particular lethal isotopes of iodine, strontium, cobalt, carbon, cesium, and noble gases. Some—particularly tritium—are also flushed out with waste water and into local rivers and the oceans. Some neutrons and gamma radiation also penetrate the containment vessel that tops the reactor. Such releases are an ongoing aspect of normal power reactor operations.[12]

Both the scientific community and the public had been assured that reactor leakage would be virtually nonexistent, and at any rate would pose no serious health threat. Now John Gofman and Arthur Tamplin were saying otherwise. At a major symposium in San Francisco in October of 1969 they warned that emissions from commercial atomic power plants considered "acceptable" could in fact kill large numbers of people. "If the average exposure of the U.S. population were to reach the allowable 0.17 rads per year average," they warned, "there would in time be an excess of 32,000 cases of fatal cancer plus leukemia per year." And the deaths would occur "year after year."[13]

Thus they recommended an immediate lowering of the legal exposure limit by a factor of ten, to 0.017 rads.

The paper was greeted by a storm of outrage. AEC and industry supporters argued that Gofman’s and Tamplin’s fears were baseless. The tightening of standards, they added, would cost billions of dollars and was simply a financial impossibility for the fledgling industry.

But the two scientists persisted in presenting their findings to the public. In the late fall of 1969, after testifying in front of a Senate subcommittee, Tamplin was ordered by his superior at Lawrence Livermore to submit all future public speeches and writings to the AEC for prior review. It was not for censorship, he was told, but only to give the

---

9. John W. Gofman and Arthur R. Tamplin, *Population Control Through Nuclear Pollution* (New York: Nelson-Hall, 1970).

10. Arthur Tamplin, interview, November 1980.

11. Gofman and Tamplin, *Population Control,* p. 111.

12. W. Boland, et al., "Radioecological Assessment of the Wyhl Nuclear Reactor," NRC Translation #520, May 1978.

13. John W. Gofman and Arthur R. Tamplin, *Poisoned Power* (Emmaus, Pa.: Rodale Press, 1971), p. 96.

commission time to respond.

On that understanding Tamplin submitted a paper he had been asked to present at a Boston meeting of the American Association for the Advancement of Science (AAAS). It was returned to him heavily censored. When Tamplin protested, he was quickly informed that a strong contingent within the AEC had wanted to fire him outright, but that he would be allowed to deliver the paper if he went to the AAAS meeting on his own time, at his own expense.

Soon John Gofman intervened on Tamplin's behalf, and a compromise was reached. Tamplin went to the meeting under commission auspices. But he deleted from his paper a call for a five-year moratorium on reactor construction.

Two weeks later seven of the twelve people on Tamplin's staff were removed from his supervision. His project on estimating internal radiation doses from nuclear facilities was taken away from him. And the following June four more staff members were cut, leaving him one coworker. The actions were not political, said the AEC, but "were taken for reasons related to budgetary reduction allocations, of resources to programs of highest priority and a judgement of relative scientific productivity." By 1975 Tamplin could hang on no longer, and he resigned.[14]

Two years earlier John Gofman had also resigned. His own budget had been slashed, his research and writings were being constantly subjected to AEC scrutiny, his public utterances open to commission harassment.

By the early 1970s the stakes had indeed grown enormous. In 1969, when Gofman and Tamplin issued their call for stricter health standards, ninety-five reactors were already operating, under construction, or on order in the U.S. In 1976 the number would peak at 219. Richard Nixon would by then have labeled nuclear energy the keystone of "Project Independence," designed to make the U.S. free of its need for foreign oil.

"What surprised us beyond belief," Gofman and Tamplin wrote in their book *Poisoned Power*, "was that from all over the country our colleagues in various aspects of nuclear energy, particularly nuclear electricity, expressed their shock and disbelief that such a massive cancer-plus-leukemia risk could conceivably accompany exposure to 'the allowable' Federal Radiation Guideline." Indeed, twenty-five years after Hiroshima, a dozen after the first atmospheric test moratorium, "a whole new industry, nuclear electricity, was growing up in the country with all of its experts totally unaware of the true hazards associated with it."[15]

Enter Ernest Sternglass

Among those scientists who had not considered the possible dangers of atomic power reactors was Dr. Ernest Sternglass. As a Navy technician about to be sent to the Pacific, Sternglass had welcomed the end of World War II—signaled by the atomic bombing of Japan—which "meant I wouldn't have to go fight there."

After the war he worked in the Naval Ordnance Laboratories, got his doctorate from Cornell, and in 1952 joined Westinghouse in Pittsburgh as a researcher. Like dozens of other leading American scientists, Sternglass also campaigned for an end to atmospheric bomb testing. When the treaty was finally signed in 1963, he—like most of his colleagues—"went back to my laboratory and didn't think about radiation issues for a while." In 1967 Sternglass joined the faculty of the University of Pittsburgh, where he headed up the newly created laboratory for radiological physics.

While at both Westinghouse and the University of Pittsburgh, Sternglass worked actively as an inventor. He played a key role in developing a number of radiation-related innovations, including an image tube used in the space program to send back pictures from the moon, and technology key to a new type of gas-cooled power reactor. When we talked with him in the fall of 1980, he was finishing work on a new method using a computer to take X rays without film.

During that interview Sternglass told us that the work of Alice Stewart had first alerted him to the dangers of small doses of radiation. "We all knew from the bombs that large doses could be dangerous," he said. "But when Dr. Stewart showed that small X-ray doses could harm infants *in utero*, that opened up a whole new way of looking at things."

Official researchers had made a crucial mistake in measuring the effects of radiation by looking primarily at damage to genes without also looking at the embryo. "A human fetus in the first trimester of development can be

14. R. S. Lewis, *The Nuclear Power Rebellion* (New York: The Viking Press, 1972), p. 102.

15. Gofman and Tamplin, *Poisoned Power*, p. 98.

many times more radiation-sensitive than human genes," Sternglass said. "When the AEC failed to consider what fallout was doing to infants, they missed the most important effect of them all, and thus vastly underestimated the damage being done by the bomb tests."[16]

In 1969 Sternglass published an article in the *Bulletin of the Atomic Scientists,* contending that some 375,000 American infants had died as a result of atomic bomb testing. The thesis rested on the idea that as medical technology was advancing, the rate of infant mortality dropped, essentially by a constant percentage each year. The better the technology got, the fewer babies were dying at birth. But when the bomb testing began, the rate of decline slowed. When the tests stopped, the rates began to drop again as they had before, in keeping with continued medical advances.

It was the "bump" in the line—a bump involving roughly 375,000 American babies—that Sternglass attributed to radioactive bomb fallout. Particularly important in that calculation was iodine 131, which could travel through the placenta and irradiate the tiny prenatal thyroid. By destroying cells in that crucial gland, in its early stage of development, radiation would cause stunted growth brain damage, and underdeveloped lungs that could make it impossible for the new baby to survive the first few days of life. Congenital deformities, underweight, hypothyroidism, and a breathing problem called hyaline membrane disease can be considered symptoms of I-131 poisoning because of fallout. They had, said Sternglass, slowed the downward trend of infant deaths below what should have been expected during the height of the bomb testing, and in so doing had killed those 375,000 American babies.[17]

Sternglass's assertions came in the same year—1969—as Gofman's and Tamplin's recommendation of a tenfold reduction in exposure levels from atomic reactors.

As shocking as Sternglass's findings seemed, they were by no means the most radical estimates of death from fallout. In 1958—eleven years before Sternglass's article—Nobel prizewinner Linus Pauling had predicted that 140,000 people would die from *each and every* bomb test, a prediction that translated into literally millions of total deaths over time.[18] Pauling also wrote that a single fallout product, radioactive carbon 14, from a single year's bomb testing—30 megatons of explosions—could cause 425,000 embryonic and neonatal deaths (deaths before one month of age), 170,000 stillbirths and childhood deaths, and result in another 55,000 children being born with "gross physical or mental defects."[19] Russian scientist Andrei Sakharov added his own calculation that bomb-produced carbon 14 would kill ten thousand people for every megaton blown off in the atmosphere, a toll that translated into millions of deaths over time. As a "conservative estimate" Sakharov said that testing by the mid-fifties had caused half a million human deaths. "We cannot exclude the possibility that the total number of victims is already approaching 1 million persons," he added and that each year continued testing increases this number by 200 to 300 thousand persons."[20]

A decade later Sternglass was pointing specifically at the American people. He was saying that as of 1969, based on national infant-mortality statistics, about 375,000 American infants had already died from the tests, and countless more American children and adults were suffering ill-effects. Because it dealt with hard statistics about American children, it was an assertion that cut to the very core of the nuclear industry.

Quickly the AEC searched its ranks for someone to refute Sternglass. It chose Arthur Tamplin at Lawrence Livermore. Tamplin dissected Sternglass's study and decided the case had been overstated. Fallout, he said, had killed about 4,000 American babies, not 375,000. The rest of the excess had been due to social factors, including poverty.[21]

The AEC was pleased with Tamplin's findings, and urged him to publish his refutation of Sternglass in *Science*.

---

16. Ernest Sternglass, interview, October 1980.

17. Ernest Sternglass, "Infant Mortality and Nuclear Tests," *Bulletin of the Atomic Scientists*, April 1969. Vol. 25. See also, Ernest Sternglass, "The Death of All Children," *Esquire,* September 1969.

18. Pauling, *No More War,* p. 108.

19. Linus Pauling, "Genetic and Somatic Effects of Carbon-14," *Science* 128, No. 3333 (November 14, 1958).

20. Andrei Sakharov, "Radioactive Carbon from Nuclear Explosion and Nonthreshold Biological Effects," *Soviet Journal of Atomic Energy* (translated from Russian by Consultants Bureau, Inc., 227 W 17th St., New York City; January 1956).

21. Arthur R. Tamplin, "Infant Mortality and the Environment," *Bulletin of the Atomic Scientists* 25 (December 1969): 23-29. See also Metzger, *Atomic Establishment*, pp. 277-278. For an additional view on Sternglass's calculations, see Michael Friedlander and Joseph Klarmann, "How Many Children?" *Environment Magazine* 11, No. 10 (December 1969). The issue also contains a comment from Sternglass.

But they asked him to omit the assertion that the bombs had killed four thousand infants.

Sternglass stuck to his figures—and does to this day. Over the decade-plus since publication of his first major article, he has been frequently attacked. One public-relations firm—Charles Yulish Associates—has published an entire volume aimed at refuting Sternglass; this book is primarily circulated among utility executives. The industry as a whole has devoted thousands of dollars to undercutting his reputation.[22]

Nuclear opponents have also had their complaints. In the wake of Three Mile Island, Tamplin told *The New York Times* that Sternglass "never completes his studies. He doesn't go back several years to see what kinds of fluctuations might be expected, and he doesn't examine enough different areas to get meaningful data."[23]

But as radiation continued to prove more dangerous than previously believed, and Sternglass persisted in his research, key confirmation of his major conclusions continued to surface. In 1969, for example, soon after issuing his estimates on the infant fallout toll, Sternglass attacked the theory of the antiballistic missile system (ABM). The multibillion-dollar proposal, then under serious consideration in Congress, would have placed nuclear missiles around American cities. In case of attack they would be fired into the air. The atomic explosions would then bring down incoming Soviet missiles, thus protecting American soil. Sternglass charged in *Esquire* magazine that such a system would jeopardize the survivability of future human generations. In "The Death of All Children," he argued that just as testing fallout had caused a rise in infant-death rates, radiation released by ABMs exploding over American cities would virtually guarantee that no future children would survive in them—or anywhere else on the planet. "A full-scale ABM system," he wrote, "protecting the United States against a Soviet first strike, could, if successful, cause the extinction of the human race."[24]

Sternglass also outlined his case in the *Bulletin of the Atomic Scientists*, which printed his conclusions alongside a counter-article by Princeton physicist Freeman Dyson, who had worked on the hydrogen bomb. Dyson argued in favor of the ABM. But when he read Sternglass's article, he decided to write the *Bulletin* a letter. "The evidence is not sufficient to prove Sternglass is right," Dyson said. But "the essential point is that Sternglass may be right. The margin of uncertainty in the effects of world-wide fallout is so large that we have no justification for dismissing Sternglass's numbers as fantastic."[25]

Sternglass's conclusions on the ABM also convinced U.S. congressmen Jonathan Bingham of New York and Lucien Nedzi of Michigan, who noted in the *Congressional Record* that his findings made a nuclear first strike "unthinkable." Bingham later said Sternglass's correlation of bomb test fallout to a rise in infant deaths "appears to be the only explanation currently available to explain the excess infant mortality in this country noted in recent years by the Public Health Service." Indeed, Bingham added, "no theory currently has much evidence to support it other than that now offered by Dr. Sternglass."[26]

Sternglass also found later confirmation of some of his fallout conclusions from a most unexpected source—the U.S. Navy. In 1979 he and Stephen Bell, an educational psychologist, presented a paper before the American Psychological Association suggesting that the atmospheric tests were linked to a decline in college-entrance Scholastic Aptitude Test (SAT) scores among American teenagers. The argument hinged on the theory that test fallout had affected the mental capacities of children born downwind. The effects were particularly strong in Utah, said Sternglass and Bell, where average SAT scores among young adults seventeen to eighteen years after the bomb tests had plunged twenty-six points while the decline was much less in control states where fallout levels were much lower. The drop was additionally significant because it had occurred among a nonsmoking, nondrinking, and highly success-oriented Mormon population. Sternglass and Bell further predicted that once children who had been born after the test ban came of age, the scores would again begin to rise.[27]

---

22. C. B. Yulish, ed., *Low-Level Radiation: A Summary of Responses to Ten Years of Allegations by Dr. Ernest Sternglass* (New York: Charles Yulish Associates, 1973). Attacking Ernest Sternglass has posed a particularly difficult problem for the nuclear industry. Most scientists have been dependent on the government or industry for their salaries and grants. As a tenured professor with patents of his own, Sternglass has been financially beyond the industry's grasp, leaving them only his reputation to attack.

23. Jane Brody, "3 Mile Island: No Health Impact Found," *New York Times*, April 15, 1980.

24. Sternglass, "Death of All Children."

25. Freeman Dyson, "A Case for Missile Defense," *Bulletin of the Atomic Scientists*, April 1969; and Dyson, "Comments on Sternglass's Thesis," *Bulletin of the Atomic Scientists*, June 1969, p. 27.

26. Richard S. Lewis, *The Nuclear-Power Rebellion* (New York: Viking, 1972), pp. 68-9.

27. Ernest Sternglass and Stephen Bell, "Fallout and the Decline of Scholastic Aptitude Scores," a paper presented at the Annual Meeting of the American Psychological Association, New York, New York, September 3, 1979.

The paper met with harsh criticism from the nuclear establishment. Among other things, an increase in television watching and the consumption of junk food were blamed for the SAT declines.

But in 1980 a study commissioned by the U.S. Navy substantiated the thesis. The Navy was concerned that its increasingly complex weapons technology was outstripping the abilities of new recruits to manage it, and it worried about a decline in the mental abilities of American youth. Researchers Bernard Rimland and Gerald Larson agreed that radiation probably played an important role. In terms of the SAT, they said, the findings were "consistent to the hypothesis that the proximity to the tests or high rainfall downwind from the point of detonation should lead to the largest decline."

In fact, Rimland and Larson added: "The state having the largest drop in scores from children born during this two-year period [1956-58] was Utah, a fact which is consistent with Utah's proximity to the Nevada Test Site and the general northeastern motion of the fallout clouds produced by the Nevada tests." Thus they said, "Sternglass and Bell provide very convincing and disquieting evidence closely linking the SAT score decline to the cumulative effects of nuclear fallout." "I wish it weren't so," Bernard Rimland told us in a 1981 interview, "but I don't think anyone could look at the data and come to any other conclusion. Sternglass's work is very sound and very convincing."[28]

But by the time Rimland and Larson had confirmed Sternglass's findings on fallout, another radiation source—atomic power reactors—had moved to center stage.

Showdown at Shippingport

In May of 1970 the Shippingport atomic plant was generally well accepted by the people of western Pennsylvania. So there were few objections when Duquesne Light opened hearings for a new reactor project to be built a few hundred yards away. The multireactor complex would be named after the area—Beaver Valley. It would be financed by a consortium of five utilities serving some 2.3 million customers. The first 850-megawatt unit at the plant would be on line by the mid-1970s.

Almost by chance Ernest Sternglass decided to take a look at the Environmental Impact Statement for Beaver Valley. To his surprise he found that the plant operators were planning to emit sixty thousand curies per year, an amount he termed "absolutely unthinkable."

"We already knew that small doses from fallout were causing problems with pregnant mothers and infants," Sternglass told us. "And here Gofman and Tamplin had pointed out that the allowed reactor dose of one hundred seventy millirems could kill thirty-two thousand people per year. And then to see that for Beaver Valley they were talking about regular releases of sixty thousand curies per year, which even without an accident meant a high dose for people all around the plant . . . well, it was totally unacceptable."[29]

By this time plans to build Beaver Valley were well under way. In keeping with federal regulations, Duquesne Light had contracted with the Nuclear Utilities Services Corporation (NUS) of Rockville, Maryland. NUS specialized in site surveys for utilities preparing environmental assessments for nuclear reactors.

Beginning in January of 1971 NUS technicians worked their way through the Beaver Valley, monitoring game animals, testing river and well water, sampling the air and soil, and inspecting conditions at local dairy farms. In April of 1972 NUS's conclusions began finding their way into the offices of Duquesne Light. By the end of the year the utility had a full report to send to the media.

But the supervisor of the new plant, in an effort to convince Sternglass the project would be safe, sent him a copy of the report. Sternglass read it and labeled it "a bombshell." Among other things the NUS survey indicated that radiation levels in the vicinity of the existing Shippingport reactor far exceeded normal expectations—by as much as a factor of fifty thousand.

Sternglass quickly issued a paper accusing the operators of the nation's premier commercial reactor of misrepresenting how much radiation was leaking into the environment. In fact, said Sternglass, the NUS statistics showed that levels of strontium 90 in milk at six nearby farms "followed the rises and declines of the monthly power output of the Shippingport plant." The strontium levels only went down when the plant shut for repairs.

---

28. Bernard Rimland and Gerald E. Larson, "Manpower Quality Decline: An Ecological Perspective," *Armed Forces and Society,* Fall 1981; and Rimland, interview, August 1981.

29. Sternglass interview. See also, Anna Mayo, "Necrophiliac Nit-Pickers," *Village Voice,* September 11, 1973.

Sternglass also charged that the NUS study showed iodine 131 levels in local milk to be 21 percent above federal standards, a factor of at least ten above what was being found anywhere else in the eastern United States. Radiation levels in Ohio River bottom sediment also "rose and subsequently declined after the plant was shut for repairs."

And perhaps most significant of all, one monitoring station inside the town of Shippingport had shown radiation levels as high as 375 millirems per year—more than twice what Gofman and Tamplin had just predicted would create extraordinary cancer and leukemia deaths nationwide. Thus, said Sternglass, radiation from the Shippingport plant was killing people, lots of them.[30]

Sternglass’s paper shocked Duquesne Light into drastic action. Significantly the company did not attack his mathematics. After all, as put by Joel Griffiths who covered the story for the *Beaver County Times*, NUS had done a "thorough job. They found radioactivity in the air, milk, soil, drinking water and just about everywhere."[31]

Duquesne did not challenge the presence of the radiation. Instead they blamed it on bomb fallout.

However the only recent tests had been staged by the Chinese. That fallout went everywhere, not just Shippingport. And Shippingport’s radiation levels were far above the national average.

Thus the AEC’s own Earth Sciences Branch, which conducted an in-depth investigation, soon concluded that "it is highly unlikely that the radioactivity was of Chinese origin. Most likely it was either of local origin or the result of inadequate sampling procedure."[32]

Until Sternglass released his paper, Duquesne Light had enjoyed the reputation of operating "the safest nuclear power plant in the world" at Shippingport. In 1971, the year previous, it had actually recorded zero radiation releases from the plant stacks, the first time any commercial reactor had claimed such an accomplishment.

But NUS had contradicted that record and had thrown the multimillion-dollar Beaver Valley project into a political morass. Something had to be done. As Griffiths put it, "a sharp divergence of opinion" soon emerged between NUS, Duquesne Light, and the AEC. "Faced with a choice between attributing the radioactivity to Shippingport or NUS’ incompetence, the AEC and others picked incompetence and began levelling various technical charges against the NUS reports."[33]

And that, wrote Griffiths, put NUS "in a delicate position"—not unlike that of so many other atomic scientists whose data had somehow unearthed conclusions the nuclear industry did not want to hear.

NUS was an established and respected operation. It was staffed with scientific experts, and it had done radiation monitoring for more than thirty other reactor sites. To undercut their credibility was to jeopardize the licenses of many other expensive projects already under way, with potentially enormous political and financial consequences.

Under tremendous pressure NUS reevaluated its findings. In March of 1973 it reported that its high readings around Shippingport were accurate. But they said the radiation had come from Chinese bomb fallout.

That conclusion was rejected out of hand by none other than Dr. John Harley, director of the AEC’s Health and Safety Laboratory. Harley promptly labeled NUS’s work "incompetent" and said an investigation "would certainly turn up gross calculation errors or even that some doctoring of numbers had occurred. . . .

"I believe," he added, "the situation is very serious."[34]

Three months later NUS had a startling new revelation to disclose. Throughout the entire controversy it had maintained that it was standard NUS policy to discard all samples. But now the company announced that somehow, in this one case, some of the soil originally tested around Shippingport had been unexpectedly found in a basement in Maryland. NUS "restudied" the samples.

Soon thereafter it "admitted" that its original sampling techniques—which had been applied at thirty-four other reactor sites—were simply in error. They said there was, after all, no extraordinary radiation around Shippingport.

---

30. Ernest Sternglass, "Significance of Radiation Monitoring Results for the Shippingport Nuclear Reactor," Pittsburgh: January 21, 1973 (hereafter cited as "Shippingport").

31. Joel Griffiths, "State Panel Questions Radiation Safety," *Beaver County* (Pa.) *Times*, June 7, 1974 (hereafter cited as "Safety").

32. Ibid.

33. Ibid.

34. Ibid.

The Shapp Commission

But Ernest Sternglass had not merely publicized the news of NUS's original radiation readings. He had also charged that an extraordinary rate of infant deaths had surfaced in communities around the reactor. It was not the first time he had made such a charge.

In the fall of 1970—a year after Gofman and Tamplin published their findings linking cancer deaths to radiation releases from reactors—Sternglass had begun to look at infant-mortality rates near a number of plants. He soon found that the area around the Dresden reactor near Chicago had experienced a significant rise in infant deaths in nearby counties and in the huge urban area downwind. Surveys of the populations near reactors at Hanford, California's Humboldt plant, and Indian Point, near New York City, showed similar impacts, as did a study of the environs of the West Valley reprocessing and waste storage facility in upstate New York.[35]

In July of 1971 the pattern of Sternglass's initial findings was given substantiation by Dr. Morris DeGroot, then chairman of the Department of Statistics at Pittsburgh's Carnegie-Mellon Institute. In his papers, and in interviews with us, DeGroot emphasized that his findings were only preliminary. But his statistics indicated a tentative correlation between reactor emissions and health problems at Dresden, Indian Point, and around the Brookhaven reactor on Long Island, New York.[36]

DeGroot also studied the reactor at Shippingport, and did notice a rise in infant-mortality rates there. But they did not seem to be directly correlated to the recorded radioactive emissions.

Now, however, Ernest Sternglass charged that the revelations from the NUS findings confirmed that the emissions must have been larger than Duquesne Light was publicly acknowledging. And that there was, in fact, a correlation to infant-death rates nearby.

Nine miles downwind in the town of Aliquippa, Sternglass found a twenty-year high in infant-mortality rates. Rises in fetal mortality, underweight births, and leukemia were also evident. And communities down the Ohio River had suffered infant-mortality rises that corresponded with emissions from both Shippingport and the nearby Waltz Mills reactor.[37]

Shippingport had now become front-page news. By April of 1973 Pennsylvania governor Milton Shapp was appointing a high-level commission to look into the affair. The commissioners included DeGroot, Dr. Karl Z. Morgan and Dr. Edward Radford, an expert in the health effects of radiation who would later chair the National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation (the BEIR committee). Also on the Shapp Commission were Dr. Paul Kotin, of Temple University's School of Medicine, and Dr. Harry Smith, dean of the School of Management at Rensselaer Polytechnic Institute.

Perhaps more important, the commission also had three staff members, all of them attached to the state of Pennsylvania. One was Thomas Gerusky, chief of the state's Department of Radiological Health. The second was his assistant, Margaret Reilly, who headed that department's Office for Environmental Survey. And the third was Dr. George Tokuhata, director of the state's Bureau of Epidemiological Research. All three would later become key figures in defending the nuclear industry at Three Mile Island.

The Shapp Commissioners concerned themselves first with the question of abnormal releases of radiation from the plant. Once the NUS findings had been revised, there was "no substantial evidence" that emissions had been greater than Duquesne Light had reported. But an "absence of comprehensive off-site monitoring" meant that Sternglass's assertions could not be denied, either.

Indeed Duquesne Light had been "derelict" in its radiation monitoring duties. Its programs were "inadequately designed" and a precise determination of how much radiation was leaking from Shippingport simply "was not possible."

---

35. Ernest Sternglass, "Environmental Radiation and Human Health," in *Proceedings of the Sixth Berkeley Symposium on Mathematical Statistics and Probability* (held at the University of California, Berkeley, April-July 1971), pp. 145-221.

36. Morris DeGroot, "Statistical Studies of the Effect of Low-Level Radiation from Nuclear Reactors on Human Health," in *Proceedings of the Sixth Berkeley Symposium on Mathematical Statistics and Probability,* presented at the Conference on "Planning an Epidemiological Study of Pollution Effects," University of California, Berkeley, July 19-22, 1971. In a letter to Senator Edwin G. Holl (October 20, 1970), DeGroot wrote: "At the present time, a certain segment of the scientific community maintains the hypothesis that exposure of a population to radioactive gaseous discharges at the levels currently being observed for the Dresden plant increases the infant mortality rate for that population. After having carried out the statistical analysis mentioned here, I believe that there is substantial probability that increased exposure to radioactive discharges does cause an increase in the infant mortality rate."

37. Sternglass, "Shippingport."

As for NUS, the commission charged the company with "inadequate and careless methods" and found it "difficult to understand why at this late date NUS now finds its early reported high values were false when several different and independent types of analyses were involved."

In fact, reported the commission, there were indications from federal network studies that the initial "uncorrected" NUS figures may have been accurate. The federal studies had shown "high levels of Sr-90 in milk and of Sr-90 and Cs-137 in total diets of Pittsburgh residents."[38] Commissioner DeGroot said it was "highly unlikely that NUS could have made systematic errors, all in one direction, in several different analytical techniques."

Commissioner Morgan was more direct. "There appears to be," he said, "a strong suspicion of dishonesty." He later added, "For a long period now the radioactivity levels in milk in that general area have been high according to the public health agency surveys, which are completely separate from the NUS survey. This has never been explained."[39]

As for infant-mortality and cancer rates, the commission also reported mixed conclusions. And this may have been a function of the staff.

As deliberation on Sternglass’s figures began, Dr. Tokuhata shifted the numbers according to DeGroot. He told the commissioners that some of the crucial local health statistics were "inaccurate" and reflected higher numbers of infant mortalities than actually existed. Some communities, he said, listed infant deaths that did not belong there because people came from elsewhere to use the hospitals, and were thus not actually town residents. After finding other "inadequacies" in the official data, Tokuhata vastly reduced the numbers on which Sternglass had based his conclusions.[40]

Tokuhata then repeated the method of adjusting the statistical base for cancer death rates. Sternglass had charged that after a five-year latency period following the opening of the reactor, cancer death rates had increased in the Shippingport environs. But when Tokuhata presented the numbers to the commission, they included the entire decade of the 1960s, averaging in the first five years of reactor operations—when no latency period had passed—with the second five, when cancer rates did start to rise.

Thus the revised statistics gave the impression that the reactor had had no effects. And thus the commission concluded that there was no "systematic pattern" of deaths increasing with proximity to the plant.[41]

There were other criticisms of Sternglass as well. Dr. Radford stressed that rising infant-mortality rates could have been attributable to additional social and environmental factors. In a letter to us Radford characterized Sternglass’s methods as "quite incorrect."[42]

But the commission remained deeply divided. DeGroot, for example, acknowledged the validity of Tokuhata’s initial changes in the infant-mortality statistics. But he warned that the key comparisons were being made year-by-year and town-by-town. Thus he outlined to us in a series of letters and interviews that it was wrong for Tokuhata to subtract deaths for one year in one community without making similar corrections for other years and other communities that were serving as controls. Changing the numbers for just some towns, and just for 1971, would result in statistical changes going all one direction—down.

In a letter to us Tokuhata denied comparing altered 1971 Aliquippa-area numbers with unaltered figures for other areas in other years. He acknowledged that "time and staff constraints" did not allow making such changes for times or places other than the Aliquippa area in 1971.

But there was then some question as to what purpose the Aliquippa-area alterations could possibly serve. DeGroot worried that Tokuhata had only done "half the job" of correcting the statistics. He said that throwing infant deaths out of Aliquippa without correcting for area children born in nearby Pittsburgh hospitals—which were attractive to Aliquippa residents because they were generally believed to be of higher quality than local hospitals—would make the Aliquippa-area infant-death problem seem less serious than it really was.[43]

---

38. Governor’s Fact Finding Committee, "*Shippingport Nuclear Power Station Alleged Health Effects*" (State of Pennsylvania, 1974) (hereafter cited as *Shapp Report*).

39. Griffiths, "Safety," Dr. Karl Z. Morgan told Griffiths he thought Duquesne Light’s radiation monitoring program was "worse than none at all" because whenever a high reading would surface, the utility "sat on it."

40. Ibid.

41. *Shapp Report*. See also, Sternglass, *Secret Fallout*, pp. 139-177.

42. Edward Radford, letter to authors, February 4, 1981.

43. Morris DeGroot, interviews, April and July 1981; DeGroot, letter to authors, May 13, 1981; and George Tokuhata, letter to authors, June 4, 1981.

Tokuhata had also made a point of comparing health statistics in the Shippingport area with the state averages. But infant-death rates around Shippingport had been significantly *lower* than the state average before the plant opened. Thus their correspondence to the state average actually represented a *rise* that could be attributed to the opening of the reactor. It was a statistical deception that would surface again at Three Mile Island.

Overall, the commissioners concluded that "no sufficient evidence" could be found to confirm charges of an escalated infant-death rate, but "neither can they be refuted from available data." The commissioners also said it was impossible to determine "whether the infant-mortality rate in Aliquippa is or is not higher than would be expected." But there was a "considerably higher" death rate there "when white infants are considered separately" from nonwhite infants.

And though the leukemia death rate for the five-mile area around the plant seemed to correspond to the state average, the death rate from other neoplasms was "slightly higher than the state average for the five-mile area and for the ‘on-river’ communities."[44]

In general the industry and the media took the Shapp report as a refutation of Sternglass’s charges. "We found," Tokuhata told us in a 1981 interview, "that his allegations just were not true. The data simply did not back up his conclusions."[45]

But two of the commissioners saw it differently. Sternglass had been criticized for basing his conclusions "only on crude published mortality data," said DeGroot in an appendix to the commission’s final report. "But those are the only data available." The criticism, he said, "should more properly fall" on public-health agencies "that have neither collected nor published" the necessary statistics.[46]

Dr. Morgan later told a congressional hearing that "some members of the public, perhaps even some members of the panel, interpreted our report to say that we had refuted the allegations of Dr. Sternglass. However, I did not put that interpretation on our report. And I think it is only fair to say that it is a fact that the levels of strontium and cesium in and about Pittsburgh and neighboring counties were higher than in other parts of the state and in other parts of the nation."

Morgan emphasized that he did not believe those levels were necessarily associated with Shippingport. But it was also clear that "the illnesses and infant mortality [were] higher than in other parts of the state and in other parts of the nation in these populations. One can attempt to give reasons for it, but I don’t think a satisfactory answer was found."[47]

One thing the commissioners did agree on was that Duquesne Light’s radiation monitoring apparatus was totally inadequate. It thus recommended that "the government carry out comprehensive evaluation of radiation exposure of the public around nuclear facilities. Where the possibility of significant exposure exists, appropriate epidemiologic evaluation of the health of these populations should be undertaken."[48] Toward that end it presented a long list of changes to make it possible to determine exactly how much radiation was leaking from Pennsylvania’s nuclear power plants, and what effect it might be having on the public.

But six years later, just after the accident at Three Mile Island, Dr. Thomas Gerusky—who was in charge of radiation monitoring for the state and who had served on the staff of the Shapp Commission—admitted that "to the best of my knowledge, not a single one of those recommendations was implemented. There just wasn’t enough money for the program."[49]

Meanwhile Duquesne Light began building two reactors at the Beaver Valley site.

---

44. *Shapp Report*.

45. George Tokuhata, interview, February 1981.

46. Morris DeGroot, "Comments," in *Shapp Report*.

47. *Radiation Standards and Public Health: Proceedings of a Second Congressional Seminar on Low-Level Ionizing Radiation* (sponsored by the Congressional Environmental Study Conference, the Environmental Policy Institute, and the Atomic Industrial Forum, Washington, D.C., February 10, 1978), p. 46.

48. *Shapp Report*.

49. Richard Pollock, "Business as Usual in Pennsylvania," *Critical Mass Journal,* December 1979, p. 7.

12
How Much Radiation?

Jane Lee is a tough-talking widow in her forties. From the kitchen of her family's stone farmhouse in Etters, a tiny town in central Pennsylvania, Lee has watched the quiet countryside around her undergo some dramatic changes.

Few rural areas in the United States have remained as well kept as the hill country around Harrisburg, a town of fifty thousand some 125 miles west of Philadelphia. With a large population of conservative, slow-moving "plain folk" from the Amish and Mennonite tradition the farm regions of the Susquehanna Valley still boast some of the most beautiful and bountiful acreage in the world. Lush, deeply cultivated fields and sturdy, well-kept barns are hallmarks of an area where traditional Dutch folk symbols still mean much more than mere souvenirs.

The deepest changes in this countryside of Jane Lee's have been the invisible kind—stemming from radiation. In the mid-1960s Metropolitan Edison, a subsidiary of the General Public Utilities (GPU) holding company, decided to build a massive atomic power complex. The plant would be at Three Mile Island, a narrow piece of land in the middle of the Susquehanna River, ten miles southeast of Harrisburg. The first 819-megawatt unit was ordered from Babcock & Wilcox reactor producers in 1966. By 1974 it was on line.

There was little opposition to TMI-1. But Jane Lee had spoken out about it. The state had already tried to put a toxic-waste dump on a nearby hilltop, where runoff would pollute the water table. "If the authorities were dumb enough to want to do something like that," Lee told us, "then I didn't think they could be trusted with a nuclear power plant either."

Living Next to Reactors

Lee's opposition to the project had made her visible. Two years after TMI-1 opened, she began to get complaints from her neighbors that strange things were happening to their animals. "We're all accustomed to having an animal die here and there, or some birthing problems, or an off-year with crops and the like," she told us. "But this seemed very new. All of a sudden we were being plagued with a whole lot of bizarre things. And when you have farmers telling you their animals are falling down and can't get up, or there are miscarriages, eggs not hatching, calves being born deformed, hair falling out and cows dying, and that people who have been farming here for decades can't find any explanation for it, well, you start to wonder."

The "wondering" led just one place—Three Mile Island. In a room behind her kitchen, three miles from the plant, Lee began accumulating files, collecting signed statements from those of her neighbors who were willing to put their animals' problems down on paper. "This isn't an area where people are used to speaking out," she told us. "It hasn't been easy to get people to come forward."

As we talked in the chilly dampness of early spring, Lee showed us photographs of a badly deformed litter of kittens, born in 1978. One appeared normal, a second was born with its hair in splotches, the final two were hairless runts, born dead. "The cats get a triple dose of radiation," Lee said. "They get it when they breathe and drink like the rest of us. They get it again when they eat wild animals like field mice. And they get it a third time when they lick themselves down after running in the fields."[1]

Nor were the cats the only animals to suffer. Duck eggs failed to hatch, and those ducklings that made it were often deformed. Rabbits and goats were stillborn. Cats dropped dead for no apparent reason. Trees lost their bark and gardens wilted overnight.

1. Jane Lee, interview, March 1980.

Emma Whitehall, who lived at the same farm within four miles of TMI for all of her seventy years, told Lee that in 1978 her ducks laid 290 eggs, not one of which hatched. She also lost a milk cow and her calf.

On the same road James Fitzgerald reported two calves born blind, with unnaturally soft bones. Across the river in Middletown, less than five miles from the reactor, Mary Ann Fisher saw a three-week-old litter of kittens drop dead overnight. One hundred eggs laid by twelve geese produced just one hatchling, which died.

In January of 1979, just after the opening of a second, larger nuclear unit at Three Mile Island, Fisher lost four litters of kittens to spontaneous abortions, had one full-term litter stillborn, and complained of four heifers being unable to conceive. Her geese laid eggs again with no hatchlings, then stopped setting.[2]

Charles Conley, who lives within eyesight of the TMI towers, also had complaints. Ever since the plant opened, he said, rainfall would wash a milky-white substance off his roof and into the cisterns from which his cows would drink. If the cows drank it, "they would get down and not be able to get up." If he dumped the white substance out of the cisterns, "the grass would die."

Other neighbors also complained of the mysterious white substance, and pointed to runoff lines below their roofs where something had created a trough of dead grass.

Conley had no proof the white substance was coming from the power plant. But he told us that "whenever it would shut down, why, the powder would disappear. And when it would fire up, the powder would come back."[3]

Born in 1914, within a half-mile of his farm, Conley readily conceded that country life is full of ups and downs, and that plants and animals get sick and die, sometimes for inexplicable reasons. "Any farmer with livestock knows you'll have a history of trouble," added Gary Huntsberger, owner of four hundred acres near the plant. "Just as you get one thing licked, you'll have another crop up."[4]

Indeed it is virtually impossible to nail down firm statistics on a "normal" rate of birth defects and reproductive problems among farm animals. Dr. Horst Leipold of Kansas State University, one of the nation's leading experts on animal husbandry, told us that a 1 percent stillbirth rate among beef and dairy cows was considered normal, and that the rate might be twice that for goats and pigs. "If I hear about two stillbirths, or malformations, at the same farm, I consider that serious enough to go out there," Leipold told us.[5]

For farmers and many observers there seemed obvious reasons why radiation around TMI, at Lloyd Mixon's ranch near Rocky Flats, and at other nuclear facilities would cause an abnormal number of symptoms to appear in animals before they would in humans. Some of them—particularly cats and rabbits—are much smaller and reproduce far more quickly, at a much earlier age, than humans. Most farm and wild animals also keep their mouths and noses constantly to the ground, for grazing and hunting. That means they absorb more heavy fallout particles from the air they breathe, the water they drink, and the plants and animals they eat. They may also receive more gamma doses from emitters on the ground.

Some animals also may be more radiation-sensitive than adult humans. In fact animals have been used as radiation monitors during abnormal emissions at the Oak Ridge National Laboratory. And it is well known that pine trees are more sensitive to radiation than grown humans.[6]

Humans, on the other hand, usually wash their vegetables. They stand farther off the ground than most other animals, and thus breathe in fewer heavy particulates. Their meat and fish are often not freshly slaughtered, giving some of the radiation time to decompose.

But ultimately, we are also susceptible. "Watch the animals," Helen Caldicott, a Boston pediatrician and radiation expert, told us in 1980. "What happens to them first will be happening to people soon enough."[7]

---

2. Affidavits at Fisher Farm, Etters, Pennsylvania.

3. Charles Conley, interview, March 1980.

4. Laura T. Hammel, "Three Mile Island's Second Accident: How Government Failed," *Baltimore News-American,* July 20, 1980 (hereafter cited as "Second Accident").

5. Horst Leipold, interview, May 1981; See also, L. O. Gilmore and N. S. Feccheimer, "Congenital Abnormalities in Cattle and Their General Etiological Factors," *Journal of Dairy Science* 52, No. 11, pp. 1831-1836.

6. Karl Z. Morgan, interview, May 1981.

7. Helen Caldicott, interview, March 1980. We talked with Dr. Caldicott just before her appearance on a nationally televised panel in Harrisburg. The occasion was the accident's first anniversary. When asked about the general rash of animal problems in the area, one pronuclear panelist blamed "milk fever" and advised giving the cows in question "a swift kick."

And what was happening to animals during normal operations at Three Mile Island also seemed to be happening near other reactor sites. At Hinsdale, New Hampshire, just across the Connecticut River from the Vermont Yankee reactor, sixty-seven-year-old Annie Fostyck was seeing things in her cows she'd never seen before. After the plant opened, she said, there was a rash of "cows miscarrying, aborting. Cows with boils, tumors, lameness. Cows eating clay even in winter." She also complained of a "white, milky film" that floated in the air and would "fly off when the corn was cut."

Neighbor John Solacz found that cows "have been harder to breed" since the plant opened. "Right after freshening," he said, "some have run a high fever, stopped eating and died within a week. They're aborting too."

Steve Stoll, a public-relations man for Vermont Yankee, had heard similar charges before. There was "nothing to substantiate" claims the reactor was harming animals. "We have people calling us up all the time with these complaints. But most of the time, it's just generalities," he told *Vermonter* reporter Susan Green. "These people do not know anything about radiation, so when anything is out of the ordinary, it's easy to blame Vermont [Yankee]."

Mildred Zywna's complaints were not so easily dismissed. As a Hinsdale town selectwoman, she had reported a general disappearance of squirrels, rabbits, and birds after Vermont Yankee opened. A number of trees had died mysteriously, and the bark was peeling off some on the sides facing the plant. A grandmother in her late fifties, Zywna had noticed a rise in thyroid cancers in town. She also knew that Dr. Rosalie Bertell of the Roswell Park Memorial Cancer Research Institute in Buffalo had noted a high rate of heart problems requiring hospitalization in Vernon, where Vermont Yankee was located. Disturbed by such findings, Zywna and her fellow town officers had asked the state for statistics on cancer rates in Hinsdale. The state never responded.[8]

Farmers in upstate New York near the Nine Mile Point and Fitzpatrick power reactors got similar treatment. "We've been trying to get a study done here for years," we were told by Nancy Weber, a dairy farmer in the town of Mexico. "But we haven't been able to get anybody to listen to us."

Weber's dairy farm has been in her husband's family for thirty-five years, and is situated near both plants. The area also has toxic-waste dumps. However, according to Weber NRC documents indicated that emissions from the nearby reactors were peaking at the same time a score of local farmers had experienced "more than normal abortions among our animals" plus "extreme difficulty in getting cows bred."

Some calves that made it were coming out deformed, including several born at 150 pounds, twice normal. "It was like a science fiction movie," she said. "One calf came out staring at me with giant red eyes." Among other things, the oversized calves were causing pelvic separations among the mothers. For about a year, Weber told us, there were instances of calves being born with two tails and three front legs, with brain and liver tumors, and with severe deformations in their internal organs. A goat farmer reported "mummified kids born left and right." Reproductive problems among cats became rampant.

The NUS Corporation, which did the controversial environmental monitoring at Shippingport in the early 1970s, also surveyed the Fitzpatrick/Nine Mile Point area in 1980. They found abnormal cesium levels at one nearby farm, but blamed it on bomb fallout. "Nobody quite believed that," said Weber.[9]

Columnist Jack Anderson also reported some similar problems at Shippingport. In his nationally syndicated column he said that the new Beaver Valley plant had contaminated the drinking water supply at the site, and had dumped nine thousand gallons of radioactive liquids into the Ohio River without warning towns downstream that drew drinking water from it.

Shippingport residents told journalist Howard Rosenberg, an investigator for Jack Anderson, of "white dust that sometimes covered their roofs and filled their cisterns. They charged that their water wells and backyard gardens had occasionally been contaminated. They showed him chunks of calcium sulfate that had fallen on their property. He brought one plate-sized chunk of pollution back as a souvenir."

Rosenberg also reported strange goings-on among area wildlife, including "tales of birds that walked backwards." Hunters and woodsmen said that "the lush foliage along the riverbank has turned brown and sickly. The deer long ago abandoned their former haunts." In an interview Rosenberg also told us that small animals like rabbits, squirrels,

---

8. Susan Green, "Yankee: The People and the Plant," *Vermonter,* December 7, 1980 (hereafter cited as "Vermont Yankee"); and David Riley, "Big Power in a Small Town," *Country Journal*, April 1980. We did follow-up interviews with most of the people mentioned in these articles and found the accounts to be quite similar to those around

9. Nancy Weber, interview, April 1981. See also, "Bovine Blues," *The Waste Paper,* the Sierra Club, spring 1980, and "Radioactive Milk?" winter 1981.

and sparrows had disappeared from the woods.[10]

One of Anderson's columns on the situation at Shippingport was banned by a number of western Pennsylvania newspapers.

But reports of similar symptoms in Arkansas surfaced on the national wire of the Associated Press. In that case a farmer named Herschel Bennett said the 850-megawatt Arkansas Nuclear One was destroying his farm, which was just a quarter mile away.

Owned by Arkansas Power and Light Company (AP&L), Nuclear One is seventy miles from Little Rock, in the town of Russellville. It was granted its operating license in 1974. In the late winter of 1977 Bennett reported a calf born on his farm with no eyeballs. "One lid was growed shut," he told the *Arkansas Gazette*. "The lid didn't open, but you could feel there was nothing back there. The other eyelid would open and close and there was no eyeball at all."[11]

The eyeless calf died on March 1, 1977. Another calf was born around the same time with no tail. "Nothing like that calf being born deformed ever happened here before," Bennett told us in a 1980 interview. Bennett and his wife had been on the same farm since the 1940s. The place had been owned by Bennett's grandfather before him.

Along with his thirty head of cattle Bennett managed a twenty-acre peach orchard. Soon after the eyeless calf succumbed, a quarter of Bennett's peach orchard also died. Bennett called the operators of Nuclear One, who soon visited his farm with a representative of the local agricultural extension service. They told him his problems were from winterkill. According to Bennett, a Louisiana State University horticulturist named Dr. Earl Puls added "poor management" and "an extremely high population of nematodes" to the list of causes. Puls, who visited the farm "for about one hour," said his findings were "conclusive in ruling out any type of nuclear radiation."[12]

Puls's report was reminiscent of official studies done of animal problems at Lloyd Mixon's ranch near Rocky Flats and of official disclaimers at Vermont Yankee and Nine Mile Point. "I've been raising peaches for more than thirty years now," Bennett told us in an interview, "and there was just one year, back in the 1950s, when we had no crop. Now this fellow comes from some university, spends an hour here and tells me I'm mismanaging my orchards and don't know what I'm talking about. Well, I'll tell you this. We haven't lost anything in this heat and drought. And that plant's been shut down for a long time now [for repairs] and ever since it's been shut down, why, we've had as good a year as any."

After the death of his eyeless calf, Bennett reported a rash of reproductive problems in his cow herd, and a drop in the hatching rate of chicken eggs laid at his farm. A laboratory confirmed the problem with the eggs, but declined to name a cause.

There were no monitoring devices at Bennett's farm. But NRC records did confirm that Nuclear One dumped an abnormal amount of radioactive liquid into nearby Lake Dardanelle in the summer and fall of 1976, when the eyeless calf might have been most vulnerable. "Their problems corresponded to mine as far as time was concerned," Bennett told us. "Leaks and spills and releases and filtering problems. . . . They did everything wrong about the time the calf was born without any eyeballs."[13]

NRC records confirmed the releases. But the commission's Jack Donohew said the levels were "a fraction" of what could cause "biological mutations." He told the *Arkansas Gazette* the fact that Bennett's animal problems surfaced at the same time as the radioactive releases was "probably just a coincidence."[14]

---

10. Jack Anderson and Les Whitten, "Washington Merry-Go-Round," November 1, 1977, November 16, 1977, and April 17, 1979 (hereafter cited as "Merry-Go-Round"). Also, Howard Rosenberg, interview, May 1981. Anderson and Whitten's November 1, 1977, column, entitled "White Clouds Over Pa.," was the one banned in some western Pennsylvania newspapers.

11. Carol Matlack, and Ginger Shiras, "Farmer Near Plant Reports Calf Deformed, Trees Died," *Arkansas Gazette*, June 2, 1979, p. 1-A (hereafter cited as "Farmer"). (We first found Bennett's story in an Associated Press story, "Farmer Thinks Nuclear Plant Is Cause of His Plight," *Columbus Dispatch*, September 23, 1979. Our thanks to Phyllis Wasserman for sending us that and many other clippings.)

12. *Arkansas Gazette*, October 17 and November 1, 1979.

13. Herschel Bennett interview, October 1980. Herschel Bennett died under mysterious circumstances as we were writing this book. He was investigating the outtake pipes at Nuclear One and somehow fell into twelve feet of water and drowned. There was just one witness to the drowning. No autopsy was performed. Bill Peters, letter to authors, November 13, 1980; and, Bill Peters, interview, November 1980.

14. Matlack and Shiras, "Farmer"; See also, *On the Record: Operations and Reported Incidents of Arkansas Nuclear One* (People's Action for Safe Energy, 401 Watson, Fayetteville, AR 72701).

The Reactors' Safety Record

The spreading fear among farmers had its political costs. Such fears—plus economic concerns—prompted the town of Eugene, Oregon, to vote down, in 1966, a reactor project planned nearby.

Through the late sixties and early seventies a small but dedicated group of concerned citizens around the country devoted thousands of dollars and years of effort to dragging the industry through the licensing process and the courts, trying to stop the reactors or at least make them safer. In so doing they laid the foundation for a social movement.

By the early seventies concern had spread, particularly in areas where the plants were being built. An amalgam of traditionally conservative farmers, fishing people, and small-town residents joined with nationally organized nuclear opponents. In 1976 the first coordinated civil disobedience actions took place at the Seabrook reactor site on the New Hampshire seacoast. Operating with nonviolent tactics, a coalition called the Clamshell Alliance helped organize a series of occupations that captured the imagination of environmental activists around the U.S. By the summer of 1978, when the Clamshell attracted some twenty thousand nuclear opponents to the Seabrook site, scores of occupations had taken place around the country, and a national antinuclear network was in place. A movement had grown to stop the reactor industry that echoed the one aimed at atmospheric testing two decades earlier.[15]

By the spring of 1979 the peaceful atom was in serious financial straits. The Arab oil embargo of 1973 had sent fuel prices soaring, which by all expectations should have made atomic energy more competitive. Instead it sent the cost of the reactors themselves soaring, at a rate far higher than the cost increases in coal burners. Electricity prices also rose sharply, prompting American consumers to use far less. That, in turn, helped undercut the demand for new reactors, which fell further because of public pressure and a loss of faith in the technology.[16] Orders fell drastically, from forty-one in 1973 and twenty-six in 1974, to four in 1975, three in 1976, four in 1977, and two in 1978. Cancellations quickly outnumbered orders. In 1978 the number of domestic reactors on line, on order or under construction dropped to 197, lowest since 1972.[17]

And there were other problems. In 1966 the Fermi fast breeder, which the UAW had fought to the Supreme Court, very nearly caused a devastating radioactive release. Starting on October 5, 1966, the reactor hovered on the brink of a catastrophic meltdown for an entire month. Its operators secretly alerted local police and officials in Detroit, forty miles north, that a mass evacuation might be necessary. The disaster was barely averted.[18]

Eleven years later two workmen at the Tennessee Valley Authority's Browns Ferry plant near Decatur, Alabama, set the plant's wiring system on fire. The workers had been using a candle to check for air leaks and had set some insulation into flames. By the time the fire was out, $100 million in damage had been done.[19]

By 1979 sloppy reactor construction, poor design, and inept operation had become a national scandal. That year's NRC records revealed more than twenty-three hundred operating errors, including a failure of control rods at Browns Ferry; a temporary blackout in the control room of a power plant in Florida; the surprise development of a steam bubble in another Florida reactor; and the blowout of a coolant pump at Arkansas Nuclear One, near Herschel Bennett's farm. New York's Fitzpatrick II—where Nancy Weber's cows were dying—listed eighty-eight incidents of its own.[20] There were other incidents as well: one reactor cooling system had been hooked up to the plant's drinking supply. At another plant a basketball wrapped in tape had been used to plug a defective pipe.[21]

Through the end of 1979, the allowable average dose to residents near the plants remained at 170 millirems per year, a rate Drs. Gofman and Tamplin calculated would guarantee an extra thirty-two thousand deaths per year. And methods of measuring radioactive releases had not been systematically improved despite the recommendations of the Shapp Commission. If anything, standards were regressing.

In 1975, for example, excessive strontium 90 radiation was found in milk at a farm near the Shippingport plant.

---

15. For a documentary history of the early antireactor movement see Harvey Wasserman, *Energy War: Reports from the Front* (Westport, Conn: Lawrence Hill, 1979).

16. Charles Komonoff, *Power Plant Cost Escalation* (New York: Komonoff Energy Associates, 1981).

17. A good reference for the history of reactor orders is the Atomic Industrial Forum's "Historical Profile of U.S. Nuclear Power Development," which can be gotten from the AIF at 7101 Wisconsin Ave., Washington, D.C. 20014.

18. Fuller, *We Almost Lost Detroit*.

19. U.S. Congress, Senate and House Joint Committee on Atomic Energy, *Browns Ferry Nuclear Plant Fire*, 94th Cong., September 16, 1975.

20. *New York Times*, July 14, 1980, p. 26; see also, *1979: 2000 Nuclear Mishaps* (Washington, D.C.: Critical Mass Energy Project, 1980).

21. Robert Pollard, ed., *The Nugget File* (Cambridge, Mass.: Union of Concerned Scientists, 1979).

The following year, monitoring at that farm was discontinued.[22]

In October of 1977 Ernest Sternglass charged that strontium emissions from the Millstone Nuclear Power Station at Waterford, Connecticut, were extraordinarily high, and had led to an increased rate of cancer.[23] Soon thereafter the NRC eliminated the requirement that utilities collect strontium 90 data. Budgetary reasons were cited.[24]

Also that fall the General Accounting Office released a report charging that the EPA's national radiation monitoring program did not measure exposure for 40 percent of the American people, "and provides only educated guesses for the remaining 60%." The GAO warned that "levels of radiation are increasing which affect not only the health of the current population, but of future generations because of genetic damage." Federal agencies lacked resources, staff, and know-how to deal with the problem, said the GAO. Environmental Protection Agency policy "may not be the result of public need, but rather reflects a crisis-oriented approach to the problem."[25] Despite the warning, the Reagan administration in 1981 drastically cut the EPA's radiation monitoring program well below the levels cited as inadequate by the GAO.

But crisis was something the industry was saying could not happen. Despite the near-catastrophes at Fermi and Browns Ferry, reactor manufacturers, utilities, and their supporters in government continued to assure the public that an accident was next to impossible. In 1976 an MIT professor named Norman Rasmussen issued a major study indicating that the odds against a major meltdown by 1980 were on the order of one in twenty thousand. Sponsored by the NRC, his report was hailed by the industry as the ultimate confirmation of nuclear reactor safety.[26]

But in January of 1979, under public attack, the NRC renounced the Rasmussen report and in essence admitted that it did not know what the odds on a reactor accident really were.[27]

In the spring of 1979 the GAO issued another study on radiation, this one entitled *Areas Around Nuclear Facilities Should Be Better Prepared for Radiological Emergencies*. Among other things the report warned that evacuation plans around military and commercial plants were deficient. "There does not appear to be a Federal policy on providing nuclear accident response information to the general public," charged the report. There was thus "only limited assurance that the people near most fixed nuclear facilities will be adequately protected from the radiological consequences of a serious nuclear accident."

In fact part of the problem seemed to be active hostility on the part of the utilities. At several locations, complained the GAO, "facilities' operators were reluctant to provide public information for fear of creating public alarm that could result in new or prolonged current protest activities."[28] The GAO report, which had been months in preparation, was dated March 30, 1979.

Two days earlier the "impossible" had begun to happen at Pennsylvania's Three Mile Island Unit Two. The reactor had been rushed into operation by its owners—The Metropolitan Edison Company—on December 28, 1978, apparently for tax purposes. Critics charged it was not fully prepared to go into operation, and its early record proved it. Within weeks after it opened, Unit Two had two valves break during a turbine test. On February 1 a throttle valve began to leak. A day later a pump blew a seal. Then another pump tripped off.

Finally, at 3:58 A.M. on March 28, 1979, alarms in the control room began to flash. Feedwater pumps went off line. Control-room operators misread their instruments and began making wrong decisions. As the core lost water, heat and pressure began to rise. A valve opened and didn't close. Radioactive water gushed onto the floor of the

---

22. Anderson and Whitten, "Merry-Go-Round," November 16, 1977.

23. Ernest Sternglass, "Strontium-90 Levels in the Milk and Diet Near Connecticut Nuclear Power Plants," October 27, 1977, and Sternglass, "Cancer Mortality Changes Around Nuclear Facilities in Connecticut," presented at a congressional seminar on low-level radiation, Washington, D.C., February 10, 1978. Sternglass's charge that high emissions from the Millstone plant might have caused a rise in cancer rates in nearby communities was given preliminary confirmation by early indicators from a Connecticut State study. See Steve Fagin, "Radiation Study Group Gets Preliminary Report on Cancer," New London *Day*, June 10, 1981, p. 2.

24. Joseph Hendrie, Chairman, NRC, letter to Dorothy B. Jones, First Vice-President, Another Mother for Peace, December 3, 1978. In the letter Hendrie says that by monitoring for Cs-137 the NRC could also determine how much Sr-90 was being released. "The omission of radiostrontium from the recommended program is not a monitoring issue," he said.

25. *New York Times,* September 15, 1977, p. A-1.

26. NRC, WASH-1400, October 1975.

27. NRC, "Statement on Risk Assessment and the Reactor Safety Study Report," WASH-1400, in *Light of Risk Assessment Group Report* (Washington, D.C.: NRC January 18, 1979).

28. GAO, *Areas Around Nuclear Facilities Should be Better Prepared for Radiological Emergencies,* EMD-78-110 (Washington, D.C.: GAO, March 30, 1979), pp. 28-31.

containment building. The emergency core cooling system kicked in, but an operator shut it off. A pump flooded an auxiliary building with contaminated water, causing a steam release. Radiation escaped through the containment. Radioactive water leaked into the Susquehanna River.

Finally, a hydrogen bubble developed in the core, apparently threatening an explosion. While America—and the world—hung with bated breath, unknown quantities of radiation escaped into the air of central Pennsylvania.[29]

How Much Radiation?

First and foremost the utility, the NRC, and the industry strove to minimize the public impression of how much radiation had escaped at Three Mile Island and how dangerous it might be. As the AEC had done in more than 250 bomb tests, and as the operators of the Windscale and Rocky Flats facilities had also done, the owners of TMI now hastened to assure the public that only negligible amounts of radiation had escaped to the atmosphere, and that there was no reason to believe anyone would be harmed.

The total emission from the accident, said Margaret Reilly of Pennsylvania's Department of Radiation Protection, amounted to "a gnat's eyelash." Despite the order from Pennsylvania governor Richard Thornburgh—two days after the accident—that pregnant women and small children abandon the immediate area, official press releases compared the maximum possible exposure to a single X ray.[30]

But there was no denying that some reactor by-products had escaped. Through a series of complex mathematical formulas the NRC estimated that sixteen million curies of noble gases and fourteen curies of radioactive iodine 131 had been added to the atmosphere. With complex calculations involving the two million people within a fifty-mile radius of TMI it was decided that each individual had received an average dose of 1.4 millirems, a bare fraction of normal background radiation. The maximum dose anyone could have gotten, added Reilly, was seventy millirems—and that was "only for someone standing stark naked at the plant gates for seven days."[31] Reilly's estimates did not apply to inhalation or ingestion of radioactive gases or particles.

Within months a presidential commission under the leadership of Dartmouth College president George Kemeny confirmed the NRC findings. "On the basis of present scientific knowledge," said the commission, the radiation doses "were so small that there will be no detectable additional cases of cancer, developmental abnormalities, or genetic ill-health as a consequence of the accident at TMI." At worst just one of the 325,000 people in the area who were eventually expected to die of cancer could be said to have a "reasonable chance" of having been affected by TMI radiation.[32]

Active supporters of atomic power went even further. In a series of national advertisements Dr. Edward Teller claimed to have been "the only victim of Three Mile Island." The nervous stress he suffered from attacks by nuclear opponents on his favored industry, he said, had led to a heart attack. As for fallout, Teller charged that the risk was no different from living in a high mountain area near Denver, where natural background radiation is higher than it is in central Pennsylvania.

Teller did not specify whether this was calculated on living upwind or downwind from Rocky Flats. But his point was clear. "There is a *possibility* but not a probability that due to the TMI accident one single person years from now might develop cancer."[33]

That conclusion was not universally shared. Karl Z. Morgan and others soon charged that the amount of emissions had been underestimated, and that specific pockets of population may well have received very heavy doses—particularly in the town of Harrisburg, which was downwind at key times during the accident.

The means of measuring plant emissions at TMI were essentially four: monitors in the stacks to gauge how much radiation was escaping; charcoal filters in the stacks which trapped some of that material for later measurement; monitors nearby to estimate how much radiation had reached into the general environment; and samplings of

---

29. There are numerous accounts of the TMI meltdown. One appears in *Washington Post, Crisis: Three Mile Island* (Washington, D.C.: *The Washington Post,* 1979) (hereafter: *Crisis*).

30. Hammel, "Second Accident."

31. Margaret Reilly, interview, March 1981. In a June 1980 interview Reilly told us the 1.4 millirem average dose estimate was "vague" and "probably meaningless. Nonetheless it was used by Edward Teller and numerous utilities in pronuclear advertising.

32. Kemeny Report, p. 34.

33. Edward Teller, "The Overblown Fear of Radiation," *Philadelphia Inquirer,* 1979.

vegetation, milk, and animal tissue from area farms and forests to estimate how much radiation was being ingested by local animals. The definitive results from each of these indicators is very much in dispute.

On April 12, for example, in the midst of the crisis, an NRC official named Lake Barrett conceded that monitors in the plant stacks "did not provide accurate readings of absolute quantities of radioactivity released during the accident." High radiation levels, said Barrett, had driven monitors "off scale" and rendered them useless.[34]

In June, Albert Gibson, a Radiation Support section chief who coauthored the NRC's final report on TMI emissions, confirmed the problem. Testifying in front of the five NRC commissioners, Gibson said, "All the radiation monitors in the vent stack, where as much as 80 percent of the radiation escaped, went off scale the morning of the accident. The trouble with those monitors is they were never contemplated for use in monitoring accidents like Three Mile Island."

Gibson explained there were three monitors in the vent stack and five more in the pathways leading to it. All eight were at their maximum levels the morning of the accident. It was impossible to tell how much radiation really escaped. The monitors merely recorded a minimum amount.

"So," asked Commissioner Victor Gilinsky, "we don't really know what went up there? Up through the vent stack?"

"That's correct," Gibson confirmed.

Inside the building readings showed a minimum of a million millirems per hour, a lethal dose. On site, the day of the accident, monitors 1000 feet from the vent stack showed levels of 365 millirems of beta and gamma rays per hour. A helicopter directly over the vent stack measured emissions three times as high. Even those measurements were "very inconclusive," said Gibson. They showed dose rates "only at the moments the measurements were made." Without full knowledge of weather patterns, he admitted, "we don't know if they were made at the appropriate locations."[35]

Thus Gibson had told his NRC superiors that one of the key methods of measuring emissions—the stack monitors—had been essentially useless during and after the accident.

But in a 1981 interview with us Gibson backtracked. "I don't want your book to read too much into what I said to the commissioners," he told us. "What I meant to say then was that *at the time of the accident* we didn't know how much radiation was escaping. But later, by measuring the charcoal filters in the stacks, we could estimate the totals."

The NRC's second line of defense, Gibson told us, did work as it should have. Charcoal filters in the plant stacks trapped a certain percentage of the iodine 131 and other isotopes that were released during the accident. "Had we known the accident was going to occur, we would have had many more monitors in operation," Gibson said. "But I have confidence the iodine concentrations released were reasonable."[36]

However one preaccident NRC study had already questioned the filters' performance and predictability under conditions involving large quantities of moisture and noble gases.[37] A fall 1978 DOE conference also discussed poor filter performance where moisture was involved, predicting such problems as corrosion which could allow radioactive material to escape and thus go undetected by later measurement of the filters.[38] A later article in *Nuclear Engineering* magazine said the filters may not have been of much use anyway. Because of "an unusual amount of aqueous vapor," wrote Seo Takeshi of Kyoto University's Nuclear Reactor Laboratory, "the adsorbent capacity of the cartridges must have been rapidly minimized." Their saturation resulted in low readings, for which the NRC and the utility "did not make any corrections," a failure Takeshi termed "inexcusable."[39]

The Kemeny commissioners were also concerned. "Due to improper use before the accident," they concluded, filters in the auxiliary and fuel handling buildings "did not perform as designed."[40]

---

34. Lake Barrett, "Preliminary Estimates of Radioactivity Releases from Three Mile Island," memorandum for distribution, NRC, April 12, 1979, p. 1.

35. Thomas O'Toole, "NRC Told Radiation Leak at A-Plant Off the Gauges," *Washington Post*, June 22, 1979. p. A-3.

36. Albert Gibson, interview, February 1981.

37. D. W. Underhill and D. W. Moeller, *The Effects of Temperature, Moisture, Concentration, Pressure and Mass Transfer on the Absorption of Krypton and Xenon on Activated Carbon,* NUREG-0678 (Washington, D.C.: Nuclear Regulatory Commission).

38. C. E. Graves, et al., "Operational Maintenance Problems with Iodine Adsorbers in Nuclear Power Plant Service," in *Proceedings,* 15th DOE Nuclear Air Cleaning Conference, Boston, August 7-10, 1978, pp. 428-444.

39. Seo Takeshi, "NRC's Gross Underestimation of the Radioactive Releases and Population Doses During the TMI-2 Accident" (hereafter cited as "NRC's Underestimation"). We saw this article, a version of which later appeared in *Nuclear Engineering,* magazine, as an unpublished manuscript.

40. *Kemeny Report,* p. 30.

And in fact, in April of 1979, the NRC's Harold Denton told a Middletown news conference that at one point at least twenty stack filters had been removed without being replaced. Thus "there was a potential for bypass leakage through the filter space getting out without being filtered." In other words radiation escaped because the filters were not there to stop it.[41]

Thus the stack monitors and filters were almost completely unreliable. But there was still the third line of defense—environmental monitoring systems operated by Met Ed and the NRC. These networks were built around a radiation reading device known as a thermo-luminescent dosimeter (TLD) designed to measure gamma radiation. The TLDs, said Albert Gibson, "gave us confirmation of the levels we estimated to be leaking from the plant."[42]

But by all accounts the TLD program was also ineffective. For one thing, they are designed to measure radiation exposures over a period of months. "Real-time" monitors, which can more accurately measure how much radiation is being released over shorter periods of time, were not in use during the TMI accident, and had not been deployed by the time of this writing, more than two years later. Second, the TLDs read only gamma radiation. But large quantities of unrelated alpha- and beta-emitters were also escaping from TMI, and there was no equipment to monitor them. According to Dr. Carl Johnson of Colorado, who worked for months to get information on alpha releases to compare with those at Rocky Flats, "no data are to be found."[43]

The TLDs themselves were irregularly placed and unreliable. Because of "poor maintenance," wrote Seo Takeshi, data for the crucial period of March 31 to April 1 were "not reliable." From many sectors around TMI "there are no data at all." And overall "estimates of the collective dose and quantity of released radioactivity based on this poor data cannot be accurate and should be considered under the actual level."

In fact, Takeshi added, based on an August 1979 study by the NRC, as much as sixty-four thousand curies of I-131 had been released, a figure four thousand times what the public had been told, and a dose capable of endangering the health of the local population.[44]

Thomas Gerusky, head of the state's Bureau of Radiation Protection, confirmed that the monitoring equipment at TMI was "geared mainly for routine accidents—little things. I think the thought was at the time that if a major accident occurred, the monitoring could always be extended. Of course, they found it couldn't."[45]

Both state and federal authorities acknowledged that in the first two days of the accident—when approximately 80 percent of the radiation was released—there were nowhere near enough TLDs around. "We don't know if there were other releases early on, other than from the stacks," Gerusky told *The* (Baltimore) *News-American*. "There are still some questions of just how much I-131 was released early in the accident." Next time, added Margaret Reilly, the authorities would know that "it is nice to be lavish with TLDs." After all, she said, TMI was a "dress rehearsal for an accident."[46]

The TLDs were sent primarily to two companies to be evaluated. One was the Radiation Monitoring Corporation, a subsidiary of Philadelphia Electric—one of the nation's most ardent promoters of atomic power. The other was Teledyne Isotopes, a subsidiary of Teledyne Inc.—a Los Angeles-based multinational corporation with some $400 million in contracts with the nuclear-committed U.S. military. Both companies thus had clear financial interests in defending atomic power.[47]

Doses read on Metropolitan Edison TLDs showed less radiation than those from the NRC, a discrepancy the Kemeny Commission discussed but could not explain.[48]

---

41. Richard Roberts, "Iodine Level from N-Plant Exceeds Limit," Harrisburg *Patriot,* April 18, 1979.

42. Gibson interview.

43. Carl Johnson, interview, May 1980. In a June 1981 interview Margaret Reilly confirmed the lack of alpha monitoring, but said that since "zip radiation" had been found in reactor coolant, it was unlikely any had escaped. Reilly also told us that methods of gauging how much radiation had escaped by taking an inventory of the core were "essentially worthless."

44. Takeshi, "NRC's Underestimation"; and Bruce Mulholt, "Testimony in Support of Off-Site Contentions of the Environmental Coalition of Nuclear Power," NRC, TMI-1 Restart Hearings, Docket 50-289, March 16, 1981, Table 5.

45. Hammel, "Second Accident."

46. Ibid.

47. Information on the corporate underpinnings of Teledyne Isotopes and Radiation Management came from the Corporate Responsibility Project, 475 Riverside Dr., Room 566, New York City 10115. Teledyne's defense contracts were cited in David Gold, "Defense Department's Top 100," *CEP Newsletter,* November 1980. Ownership of Radiation Management can be traced through Standard and Poor's 1981 index. The president of Philadelphia Electric is also the president of Radiation Management.

48. Health Physics and Dosimetry Task Group, Kemeny Commission, *Report of the Public Health and Safety Task Force on Health Physics and Dosimetry* (Washington, D.C., October 1979), p. 133.

And one particular reading threw a shadow over the entire evaluation. In the course of sifting through the measurements, the Kemeny staff found a station 96 miles to the northwest of TMI with comparatively high readings. The absolute dose was very small, but in comparative terms it seemed to indicate an abnormal radiation level in Harrisburg. The commission dismissed the high reading as inaccurate, theorizing that the dose had accumulated on that particular TLD because of improper handling. They labeled it the "northwest anomaly."[49]

But in fact the "anomaly" seemed to confirm one of the most crucial charges of all—that the radiation from the plant had not spread evenly over the area, but had in fact blown in a narrow path to the northwest, toward Harrisburg—some ten miles away.

The last line of official monitoring rested with vegetation, milk, and animal surveys. According to John Nikoloff, a spokesman for the state Agriculture Department, "hundreds" of milk samples were taken after the accident. Overall, he told us, no concentrations were found exceeding forty-one picocuries per liter of radioactive iodine—far below the state's maximum limit of 100 picocuries per liter. "Nothing we saw indicated any serious problem," Nikoloff said.[50]

But Metropolitan Edison's own readings indicated a finding of 105 picocuries per liter in goats' milk at the Louise Hardison farm, less than two miles from the plant.[51] And *The* (Baltimore) *News-American* reported that an independent survey conducted by an associate professor of nuclear engineering at nearby Pennsylvania State University produced seven readings of twelve hundred picocuries or more per liter.[52] The findings led Thomas Gerusky to tell *The News American* that "there might have been more iodine out there than we thought."[53]

There were other contradictions. Margaret Reilly told us the state tested a number of animals for radioactivity and "found nothing."[54] But the U.S. Bureau of Fish and Wildlife at Harrisburg also conducted a survey and reported levels of I-131 in rabbit thyroids considerably higher than what had been previously recorded. "We put our trust in the NRC and Met Ed," said the bureau's Norman Chupp, "and it seems like they're not interested in the animals we're interested in. . . . Who knows if the results would have been more significant if we had gotten out earlier?"[55]

A second study, conducted by four faculty members of the nearby Millersville State College around the same time as the DOA survey, seemed to confirm the high iodine findings elsewhere. The study used meadow voles—a small rodent—as a control and found high levels of I-131 in the thyroids of animals caught near the plant.[56]

Meanwhile an article in *Science* indicated that extraordinary readings had been registered as far away as Albany-Troy.[57] Another independent monitor noted high readings in Maine following the accident.[58]

Throughout the TMI area local residents complained of a strange, "metallic" taste in their mouths. "You can tell it's in the air," Charles Conley told us at his farm near TMI. "You can taste it. We all did."[59]

TMI's unhappy neighbors also created a run on Geiger counters, which many soon claimed were showing abnormal levels throughout central Pennsylvania. The trend prompted Margaret Reilly to "joke" to *The* (Baltimore) *News-American* that the state had been considering buying the instruments off the shelves to stop the flow of alarmed complaints about high releases.[60]

In an April 1980 panel sponsored by the New York Academy of Sciences, Pennsylvania's Thomas Gerusky

---

49. Ibid., p. 136.

50. John Nikoloff, interview, March 1980.

51. Metropolitan Edison Company, "Three Mile Island Nuclear Station Radiological Environmental Monitoring Program: Annual Report for 1979," April 1980, p. 19.

52. Hammel, "Second Accident."

53. Ibid.

54. Reilly interview.

55. Hammel, "Second Accident."

56. R. William Field, et al., "Iodine 131 in Thyroids of the Meadow Vole (*Microtus Pennsylvanicus*) in the Vicinity of the Three Mile Island Nuclear Generating Plant." We used an unpublished version of this article.

57. Martin Wahlen, et al., "Radioactive Plume From the Three Mile Island Accident: Xenon 133 in Air at a Distance of 375 Kilometers," *Science*, February 8, 1980, Vol. 207 pp. 639-640.

58. Thomas Pawlick, "The Silent Toll," *Harrowsmith*, June 1980.

59. Conley interview.

60. Hammel, "Second Accident."

emphasized that "thousands of samples of milk, air, water, produce, soil, vegetation, fish, river sediment, and silt in the TMI vicinity were analyzed." But precise dose estimates were "valid only for individuals living within three miles of TMI," he said, "because most of the sampling took place within that area."[61] Reilly added in a June 1981 interview that though they "posed no health hazard," noble gas releases pouring out of TMI on Thursday, the night after the accident began, were so heavy that radiological experiments being conducted at a building in Harrisburg had to be discontinued because of radioactive interference.[62]

Few people were more worried about those releases than NRC chairman Joseph Hendrie. On Friday morning, March 30, at the height of the crisis, Hendrie got word of a burst release over the stacks. It indicated emissions of "about 1200 millirem per hour which seems to calculate out, by the time the plume comes to the ground, where people would get it, would be about 120 millirem per hour. Now that is still below EPA evacuation trigger levels; on the other hand, it certainly is a pretty husky dose rate to be having off-site."[63]

At least a portion of that "husky dose rate" was apparently coming down in Harrisburg, where its effects on local babies would be lethal.

---

61. Thomas H. Moss and David L. Sills, eds., "The Three Mile Island Nuclear Accident: Lessons and Implications," in *Annals* of the New York Academy of Sciences, April 24, 1981, pp. 56-57.

62. Margaret Reilly, interview, June 1981. Reilly said the building affected was the Evangelical Press Building, where the state maintained a laboratory.

63. *Pittsburgh Post-Gazette*, April 16, 1979, p. 1.

13

Animals Died at Three Mile Island

Dr. Robert Weber fits the Norman Rockwell image of a country veterinarian. Of gentle countenance but powerfully built, Weber wore his western-style hat and handlebar mustache into the lavishly paneled hearing room of the Pennsylvania Public Utilities Commission, where, in March of 1980, public testimony was being heard on the accident at TMI.

Though the intricacies of debate over curies, millirems, and isotopes meant little to Weber, he had a pretty clear idea of what was happening to the animals of his clients. And when the PUC finally held hearings, just shy of a year after the accident, Weber came straight to the point. Ever since the accident, he said, he was getting calls to treat stillbirths among pigs near TMI at the rate of two per week. Normally he treated two such cases per year. He had been practicing out of Mechanicsburg since the 1940s and had never seen an epidemic like it. Hormones that usually aided the pigs in dilation had failed to work.

And that spring of 1980 he was having to do two caesarean sections per week on local goats and sheep, also an extraordinary rate.

Weber was immediately challenged by a lawyer from Metropolitan Edison, who demanded to know if Weber was saying that radiation from TMI had caused the problem.

"I am not prepared to say it is radiation," the veterinarian replied. "I do not know what the cause is."

But outside in the hall Weber told us that if ever animals had served as radiation monitors in a nuclear accident, this was the time. "A lot of these problems are happening right in the path of TMI," he said. "I won't say for sure it's the power plant that's causing it. But I can't imagine what else is going on down there." In fact the "heavy run" of birthing problems among pigs came "right after the plant went bad. I don't know if we were in some kind of streak. The samples haven't come up with any particular diseases that might be causing it.

Weber also told us he had seen plenty of cases to support the affidavits Jane Lee had accumulated. "Since 1976 I've been noticing cows that have gone down after they had their calves and couldn't walk. They didn't have typical milk fever, but we don't know what they did have. They were just down and we had to get rid of at least two of them. Everything I used just wouldn't work." He added that things had gotten significantly worse after the accident, including an increase in Hodgkin's disease among dogs, and widespread complaints that deer, pheasant, and other game had all but disappeared from the area.[1]

Charles Conley confirmed that pattern. "My daddy bought this farm in 1912," he told *The* (Baltimore) *News-American*. "I've had more trouble in two years than he had in all the years he farmed."[2]

Conley noted that soon after the accident the bark peeled off a maple tree in his front yard. "My wheat crop was not good that year," he complained. "The fruit's been small and some of the vegetables just plain curled up. Birds disappeared too. After the accident, there wouldn't be any of them swarming around behind the plows like they always do. We used to have all kinds here. Used to be you'd have twenty-five robins out there in the backyard. This year [1980] I've only seen one. I found a bunch of starlings that just flew into the hay mow and died. And my brother, he found a robin that just keeled over in a peach basket. That thing killed the snakes, too. We don't have any copperheads around here, but the garter and black snakes, you used to see a lot of them. Now you don't."[3]

At Jane Lee's house the number of complaints from farmers reporting animal problems increased dramatically

---

1. Robert Weber, interview, March 1980.
2. Hammel, "Second Accident."
3. Charles Conley, interview, March 1980.

after the accident. Down the road at Emma Whitehall’s—which in 1978 had reported 290 duck eggs that would not hatch—a nanny goat inexplicably aborted twins eight days after the accident. Located less than three miles from TMI, the farm soon thereafter saw two other pregnant nannies die mysteriously, along with twenty-six newborn rabbits and nineteen guinea pigs.

At the nearby James Fitzgerald farm, a colt was born deformed. At the Mary Ann Fisher place, across the river in Middletown, a litter of kittens inexplicably died. At Fran Cain’s dog kennel, a quarter mile from the reactor, a poodle was born with no eyes.[4]

One after another the complaints of sterility; stillbirths; malformations; disease; unexplained deaths; disappearance of game, snakes, and wild insects; and wilting of vegetation arrived in increasing numbers in the wake of the accident.

Pennsylvania’s Official Findings

In mid-May the Pennsylvania Department of Agriculture (DOA) decided to conduct a study of its own. The department’s information director, John Nikoloff, told us that the survey was done in two days—May 23 and 24—and that it involved ten department staff, two of whom were veterinarians. Nikoloff said that one hundred person-hours were devoted to interviewing one hundred farmers. According to the survey only five of them complained of abnormal problems.

Nikoloff emphasized that the study, which was untitled, was informal and "for internal use only." It was not sophisticated or thorough, but rather a "spot check" that was done by compiling a rough list of the dairy farms within five miles of the plant and arranging for interviewers to stop off—unannounced—at other farms along the way "if they had time."

Nikoloff added that the department had done a few autopsies, but not as many as they would have liked. "In a way we’re stuck," he said, "because most of the animals that get reported with problems are dead and gone before we can autopsy them." The dozen-odd animals the state had tested had shown no evidence of radiation damage. Thus on the basis of that and the small number of complaints Nikoloff and the DOA had concluded that there was "no evidence that would indicate any animal problems in the area that had anything to do with radiation from TMI."[5]

In April of 1980, more than a year after the accident, *The New York Times* editorial board relied on the DOA survey in a strongly worded opinion piece called "Nuclear Fabulists," which dealt largely with the growing controversy over human infant-mortality rates near TMI. The "reports of bizarre deformities among farm animals and wildlife" had been discredited, they wrote. The problems "were attributed to viral infections or to feed and poor nutrition; there was no evidence of radiation damage."[6]

---

4. Jane Lee, interview, March 1980.

5. John Nikoloff, interview, March 1981; and Hammel, "Second Accident."

6. *New York Times,* "Nuclear Fabulists," April 18, 1980. The editorial read in full:

"Those scare stories about radiation damage from the accident at Three Mile Island look increasingly far-fetched. Federal officials have said all along that little radiation escaped, posing virtually no threat to public health. Their judgment has been supported by all major investigations of the accident. But rumors of frightening physical damage to human and animal infants persist.

"None of these allegations have held up under careful scrutiny by disinterested authorities. The only real health damage detected so far has been psychological. For example a report made public yesterday says that many of the community’s residents remained distressed for months and resorted to sedatives and alcohol for relief. Their anxiety could only have been heightened by the ‘experts’ and critics who have issued alarming statements about radiation hazards based on scant or distorted data.

"The most worrisome charge has been that radiation from the crippled reactor has already caused an increase in infant mortality and thyroid defects in newborn babies. Those fears were effectively laid to rest by state and Federal health investigators, as reported in *The Times* by Jane Brody. The concern about infant mortality was based largely on raw statistics showing an increase in the number of infant deaths within a ten-mile radius of the reactor after the accident. But those numbers in themselves are meaningless; there was also an increase in the total number of births. The *rate* of infant deaths remained normal.

"Similarly, the concern over thyroid disease was based on unevaluated statistics showing, in three counties, a possibly abnormal number of children born with thyroid defects. But on investigation, most of these cases were attributed to hereditary defects or other circumstances predating the nuclear accident. Four counties equally close to the reactor, or closer, had no such cases at all.

"Reports of bizarre deformities among farm animals and wildlife have also circulated. Worried farmers and at least one veterinarian have described animals born with legs or eyes missing, stillbirths, spontaneous abortions, defective bone structures and sudden deaths. Many blame the reactor. But the Pennsylvania Department of Agriculture investigated 100 farms within five miles of the reactor last May and found only five with any unusual problems among livestock. These were attributed to viral infections or to feed and poor nutrition; there was no evidence of radiation damage.

"Several long-term studies are still under way. But for now the public can draw considerable reassurance from these negative findings. It is not only apologists for the nuclear industry who say that radiation damage has been negligible; so do health officials whose main concern is the public’s safety, and agriculture officials whose mission is protecting farmers and livestock.

"What is not at all reassuring is the behavior of ‘experts’ who have inflamed fears by dealing recklessly with statistics. Dr. Gordon MacLeod, who was Pennsylvania’s Secretary of Health at the time of the accident but was later forced to resign by the governor, irresponsibly publicized some of the raw data

But three months after the editorial appeared, an investigative team from *The* (Baltimore) *News-American* reported that the DOA study was "worthless." The concerns of local farmers had been "vastly underreported." The state's "data erred. Their conclusions were wrong."

In a four-page feature written primarily by investigative reporter Laura T. Hammel, *The News-American* charged that not 5 percent, but at least 40 percent of the farmers listed in the DOA survey complained of problems with plants and animals that dated not just after the accident, but to the opening of TMI-1.

Dairy farmer Joseph Conley (a cousin to Charles, whom we interviewed earlier) told *The News-American* that beginning in 1974, the leaves on his grape arbor turned white, limbs on his walnut trees shriveled and died, and, in late 1978, just before the opening of TMI-2, his cattle became jumpy.

Shortly after the 1979 accident two of his cows aborted, ten of his calves died soon after birth, his cats wouldn't breed, and his own family began acting so sickly and sluggish that he packed up all his belongings and moved to another county. But the DOA listed him as having "no problems."

Richard Bailey, who raised cattle at York Haven, thirteen miles from TMI, was also listed as having no problems. But he told *The News-American* that within two months after the accident he lost six new calves in a row. A seventh was born a midget. Prior to the accident he had lost only ten calves to stillbirths in more than thirty years of farming.

Russell Whisler of Manchester, who was also listed in the DOA survey as having no problems, said he had lost two ewes and four lambs from abnormal pregnancies following the accident—and that the state knew it. "They asked us what we had, and we told them," he said.

Jane Ressler of Elizabethtown, who complained of four horses suffering stiff, swollen joints just after the accident, was also listed as having no problems. She told *The News-American*, "We've had lots of problems. I never talked to anyone from the government, and neither did my husband. But I would have liked to."[7]

According to reporter Hammel, at least thirty-five farmers listed in the survey said their views had been misrepresented. At least three said they told state inspectors they were having problems and were listed as having none. And a number of animal inventories in the survey were grossly inaccurate.

Several nearby farmers who had severe problems were never contacted at all. One was Robert Ziegler of Newberry Township, directly across the river from TMI. Two days after the accident Ziegler's hogs refused to leave their pen and his chickens began flying wildly around their coop. By mid-May twenty-seven chickens and eleven hogs were dead of inexplicable causes. At harvesttime his corn was mushy and half-formed, his oat crop was half its normal yield, and the bark had peeled off a twenty-three-year-old walnut tree. Yet Ziegler was not in the survey, while some farms eighty miles away were.[8]

The reason for that, explained secretary of agriculture, Penrose Hallowell, was to provide a "spot check" to see if "there was a difference between the farms farther away and those close in." Hallowell also said some of the faraway spreads were included because the department "wanted to hit the biggest dairy farms in the area, and they were generally outside the five-mile limit."[9]

Yet the survey did include eleven families who were not farmers at all, and it listed as having "no problems" the fifty-eight-acre Manchester spread of Barbara and Homer Meyers, who said they had "no contact" with state surveyors.[10]

Nikoloff explained that the survey did include some animal owners who were not farmers. And that some farmers who were being surveyed may not have known it, because the work was being done by inspectors who also routinely test milk, feed, and fertilizer in the area.

As for the large numbers of farmers who complained about additional problems, Nikoloff told us he suspected that many of them might have come to mind in the year between the state's survey and *The News-American* investigation.

So we asked him why the DOA had not done a follow-up. "We requested no funding for further study," he

---

suggesting the existence of health problems. And Dr. Ernest Sternglass, a perennial campaigner against nuclear power, is accused by neutral health authorities of mishandling data to demonstrate health damage. Even in nuclear fables there are people who cry wolf."

7. Hammel, "Second Accident."

8. Ibid.

9. Ibid.

10. Ibid.

replied. "The radiation experts advised us there was no need to do it based on the amount of radiation in the air. They told us we'd be wasting the taxpayers' time and money."[11]

Among the farmers themselves there was disbelief and anger. "We aren't going to get any answers," concluded Vance Fisher, a sixty-year-old Etters cattle farmer whose livestock had been dying. "Anyone who works for the state is afraid to say anything against TMI."

"I have trouble believing anything they say," added Pat Baum, a dairy farmer from Elizabethtown. "They didn't know what they were doing when it all began, and I don't think they know what they're doing now."[12]

"By the time we came around," *News-American* reporter Hammel told us, "the hostility was so bad that I had to prove I was not from the state before the farmers would talk to us."

Once they did, Hammel said she encountered "a lot of people who didn't know each other who were telling us startlingly similar stories."[13]

The NRC Steps In

By the summer of 1980 stories about Dr. Weber, Jane Lee, Charles Conley, and other area farmers had begun to seep into the media.[14] It was precisely the kind of publicity the industry could least stand. The reactors were operating at roughly 65 percent of full capacity; originally the industry had promised 80 percent. And with just seventy plants on line, atomic power was producing a net of just 9 percent of the U.S. electricity supply, and less than 2 percent of all U.S. energy. After thirty-five years of research and development, $40 billion in taxpayer subsidies, and more than $100 billion in utility investments, commercial reactors were providing American consumers with less usable energy than firewood.[15]

In the wake of TMI came a federal moratorium on licensing. With no new orders coming in, construction costs soaring, electricity demand on the downswing, and the waste question still unresolved, the economic underpinnings of the peaceful atom seemed shakier than ever.

And now the political pillars were crumbling as well. On May 6, just five weeks after the TMI accident, more than 100,000 nuclear opponents gathered at the national capital in Washington to protest the radioactive dangers highlighted by the mishap. On September 23 more than 200,000 gathered in lower Manhattan for an antinuclear rally and concert that was the biggest American political gathering of the 1970s. Wherever atomic reactors were operating or being built, local citizens were working against them.

But nuclear power was not being abandoned. Those still in the industry had billions of dollars invested. First and foremost, it seemed necessary to dispel the idea that TMI had caused anyone any harm. And that meant the animal question. Just as Nevada sheep had become the first visible victims of the 1950s bomb tests, so the goats, pigs, cows, and cats of central Pennsylvania seemed destined to play the role at the dawn of the 1980s.

And like the AEC before it, the state of Pennsylvania stood firm. "There's not a shred of evidence that there's been a radiation-connected problem," Governor Richard Thornburgh said of the farmers' complaints. "If you could tell me of a single instance of a radiation-connected problem, then we'd want to take a look."[16]

But resistance at the state level to pursue the question further than the limited DOA study remained firm. "There

11. Nikoloff interview.

12. Hammel, "Second Accident."

13. Laura T. Hammel, interview, January 1981.

14. *The Progressive,* June 1980; *Village Voice,* March 1980; Pacific News Service, March 25, 1980; *Valley Advocate,* March 26, 1980; Pawlick, "Silent Toll"; *New York Times,* March 27, 1980. There were also numerous radio reports dealing with the animal problems around TMI.

15. For information on rising capital costs of atomic reactors versus coal-fired plants, see Komonoff, *Power Plant Cost Escalation*. For a table of falling reactor orders, see the Atomic Industrial Forum, *The Nuclear Industry in 1980: A Rocky Road to Recovery* (Washington, D.C.: Atomic Industrial Forum), January 19, 1981. The release, full of optimism for "some good years," was characterized as "whistling past the graveyard" by Anthony Parisi, in "Hard Times for Nuclear Power," *New York Times Magazine,* April 12, 1981. According to the AIF, in 1980 there were sixteen reactors canceled in the U.S. against no new orders. There were sixty-nine postponements.

The comparison of nuclear energy output to firewood comes from Tim Glidden, project manager of the Resource Policy Center, Dartmouth College. In a June 1981 interview Glidden said he calculated the 1980 usable energy output of U.S. nuclear power plants at 0.868 quads; that of wood was 1.351 quads. The nuclear figure did not account for energy consumed in the enrichment of uranium for reactor use, which could lower it by 25 percent, or for energy used in attempting to deal with nuclear waste.

16. Hammel, "Second Accident."

was not enough radiation to give any evidence of any need to do such a study," said Robert Furrer, a management analyst for the DOA. "To do more study would have been chasing a ghost," added Nunzio Palladino, dean of Pennsylvania State College of Engineering. "I wouldn't put a nickel toward more study."[17] In 1981 Palladino became chairman of the Nuclear Regulatory Commission.

Despite such opinions the NRC teamed up with the EPA to study the animals around Three Mile Island in the spring of 1980. Headed by the NRC's Germain LaRoche, the task force set about contacting those farmers who had complained of problems with their animals. By the fall of 1980 their investigation was complete and their conclusions firm—"no reasonable connection" could be made between radiation from TMI and damage to any nearby animals.

Among other things, the report said symptoms in cat and kitten deaths and reproductive problems "suggest infectious diseases." Problems in sheep, goats, and cows "suggest a nutritional deficiency." The tendency of local cows to fall down also seemed to be a dietary problem. Hatching problems with duck and goose eggs "could have come about because of fluctuation in incubator temperatures where incubators were used."

Overall the report concluded that "while many of the symptoms reported are characteristic of radiation sickness," many were also "diagnosed as common occurrences in domestic and wild animals." As a whole "no relationship can be established between the operation of TMI or the accidental releases of radioactivity and the reported health effects."[18]

Published in October of 1980, the study immediately became national news. *The New York Times* accepted it as definitive proof that the farmers' claims were without basis. In November the *Times* printed an editorial entitled "Goat Stories from Three Mile Island," which stated with confidence that the "findings are clear. None of the plant or animal defects can be attributed either to the accident or to normal nuclear operations at Three Mile Island. Many of the animal defects, in fact, were traced to the carelessness of the protesting farmers." Unequivocally revealing the paper's point of view, the editorial said reproductive problems in one goat had been solved with "a new buck." Horses that failed to breed had "a chronic infection." Calves that "could not stand or walk without staggering" suffered "nutritional deficiencies." Damage to plants and trees was "traced to disease and insects, not radiation."

Thus, said the *Times*, "the horror stories evaporate." The TMI accident was "highly dramatic and frightening," but it "caused no defects in Pennsylvania's woods and barnyards."[19] The *Times*'s editorial was reproduced and distributed by nuclear-committed utilities around the country. It was taken by many as a final word that the farmers near TMI were simply off base.

But apparently neither the *Times*'s editorial board nor much of the major media had read the NRC/EPA report carefully. Its authors had warned in their introduction that the survey "should in no way be thought of as an epidemiological study." There were, they said, numerous cases "that could not be investigated in depth because not

---

17. Ibid.

18. G. E. Gears, et al., *Investigations of Report Plant and Animal Health Effects in the Three Mile Island Area* NRC and EPA, NUREG-0738 and EPA 600/4-80-049 (Washington,D.C.: NRC and EPA, October l980), p.31 (hereafter cited as *NRC/EPA Animal Study*).

19. *New York Times,* "Goat Stories from Three Mile Island," November 23, 1980. The editorial read in full:

"Remember those frightening stories about deformed animals and dead vegetation around the nuclear plant at Three Mile Island? Not just the anti-nuclear crowd spread the tales of unusual animal deaths, stillbirths, broken bones, missing eyes—even a glowing fish. Reports came from farmers, housewives and a veterinarian who had long practiced in the area. Here was the evidence, some said, that the radiation from nuclear power plants, including even normal releases, can cause devastating biological injury.

"Well, the results of a thorough investigation of plant and animal defects are now in. The inquiry was run by the Nuclear Regulatory Commission with the help of two agencies that are highly sensitive to biological harm—the Pennsylvania Department of Agriculture, looking out for farmers and livestock, and the Federal Environmental Protection Agency, which safeguards the public.

"The findings are clear. None of the plant or animal defects can be attributed either to the accident or to normal nuclear operations at Three Mile Island. Many of the animal defects, in fact, were traced to the carelessness of the protesting farmers.

"Calves that could not stand, or walk without staggering, turned out to be suffering nutritional deficiences; when fed mineral and vitamin supplements, their problems disappeared. Goats that failed to produce offspring were found to be victims of genetic infertility; when a new buck was tried, reproduction soared. Horses that failed to breed were found to have a chronic infection. A group of 500 parakeets, canaries and other birds succumbed to toxic fumes or an overheated aviary; they showed no signs of radiation injury. A decline in the sightings of toads was hardly peculiar to Three Mile Island; it had been recorded all over the East, and for two decades, and may be attributable to pesticides. Suspicious damage to plants and trees was traced to disease and insects, not radiation. A few cases of animal anemia were nowhere near the radioactive plume.

"So the horror stories evaporate. That is not unusual. People often blame a highly dramatic and frightening event for unrelated difficulties. The wise citizen withholds judgment until hysteria subsides and dispassionate investigators assemble the facts. Three Mile Island taught a lot about the defects of nuclear plants, but it caused no defects in Pennsylvania's woods and barnyards."

enough data were available." There was also a "lack of background information" on many diseases in the area.

According to Germain LaRoche, whom we contacted by telephone in early 1981, the authors of the report "did not survey animals. We surveyed people and reports from the lab. We got a list of problems from the state and contacted as many of the farmers as we could."

In other words the Pennsylvania DOA's sketchy 1979 survey, which had been labeled "worthless" by *The* (Baltimore) *News-American*, had served as the basis for the "definitive" federal study of animal problems around the nation's biggest reactor accident. And in fact the NRC had contacted even fewer farmers—a year later—than had the state. "We did not go to all those people," LaRoche told us. "But we did go to quite a few."

Nor was there any improvement in actual testing of livestock. "We did not see any animals," LaRoche explained. "We did not do any autopsies. This [study] was done over a year after the accident. By the time we did our survey, all those animals had died or had been disposed of."[20]

In fact the final NRC/EPA report listed fewer than thirty-five cases involving animal problems near TMI. In more than half of them the investigators conceded that there were insufficient data to draw any conclusions about radiation poisoning one way or the other. Under the category of farm animal reproductive problems, for example, the report listed fourteen different cases. In ten of them the researchers acknowledged having either no data, insufficient data, or "cause unknown."[21]

As for the reports of Dr. Robert Weber that stillbirths and malformations among area pigs were epidemic, there was no survey or interview. The authors simply noted that "episodes of farm animals requiring caesarean delivery of young were reported after the accident." A repeat of "this specific problem was not evident in 1980; however, an increase of stillbirths in pigs was reported during the spring of 1980." There was no systematic poll of local veterinarians, no tabulated survey of area pig farmers.

"Similar problems in goats and sheep were also reported," said the authors. "But increases in the number of stillbirths in these animals were not observed. Again, these problems do not appear to be recurring events. Sterility and lower reproductive rates, especially in ducks and goats, have been reported but not confirmed."[22]

The study went on to note that an "oral report by a private citizen" had indicated a poodle was born in an unspecified location "without one eye socket." In fact the dog—as John Nikoloff of the state DOA later confirmed—was born with two eye sockets but no eyeballs at Fran Cain's kennel near the plant. Its case had been widely reported in the media, but the NRC never visited the kennel. Instead it concluded that the problem "was probably a developmental malformation, cause unknown."[23] In a cross section of nine other cases the findings were similarly inconclusive. In half of the remaining cases shipping fever, foot rot, nutritional deficiencies, virus, and several other diseases were mentioned. "Insufficient data" and "no diagnosis" accounted for the majority.

As for the widely reported disappearance of wildlife, the report blamed pesticides and the weather. There was no mention of independent studies showing high radiation levels in local rabbits, meadow voles, and milk.

To support one of the most crucial official health contentions in American history, the NRC and EPA had cited less than two dozen year-old autopsies and performed none on its own; presented no systematic survey of area hunters, farmers, gardeners, veterinarians, doctors, breeders, or fishermen; and made no substantial contributions to the very brief two-day survey done a year before by the state. "I was disappointed in the NRC's report," said Pennsylvania's John Nikoloff. "I felt with their resources they could have done a better job."[24]

Still the commission was prepared to promise that "concerned citizens may be assured that in keeping with its mission to safeguard the public health and safety, the staff of the Nuclear Regulatory Commission will continue to investigate reports of unusual problems experienced with plants and animals, and any pertinent findings will be made available."[25]

Had the NRC investigated more thoroughly, it might have found some important evidence. In early 1981, two years after the accident, Dr. Robert Weber, the Mechanicsburg vet, told us the plague of birthing problems among

---

20. Germain LaRoche, interview, February 1981.

21. *NRC/EPA Animal Study*, pp. 19-26.

22. Ibid., pp. 19-20.

23. Ibid., p. 8; and Nikoloff interview.

24. Nikoloff, interview, March 1981.

25. *NRC/EPA Animal Study*, p. 1.

pigs, goats, and sheep had come to an end. "Since the plant's been shut," he said, "there are no down cows or animals with hypertension or mental conditions over there. There's been a decline in everything that we had a lot of last year. I hardly get a call to go over there any more."[26]

"Since they shut the place down," added Charles Conley, "why, things have been much better. Had a good crop, and some of the birds are back."[27] Conley was one of many local farmers to claim a noticeable improvement in the health of his animals in the wake of the TMI shutdown. He also told us the mysterious white powder that had been plaguing his rainwater had not reappeared since the plant shutdown.

In fact the NRC/EPA investigators spent a good deal of time tracing tales of the powder. But with TMI shut, none was to be found. "We asked all over for farmers to bring us in a sample of that white powder," said Germain LaRoche. "The only thing we got was some stuff from a woman that turned out to be mildew."[28]

On a broader scale a survey of "fresh water cooling towers throughout the country has not shown any evidence of white powder," said the report. But somehow they missed a white residue reported by residents as close as Shippingport, reports that were nationally syndicated by Jack Anderson in 1977. Statements of strange residues coming from the sky near Vermont Yankee also went uninvestigated.

Nor, apparently, did the government give much credence to a broad cross section of experienced, deeply rooted, conservative Pennsylvania farmers who were—like sheepherders downwind from the Nevada Test Site, like Herschel Bennett in Arkansas, like Nancy Weber in upstate New York, like Lloyd Mixon at Rocky Flats, like Mildred Zywna at Vermont Yankee, like Emil Zimmerman at West Valley, like Clarence Ransome near Canon City—simply unable to find any other possible explanation for the unprecedented plague of diseases among their animals except nearby sources of human-made atomic radiation.

26. Weber, interview, February 1981.

27. Conley, interview, October 1980.

28. LaRoche interview.

14

People Died at Three Mile Island

Gordon MacLeod sat across from the governor of Pennsylvania. It was October 9, 1979. MacLeod had been state secretary of health since twelve days prior to the accident at Three Mile Island.

A tall, trim Bostonian, MacLeod was a lifelong Republican who had served in Richard Nixon's Department of Health, Education, and Welfare. As both a medical doctor and an engineer he had moved from a research fellowship at Harvard Medical School to a chairmanship at the University of Pittsburgh's Graduate School of Public Health.

In 1979 Governor Richard Thornburgh, a neighbor of MacLeod's, had urged him to take charge of the state's Department of Health, which was in disarray. MacLeod had resisted, but finally agreed, with the understanding he would serve just two years, then return to academia.

Now, eight months later, as controversy still raged over how much radiation had been released at Three Mile Island, the governor's office called the secretary of health for a conference. The meeting began with some small talk, MacLeod told us a year later. And then Thornburgh got to the point. "'Gordon,' the governor said, 'I'm going to have to ask for your resignation.'"

"I just sat there," MacLeod told us, "stunned. After going to all that trouble to get me to come on board, he was now telling me to leave after just eight months because things were 'just not working out.'"[1]

Thornburgh's public explanation for MacLeod's firing was a "difference in institutional style." But the state media had other ideas. As the UPI reported it, MacLeod had been "state government's harshest critic of the way the Thornburgh administration responded to the Three Mile Island accident. And that may have been why he was fired."[2]

Indeed, MacLeod's problems with Thornburgh had begun on March 29, the day after news of radioactive releases from TMI began to spread. MacLeod had, in his words, "recommended and, on the next day, urged the governor in the strongest possible terms to call for the departure of pregnant women and young children from an area within five miles of the Three Mile Island plant." MacLeod told us later that if he had a chance to do it over, he would also have urged the departure of children in puberty, who are also extraordinarily radiation-sensitive.

But the state's nuclear engineers and radiation health physicists disagreed with MacLeod, and they told the governor there was no need for an evacuation. Initially Thornburgh advised area residents to stay indoors, but said nothing about evacuating.[3]

Meanwhile Dr. Ernest Sternglass had gone to Harrisburg the day after the accident. After testing on his own and finding high radiation levels, he urged that the state evacuate pregnant women and small children. He was worried in particular that I-131 doses could prove devastating to the small children and infants *in utero* who were particularly vulnerable to miscarriages, stillbirths, malformations, childhood leukemias, and other radiation-linked problems. Thornburgh publicly charged Sternglass with being an alarmist and stood firm in his refusal to call for an evacuation.

That night the state's Department of Environmental Resources announced that because the holding tanks at TMI were overloaded with radioactive liquids, Met Ed had been flushing them for hours into the Susquehanna River. No one had bothered to notify communities downstream that were continuing to draw their drinking water from the

---

1. Gordon MacLeod, interview, October 1980; see also, Anna Mayo, "The Nuclear State in Ascendancy," *Village Voice,* October 22-28, 1980.

2. *York Daily Record,* November 5, 1979, p. 4-A.

3. MacLeod interview, and Gordon MacLeod, "Three Mile Island and the Politics of Public Health," prepared for presentation for the New York City and Old Westbury chapters of Physicians for Social Responsibility, Columbia University, New York, November 22, 1980 (hereafter cited as "Politics"); see also, Gordon MacLeod, "Some Public Health Lessons from Three Mile Island: A Case Study in Chaos," *Ambio* 10, No. 1 (1981).

river.[4]

Finally Thornburgh asked NRC chairman Joseph Hendrie, a nuclear engineer, what he would do if he had a pregnant wife in the area. Hendrie replied that he would get her out "because we don't know what is going to happen."[5]

Thornburgh then decided to do what MacLeod had quietly urged and what he had attacked Ernest Sternglass for publicly suggesting. At noon on March 30—two days after the start of the accident—he announced that he was "advising those who may be particularly susceptible to the effects of radiation, that is, pregnant Women and pre-school-age children, to leave the area within a 5-mile radius of the Three Mile Island facility until further notice."[6]

Public Health in Crisis

Meanwhile Gordon MacLeod was desperately trying to choreograph an official health response. Despite the recommendations of the Shapp Commission at Shippingport six years earlier MacLeod found the state woefully unprepared for a nuclear incident. "There was not even a book on radiation medicine in the department," he said. "Nor was there a single physician specially trained in radiation medicine anywhere in the Pennsylvania state government."

Apparently the NRC was equally unprepared. As the accident progressed, MacLeod asked the commission to send in a doctor trained in the field of radiation health. "I was told," MacLeod said, "that the NRC had no physicians on its staff, much less a physician trained in the field of radiation medicine."[7]

The commonwealth also tried to get from the federal government a supply of potassium iodide, a liquid that may be taken to block the ingestion of radioactive iodine from the atmosphere, and thus prevent harm to the thyroid.[8] Finally, five days after the accident—far too late for it to do much good—eleven thousand "little brown vials" arrived. According to MacLeod, six thousand of them were unlabeled. Many of the droppers yielded only half the correct dose. Other droppers did not fit the vials at all. And many of the vials contained "hairlike filamentous material and other particulate matter."[9]

Despite his belief that the official health response to the accident had been grossly inadequate, MacLeod remained a supporter of atomic energy. "I personally believe," he told a conference at Columbia University eighteen months after the accident, "that nuclear power can be made relatively safe if we don't ignore the public health lessons of the past."[10]

But MacLeod worried that those "health lessons" were being ignored. Several months after the accident he clashed with Thomas Gerusky, chief of radiation monitoring at the state's Department of Environmental Resources, who had opposed the early evacuation of pregnant women and small children from the area. MacLeod found Gerusky's testimony to the Kemeny Commission inquiry into the accident to be misleading. In the fall he wrote a letter to Commission chairman John Kemeny outlining his objections to what Gerusky had said.[11]

That, apparently, was the last straw for the Thornburgh administration. Word soon spread that MacLeod's behavior during the accident had been "erratic." By mid-October he had been removed from his position.[12] The state media interpreted MacLeod's dismissal as a concession to the nuclear industry. Some atomic backers had deeply resented the call for the TMI evacuation, saying it had been unnecessary, unwarranted, and had served only to frighten the population.

---

4. *Washington Post, Crisis*.
5. *Kemeny Report,* p. 118.
6. *Washington Post, Crisis*.
7. MacLeod,"Politics."
8. A discussion of the efficacy of potassium iodide in preventing harm during a nuclear accident appears in Jan Beyea, *Some Long-Term Consequences of Hypothetical Major Releases of Radioactivity to the Atmosphere from Three Mile Island* (Princeton, N.J.: Center for Energy and Environmental Studies, 1979).
9. MacLeod interview.
10. MacLeod, "Politics."
11. MacLeod interview.
12. Pawlick, "Silent Toll. "

But the firing of Gordon MacLeod hardly ended the controversy over the health impact of the accident and how it had been handled. In November, Ernest Sternglass charged that figures from the nearby Harrisburg and Holy Spirit hospitals indicated that infant deaths there had doubled from six during February through April of 1979 to twelve in May through July. Only one infant had died at the Harrisburg Hospital in May through July of 1978; seven had died there in those same three months following the accident. The statistics seemed tragically reminiscent of the era of nuclear bomb testing. The NRC, the state, and the utility had all claimed—as had the AEC after so many atomic explosions—that radiation releases had been too small to have more than a very marginal health impact, if any at all. Sternglass asserted the authorities had failed to account for the extreme sensitivities of fetuses *in utero* in claiming a very marginal health impact from the accident's releases.[13]

He also pointed out a crucial shortcoming in the method of calculating estimated doses from a nuclear accident. An average population dose had been set by estimating how much radiation had been released and making calculations around the two million people in the fifty-mile radius around TMI. But, he said, the winds during the most crucial hours of the accident—when most of the radiation was released—generally headed to the west, northwest, and north. Thus the real doses were impacting not the vast surrounding population, but the people specifically in the path of the plume. And as Chairman Joseph Hendrie had confirmed on March 30, in the midst of the accident, the doses to individual areas where the plume touched the ground were "husky" and in the range of 120 millirems per hour and more, quantities easily large enough to cause severe damage to fetuses in the womb.[14]

Sternglass now charged that the doses had in fact impacted people in the path of the plume, and with visible effect. Syracuse, Rochester, and Albany had all received windblown doses from the plant, he said, and had suffered rising infant deaths. A preliminary study by the Canadian journal *Harrowsmith* indicated a possibly similar pattern emerging among infants born at eastern Ontario and western Quebec hospitals, due to radiation from nearby Nine Mile Point.[15]

In December of 1979, Sternglass carried his conclusions much further. In a paper delivered to the Fifth World Congress of Engineers and Architects at Tel Aviv, he said that data from the U.S. Bureau of Vital Statistics showed that there were "242 [infant] deaths above the normally expected number in Pennsylvania and a total of 430 in the entire northeastern area of the United States," a rise of clear statistical significance. The linkage with TMI was clear because "large amounts of radioactive Iodine-131 were released from the plant" and the peak of infant mortality came within a matter of months thereafter. The greatest rises took place near the plant, with effects decreasing as a function of distance away from Harrisburg.

He backed up his case by analyzing the amount of radiation to which pregnant women downwind might have been subjected. Accepting minimum official estimates, Sternglass calculated that the doses of radioactive I-131 alone could have been on the order of one hundred millirems to individual pregnant women in the path of the plume. Such doses, he said, were clearly capable of causing rises in infant mortality.[16]

Using federal statistics, Sternglass then demonstrated that Pennsylvania's infant death rate in July was the highest of any state east of the Mississippi that month (except for Washington, D.C.), although Pennsylvania usually has one of the lowest rates in the nation. He went on to say that a similar rise was evident in infant-mortality rates in northern New England—where wind had carried fallout from the plant—as opposed to southern New England, where it had not.[17]

The hypothesis was confirmed by the fact that infant-death rates began to fall again after the accident. This, he said, was predictable because embryos *in utero* who were too small to have developed a thyroid, or who were conceived after the accident, would not have been affected by their mothers' ingestion of radioactive iodine.

But I-131 was not the only radioactive element released from TMI—nor were infants the only humans likely to be harmed. Strontium 90, cesium 137, noble gases, and other disease-causing isotopes may also have escaped. Overall, said Sternglass, increases in cancers, leukemia, and a wide range of other diseases were "likely to occur." The Three

---

13. Ernest Sternglass, "Infant Mortality Changes Following the Three Mile Island Accident," presented at the 5th World Congress of Engineers and Architects, Tel Aviv, Israel, 1980 (hereafter cited as "Infant Mortality Changes"); and Pawlick, "Silent Toll."

14. *Pittsburgh Post-Gazette*, April 16, 1979, p. 1.

15. Pawlick, "Silent Toll," and Sternglass, "Infant Mortality Changes."

16. Ibid.; and Sternglass interview.

17. Sternglass, "Infant Mortality Changes"; see also, Sternglass, "TMI Update," *Nation*, April 25, 1981.

Mile Island accident, he predicted, "will turn out to have produced the largest death toll ever resulting from an industrial accident, with total deaths from all causes likely to reach many thousands over the next 10 to 20 years."[18]

Pennsylvania Denies Infant Deaths

The charge that TMI had actually killed area infants provoked a storm of outrage from the government of Pennsylvania. The state responded—as it had at Shippingport six years earlier—that the official statistics Ernest Sternglass had used were, after all, inaccurate. Dr. George Tokuhata, director of the state's Department of Epidemiological Research, said a "printing error" on the part of the U.S. Bureau of Vital Statistics had skewed the state's infant-mortality figures. There were thus eighty-eight fewer infant deaths in Pennsylvania in the summer of 1979 than originally recorded.[19]

Sternglass, however, held his ground. Discrepancies between state and federal data are not uncommon. But this particular case seemed "suspicious." The discrepancy in infant deaths between the two sources for the period of April 1 through June 30, 1979, had been two; from October 1 through December 31 it had also been two. For eighty-eight to surface between July 1 and September 30, precisely in the controversial summer months after the TMI accident, seemed unlikely.[20]

But even after subtracting those eighty-eight infant deaths, Sternglass said, Pennsylvania's infant-mortality rate still exceeded the average U.S. rate—contrary to normal patterns—"and also exceeded it for every month following the accident up to December." He thus maintained that his overall conclusions about infant deaths in the Northeast remained unchanged.[21]

Tokuhata nonetheless told *The New York Times*, which accepted his remarks uncritically, that Sternglass's analysis had been based on "the wrong number." Tokuhata further charged that Sternglass's reports were "full of problems" and had been built around "methodologies inconsistent with standard epidemiological procedures." He had, said Tokuhata, "selected areas for analysis that fit his hypothesis ignoring those close to the reactor where the infant mortality rate was very low."[22]

Sternglass replied—though not in *The New York Times*—that he had not initially studied those close-in areas in his Tel Aviv report "because Tokuhata himself had refused to make [those figures] available to me at the time I was doing my study."[23]

In an interview with us Tokuhata denied having ever refused to give Sternglass the data. "He must have asked some other department," Tokuhata said. "We never refused."[24]

But in fact the infant-mortality statistics around TMI only became public in the winter of 1980, when Dr. MacLeod—who had since returned to the University of Pittsburgh—began receiving calls from his former colleagues. Anonymous members of the department told MacLeod that the state was suppressing statistics that indicated a rise in infant-mortality rates near TMI. Alarmed by what MacLeod termed a "restrictive policy" on health data, he released the numbers in a pulpit address at Pittsburgh's First Unitarian Church. That, in turn, forced the Department of Health to make the figures officially public.[25]

And the numbers apparently confirmed the public's worst fears. In the six-month period following the accident, in a ten-mile radius around TMI, thirty-one infants had died. In 1978 the number was only fourteen; in 1977 it had been twenty.

Tokuhata told the *Times* the apparently sharp rise in infant deaths in 1979 was not significant because that was an

---

18. Sternglass, "Infant Mortality Changes."

19. George Tokuhata, interview, February 1981.

20. Pawlick, "Silent Toll"; and MacLeod, "Politics."

21. Pawlick, "Silent Toll."

22. Brody, "3 Mile Island."

23. Pawlick, "Silent Toll."

24. Tokuhata interview. In this February 1981 interview Tokuhata denied having refused to send Sternglass the data in question. Later in the interview, however, we asked him for infant-mortality data for 1975 and 1976. He said he could not send it to us. We also asked him about Gordon MacLeod's remark to us (in our October 1980 interview) that Tokuhata had called MacLeod at 7:00.A.M. one morning in the winter of 1979-80 to discuss the hypothyroid cases that had surfaced in southeastern Pennsylvania. Tokuhata denied having made the call.

25. MacLeod interview.

absolute number, not a rate of deaths against live births. *Times* reporter Jane Brody paraphrased him thusly: "When the 31 infant deaths were considered in relation to the number of live births, no statistically meaningful difference was found."[26]

But in fact, said Sternglass, these "preliminary" figures showed an infant-death *rate* within that ten-mile radius of 7.2 per 1000 live births in 1978; in 1979, after the accident, the number had risen to 15.7 per 1000—a more than doubling.

The numbers for infant-death rates within a five-mile radius of TMI—though small—were even more damning. In 1978 the rate had been 2.3 infant deaths per 1000 live births; in 1979, after the accident, it was 16.2—a jump by a factor of seven.[27]

But the state had an explanation. At a press conference in April of 1980 Dr. H. Arnold Muller, who had taken MacLeod's place as secretary of health, announced that the TMI-area infant-death rates showed "no statistically significant difference in the mortality rate than for the state as a whole."[28] To support its case the state introduced a racial factor. Black people, it said, are known to suffer a higher rate of infant mortality than whites. Thus the presence of large numbers of blacks in Harrisburg—some of whom had been counted into the figures for the ten-mile radius around TMI—had made the local infant-mortality rates seem unduly large. As Tokuhata was paraphrased by Jane Brody in the *Times*: ". . . when analyzed without taking into account Harrisburg, where the large black population ordinarily has a much higher infant mortality rate than the rest of the region, the rate for the population living within 10 miles of the plant was the same as that *for the state as a whole*" (our emphasis).[29]

The analysis was deceptive.

The charge that TMI had killed nearby infants had nothing to do with a comparison with the state average. It had been based on comparing death rates *in the same area* from the spring and summer of 1977 and 1978—before the accident—against those of the spring and summer of 1979—after the accident.

To subtract the figures for black people from the 1979 statistics without doing the same for 1978 and 1977 would have made sense only if they had all moved into Harrisburg the day of the accident.

And in fact, prior to the accident, the infant-mortality rate in the TMI area had been generally *lower* than the state average. If it now equaled the state average, that would really mean a significant *rise* in the normal local infant-mortality rate.

But the state's own statistics showed the local rates were actually *above* the state average anyway. From April 1 to September 30, 1979, the state infant-mortality rate was put at 13.3 per 1000. For that period in the ten-mile radius around TMI it was 15.7; for the five-mile radius (which excluded Harrisburg's blacks) it was 16.2. Thus in the same press release in which the state had claimed preliminary proof that the TMI accident had harmed no babies, its own figures indicated precisely the opposite.[30]

Meanwhile, another controversy had erupted over an unexpected outbreak of thyroid-deficiency problems among infants born to the southeast of the plant. Again Gordon MacLeod was responsible for making the information public. Having been informed by colleagues still within the Department of Health that the numbers had surfaced, MacLeod privately asked the state—four times—to release the data. The state refused all four times. So MacLeod alerted a UPI reporter that "there's a story over there," and it was soon in the newspapers.[31]

The problem focused around thirteen cases of infant hypothyroidism in an area where normally three such cases would be expected. MacLeod was particularly sensitive to the state's withholding data on hypothyroidism because it is a disorder that can be easily treated at birth with the administration of iodine supplements. Untreated, it can cause

---

26. Brody, "3 Mile Island."

27. Sternglass, "Infant Mortality Changes"; and Pawlick, "Silent Toll." See also, Sternglass, *Secret Fallout*, pp. 241-275.

28. Pennsylvania Department of Health, *Health Department Releases Preliminary Study on Infant Deaths in TMI Area* (Harrisburg: Department of Health, April 2, 1980) (hereafter cited as *State Preliminary Study*).

29. Brody, "3 Mile Island."

30. *State Preliminary Study*. This press statement also included a long discussion of infant-death rates in the January 1-September 30, 1979, period and the October 1, 1978-March 31, 1979, period, neither of which was particularly relevant to the question of what the accident did or did not do to local infant-death rates. Both sets of figures included seasonal changes and neither offered the year-to-year comparisons that were the heart of the matter. See Pawlick, "Silent Toll," for a lengthy discussion of which periods were relevant and which were not.

31. MacLeod interview.

brain damage and a wide variety of other serious defects. "The most important thing was that there be some opportunity to prevent the disease," MacLeod told us. Warning the public "might help pick up any case that might otherwise slip through the cracks."[32]

But the question raised a sensitive issue. Thyroid problems were well known to have surfaced among Marshall Islanders downwind from atomic tests. To imply an outbreak downwind of TMI was potentially to indict the reactor.

Industry response was thus immediate and sharp. "There cannot be any connection" between TMI and the disease, said Dr. Victor Bond of the Brookhaven National Laboratory. "I can say that unequivocally. For thyroid effects, the doses would have to have been thousands of times higher than they were." "A link just cannot be there," added William Dornsife, a nuclear engineer with the state Bureau of Radiation Safety.[33]

Tokuhata later told us that a case-by-case investigation in Lancaster County, where seven of the hypothyroid cases had surfaced, showed "no evidence" to link TMI to the disease. One case, he said, had surfaced "before the accident." Another was "inherited" and a third baby was "born three months after the accident and could not have been affected." Two others "had the thyroid in the wrong locations, which is a developmental disorder and highly unlikely to have anything to do with TMI." The final two cases were "unexplained." But having eliminated five of the seven victims, Tokuhata said the remaining two fitted the "normal pattern" of two hypothyroids per fifty-five hundred live births.[34]

By culling the cases Tokuhata brought the hypothyroid statistics down to what the state termed a "normal" rate. But Gordon MacLeod charged that even while accepting Tokuhata's subtractions, the extraordinary concentration of cases in a short period of time after the accident still reflected a five- to tenfold increase in the expected number.[35]

The New York Times, however, accepted Tokuhata's analysis without question. In Jane Brody's April 15, 1980, report—entitled "Three Mile Island: No Health Impact Found"—the paper definitively exonerated the crippled reactor. In the instance of the hypothyroids a "potentially biased selection of cases led to the conclusion that radiation had damaged fetal thyroid glands."

The article dismissed the infant mortalities, saying incomplete figures and incorrect survey methods were the real culprits. Relying on statements from Tokuhata, other Pennsylvania officials, and the Atlanta-based Center for Disease Control—and without interviewing Gordon MacLeod—Brody concluded that "health officials say that thus far data do not support" claims of any extraordinary health problems among infants downwind.[36]

Unfortunately, in taking utility, state, and federal officials' word at face value, Brody had failed to notice a middle ground developing. Dr. Thomas Foley of the Pittsburgh Children's Hospital told *The Washington Post* that no cause-and-effect relationship had been definitely proven linking TMI to the hypothyroids. But "the fact that it did follow the accident raises an issue," he said. The timing was "peculiar and curious."[37]

The *Times* also overlooked the possibility that radiation from TMI might have been only partially at fault, and that emissions from normal operations at the nearby Peach Bottom reactor might also have contributed to the problem. A survey of cases in nearby Maryland might have helped clear up the issue, but none was done.[38]

Three days after Jane Brody's story appeared, the staff editorial "Nuclear Fabulists" appeared in the *Times*. It charged that "those scare stories about radiation damage from the accident at Three Mile Island look increasingly far fetched." Just as "reports of bizarre deformities among farm animals and wildlife" had been squelched by the Department of Agriculture, so concerns about infant mortality and hypothyroidism had been "effectively laid to rest by state and Federal health investigators." Findings that "little radiation escaped, posing virtually no threat to public health" had been "supported by all major investigations of the accident," said the *Times* editorial board.

---

32. Ibid., and MacLeod, "Politics."

33. *Philadelphia Inquirer*, February 22, 1980.

34. Tokuhata, interview, April 1980.

35. Gordon MacLeod, interview, June 1981. MacLeod explained to us that the state had averaged the two "accepted" hypothyroid cases over a full year's period, when in fact they had both occurred in a matter of months after the accident. One might also question Tokuhata's methods of culling the cases. Overall hypothyroid incidence rates are calculated on a total number of reported cases. For the state to cull the count in this single instance was to give it special treatment not given the method of calculating the "normal" rate.

36. Brody, "3 Mile Island." Among other things Brody's article incorrectly stated there had been twenty infant deaths in the ten-mile area around TMI in 1978; in fact state statistics showed fourteen for that year, and twenty for 1977.

37. Victor Cohn, "A-Plant Involved in Probe of Thyroid Ills," *Washington Post*, February 21, 1980.

38. The suggestion that Maryland infant-mortality rates be investigated came from Dr. Alice Stewart.

In fact the real problem was "experts" who had "inflamed public fears by dealing recklessly with statistics." Among them was Dr. MacLeod, who "irresponsibly publicized some of the raw data suggesting the existence of health problems," and Dr. Sternglass, who was "accused by neutral [!] health authorities of mishandling data to demonstrate health damage. . . . Even in nuclear fables," concluded America's journal of record, "there are people who cry wolf."[39]

Infants Died at TMI

As debate over hypothyroids and infant deaths intensified, so did the anger and fears of the people around Three Mile Island. In March of 1980, at the first anniversary of the accident, some eleven thousand people gathered at the state house in Harrisburg to demand a permanent shutdown at TMI. The controversy largely focused on Met Ed's "other" reactor, Three Mile Island Unit One.

At the time of the 1979 accident TMI-1 had been just about to come back on line after a refueling shutdown. Ironically TMI-1 had one of the best operating records of any reactor in the U.S. The accident at TMI-2 had kept it shut. Now Metropolitan Edison, operating at the brink of bankruptcy, facing a bill of at least one billion dollars for cleaning up TMI-2, wanted desperately to get TMI-1 reopened and back in its rate base.

Increasingly fierce local opposition was in the way. In March of 1981 local citizens burned fifty thousand dollars in Met Ed electric bills on the state-house steps. The next day, on the accident's second anniversary, fifteen thousand people gathered to demand a permanent shutdown. The latter rally marked a major turning point in public attitudes toward nuclear power because it had been sponsored by eleven international trade unions—representing some seven million workers. For years organized labor had been portrayed as a staunch, unified supporter of atomic energy. But now increasing concern over health, safety, and economic issues had helped change that.

At the same time, however, the newly inaugurated Reagan administration was pushing ahead to restart atomic licensing. Through the last months of the Carter administration industry supporters had been lobbying hard to call the post-TMI moratorium to an end. The industry had learned much about safety, they said and it was time to build more plants. Led by NRC chairman Joseph Hendrie a strong drive to shorten the licensing process, and limit public participation in it, gained momentum.

But critics charged that this was precisely the time the reactors were proving more dangerous than ever. One particularly harsh fight was developing over the Diablo Canyon Nuclear Station, a double-reactor project on the coast of California that sat just three miles from a major earthquake fault. The plant had been tied up in legal battles since it was completed in 1976. Hundreds of arrests had taken place at the site, and in 1981 a national-scale confrontation erupted there.

And in the midst of increasing polarization evidence continued to surface that nuclear power was far more dangerous than anyone had believed, and that the "wolf" Gordon MacLeod and Ernest Sternglass were pointing to was in fact very real.

As early as October of 1979—six months after the TMI accident, and the same month in which Gordon MacLeod was fired—the Arkansas Department of Health issued a study indicating a sharp rise in stillbirths in Pope County, where Arkansas Power and Light's Nuclear One is located. The infant-mortality rate had dropped slightly. But the stillbirth rate had soared so significantly that the combined total had climbed from 20.3 per 1000 live births in 1974, when Nuclear One opened, to 25.4 in 1975, 27.6 in 1976, and 26.8 in 1977. The combined rate in control counties farther from the site had, by contrast, dropped sharply.

Arkansas Power and Light quickly denied any likelihood that Nuclear One "would have any effect on the health of newborns. We have worked closely with the hospital there," said AP&L vice-president, Charles Kelly, "and every indication we've had in monitoring the health effects is that there is none." The study, added Director Robert Young of the Arkansas Health Department, was "inconclusive" and offered no evidence that Nuclear One was to blame for the escalating stillbirth rate.

But Drs. George Carlo and Carol Hogue, the epidemiologists at the University of Arkansas Medical Sciences campus who prepared the study, warned that "a pattern of risk" seemed to be developing. "The situation should be monitored closely," they said, because "we may be detecting a weak signal."[40]

---

39. *New York Times,* "Nuclear Fabulists."

40. *Arkansas Gazette,* October 31, 1979, p. 8-A.

The signal from TMI seemed considerably stronger. In February of 1981 Pennsylvania released its 1979 vital statistics—seven months later than normally expected. Missing from the data for the first time were general disease figures from the town of Aliquippa, near Shippingport. Also omitted were county-by-county tallies of congenital malformations, and information on how many infants had been born under a weight of fifteen hundred grams. "This key information," charged Ernest Sternglass, "is needed to study the possible effects of radioactive iodine from the release of TMI or the other large reactors in the state of Pennsylvania.

"The pattern is clear," he said in an angry article in *The Nation*. "Two years after the TMI accident, the nuclear industry and the state of Pennsylvania continue to mislead the public about its adverse effects on human health."[41]

Just prior to the 1981 union-sponsored rally at the state capital, the Department of Health released what it termed a "final" report on infant deaths near the plant. On March 20, Dr. George Tokuhata told the media that the rate of infants dying in their first year of life had definitely not gone up after the accident. In fact, he said, in a ten-mile radius around TMI, the infant death rate per 1000 live births was an identical 19.3 in the quarter before the accident and in the quarter after it. There was "no difference" in the infant-mortality rate in January through March 1979 as opposed to April through June. If the accident had killed any area infants, "a significant increase in infant deaths during the last six months of 1979 would have occurred." Rather the death rate dropped to 12.7 in July through September of 1979 and 13.4 in October through December.

Thus, Tokuhata concluded, "there is no evidence to date that radiation from the nuclear power plant influenced the rise or fall of statistics."[42] An aide in the Department of Epidemiological Research told us that Sternglass and others had erred by relying on "provisional data," and that this latest, "definitive" report would settle all that.[43]

In general the state and nuclear industry focused their defense of TMI on attacking Ernest Sternglass. But as in the past Sternglass's primary role had been to call attention to the issue. Ultimately it was the state's own numbers that would indicate whether or not TMI had harmed local infants.

In this case, as he had done in years previous, Dr. Tokuhata had compared time frames that were essentially irrelevant to each other. In his public analysis he had emphasized that the 1979 infant-death rates near TMI in the winter months of January through March—before the accident—had been the same as in the spring months of April through June—after the accident.

But infant-death rates usually drop in the spring. The fact that they were as high in the spring of 1979 as they had been that winter was extremely significant.

Indeed, a strong case could be made that the December 1978 opening of TMI-2—not just the accident—could have been related to a significant increase in infant mortality. The 1979 winter death rates were far higher than those of 1977 and 1978.

In the winter of 1977 state figures showed that 14.7 infants had died per 1000 live births in the ten-mile TMI radius. The figure was equal to the state average for that period of that year. In 1978 the figure was 14.0—less than the state average for that period of that year. But in 1979, after the opening of TMI-2, the number had soared to 19.3—far above the state average for that period of that year, and far above the rate for that period of the previous two years in the same area. Something had caused a jump in infant deaths in TMI area the winter of 1979.

As for the spring of 1979—the three months after the accident—the contrasts were even more striking. In April through June of 1977, infants had died in the ten-mile TMI area at the rate of 11.7 per 1000 live births, less than the state average. In 1978 the figure was 9.8, again less than the state average. But in 1979 the number jumped to 19.3, far above the state average, and nearly doubling the rate of the previous two years.

---

41. Sternglass, "TMI Update"; see also, "The First Casualty at T.M.I." and "The Lethal Path of T.M.I. Fallout," *Nation*, February 28 and March 7, 1981.

42. Pennsylvania Department of Health, *TMI Area Infant Death Rates No Higher Than Statewide Averages, Health Department Report Says* (Harrisburg: Department of Health, March 20, 1981) (hereafter cited as *State Final Report*).

43. Ed Degan, Pennsylvania Department of Health, interview, March 1981.

Infant Death Rate per 1000 Live Births

Ten-Mile Radius Around Three Mile Island

Winter	*Total*	*Harrisburg*	*Excluding Harrisburg*	*State Average*
1977	14.7	24.8	10.9	14.7
1978	14.0	30.7	7.5	14.3
1979	19.3	33.8	12.6	13.3
Spring				
1977	11.7	8.1	13.1	14.4
1978	9.8	11.5	9.1	14.0
1979	19.3	29.7	14.7	14.0
Summer				
1977	9.2	10.9	8.5	12.9
1978	4.9	3.3	5.5	11.8
1979	12.7	9.9	13.9	12.1
Fall				
1977	14.7	16.9	14.0	13.7
1978	15.1	25.9	11.5	13.6
1979	13.4	31.7	5.9	14.4

Source: Pennsylvania Department of Health, "TMI Area Death Rates No Higher than State Average, Health Department Report Says," Harrisburg, March 20, 1981, Table 5.

The figures for the July through September summer months were also striking. Though fewer infants died in the summer of 1979 than in the spring of 1979, the rate was clearly higher than it had been in the summers of 1977 and 1978. The numbers were 12.7 in 1979 as opposed to 9.2 in 1977 and 4.9 in 1978. The figures then leveled off for the fall months of October through December, with infant-death rates actually lower in 1979 than they had been for the same period in 1977 and 1978.

The numbers were small in absolute terms, but of clear statistical significance in the time periods that were most crucial. Overall the pattern seemed to fit the worst-case scenario for a radioactive accident. Comparative infant-death rates in a ten-mile radius around TMI had risen when the second reactor opened there and had skyrocketed in precisely those critical first three months after the accident. The figures for Harrisburg itself—where some argued that the worst of the plant's radioactive emissions had set down—seemed even more frightening.

Neonatal Death Rate per 1000 Live Births

Ten-Mile Radius Around Three Mile Island

Winter	*Total*	*Harrisburg*	*Excluding Harrisburg*	*State Average*
1977	12.4	20.7	9.3	10.7
1978	8.6	19.2	4.5	9.9
1979	17.2	33.8	9.4	9.3
Spring				
1977	8.5	-0-	11.6	11.1
1978	7.6	7.6	7.6	11.1
1979	19.3	29.7	14.7	10.5
Summer				
1977	6.1	7.3	5.7	10.1
1978	1.0	-0-	1.4	9.3
1979	7.8	6.6	8.3	9.3
Fall				
1977	10.5	12.7	9.8	10.1
1978	10.8	17.2	8.6	10.5
1979	9.3	21.1	4.4	10.1

Source: Pennsylvania Department of Health, "TMI Area Death Rates No Higher than State Average, Health Department Report Says," Harrisburg, March 20, 1981, Table 4.

In 1977, in the April through June spring quarter, infants in Harrisburg died at the rate of 8.1 per 1000 live births, well below the contemporary state average. In 1978 the figure was 11.5, again well below the state average. But in 1979 it reached a horrifying 29.7, more than doubling the state average and nearly tripling the Harrisburg figures for the two previous years. Though the absolute numbers were small, the changes were of clear statistical significance.[44] Nor did the figures account for any of the pregnant women who fled the area during the accident to have their babies elsewhere, and who might well have been affected by the emissions of those terrifying first two days.

But the fiercest toll of all seemed to be taken on infants born in Harrisburg right after the accident, who then died within twenty-eight days. Infant-mortality rates—on which most of the public debate on TMI health impacts centered—are based on infants' dying in their first year of life. Neonatal death rates, a subsection of infant-mortality statistics, focus on infants who die in their first month of life. And in those tragic three months after the TMI accident every Harrisburg baby listed as an infant-mortality statistic had in fact died in the first twenty-eight days of

44. *State Final Report,* Table 5.

life. Thus, in April through June of 1979, state neonatal statistics indicated that infants one month old or less died in Harrisburg at a rate of 29.7 per 1000 live births. In 1978 the number had been 7.6. In 1977 it had been zero. Though the absolute numbers were again small, the changes were of even greater statistical significance than those in the infant-mortality rate.[45]

The Mental Fallout

In those frightening first days of the accident at Three Mile Island fifth and sixth graders in nearby Middletown had gotten together to write their last wills and testaments.[46] The terror was at the gut and instinctual levels, and it dated all the way back to Hiroshima. "The first application of nuclear energy was the atomic bombs which destroyed two major Japanese cities," explained the Kemeny Commission in 1979. "The fear of radiation has been with us ever since, and is made worse by the fact that, unlike floods or tornadoes, we can neither hear nor see nor smell radiation."

Thus, predicted the commissioners, the "major health effect of the accident" appeared to be "mental distress" felt by "certain groups" living near the reactor. The problem, they said, was "short lived."[47] But nine months later state researchers confirmed a 113 percent jump in the number of TMI neighbors using sleeping pills and an 88 percent rise in those using tranquilizers. The use of alcohol was up by 14 percent and cigarette smoking had increased by nearly a third.

As documented by one thousand telephone interviews, a wide range of "psychosomatic illnesses" had surfaced, including chronic headaches, diarrhea, loss of appetite, sweating, rashes, and hypertension.[48] "The symptoms people are suffering are similar to those suffered by people who work at dangerous jobs," we were told by Dr. Robert Holt, a New York University psychologist who studied the TMI area. "In those situations you expect an increase of tension, shortened tempers, mood swings and more physical symptoms like hyperventilations, ulcers, and asthma."[49]

In addition to finding stress they also discovered that the population had become somewhat politicized. Fierce debate raged over such issues as the venting of krypton gas from TMI-2, the dumping of more radioactive water into the Susquehanna, the reopening of TMI-1, who should pay for the cleanup of the site, and whether or not Metropolitan Edison should be allowed to go bankrupt.

Meanwhile news continued to surface of abnormal radiation levels in test wells around the plant site, and in area groundwater.[50] Such reports had an effect. "I am scared to death," Mary Enterline told *The New York Times*. "I have a two-year-old son and every night when I pull his shade down at bedtime, and look out the window and see the cooling towers, I nearly cry."[51]

"I live in fear every day," Donna Umholtz told the state Public Utilities Commission. "I am ready to evacuate on a second’s notice."

"I won’t allow my children to be exposed to low-level radiation," added Joanne Topolsky, who—like many others—was trying to sell her home and move out of the area. "We had so many dreams, and they are shattered now because of TMI."[52]

As the 1980s began, rallies, marches, and a utility-rate revolt continued to rock what had long been a quiet, staunchly conservative area. Dislike and distrust of Met Ed, the state, and the NRC continued to grow. Some public forums had degenerated into bitter shouting matches. "We will never forgive or forget what you have done here," twenty-six-year-old Michelle Stewart yelled at an NRC panel in the spring of 1980. "You have created tension between husbands and wives. You have turned us into cynical people. . . ."[53]

---

45. Ibid., Table 4.

46. Mayor Robert Reid of Middletown, quoted in Robert Del Tredici, *The People of Three Mile Island* (San Francisco: Sierra Club Books, 1981) (hereafter cited as *People*).

47. *Kemeny Report,* p 35.

48. Pennsylvania Department of Health, *Health Department Releases TMI Stress Study* (Harrisburg: Department of Health, April 17, 1980) (hereafter cited as *State Stress Study*); and Tokuhata, interview, April 1980.

49. Robert Holt, interview, April 1980.

50. *New York Times,* February 21, 1981.

51. *New York Times,* March 27, 1980.

52. Jim Hill, "Residents Still Fearful of TMI, Survey Reports," *York Daily Record,* March 13, 1980, p. 1.

53. Steve Lawrence, "‘We’ll Never Forgive or Forget,’" *Daily News* (New York), March 27, 1980.

"My husband is a construction worker who helped build both those reactors, and now he’s damned sorry for it," one local housewife told us in 1980. "No one in the world can possibly understand what we have lived through here."

We asked what, of all problems, bothered her the most. She thought a moment. "I’m tired," she then replied, "of having my children’s health used in an experiment."[54]

Meanwhile some TMI neighbors questioned the fact that so much attention had been given to the mental fallout from the accident, and so little to its physical health effects. According to *The New York Times,* at least fourteen psychological surveys were taken of area residents in the wake of the accident, based in part on grants of $375,000 from the National Institute of Mental Health and another $52,000 from the utility industry. The state of Pennsylvania, which had mustered a bare hundred work hours to study area animals and which had established no systematic ongoing survey for possible physical damage from TMI radiation, did conduct a one-thousand-person telephone poll on the mental impact of the accident.[55] "It makes you wonder," Jane Lee told us, "how they can get so much money to study the psychological effects of this accident when they can’t seem to pull it together to look at the physical effects on animal and human health."[56]

The Taste of Tragedy

For many in the TMI area the outcome of the reactor accident now seemed as obvious as it had become at Bikini Island, St. George, Utah, and other communities downwind from years of nuclear bomb testing; among the GIs who had helped clean up Hiroshima and Nagasaki; among the 300,000 who had served as guinea pigs at the tests in Nevada and the Pacific; among millions of citizens exposed to too many medical X rays; among workers in the uranium mines and mills such as Church Rock and Shiprock, and at nuclear facilities such as Hanford, Portsmouth, Paducah, Piketon, U.S. Radium Dial, American Atomics, and Rocky Flats; among citizens living downwind of Windscale, Kyshtym, American Atomics, Rocky Flats, and downriver from Church Rock, Durango, and other mill-tailing sites; among thousands of Americans living near those tailings piles, some of whom built homes with them, others of whom suffer from them in their water supply and air; among millions of Americans near low- and high-level waste dumps with reason to fear for their own and their children’s long-term health; among farmers near the Shippingport, Arkansas Nuclear One, West Valley, Vermont Yankee, Rocky Flats, and Fitzpatrick and Nine Mile Point facilities with reason to believe that their animals are coming to the same ugly end as the sheep caught in the "Dirty Harry" bomb fallout of 1953; and among citizens near the Dresden, Humboldt, Indian Point, Shippingport, Millstone, Arkansas One, and seventy-odd other American reactors with reason to fear that their babies are being killed by radiation before they live even a month.

Now, in the wake of TMI, the patterns were repeating themselves in central Pennsylvania. In the fall of 1979 one York couple sued Metropolitan Edison over the August stillbirth of their daughter. A Hershey engineer named Steven Scholly saw his daughter born with Down’s syndrome the summer following the accident. The state, he said, had assured him the reactor emissions could not have caused it. But, he told us, "We know radiation causes genetic defects."[57] "It’s unbelievable," noted Diane McCleary of Valley Green, less than five miles from the site. "I’ve talked to so many people in just this area who have lost their babies, miscarried or carried them almost full term then lost them. I’ve lived in different places and never heard of anything like this." "It’s like I was saying last night," added her neighbor Deborah Frey in an interview with *Harrowsmith,* "reading the death columns in the paper, I’ve never seen so many babies that live a day or two and then they’re dead."[58] "I’ve been seeing a lot of strange things," Dr. Joseph Leaser told us a year after the accident. "It’s nothing you can pin down, exactly. But there are symptoms surfacing here that just can’t be explained by nerves alone."

A general practitioner in Middletown, Leaser is a father of four children, a part-time horse breeder and a longtime

---

54. Anonymous, interview, March 1980.

55. *State Stress Study*; Ben Franklin, "Researchers Find Anxiety in the Air Near 3 Mile Island," *New York Times,* March 27, 1980; and Ben Franklin, "Long Distress Found Over Atom Incident," *New York Times,* April 18, 1980.

56. Jane Lee, interview, March 1980.

57. Steven Scholly, interview, March 1980.

58. Pawlick, "Silent Toll,"

resident of the area. "We’ve had a real run on unusual rashes, allergic reactions, dermatitis, skin lesions, itch, and people complaining of a funny taste in their mouths," Leaser told us in 1980.

He also wondered about an uncommon aberration he had noticed among his patients. "We have found abnormal counts of eosinophils—that’s a type of white blood cell—in what I would say is a significant number of patients," he told us. "It isn’t a scientifically controlled study. But I’d say that when I review blood smears, it seems to me I see more." A high count of eosinophils, he added, was a "well-known symptom of excessive radiation exposure."[59]

The mysterious, scientifically unexplained "funny taste" Leaser said his patients mentioned was cited by numerous residents of both sides of the Susquehanna—as it had been by Utah residents after the 1953 "Dirty Harry" shot. "We had very bad tastes in our mouths, like an iron or metal taste," said Fran Cain, the dog breeder living within eyesight of the plant. "It came right in the house to us. We had it three or four times."[60]

"It tasted like, you know, like when you’re a kid and you put money in your mouth?" said Jane Lee. "And we all had it."[61]

"It was like having a penny in your mouth," said Bill Whittock, a retired engineer in his seventies living a quarter mile from the plant. "I’d be curious to know what degree of radioactivity I was exposed to."[62]

There were some other symptoms as well. "I got kind of scorched the first day," said Vance Fisher, a local farmer. "I didn’t know what was going on and I had outdoor work to do, so I was out most of the day. Got a little burn out of it. Well, it wasn’t a sunburn, anyhow. My face got red."[63]

In the midst of the accident Celeste Crownover of nearby Londonderry began suffering an unexplained twitch in her leg, which—as of our June 1980 interview—had not entirely gone away. During the worst of the radioactive emissions tears began to gush from her eyes, she suffered a bad metallic taste in her mouth, a burning sensation covered her arms and legs, and a "fiery blister" broke out on her shoulder. In the summer her hair fell out "by the hands full." "I am fifty-one years old," she told us, "and nothing like that has ever happened to me before or since."[64]

"My daughter got real sick," Becky Mease of Middletown told an NRC panel. "She had diarrhea for three days straight and headaches and she became anemic. I didn’t know what to do. My little girl is still getting colds and sinus problems," Mease added. "Now if that’s not because of that power plant, you tell me what it is."[65]

"I haven’t felt myself since about three months after the accident," we were told by Louise Hardison, whose goats—at 1.2 miles from the reactor—produced milk with high radiation counts. "I’ve been tired all the time. Maybe it’s all in my head. But maybe it isn’t."[66]

Hardison’s complaints of tiredness came nearly two years after the accident, and were echoed by others in the TMI area, as well as by people living near Vermont Yankee and Rocky Flats.[67]

Dr. Joseph Leaser told us in early 1981 that "since about six months after the meltdown, I’ve noticed that the problem with the white blood cells has disappeared and hasn’t come back."

He added that during the fall 1980 venting of krypton gas from the TMI-2 core, "a number of patients who didn’t know it was happening came in independently complaining about the funny taste in their mouths. I hadn’t heard of that since the accident, and I haven’t heard any of it again since the venting."

Leaser said he thought it all indicated something very frightening and dangerous. "These are a rock-ribbed, churchgoing, Bible-thumping lot of people. They are not the kind who will go off running at the mouth. Some of these symptoms you can explain away from psychological stress, there’s no doubt about it.

"But some you just can’t."[68]

---

59. Joseph Leaser, interview, March 1980.

60. Del Tredici, *People*.

61. Ibid.

62. Bill Whittock, interview, March 1981; and Del Tredici, *People*.

63. Del Tredici, *People*.

64. *Paxton Herald,* March 26, 1980; and Celeste Crownover, interview, June 1980.

65. Lawrence, "We’ll Never Forgive."

66. Louise Hardison, interview, February 1981.

67. Green, "Vermont Yankee"; and Mixon, interview, May 1981.

68. Leaser, interview, February 1981.

15

Conclusion: Surviving the New Fire

Soon after Dr. Gordon MacLeod was fired as Pennsylvania's secretary of health, he warned that "if another Three Mile Island were to happen tomorrow, we still would not be ready to deal with the health concerns involved in a nuclear accident.[1] And one year later he told an audience at Columbia University that in terms of preparation for a nuclear emergency, "the people of Pennsylvania are not better off today, and are perhaps worse off, than they were the day before the radiation release at TMI."[2]

By April of 1981 he informed the American College of Physicians that there was still "no radiation health unit anywhere in Pennsylvania," and thus "no way to manage the medical aspects of any future accident." And, he added, "we shall almost surely have one."[3]

That inevitability was underscored the following July when a high-level DOE study group concluded that two years after the accident the safety lessons of TMI had not been applied to the thirty-five reactors being operated by the DOE. Nor warned the panel, did the department have adequate personnel to operate them safely in the future.[4] The same charge was made about the nation's commercial plants when the Presidential Nuclear Safety and Oversight Committee told Ronald Reagan it doubted the NRC or any other federal agency "has the experience or the competence to manage atomic power plants."[5] Congressman Edward Markey (D-Mass.) added that the majority of the nation's seventy-odd operating commercial power reactors still did not have federally approved evacuation plans in place.[6] And the staff of the House Interior Committee concluded in February of 1981 that the managers of TMI had withheld information on the severity of the accident and had made misleading statements to state and federal officials. Victor Stello, director of the NRC's Office of Inspections and Enforcement, had already called for Metropolitan Edison to be cited for failing to issue proper reports.[7]

Met Ed in turn was suing the NRC for four billion dollars in damages, charging the commission had failed to inform them of an accident at a reactor similar to TMI, thus depriving them of vital knowledge. The NRC was also attacked by President Carter's Kemeny Commission on TMI. Their final report concluded, "The evidence suggests that the NRC has sometimes erred on the side of the industry's convenience rather than carrying out its primary mission of assuring safety."[8]

Inherent in that mission has been the responsibility to protect Americans from radiation. In December of 1979 the NRC lowered the allowable dose for populations around atomic reactors from 170 millirem per year to 25 millirem. The regulatory change came nine months after the TMI accident and a full decade after John Gofman and Arthur Tamplin were viciously attacked and then forced from their jobs for urging a similar action.

But the new standard may have been just academic. As the GAO reported in December of 1979, a review of

---

1. *York Daily Record,* November 5, 1979.
2. Gordon MacLeod, "Politics."
3. Gordon MacLeod, "Reflections on Three Mile Island—Two Years Later," prepared for presentation at the American College of Physicians Sixty-second Annual Meeting, Kansas City, Missouri, April 7, 1981.
4. Irwin Molotsky, "Study of Energy Department's 35 Reactors Finds Safety Deficiencies," *New York Times,* July 7, 1981, p. A-14.
5. James Foster, "Presidential Task Force Claims Utility Executives Lack Nuclear Knowledge," *Columbus Citizen-Journal,* May 11, 1981, p. 10.
6. Edward J. Markey, "One Year After TMI, And Danger Remains," *Boston Globe,* March 28, 1980.
7. Philip Shabecoff, "Reactor Data Said Withheld," New York Times News Service, February 10, 1981.
8. *Kemeny Report,* p. 19.

radiation monitoring programs in eight key states indicated that "many sources of radiation were not regulated, the coverage of regulated sources was limited, and there was limited assurance that identified hazards were corrected."[9] And as the budget-cutting Reagan administration took office in 1981, the NRC and industry backers moved to speed the licensing process and gut the monitoring programs around atomic reactors.

Similar trends were evident in the study of public health. Despite the findings of Gofman, Tamplin, Pauling, Sakharov, Caldwell, Knapp, Lyon, Weiss, Martell, Livingston, Pendleton, Sternglass, Caldicott, Rimland, Larson, Dyson, Morgan, Stewart, Kneale, Bross, Blumenson, Bertell, Abrams, Kushner, Matanowski, Mancuso, Cobb, Najarian, Drinker, Flinn, Martland, Wagoner, Archer, Eisenbud, Johnson, Radford, Winterer, Gottleib, Odin, Goodman, Franke, Steinhilber-Schwab, Talbott, Jordan, Kepford, Pohl, Lochstet, Resnikoff, Medvedev, MacLeod, Takeshi, and a host of other "dissident" scientists, doctors, and researchers in the radiation field, no major systematic steps had been taken to survey public-health trends around America's nuclear facilities.

By attacking these experts on an *ad hominum* basis, by ignoring the findings of "nonprofessional" farmers and private citizens, and by failing to provide independent studies of their own, the nuclear industry and public-health authorities have denied thousands of victims of radiation poisoning access to speedy treatment, and millions of Americans the right to make an informed decision on this nation's nuclear policies. Official statistics have been uniformly sketchy or nonexistent. Nine years after Pennsylvania's Shapp Commission made its recommendations for modernizing radiation and health monitoring around nuclear facilities, and more than two years after TMI, none of the high-level recommendations had been put into law. "Regrettably," George Tokuhata told us in early 1981, "the legislature simply has not voted the money."[10]

Nor does the problem end with atomic reactors. Two decades after it was commissioned by the Atomic Energy Commission, the largest systematic study of the health of nuclear workers—the Mancuso Report—remains shrouded in bitter controversy and attempts at outright suppression. Three decades after the first GIs were marched up to nuclear bomb testing sites, the military steadfastly refuses to allow public access to the names of those involuntary "guinea pigs."

Thus the soldiers remain uninformed about the health risks they incurred, and the public has no knowledge of what the radiation really did to the 300,000 Americans deliberately exposed in those blasts. Thirty-five years after the first "tests" of massive radiation releases on the human populations of Hiroshima and Nagasaki, many of the health statistics surrounding those bombings remain cloaked in secrecy and prone to consistent revisions that indicate that the damage was far worse than the global community has been led to believe.

In fact all signs indicate that radiation from bomb tests, power reactors, uranium mines, mills and tailings piles, bomb production factories, "rear-end" waste dumps, commercial production facilities, and X-ray machines are far more dangerous than previously expected. Soon after the TMI accident, for example, a team of fourteen West German scientists from Heidelberg University estimated that official judgments by the U.S. Nuclear Regulatory Commission on how much plutonium, cesium, and strontium are picked up by plant vegetation may be as much as one thousand times too low. Thus the doses coming from production plants, power reactors, bomb tests, and a possible nuclear war may be far deadlier than previously believed.[11]

The danger is to all living creatures. But perhaps the most significant toll is levied on the unborn, whose fetal size and vulnerability make them infinitely susceptible to even the tiniest doses of radiation. And since all humans must go through the fetal stage, the whole species is at risk—even to doses heretofore considered "low."

These dangers have not been lost on the American public. Since the mid-1970s a movement to stop construction of atomic power reactors has made a marked impact on American energy planning. Years of costly legal interventions, hundreds of demonstrations, and thousands of arrests at nuclear sites around the country have transformed the peaceful atom from a quiet miracle into a bitter political issue. Had those demonstrations not taken place, it is unlikely TMI would have elicited much more than a few passing paragraphs in the national press.

Now atomic power plants seem very much on the decline. The reasons are partly financial, partly political. With soaring construction costs and a stabilizing level of energy demand atomic power is simply no longer a reasonable investment—if it ever was. Since energy costs have skyrocketed in the wake of the 1973 Arab oil embargo, the

9. GAO, *Radiation Control Programs Provide Limited Protection,* HRD-80-25 (Washington, D.C.: GAO, December 4, 1979).

10. Tokuhata, interview, February 1981.

11. Dick Brukenfeld, "A New German Study Challenges the NRC's Assurances," *Washington Post,* November 11, 1979.

American public has found it can conserve large quantities of energy and still survive quite nicely. Utilities that were essentially coerced into going nuclear at the outset now find that conservation can ultimately increase profits and cause fewer headaches than the wonders of atomic fission.[12]

In 1976 there were 219 reactors on line, on order, or under construction in the U.S. Four years later, after fierce combat in the neighborhoods, courts, banks, legislatures, and at the plant sites, the number has slipped to less than 180. In 1980 alone, 16 reactors were canceled—against no new orders—and 69 plants under construction were postponed.[13] Several plants have already been permanently shut at great expense, including Michigan’s Fermi I, which suffered a major accident in 1966; New York’s Indian Point I, which lacked a basic emergency core cooling system; and California’s Humboldt reactor, which was found to be operating directly on top of an earthquake fault.

In 1981 the builders of the Diablo Canyon nuclear plant, on the California coast, were forced to admit the facility had been built with the wrong set of plans, and that it might not be as earthquake-resistant as promised. Major questions also arose over the viability of reactor pressure vessels and cooling systems at plants nationwide, raising the specter of mass shutdowns and abandonments across the board. Also in 1981 an Israeli air raid against an Iraqi reactor raised serious new questions about the wisdom of exporting nuclear technology.

Nonetheless, the Reagan administration moved to allow spent fuel reprocessing and to slash basic safety requirements to allow quick reactor licensing. The move raised concern that even minimum design and construction standards in domestic and exported plants were being abandoned.

Doubts were also raised as to whether the lax regulations could save atomic power. With high interest rates, slumping demand, and growing skepticism over reactor performance, the administration’s regulatory carte blanche offered no guaranteed rescue from the industry’s economic morass.

Ultimately the "peaceful atom" may be remembered less for its ability to generate electricity than for its function as a radioactive warning beacon. If the health indicators at Three Mile Island and other nuclear facilities are correct, it may take far less radiation to damage human and animal health than anyone ever imagined. And that, in turn, may have basic implications for atomic energy’s most visible application—as a tool of war.

For as British historian E. P. Thompson has argued, a hostile nuclear exchange could "make the worst possible outcome of Three Mile Island appear as no more than a pistol shot." Not only would entire cities be destroyed, but the lingering effects of radioactive fallout would be incalculable, almost beyond our imagination.[14]

The threat of such a holocaust has become increasingly real. In 1980 George Bush, once the U.S. ambassador to China and head of the CIA, at this writing Vice-president of the United States, was asked by *Los Angeles Times* reporter Robert Scheer: "How do you win a nuclear war?" Bush replied: "You have a survivability of command in control, survivability of industrial potential, protection of a percentage of your citizens, and you have a capability that inflicts more damage on the opposition than it can inflict upon you."[15]

Bush later protested that his assessment applied to the minds of Soviet, not American, war planners. But whosesoever’s mind it came from, the assessment overlooked one all-encompassing factor: though there may be temporary survivability of some top generals and politicians, industrial potential, and a few other random survivors, there will almost certainly be no children or grandchildren left on this planet to tell about it. A human embryo in its second month of development weighs 0.1 gram, one 600,000th the weight of its mother. Radiation doses received by the mother can have enormous impact on the unborn fetus. Few, if any, could survive the shock of an atmosphere laden with the amounts of radiation likely to be released in a nuclear war. And those that did survive might be so thoroughly mutated as to scarcely warrant the label "human."[16]

In that respect TMI, Kyshtym, Windscale, American Atomics, Church Rock, Rocky Flats, the radiation industry, the X-ray controversy—they all serve as vital warning signs. And the hundreds of American bomb tests in the 1950s and early 1960s offered indicators not originally intended by the military. If those explosions—now considered relatively "small" in light of the power of today’s warheads—harmed thousands of GIs and nearby residents, killed thousands of infants and impaired the growth of thousands more, one can only shudder at what any atomic

---

12. Jay Mathews, "A New Energy Strategy—Conservation," *Washington Post,* June 2, 1981, p. 1.

13. AIF, "A Rocky Road to Recovery."

14. E. P. Thompson, "A Letter to America," *Nation,* January 24, 1981.

15. Bill Stahl, "Bush Explains Views on ‘Winning’ A-War," *Los Angeles Times,* February 6, 1980.

16. Griffiths and Ballantine, *Silent Slaughter,* p. 147.

exchange—"limited" or otherwise—would do to life on earth.

Nor would it make much difference where the bombs landed. Four days after the Chinese exploded a bomb on their own soil in September of 1976, dangerous levels of radiation were recorded in milk throughout New England. The radioactive cloud then circled the globe and was monitored as it passed over the East Coast of the United States a second time, several days later.[17] An American attack on the Soviet Union or a Soviet attack on America would ultimately have the same basic impact on future generations in each country. And bombs manufactured and used, or reactors blown up in smaller countries, will ultimately kill and maim the children of the nation that sold them the technology.

This catalogue of radioactive disaster has been neither happy reading nor pleasant writing. Its conclusion is inescapable—except for a far more prudent application of medical X rays and other health aids, the vast bulk of nuclear technology is simply too dangerous for safe use. There is no "peaceful atom"—only a failed, expensive experiment that has become far too hot to handle. There is also no such thing as nuclear war—only radioactive suicide. One nation might emerge from the holocaust a temporary victor, with those who conspired to push the button hidden deep in their special shelters. But ultimately the human race as a whole would not survive.

Citizen action has already drastically changed the course of atomic planning. Energy conservation and political organizing have led to the cancellation of scores of atomic reactors. Numerous attempts to mine and mill uranium in the U.S., Canada, and Australia have been stopped by public protest. The transportation of nuclear materials and storage of radioactive waste have been forcefully resisted all over North America. And despite fierce military pressure, an atmospheric test ban treaty was signed in 1963—an act that saved millions of human lives, American and otherwise.

At the dawn of the 1980s, continued underground testing and talk by the Reagan/Bush regime of "limited" nuclear war and the "winnability" of a global confrontation sparked major protests in the U.S., Europe, and Japan. A worldwide campaign to do away with nuclear weapons altogether rapidly gained steam.

That campaign may become the most vital social force of the 1980s, and it may also hold the key to all of human history. When Albert Einstein, in 1947, compared the discovery of nuclear fission to the discovery of fire, he did not note how long it took primitive human society to learn to keep that fire from destroying it, or what kinds of conscious changes were required of the species.

Nor did he calculate how long it would take, or what changes in consciousness would be necessary, for modern society to survive the splitting of the atom. He clearly suspected the time allowed for this second job was short, and that the future of the human race was at stake. But he also believed that given an informed populace, it could be done.

17. Wasserman, *Energy War*.

Appendix A

The Basics of Radiation and Health

Ionizing radiation comes from an instability in the fundamental building block of all matter—the atom. It is a phenomenon involving the interchangeability of matter and energy first described by Einstein's Theory of Relativity. Einstein understood that small amounts of mass can be converted to very large amounts of energy—with the conversion ratio described by the very large number of the speed of light squared.

This energy, in turn, can be lethal to the human body—in particular the cell structure.

A stable atom is made up of negatively charged electrons that revolve in orbit around a nucleus composed of an equal number of protons. Also contained in the nucleus are neutrons, which have no electrical charge but which are endowed with a "binding energy" that keeps the nucleus together. Protons and neutrons account for more than 99.9 percent of the atom's weight and determine the basic properties of the element involved.

When an atom has an imbalance between protons and electrons it is considered unstable, or radioactive. Unstable atoms are called *radioisotopes* or *radionuclides*. In the process of achieving stability a part of the nucleus of a radioisotope disintegrates and emits particles and energy. It does this until it reaches stable equilibrium and is no longer radioactive. Thus radioactive elements travel through a "decay chain," emitting particles and energy until they transform into lighter, stable elements at the end of their chain.

The *half-life* of a radioactive substance describes the time it takes for one half of any quantity of it to decay into the next lighter element along its decay chain. Often, complete radioactive decay involves very long periods of time. For example, uranium 238 takes about twenty-eight billion years for half of it to decay into a stable form of lead.

Radiation is *ionizing* when it has enough energy to remove one or more electrons from an atom with which it comes in contact. When this occurs, the ionized atom is made chemically reactive and capable of damaging living tissue. Nonionizing radiation—as in the form of microwaves—falls on the other end of the electromagnetic spectrum and does not have sufficient energy to physically displace electrons of atoms. It can also, however, be damaging to human health.

Types of Radiation

There are essentially five types of ionizing radiation with which we are concerned here:

1. *Alpha radiation* is created when two protons and two neutrons are emitted from the nucleus of an atom. Alpha particles have the same nucleus as the helium atom but lack the two electrons that make helium stable. Alpha particles travel at speeds up to ten thousand miles per second. Because they are so large in "subatomic" terms, alpha particles have been likened to large-caliber bullets. They tend to collide with molecules in the air and are easily slowed down. A thin sheet of paper or two inches of air can usually stop an alpha particle.

Unfortunately so can a human cell. When alpha-emitting elements are inhaled or ingested into the body, the high-energy particles they emit can rip into the cells of sensitive internal soft tissues, creating serious damage.

Alpha particles are emitted by a wide array of heavy elements, including plutonium, a by-product of nuclear fission; and radon, which seeps into the environment from the uranium-mining and -milling process; and radon gas, whose decay or "daughter" elements are carried into the atmosphere from uranium-mining wastes.

2. *Beta radiation* is composed of streams of electrons that often travel at close to the speed of light. In some cases beta particles are emitted from a nucleus when a neutron breaks down into a proton and electron. The proton stays in the atom's core while the electron shoots out. Because they move faster than alpha particles, and weigh much less, beta particles are far more penetrating than alpha particles. Sheets of metal and heavy clothing are required to stop

them.

Beta emissions to the skin can lead to skin cancer. And like elements that emit alpha particles, beta-emitters can be very dangerous when inhaled or ingested into the body. Beta radiation can be emitted from many substances released by nuclear bombs and power plants, including strontium 90 and tritium.

3. *Neutron emissions* occur when the nucleus of an atom is struck by a particle that causes the unsticking of the "binding energy" in the atom's core. The resulting disequilibrium causes neutron particles to be shot out in a way that makes them capable of penetrating solid steel walls. Several feet of water or concrete are required to stop most of them.

Because of their tremendous penetrating ability, neutrons can be very damaging to the human body, a fact well known by the U.S. military, which is developing a bomb designed to kill people (but preserve property) by emitting large quantities of lethal neutron fragments. When neutrons strike atoms of elements that are not fissionable, they can render them radioactive by changing their atomic structure. For example, in a building near a neutron bomb explosion, the neutrons can change stable cobalt in the steel girders to cobalt 60, an emitter of highly penetrating gamma radiation.

4. *Gamma radiation* is a form of electromagnetic or wave energy similar in some respects to X rays, radio waves, and light. Like X rays, gamma radiation is highly energetic and can penetrate matter much more easily than alpha or beta particles. Gamma rays are usually emitted from the nucleus when it undergoes transformations. An inch of lead or iron, eight inches of heavy concrete, or three feet of sod may be required to stop most of the gamma rays from an intense source.

5. *X rays* are produced whenever high-energy electrons are accelerated or decelerated as they penetrate matter. X rays are produced by machine when electrons are accelerated to extremely high speed and are then crashed into a solid target. They are also produced in nuclear fission when electrons are accelerated out of the fissioning nucleus and are then slowed down by air and other materials. The energy released in the collision is a form of electromagnetic radiation, and is comparable in penetrating power to gamma rays. Because X rays can expose film after passing through some substances—such as human flesh and some building materials—they have been widely used in medicine and some industrial processes.

It is believed by many that because they are directly applied to the human body, medical X rays are at present the single greatest source of external exposure to human-made radiation. But unlike radioactive products that can escape into the environment and concentrate in the food chain, X-ray exposure can be controlled more easily than the fallout from a nuclear bomb or power plant.

Radiation and Human Health

Radiation attacks the human body at its most basic level—the cell structure.

Cells carry out the vital functions necessary to sustain and develop all living creatures. Over ten trillion cells make up the human body. The cell takes in food, gets rid of wastes, produces protein vital to life, and reproduces itself. Just as all living things are made up of cells, so every new cell is produced from another cell.

The nature of the cell is determined by the genetic material in its nucleus. Enormously complex, and not fully understood as yet, the genetic "coding" in each nucleus is carried by a complex protein called DNA—deoxyribonucleic acid. This DNA is tightly coiled in the forty-six chromosomes, which are stored in the cell nucleus. Surrounding the nucleus is the cytoplasm, the "factory" that carries out the directions of the DNA intelligence center. The cytoplasm in turn is contained by a semipermeable membrane, the cell wall. It is the whole of this cell mechanism—cell wall, cytoplasm, and nucleus—that forms the basis of human life.

When a radioactive particle or ray strikes a cell, one of at least four things can happen:

1. It may pass through the cell without doing any damage;
2. It may damage the cell, but in a way that the cell can recover and repair itself before it divides;
3. It may kill the cell;
4. Or, worst of all, it may damage the cell in such a way that the damage is repeated when the cell divides.

Three of those four circumstances can have health effects. The issue of what happens to a cell once it repairs itself, for example, is the subject of scientific debate. Dr. Alice Stewart has compared the radiation-damaged cell to a broken plate. Though the plate can be glued together again, its original integrity will never be the same. Every time it is stressed, it can be more prone to break. The repaired cell may not react to disease or physical injury as well as an undamaged cell; when it reproduces, this defect may be passed on.

Cell killing can also be harmful. Thousands of dead cells are eliminated from the human body every day, and thus the body has a certain tolerance for it when radiation adds to the natural toll. In fact radiation is used in some forms of therapy to kill cancerous cells, to prevent their reproducing. But if enough cells are killed by radiation, it can seriously impair bodily functions or cause blockages in the body's circulatory system.

The prime danger from radiation striking a cell, however, comes from the potential for damage to the DNA coding and the creation of cancerous cells. If the DNA is damaged by a ray or particle, it may reproduce itself in an abnormal manner that is, in essence, the basis of radiation-induced cancer. It is still not fully understood how radiation actually induces cancer or genetic damage in cells. Drs. John Gofman and Arthur Tamplin theorized in the early 1970s that when radiation damages a cell "a massive nonspecific disorganization" and destruction of chemical bonds occurs that is similar to "the effect of a jagged piece of shrapnel passing through a tissue."

Damage can occur to the cell wall, cytoplasm, and nucleus. It is most serious, however, when the DNA or genetic coding in the nucleus is harmed. Dr. Karl Z. Morgan has likened the disorganization by radiation of the cell DNA structure to a madman loose in a vast library, randomly tearing out pages of ancient, irreplaceable manuscripts. Once the DNA is damaged, distorted messages can be transmitted to the cell and passed on through reproduction. Thus thousands of mutated clone cells can reproduce themselves, forming the basis for tumors and a devastated bodily system. By the time a tumor can be seen or felt by the touch, it is composed of several million of these abnormal cells.

There has been considerable debate among radiobiologists about how often a cell must be hit by radiation to mutate into a cancer. Dr. E. B. Lewis in 1957 advanced the idea that it took just one "hit" to produce irreversible cell damage. Others believe it may take two or more. There is little dispute, however, over the fact that the cell is most vulnerable when it is dividing. The human fetus, infants, and young children—whose cells are multiplying most frequently—are thus the most sensitive to radiation damage; blood-forming organs such as the bone marrow are also particularly vulnerable.

Radiation can also damage the body's immune system and cause a general degeneration in the health of the cell structures. Thus radiation may cause illness and premature aging without actually bringing on the more easily isolated diseases of cancer and leukemia.

Susceptible Groups

In recent years controversy has arisen over the particular vulnerability of infants *in utero* and small children to the ill-effects of radiation. Exposure of the fetus to radiation during all stages of pregnancy increases the chances of developing leukemia and childhood cancers. Because their cells are dividing so rapidly, and because there are relatively so few of them involved in the vital functions of the body in the early stages, embryos are most vulnerable to radiation in the first trimester—particularly in the first two weeks after conception. This period carries the highest risk of radiation-induced abortion and adverse changes in organ development. During this stage of development the tiny fetus can be fifteen times more sensitive to radiation-induced cancer than in its last trimester of development, and up to a thousand or more times more sensitive than an adult. In general it is believed that fetuses in the very early stages of development are most vulnerable to penetrating radiation such as X rays and gamma rays.

In all stages, they are vulnerable to emitting isotopes ingested by the mother. For example, if a pregnant mother inhales or ingests radioiodine, it can be carried through the placenta to the fetus, where it can lodge in the fetal thyroid and where its gamma and beta emissions can cause serious damage to the developing organ. Once the fetal thyroid is damaged, changes in the hormonal balance of the body may result in serious—possibly fatal—consequences for the development of the child through pregnancy, early childhood, and beyond. Such effects include underweight and premature birth, poorly developed lungs causing an inability to breathe upon delivery, mental retardation, and general ill-health.

Other emitters can lodge in other fetal organs. For example, yttrium-90, a decay product of strontium 90, can gravitate toward the pituitary gland. Overall, fetal irradiation during the second and third trimester has been linked to microcephaly (small head size), stunted growth and mental retardation, central nervous system defects, and behavioral changes. Exposure of the fetus to radiation during all stages of pregnancy increases the chances of developing leukemia and childhood cancers.

Young children also undergo more rapid cell division than adults, as do children in puberty. This rapid growth makes them very susceptible to radiation damage. Also at high risk are the elderly and chronically ill. These groups have weakened immune systems because of less active red bone marrow. Healthy immune systems can often isolate and remove damaged cells before malignancies develop. Older people generally have less vigorous immune systems; they have also generally experienced more radiation from both natural and human-made sources than young people, and thus may be more susceptible to additional exposure.

Women are also considered to be twice as sensitive to radiation as men because of their predominance in contracting breast and thyroid cancers.

Cancers shown to be initiated by radiation include leukemia, and cancers of the pancreas, lung, large intestine, thyroid, liver, and breast. Life-shortening anemia and other blood abnormalities, benign tumors, cataracts, and lowered fertility are other random effects attributed to radiation exposure.

Genetic Effects

The health effects of radiation with the greatest long-term implications are those centered on damage to the genes. Radiation is known to increase genetic mutations that can be passed on from generation to generation. Natural background radiation contributes some genetic mutations, and has been labeled by some as a factor in the evolutionary process. Some inherited mutations change a plant or animal so that it is better equipped to live in its surroundings.

But problems arise with artificially produced mutations. No mutation randomly produced by human-made radiation has been known to be beneficial. And mutations may not surface for generations. In 1972 the National Academy of Sciences Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR committee) stated that "the spectrum of radiation-caused genetic disease is almost as wide as the spectrum from all causes." They added that "a genetic death may be the death of an embryo that no one ever knows about, or it may be the failure to reproduce. On the other hand, it may be a lingering and painful death in early adult life that causes great distress."

Based on the BEIR committee’s assumptions of genetic risk from ionizing radiation, the risks to future generations can multiply enormously through time. If a single exposed radiation worker produces two children, who in turn have two children each, and so on through the generations, by the twentieth generation there may be as many as 2,097,152 human beings put at risk from the single exposed worker.

Sensitivity of Various Tissues to Cancer Induction by Radiation

Site or Type of Cancer	Spontaneous Incidence of Cancer	Relative Sensitivity to Radiation Induction of Cancer	Remarks
Major radiation-induced cancers			
Female breast	Very high	High	Puberty increases sensitivity
Thyroid	Low	Very high, especially females	Low mortality rate
Lung (bronchus)	Very high	Moderate	Quantitative effect of smoking uncertain
Leukemia	Moderate	Very high	Especially myeloid leukemia
Alimentary tract	High	Moderate to low	Occurs especially in colon
Minor radiation-induced cancers			
Pharynx	Low	Moderate	-
Liver and biliary tract	Low	Moderate	-
Pancreas	Moderate	Moderate	-
Lymphomas	Moderate	Moderate	Lymphosarcoma and multiple myeloma, but not Hodgkin's disease
Kidney and bladder	Moderate	Low	-
Brain and nervous system	Low	Low	-
Salivary glands	Very low	Low	-
Bone	Very low	Low	-
Skin	High	Low	Low mortality. High dose necessary?
Sites or tissues in which magnitude of radiation-induced cancer is uncertain			
Larynx	Moderate	Low	-
Nasal sinuses	Very low	Low	-
Parathyroid	Very low	Low	-
Ovary	Moderate	Low	-
Connective tissues	Very low	Low	-
Sites or tissues in which radiation-induced cancer has not been observed			
Prostate	Very high	Absent?	-
Uterus and cervix	Very high	Absent?	-
Testis	Low	Absent?	-
Mesentery and mesothelium	Very low	Absent?	-
Chronic lymphatic leukemia	Low	Absent?	-

Source: 1980 BEIR Report

High- and Low-Level Radiation

Growing controversy has focused on what levels of radiation exposure are capable of doing the most harm. It has long been assumed that the most serious harm came from high-level exposures, such as those produced by the flash of the explosions at Hiroshima and Nagasaki, or those endured by scientists killed at the Los Alamos Laboratory while experimenting with primitive fission reactions. One of the most serious effects of high-level exposure to the body is the destruction of the red bone marrow. Once this occurs, a person's ability to resist infection is seriously compromised and can lead to chronic illness and early death. Other high-dose effects include skin burns, cataracts, loss of hair, loss of appetite, nausea, vomiting, sterility, and fatigue.

It now appears that constant exposure to small doses of radiation may also be extremely dangerous. A 1972 study by Dr. Abram Petkau found that prolonged exposures of low-dose radiation could do more damage to cell membranes than short flashes of intense doses. This insight, along with studies of fetal irradiation over long periods of time, has lent weight to a body of evidence indicating that such doses may be causing unexpected disease among far more people than previously believed.

Radiation Measurements

Some of the units used to measure radiation are *curies, rads,* and *rems*.

The *curie* (Ci) is so named to honor Marie Curie, who discovered radium. A curie refers to the amount of radioactivity in a gram of radium: twenty-seven billion disintegrations per second. There are many billion curies of radioactivity in an atomic reactor. The curie is often broken down into smaller units, with one curie equaling one thousand millicuries (mCi), one million microcuries (uCi), or one trillion pico-curies (pCi). The curie is a measurement of gross radioactivity and does not refer to biological damage.

The *rad* (radiation absorbed dose) measures the amount of radiation absorbed by body tissues. Rads usually describe doses from both external penetrating radiation and from radionuclides contained within the body, but do not measure specific biological damage. A rad to the hand, for example, is not considered as dangerous as a rad distributed over the whole body.

The *rem* (radiation equivalent man) is currently considered the most appropriate for measuring biological damage from radiation. It reflects the fact that some forms of radiation create more damage in a given exposure than others. The rem is calculated by multiplying the rad dose by modifying factors calculated on considerations of ionization and radiosensitivity of the tissues involved.

In terms of measuring X and gamma rays, the rad and the rem are the same relative to their biological damage potential. But alpha- and beta-emitters do much more biological damage when they are taken inside the body and lodged in sensitive tissues than when there is exposure just from outside the body. The rem measurement factors in these differences.

Because the units are too large for many uses, the prefix milli (m) is often used with roentgens, rads, and rems to signify smaller quantities. One rad or rem equals one thousand millirads (mrad) or one thousand millirems (mrems).

When radiation doses are measured for large populations, the unit *person rem* is used. This is calculated by multiplying the total number of people exposed times their average dose in rems. Or it can be the actual sum of all the doses they receive. For example, ten thousand person rems is a dose received by five thousand people exposed to two rems each; or by ten thousand people exposed to one rem each. According to Dr. John Gofman, at least one death will result for every 300 person-rem dose. The nuclear industry says some 2000 person rems escaped at Three Mile Island.

Fission and Fusion

Radioactive rays and fallout from atomic weapons and power plants are created in the nuclear fission process, adding to global radiation levels. In fission a heavy radioactive element—usually uranium 235 or plutonium 239—is struck with a slow-moving neutron. The neutron trips a reaction within the fissionable nuclei that causes them to split apart, releasing large quantities of energy, radioactive particles, and large numbers of fission by-products—radioactive isotopes of different elements.

When there is a sufficient quantity of fissionable material present—called a *critical mass*—a *chain reaction* occurs. Here atoms are struck by particles and energy from other fissioning atoms, leading to more releases and collisions until a self-generating explosive situation is created. In a bomb it is this explosive power that is used to inflict damage. In a reactor the power is modified by "control rods"—usually made of boron—which absorb some of the particles and energy and allow reactor operators to manipulate the speed of the chain reaction. The energy from the fissioning core is then converted to steam, by the circulation of water through it, which is then used to turn turbines to generate electricity.

In the course of the reaction, nuclear fission creates a wide array of radioactive by-products emitting gamma rays, alpha, beta, and neutron radiation—plus several hundred radioisotopes created by the fission process. These include fission products such as cobalt 60, strontium 90, iodine 131, xenon 133, cesium 137, and plutonium 239.

The other principal human-made source of atomic energy is nuclear fusion, which is in a sense the opposite of fission. In fusion, light atoms such as hydrogen are brought together under conditions of enormous heat and pressure. Hydrogen atoms then "fuse" together into helium. But in the process additional mass is lost—the helium atom weighs less than the hydrogen atoms that created it—and this excessive mass is released as energy.

Fusion is the process by which the sun creates heat and light. It is also the basis of the hydrogen bomb. The federal government is actively pursuing the use of fusion energy to produce electricity. But the process is not entirely "clean." Radioactive tritium is one by-product of fusion; so are large quantities of neutrons which could render a fusion-reactor building highly radioactive after a short period of time.

In nuclear weaponry a fission explosion is required to create the conditions under which a fusion—hydrogen—explosion can take place. Thus the plutonium "triggers" built at Rocky Flats serve as the basis of hydrogen weaponry. This weaponry is sometimes called "thermonuclear" because of the huge amounts of heat involved.

Other Sources of Ionizing Radiation

It is generally acknowledged that the amount of radioactive bomb debris now lacing the air flow of the earth's atmosphere is in the tens of tons. Scientists now estimate that everyone living in the Northern Hemisphere carries some fallout debris—including plutonium—in their bodies. New York City residents, for example, eat plutonium in their bread every day.

It is also true that each of us is exposed every day to certain quantities of *background radiation* that are naturally produced. Some of this comes from *cosmic radiation* from outer space. Two forms of this radiation are speeding protons and neutrons, which enter the earth's atmosphere and collide with the air we breathe. Carbon 14, which can cause long-term biological damage including genetic mutations, is created when a cosmic neutron collides with nitrogen in the atmosphere. People who live in higher altitudes generally receive more cosmic radiation than those in the lowlands because there is less protective atmosphere for shielding.

Radiation exposures also result from the natural radioactivity in many of the earth's minerals. There are some extreme examples: thorium-bearing sands in Kerala, India, and soils in Brazil measure as much as twenty times above average background levels. Isotopes present in the body, such as potassium 40 and radium 226, also contribute to background levels.

Overall, background radiation levels in the United States are estimated to range from 100 to 150 millirem per year. These amounts are not harmless; background radiation is generally acknowledged to cause thousands of cancer deaths every year and even more genetic mutations in the United States, and far more globally.

Human-made radiation can add to that toll. Fallout from nuclear weapons testing, atomic reactor emissions, the mining and milling of uranium, the creation and storage of nuclear wastes, the transportation and use of radioactive materials in industry, and the exposure of millions of people to medical X rays all have their costs in terms of human health.

In recent years knowledge that radiation tends to concentrate through the food chain far more intensively than previously believed has contributed to growing fears of human-made ionizing radiation. That, in turn, has coupled with a basic acknowledgment on the part of the global medical community that the human body is far more sensitive to radiation than previously believed. As the 1980 edition of the *Encyclopaedia Britannica* notes, "it can be concluded that there is no 'safe' level of radiation exposure, and no dose set so low that the risk is zero."

Appendix B

Summary of Atomic Bomb Tests

"Summary of Announced United States Nuclear Tests"

(Source: U.S. Department of Energy)

Totals by Year

1945— 3
1946— 2
1947— 0
1948— 3
1949— 0
1950— 0
1951—16
1952—10
1953—11
1954— 6
1955—18
1956—18
1957—32
1958—77
1959— 0
1960— 0
1961—10
1962—98
1963—43
1964—30
1965—29
1966—40
1967—28
1968—33
1969—29
1970—30
1971—11
1972— 8
1973— 9
1974— 8
1975—16
1976—16
1977—12
1978—13
1979—15
1980—17

TOTAL: 691
(Total includes 12 joint American-British tests since 1962.)

Totals by Type

Airdrop/Airburst (mid-air)	55
Tower	56
Barge (in shallow lagoon)	36
Surface (sea-level or ground-level)	28
Balloon	25
Rocket	15

TOTAL ATMOSPHERIC: 212

Shaft or Tunnel	465
Crater	9

TOTAL UNDERGROUND: 474

TOTAL UNDERWATER: 5

Totals by Purpose

Warhead Development/Assessment (more than 85 percent for new weapons design testing)	606
"Safety Experiments"	33
Plowshare ("Peaceful uses" program)	27
Joint US-UK	12
"Vela Uniform" (Detection tests)	7
Storage/Transportation	4
Combat (Hiroshima and Nagasaki)	2

Totals by Location

TOTAL PACIFIC: 106

Eniwetok	43
Christmas Island Area	24
Bikini	23
Johnson Island Area	12
Elsewhere in Pacific	4

TOTAL NEVADA TEST SITE: 563

TOTAL SOUTH ATLANTIC: 3

MISC. TOTAL: 19

Nevada, outside NTS	7
Amchitka, Alaska	3
Alamogordo, New Mexico	1
Japan	2
Carlsbad, New Mexico	1
Hattiesburg, Mississippi	2
Farmington, New Mexico	1
Grand Valley, Colorado	1
Rifle, Colorado	1

Appendix C

Commercial Nuclear Power Reactors in the U.S.

December 31, 1980

This list includes only commercial nuclear reactors on order, with limited work authorizations, construction permits or operating licenses. Status is indicated by: O—order; LWA—limited work authorization; C—construction permit, and bold face type—operating license.
A single asterisk indicates that the estimated commercial operation date of the unit has been deferred indefinitely and the new date has not been announced. A double asterisk indicates that no start-up date has yet been established.

State and Utility	*Plant*	*Location*	*Net M/We*	*Comm'l Operation*
ALABAMA				
Alabama Power Co.	**Joseph M. Farley 1**	**Houston County**	**860**	**12/77**
Alabama Power Co.	**Joseph M. Farley 2**	**Houston County**	**860**	**10/80***a*
Tennessee Valley Authority	**Browns Ferry 1**	**Decatur**	**1,067**	**8/74**
Tennessee Valley Authority	**Browns Ferry 2**	**Decatur**	**1,067**	**3/75**
Tennessee Valley Authority	**Browns Ferry 3**	**Decatur**	**1,067**	**12/85**
Tennessee Valley Authority	Bellefonte 1(C)	Scottsboro	1,213	9/86
Tennessee Valley Authority	Bellefonte 2(C)	Scottsboro	1,213	6/84
ARIZONA				
Arizona Public Service Co.	Palo Verde 1(C)	Wintersburg	1,270	5/83
Arizona Public Service Co.	Palo Verde 2(C)	Wintersburg	1,270	5/84
Arizona Public Service Co.	Palo Verde 3(C)	Wintersburg	1,270	5/86
ARKANSAS				
Arkansas Power & Light Co.	**Arkansas Nuclear One—1**	**Russellville**	**850**	**12/74**
Arkansas Power & Light Co.	**Arkansas Nuclear One—2**	**Russellville**	**912**	**3/80***b*
CALIFORNIA				
Pacific Gas & Electric Co.	**Humboldt Bay***c*	**Humboldt Bay**	**65**	**8/63**
Pacific Gas & Electric Co.	Diablo Canyon 1(C)	Avila Beach	1,084	0/81
Pacific Gas & Electric Co.	Diablo Canyon 2(C)	Avila Beach	1,106	0/81
Pacific Gas & Electric Co.	unit 1(O)	-	1,168	*
Pacific Gas & Electric Co.	unit 2(O)	-	1,168	*
Sacramento Municipal Utility District	**Rancho Seco 1**	**Clay Station**	**918**	**4/75**
Southern California Edison Co.	**San Onofre 1**	**San Clemente**	**436**	**1/68**
Southern California Edison Co.	San Onofre 2(C)	San Clemente	1,100	12/81
Southern California Edison Co.	San Onofre 3(C)	San Clemente	1,100	2/83

a On 10/23/80 received limited operating license to load fuel, reach criticality and do power testing.

b Received operating license 9/1/78 and went into commercial operation 3/26/80.

c Shut down 7/2/76 for seismic modifications. Operational date uncertain.

State and Utility	*Plant*	*Location*	*Net M/We*	*Comm'l Operation*
COLORADO				
Public Service Co. of Colorado	**Fort St. Vrain**	**Platteville**	**330**	**1/79**
CONNECTICUT				
Connecticut Yankee Atomic Power Co.	**Haddam Neck**	**Haddam Neck**	**575**	**1/68**
Northeast Nuclear Energy Co.	**Millstone 1**	**Waterford**	**660**	**3/71**
Northeast Nuclear Energy Co.	**Millstone 2**	**Waterford**	**870**	**12/75**
Northeast Nuclear Energy Co.	Millstone 3(C)	Waterford	1,150	5/86
FLORIDA				
Florida Power Corp.	**Crystal River 3**	**Red Level**	**825**	**3/77**
Florida Power & Light Co.	**Turkey Point 3**	**Turkey Point**	**666**	**12/72**
Florida Power & Light Co.	**Turkey Point 4**	**Turkey Point**	**666**	**9/73**
Florida Power & Light Co.	**St. Lucie 1**	**St. Lucie County**	**777**	**12/76**
Florida Power & Light Co.	St. Lucie 2(C)	St. Lucie County	777	5/83
GEORGIA				
Georgia Power Co.	**Edwin I. Hatch 1**	**Baxley**	**786**	**12/75**
Georgia Power Co.	**Edwin I. Hatch 2**	**Baxley**	**790**	**9/79**
Georgia Power Co.	Alvin W. Vogtle 1(C)	Waynesboro	1,100	5/85
Georgia Power Co.	Alvin W. Vogtle 2(C)	Waynesboro	1,100	11/87
ILLINOIS				
Commonwealth Edison Co.	**Dresden 1***a*	**Morris**	**200**	**7/60**
Commonwealth Edison Co.	**Dresden 2**	**Morris**	**794**	**7/70**
Commonwealth Edison Co.	**Dresden 3**	**Morris**	**794**	**11/71**
Commonwealth Edison Co.	**Zion 1**	**Zion**	**1,040**	**12/73**
Commonwealth Edison Co.	**Zion 2**	**Zion**	**1,040**	**9/74**
Commonwealth Edison Co.	**Quad Cities 1**	**Cordova**	**789**	**2/73**
Commonwealth Edison Co.	**Quad Cities 2**	**Cordova**	**789**	**3/73**
Commonwealth Edison Co.	LaSalle 1(C)	Seneca	1,078	6/81
Commonwealth Edison Co.	LaSalle 2(C)	Seneca	1,078	6/82
Commonwealth Edison Co.	Braidwood 1(C)	Braidwood	1,120	10/85
Commonwealth Edison Co.	Braidwood 2(C)	Braidwood	1,120	10/86
Commonwealth Edison Co.	Byron 1(C)	Byron	1,120	10/83
Commonwealth Edison Co.	Byron 2(C)	Byron	1,120	10/84
Commonwealth Edison Co.	Carroll County 1(O)	Savanna	1,150	10/92
Commonwealth Edison Co.	Carroll County 2(O)	Savanna	1,150	10/93
Illinois Power Co.	Clinton 1(C)	Clinton	950	8/83
Illinois Power Co.	Clinton 2(C)	Clinton	950	*
INDIANA				
Northern Indiana Public Service Co.	Bailly Nuclear 1(C)*b*	Dunes Acres	644	12/89
Public Service Indiana	Marble Hill 1(C)	Madison	1,130	12/86
Public Service Indiana	Marble Hill 2(C)	Madison	1,130	12/87
IOWA				
Iowa Electric Light & Power Co.	**Duane Arnold**	**Palo**	**538**	**2/75**
Iowa Power & Light Co.	Vandalia(O)	Vandalia	1,270	*

a Shut down 10/31/78 to upgrade ECCS chemical clean and refuel. Estimated startup 6/86.

b Canceled, 1981.

State and Utility	*Plant*	*Location*	*Net M/We*	*Comm'l Operation*
KANSAS				
Kansas Gas & Electric Co.	Wolf Creek(C)	Burlington	1,150	4/84
LOUISIANA				
Gulf States Utilities Co.	River Bend 1(C)	St. Francisville	934	4/84
Gulf States Utilities Co.	River Bend 2(C)	St. Francisville	934	*
Louisiana Power & Light Co.	Waterford 3(C)	Taft	1,165	3/83
MAINE				
Maine Yankee Atomic Power Co.	**Maine Yankee**	**Wiscasset**	**825**	**12/72**
MARYLAND				
Baltimore Gas & Electric Co.	**Calvert Cliffs 1**	**Lusby**	**845**	**5/75**
Baltimore Gas & Electric Co.	**Calvert Cliffs 2**	**Lusby**	**845**	**4/77**
MASSACHUSETTS				
Boston Edison Co.	**Pilgrim 1**	**Plymouth**	**655**	**12/72**
Boston Edison Co.	Pilgrim 2(O)	Plymouth	1,150	*
Yankee Atomic Electric Co.	**Yankee Rowe**	**Rowe**	**175**	**7/61**
MICHIGAN				
Consumers Power Co.	**Big Rock Point**	**Charlevoix**	**63**	**3/63**
Consumers Power Co.	**Palisades**	**South Haven**	**740**	**12/71**
Consumers Power Co.	Midland 1(C)	Midland	522	7/84
Consumers Power Co.	Midland 2(C)	Midland	807	12/83
Detroit Edison Co.	Enrico Fermi 2(C)	Lagoona Beach	1,093	11/83
Indiana & Michigan Electric Co.	**Donald C. Cook 1**	**Bridgman**	**1,054**	**8/75**
Indiana & Michigan Electric Co.	**Donald C. Cook 2**	**Bridgman**	**1,100**	**7/78**
MINNESOTA				
Northern States Power Co.	**Monticello**	**Monticello**	**545**	**6/71**
Northern States Power Co.	**Prairie Island 1**	**Red Wing**	**530**	**12/73**
Northern States Power Co.	**Prairie Island 2**	**Red Wing**	**530**	**12/74**
MISSISSIPPI				
Mississippi Power & Light Co.	Grand Gulf 1(C)	Port Gibson	1,250	4/82
Mississippi Power & Light Co.	Grand Gulf 2(C)	Port Gibson	1,250	4/86
Tennessee Valley Authority	Yellow Creek 1(C)	Luka	1,285	4/88
Tennessee Valley Authority	Yellow Creek 2(C)	Luka	1,285	*
MISSOURI				
Union Electric Co.	Callaway 1(C)	Callaway County	1,150	10/82
Union Electric Co.	Callaway 2(C)	Callaway County	1,150	4/88
NEBRASKA				
Nebraska Public Power District	**Cooper**	**Brownville**	**778**	**7/74**
Omaha Public Power District	**Fort Calhoun 1**	**Fort Calhoun**	**490**	**9/73**
NEW HAMPSHIRE				
Public Service Co. of New Hampshire	Seabrook 1(C)	Seabrook	1,150	0/83
Public Service Co. of New Hampshire	Seabrook 2(C)	Seabrook	1,150	0/85

State and Utility	*Plant*	*Location*	*Net M/We*	*Comm'l Operation*
NEW JERSEY				
Jersey Central Power & Light Co.	**Oyster Creek**	**Lacey Township**	**650**	**12/69**
Public Service Electric & Gas Co.	**Salem 1**	**Salem**	**1,090**	**6/77**
Public Service Electric & Gas Co.	**Salem 2**	**Salem**	**1,115**	**4/80***a*
Public Service Electric & Gas Co.	Hope Creek 1(C)	Salem County	1,067	12/86
Public Service Electric & Gas Co.	Hope Creek 2(C)	Salem County	1,067	12/89
NEW YORK				
Consolidated Edison Co. of New York, Inc.	**Indian Point 2**	**Buchanan**	**873**	**8/73**
Power Authority of the State of New York	**Indian Point 3**	**Buchanan**	**965**	**8/76**
Power Authority of the State of New York	**James A. FitzPatrick**	**Scriba**	**821**	**7/75**
Long Island Lighting Co.	Shoreham(C)	Brookhaven	854	1/83
Niagara Mohawk Power Corp.	**Nine Mile Point 1**	**Oswego**	**620**	**12/69**
Niagara Mohawk Power Corp.	Nine Mile Point 2(C)	Oswego	1,080	10/86
Rochester Gas & Electric Corp.	**Robert E. Ginna**	**Rochester**	**470**	**7/70**
NORTH CAROLINA				
Carolina Power & Light Co.	**Brunswick 1**	**Southport**	**821**	**3/77**
Carolina Power & Light Co.	**Brunswick 2**	**Southport**	**821**	**11/75**
Carolina Power & Light Co.	Shearon Harris 1(C)	New Hill	900	3/85
Carolina Power & Light Co.	Shearon Harris 2(C)	New Hill	900	3/88
Carolina Power & Light Co.	Shearon Harris 3(C)	New Hill	900	3/94
Carolina Power & Light Co.	Shearon Harris 4(C)	New Hill	900	3/92
Duke Power Co.	William McGuire 1(C)	Cowans Ford Dam	1,180	7/81
Duke Power Co.	William McGuire 2(C)	Cowans Ford Dam	1,180	6/83
Duke Power Co.	Thomas L. Perkins 1(O)	Davie County	1,280	*
Duke Power Co.	Thomas L. Perkins 2(O)	Davie County	1,280	*
Duke Power Co.	Thomas L. Perkins 3(O)	Davie County	1,280	*
OHIO				
Cincinnati Gas & Electric Co.	Wm. H. Zimmer 1(C)	Moscow	810	6/82
Central Area Power Coordination Group(CAPCO)	Perry 1(C)	North Perry	1,205	5/84
Central Area Power Coordination Group(CAPCO)	Perry 2(C)	North Perry	1,205	5/88
Central Area Power Coordination Group(CAPCO)	**Davis-Besse 1**	**Oak Harbor**	**890**	**11/77**
OKLAHOMA				
Public Service Co. of Oklahoma	Black Fox 1(LWA)	Inola	1,150	7/85
Public Service Co. of Oklahoma	Black Fox 2(LWA)	Inola	1,150	7/88
OREGON				
Portland General Electric Co.	**Trojan**	**Rainier**	**1,130**	**5/76**
Portland General Electric Co.	Pebble Springs 1(O)	Arlington	1,260	1990s
Portland General Electric Co.	Pebble Springs 2(O)	Arlington	1,260	1990s
PENNSYLVANIA				
Department of Energy	**Shippingport**	**Shippingport**	**60**	**12/57**
Central Area Power Coordination Group(CAPCO)	**Beaver Valley 1**	**Shippingport**	**833**	**10/76**
Central Area Power Coordination Group(CAPCO)	Beaver Valley 2(C)	Shippingport	833	5/86

a 4/21/80 received limited operating license to load fuel, reach criticality and do power testing.

State and Utility	*Plant*	*Location*	*Net M/We*	*Comm'l Operation*
Metropolitan Edison Co.	**Three Mile Island 1***a*	**Londonderry Township**	**819**	**9/74**
Metropolitan Edison Co.	**Three Mile Island 2***b*	**Londonderry Township**	**906**	**12/78**
Pennsylvania Power & Light Co.	**Susquehanna 1(C)**	**Berwick**	**1,050**	**5/82**
Pennsylvania Power & Light Co.	**Susquehanna 2(C)**	**Berwick**	**1,050**	**5/83**
Philadelphia Electric Co.	**Peach Bottom 2**	**Peach Bottom Township**	**1,065**	**7/74**
Philadelphia Electric Co.	**Peach Bottom 3**	**Peach Bottom Township**	**1,065**	**12/74**
Philadelphia Electric Co.	Limerick 1(C)	Limerick Township	1,055	4/85
Philadelphia Electric Co.	Limerick 2(C)	Limerick Township	1,055	4/87
SOUTH CAROLINA				
Carolina Power & Light Co.	**H.B. Robinson 2**	**Hartsville**	**700**	**3/71**
Duke Power Co.	**Oconee 1**	**Lake Keowee**	**860**	**7/73**
Duke Power Co.	**Oconee 2**	**Lake Keowee**	**860**	**9/74**
Duke Power Co.	**Oconee 3**	**Lake Keowee**	**860**	**12/74**
Duke Power Co.	Catawba 1(C)	York County	1,145	3/84
Duke Power Co.	Catawba 2(C)	York County	1,145	9/85
Duke Power Co.	Cherokee 1(C)	Cherokee County	1,280	1/90
Duke Power Co.	Cherokee 2(C)	Cherokee County	1,280	1/92
Duke Power Co.	Cherokee 3(C)	Cherokee County	1,280	*
South Carolina Electric & Gas Co.	Virgil C. Summer 1(C)	Parr	900	6/81
TENNESSEE				
Tennessee Valley Authority	**Sequoyah 1**	**Daisy**	**1,148**	**9/80***c*
Tennessee Valley Authority	Sequoyah 2(C)	Daisy	1,148	7/82
Tennessee Valley Authority	Watts Bar 1(C)	Spring City	1,177	11/82
Tennessee Valley Authority	Watts Bar 2(C)	Spring City	1,177	8/83
Tennessee Valley Authority	Hartsville A-1(C)	Hartsville	1,233	7/88
Tennessee Valley Authority	Hartsville A-2(C)	Hartsville	1,233	4/89
Tennessee Valley Authority	Hartsville B-1(C)	Hartsville	1,233	*
Tennessee Valley Authority	Hartsville B-2(C)	Hartsville	1,233	*
Tennessee Valley Authority	Phipps Bend 1(C)	Surgoinsville	1,233	2/89
Tennessee Valley Authority	Phipps Bend 2(C)	Surgoinsville	1,233	*
Tennessee Valley Authority	Clinch River Breeder Reactor Plant(O)	Oak Ridge	350	9/88*d*
TEXAS				
Houston Lighting & Power Co.	**Allens Creek 1(O)**	**Wallis**	**1,200**	**2/88**
South Texas Project	South Texas Project 1(C)	Matagorda County	1,250	2/84
South Texas Project	South Texas Project 2(C)	Matagorda County	1,250	2/86
Texas Utilities Generating Co.	Comanche Peak 1(C)	Somervell County	1,150	0/82
Texas Utilities Generating Co.	Comanche Peak 2(C)	Somervell County	1,150	0/84
VERMONT				
Vermont Yankee Nuclear Power Corp.	**Vermont Yankee**	**Vernon**	**514**	**11/72**

a Shut down owing to NRC order pending re-start hearings.

b Shut down since 3/28/79 accident which caused core damage.

c Received full-power operating license 9/16/80.

d Subject to resolution of national policy debate.

State and Utility	*Plant*	*Location*	*Net M/We*	*Comm'l Operation*
VIRGINIA				
Virginia Electric & Power Co.	**Surry 1**	**Gravel Neck**	**775**	**12/72**
Virginia Electric & Power Co.	**Surry 2**	**Gravel Neck**	**775**	**5/73**
Virginia Electric & Power Co.	**North Anna 1**	**Mineral**	**850**	**6/78**
Virginia Electric & Power Co.	**North Anna 2**	**Mineral**	**850**	**12/80***a*
Virginia Electric & Power Co.	North Anna 3(C)	Mineral	907	0/89
WASHINGTON				
Puget Sound Power & Light Co.	Skagit 1(O)	Hanford	1,288	1/91
Puget Sound Power & Light Co.	Skagit 2(O)	Hanford	1,288	1/93
Department of Energy	**Hanford—N**	**Richland**	**800**	**9/66**
Washington Public Power Supply System	WPPSS 1(C)	Richland	1,267	2/86
Washington Public Power Supply System	WPPSS 2(C)	Richland	1,093	9/83
Washington Public Power Supply System	WPPSS 3(C)	Satsop	1,240	9/86
Washington Public Power Supply System	WPPSS 4(C)	Richland	1,267	2/87
Washington Public Power Supply System	WPPSS 5(C)	Satsop	1,240	9/87
WISCONSIN				
Dairyland Power Coop.	**LaCrosse**	**Genoa**	**50**	**11/69**
Wisconsin Electric Power Co.	**Point Beach 1**	**Two Creeks**	**497**	**12/70**
Wisconsin Electric Power Co.	**Point Beach 2**	**Two Creeks**	**497**	**10/72**
Wisconsin Public Service Corp.	**Kewaunee**	**Carlton Township**	**535**	**6/74**

a Received full-power operating license 8/20/80 and went into commercial operation 12/14/80.

OPERATING LICENSES ISSUED IN 1980

Plant	**Location**	**Net MWe**	**Utility**
North Anna 2*a*	Mineral, VA	850	Virginia Electric & Power Co.
Sequoyah 1*b*	Daisy, TN	1,148	Tennessee Valley Authority
Salem 2*c*	Salem, NJ	1,115	Public Service Electric & Gas Co.
Joseph M. Farley 2*c*	Houston County, AL	860	Alabama Power Co.

Total: 4 reactors = 3,973 MWe

a Received full-power operating license and went into commercial operation.
b Received full-power operating license only.
c Received limited operating license to load fuel, reach criticality and do power testing only.

REACTOR RETIRED IN 1980

Plant	Location	Net MWe	Utility	Comm'l Operation
Indian Point 1	Buchanan, NY	265	Consolidated Edison Co. of New York	10/62

CANCELLATIONS IN 1980

Plant	Location	Net MWe	Utility	Comm'l Operation
Davis-Besse 2(LWA)	Oak Harbor, OH	906	Toledo Edison Co.	4/85
Davis-Besse 3(LWA)	Oak Harbor, OH	906	Toledo Edison Co.	4/87
Erie 1(O)	Berlin Heights, OH	1,260	Ohio Edison Co.	4/86
Erie 2(O)	Berlin Heights, OH	1,260	Ohio Edison Co.	4/88
Forked River 1(C)	Lacey Township, NJ	1,168	Jersey Control Power & Light Co.	5/86
Greenwood 2(O)	St. Clair County, MI	1,264	Detroit Edison Co.	9/90
Greenwood 3(O)	St. Clair County, MI	1,264	Detroit Edison Co.	9/92
Haven 1(O)	Haven, WI	900	Wisconsin Electric Power Co.	6/89
Jamesport 1(C)	Riverhead, NY	1,150	Long Island Lighting Co.	6/89
Jamesport 2(C)	Riverhead, NY	1,150	Long Island Lighting Co.	6/91
Montague 1(O)	Montague, MA	1,150	Northeast Nuclear Energy Co.	*
Montague 2(O)	Montague, MA	1,150	Northeast Nuclear Energy Co.	*
New Haven 1(O)	New Haven, NY	1,250	New York State Electric & Gas Corp.	5/93
New Haven 2(O)	New Haven, NY	1,250	New York State Electric & Gas Corp.	5/94
North Anna 4(C)	Mineral, VA	907	Virginia Electric & Power Co.	0/92
Sterling(C)	Sterling, NY	1,150	Rochester Gas & Electric Corp.	5/88

Total: 16 reactors = 18,085 MWe

Source: **Atomic Industrial Forum, Inc., Washington, D.C.**

Appendix D

Organizations

Committee of the Atomic Bomb Survivors in the U.S.
1109 Shell Gate Place
Alameda, CA 94501

Committee for Nuclear Responsibility
P.O. Box 11207
San Francisco, CA 92401

American Friends Service Committee/Rocky Flats Project
1660 Lafayette Street, Suite D
Denver, CO 80218

Oil, Chemical and Atomic Workers
P.O. Box 2812
Denver, CO 80201

Rocky Flats Coalition
1315 Broadway, # 1
Boulder, CO 80302

Micronesia Support Committee
1212 University Avenue
Honolulu, HI 96826

National Association of Atomic Veterans
1109 Franklin Street
Burlington, IA 52601

Union of Concerned Scientists
1208 Massachusetts Ave.
Cambridge, MA 02138

Nevada Test Site Radiation Victims Association
P.O. Box 18414-192
Las Vegas, NV 89114

American Indian Environmental Council
3812 Central S.E.
Albuquerque, NM 87106

Southwest Research and Information Center
P.O. Box 4524
Albuquerque, NM 87106

Focus on Micronesia Coalition
475 Riverside Drive, Room 616
New York, NY 10115

Fellowship of Reconciliation/Nuclear Weapons Facilities Project
Box 271
Nyack, NY 10960

Committee for U.S. Veterans of Hiroshima and Nagasaki
P.O. Box 14424
Portland, OR 97214

TMI Alert
315 Peiffer Street
Harrisburg, PA 17102

Citizens' Call
126 South 1400 West
Cedar City, UT 84720

Center for Renewable Resources
Room 1100
1028 Connecticut Ave., NW
Washington, D.C. 20036

Critical Mass Energy Project
P.O. Box 1538
Washington, D.C. 20013

Environmental Policy Center
317 Pennsylvania Avenue, SE
Washington, D.C. 20003

Health and Energy Learning Project
236 Massachusetts Avenue, NE, # 506
Washington, D.C. 20002

International Association of Machinists and Aerospace Workers
1300 Connecticut Avenue, NW
Washington, D.C. 20036

Natural Resources Defense Council
1725 I Street, NW
Washington, D.C. 20002

Nuclear Information & Resource Service
1536 16th Street, NW
Washington, D.C. 20036

SANE
514 C Street, NE
Washington, D.C. 20002

[The index has been included verbatim from the original book. Although the page numbers are not correct for this copy of the book, it was felt the subjects noted here would still be useful as reference. The original chapter page numbers are listed below to facilitate cross-referencing —ratitor]

	Acknowledgments	ix
	Notes	297
	Introduction by Dr. Benjamin Spock	x
1	The First Atomic Veterans	3
2	300,000 GIs Under the Mushroom Clouds	31
3	Bringing the Bombs Home	58
4	Test Fallout, Political Fallout	82
5	Continued Testing: Tragic Repetitions	102
6	The Use and Misuse of Medical X Rays	125
7	Nuclear Workers: Radiation on the Job	140
8	Bomb Production at Rocky Flats: Death Downwind	165
9	Uranium Milling and the Church Rock Disaster	177
10	Tritium in Tucson, Wastes Worldwide	190
11	The Battle of Shippingport	207
12	How Much Radiation?	223
13	Animals Died at Three Mile Island	237
14	People Died at Three Mile Island	246
15	Conclusion: Surviving the New Fire	264
Appendix A	The Basics of Radiation and Health	270
Appendix B	Summary of Atomic Bomb Tests	280
Appendix C	Commercial Nuclear Power Reactors in the U.S.	282
Appendix D	Organizations	295
	Index	359

Index

A-bomb. *See* Nuclear weapons tests
Aiken (SC), 167, 196
Alabama, 229
Alaska, 210
Albany (NY), 73, 96, 108-10, 236, 249
Albuquerque (NM), 180
Aliquippa (PA), 219-21, 255
Alpha Radiation. *See* Radiation
Amarillo (TX), 83, 166
American Association for the Advancement of Science (AAAS), 88, 95, 211
American Atomics Corporation, 153, 190-94, 261, 268
American Cancer Society, 132-33
American College of Radiology, 132, 136
American Medical Association (AMA), 137
American Physical Society, 48, 56
American Society of Radiologic Technologists, 128
Americium, 161
Amish, 223
Anaconda Company, 180, 183
Anderson, lack, 23, 226-27, 244
Animal Mutations. *See* Radiation
Antiballistic Missile System (ABM), 214
Argonne National Laboratory, 48

Arizona, 43, 62-66, 111-13, 118, 177-78, 180-83
  birth defects in, 186
  Center for Occupational Safety and Health, 193
  fallout on, 72, 92
  radioactive wastes in, 192-93
Arizona Daily Star, The, 191-93
Arkansas, 173, 227, 245, 255
Arkansas Gazette, The, 227-28
Arkansas Nuclear One. *See* Nuclear power plants
Arkansas Power and Light, 227 255, 261
Associated Press (AP), 16, 20, 27, 92, 111, 122, 227
Atlantic Ocean, 171, 195-96, 253
Atomic Bomb Casualty Commission (ABCC), 88, 145-46
Atomic Energy Act, 80
Atomic Energy Commission. *See* United States Government
Atomic Establishment, The, 184
Atomic Industrial Forum, 112
Atomic Safety and Licensing Board, 185
Atomic Tests in Nevada, 105
"Atoms for Peace," 56, 71, 111, 207-08, 267-68
Australia, 3, 268

Babcock and Wilcox, 223
(Baltimore) *News-American, The,* 234-36, 248-40, 243
Barnwell Nuclear Center, 198
Barrett, Lake, 232
Battelle Laboratory, 143-44
Beaver County Times, The, 217
Beaver Valley (PA), 216-17, 222, 226
Beaver Valley. *See* Nuclear power plants
BEIR Committee. *See* National Academy of Sciences
Bell Laboratories, 56
Bennett, Herschel, 227-29, 245
Berkeley (CA), 48
Berkeley Radiation Laboratory, 48, 153
Berlin (FRG), 99, 107
Bertell, Rosalie, 133-34, 226, 265
Berwyn (IL), 10
Bethe, Hans, 56
Bikini Islands, 31-32, 37-47, 85-87, 99, 102-103, 260. *See also,* Nuclear weapons tests
Birth defects. *See* Radiation
Bismuth, 147
Black, Hugo, 209
Blumenson, Leslie, 132, 265
Bond, Victor, 252
Bonebrake, Richard W., 24-25, 30
Boston (MA), 25, 127, 138, 211
Boston Globe, The, 155-56
Boston Veterans' Hospital, 155
Boulder (CO), 154
Bradbury, Norris, 50, 84
Bradley, David, 31-32, 38-42
Brafford, Chris 187; Neil, 187
Brody, Jane, 251-53
Broken Arrows, 166
Brookhaven National Laboratories, 218, 252
Brooklyn (WI), 43
Broomfield (CO), 173
Bross, Irwin, 132, 134, 136, 156, 265
Broudy, Charles, 105; Pat, 105-106

Brower, Stephen, 75, 77-78
Brown's Ferry. *See* Nuclear power plants
Buffalo (NY), 132, 159, 226
Bulletin of the Atomic Scientists, The, 53, 106, 110, 208, 212, 214
Bulloch, Kern, 76; McRae, 79
Burlington (IA), 35, 166
Bush, George, 267, 269

Cadmium, 177
Cain, Fran, 238, 242, 262
Caldicott, Helen, 225, 265
Caldwell, Glyn C., 33, 265
California, 3, 14, 21, 42, 46, 50, 73, 90-91, 105
  Radiation and, 64, 66, 121, 128, 183
California Institute of Technology, 88, 95
California, University of, 48-49, 53, 81, 94
Camp Desert Rock, 67, 70, 90
Camp Mercury, 58
Canada, 14, 116-17, 159, 249, 268
Cancer. *See* Radiation
Canon City (CO), 186, 245
Canonsburg (PA) 188-90
Carbon-14, 56-57, 97, 210, 213, 279
Carlsbad (NM), 122
Carnegie-Mellon Institute, 218
Carter, Jimmy, 21, 136, 156, 159-60, 162, 198, 202, 254, 264
Calder Hall. *See* Nuclear power plants
Cedar City (UT), 59-60, 76, 79
Center for Disease Control, 33-34, 36, 156, 181, 186, 253
Center for Investigative Reporting, 103
Central Intelligence Agency (CIA), 102, 200-203, 267
Cesium-137, 9, 87, 114, 171, 195, 249, 266, 278
  badges and, 36
  escape from plants, 210
  ocean dumping, 196
  Pittsburgh residents and, 219
Chalk River (Canada), 159
Charlotte Observer, The, 13
Chicago (IL), 126, 151, 184, 203, 218
Chicago, University of, 48, 57
China, 217-18, 267 68
Christmas Island 104
Church Rock (NM), 177 80, 182-84, 190, 197, 261, 268
Clamshell Alliance, 228
Clapp, Delores, 12; Ralph, 11-14
Cleland, Max, 17-18, 21, 26
Cobalt-60, 190, 210, 272, 278
Cobb, John C., 156-57, 169, 175, 265
Colorado, 65, 122, 149, 162, 168, 182-3, 186, 234
  birth defects in, 173, 186-88
  fallout in, 72, 92-93
Colorado, University of, 92, 156, 169, 175
Colorado River, 118, 178, 183
Columbia Broadcasting System (CBS), 36
Columbia River, 11, 196
Columbia University, 56, 152, 248, 264
Committee for Nuclear Information, 97-99
Committee for U.S Veterans of Hiroshima and Nagasaki, 18
Commoner, Barry, 97
Commonwealth Edison, 151

Congressional Record, 215
Conley, Charles, 224, 236, 238, 241; Joseph, 239
Connecticut, 230
Conqueror, The, 80-81
Coppola, Anna, 20, 22; Harry, 14-15, 18-23, 25, 30, 36
Cornell University, 56, 185, 212
Critical mass, defined, 278
Critical Mass Energy Project, 203
Cuba, 107
Curie, 237, 277
Curie, Marie, 140, 277; Pierre, 140
Czechoslovakia, 140, 147 48

Dark Circle, 165, 173-75
Day, Sam, 208
Dean, Gordon, 69-70, 75
Decatur (AL), 229
Defense Nuclear Agency (DNA), 13, 16, 19, 23-24, 27-30, 35-37, 81, 104, 147
DeGroot, Morris, 218-221
Denmark, 166
Denver (CO), 10, 92, 109, 149, 160, 165, 232
  Rocky Flats and, 162, 168, 172-73
Denver Post, The, 201
Detroit (MI), 208, 229
Detroit Edison, 209
Diablo Canyon. *See* Nuclear power plants
Dillon, Read and Company, 55
Dine (Navajo) Nation, 177
Dosimeter. *See* Radiation
Dow Chemical Co., 56, 160-62, 169, 172
Down's Syndrome. *See* Radiation
Douglas, William O., 209
Dresden. *See* Nuclear power plants
Drinker, Cecil, 152, 265
Duckwater Shoshones, 65
DuPont, 56
Duquesne Light, 208, 216-19, 222
Durango (CO), 183, 185, 261
Dyson, Freeman, 214, 265

Edison, Thomas, 127
Eisenbud, Merrill, 96, 100, 148-49, 150, 265
Eisenhower, Dwight, 62, 75, 84, 98-99, 103, 107
  "Atoms for Peace" program, 71, 207
Einstein, Albert, 52, 269-70
Elugelab Island, 83
Encyclopaedia Britannica, 143, 279
Eniwetok, 49-50, 82-85, 99, 104. *See also,* Nuclear weapons tests
Enterprise (UT), 59, 65
Environmental Protection Agency (EPA). *See* U.S. Government
Eskimos, 210
Espionage Act, 32
Europe, 150, 171, 269

Face the Nation, 95
Fallout, 3-122, 268. *See also*, Radiation
Federal Bureau of Investigation (FBI), 84, 157
Federal Republic of Germany (FRC), 181, 266
Federation of Atomic Scientists (FAS), 37, 47, 93, 110
Fermi. *See* Nuclear power plants

Fermi, Enrico, 52, 58
Fission, defined, 278
Fitzpatrick. *See* Nuclear power plants
Flagstaff (AZ), 193-94
Florida, 20-22, 44-45, 49, 71, 196, 229
Ford Administration, 202
Ford, Betty, 132
Foreign Policy Bulletin, The, 96
Fort Bragg (NC), 70
Fort Lauderdale (FL), 19
France, 49, 107, 148
Franck Report, 5-6
Fredonia (AZ), 62-65, 111, 113
Freedom of Information Act, 202
Fusion, defined, 278

Gallup (AZ), 177, 180
Gamma Ray. *See* Radiation
Geiger Counter. *See* Radiation
General Accounting Office (GAO), 25, 158, 184, 194, 230, 265
General Advisory Committee, 52, 100
General Dynamics Corporation, 155
General Electric, 56, 79, 190
General Public Utilities (GPU), 223
Genetic defects. *See* Radiation
Geneva (Switzerland), 94, 171
George Washington University, 67
Georgia, 152-53, 166, 196
Gerusky, Thomas, 219, 222, 234-36, 248
Getty Oil, 198
Gilinsky, Victor, 178, 184-85, 233
Glendale (AZ), 63
Gofman, John W., 111, 145, 153, 209-13, 218, 265
    on radiation, 216-17, 229, 273, 278
Goodman, Leo, 209
Goodyear Corporation, 158
Grand Junction (CO), 187-89
Great Britain. *See* United Kingdom
Greenland, 166
Guadalcanal, 21-23
Guam, 23
Gulf of Mexico, 195

Haag, Kristen, 165, 171, 175; Rex, 162, 165, 175-76, 190
half-life, definition of, 270
Hammarskjold, Dag, 98
Hammel, Laura T., 239-41
Hanford Nuclear Reservation (WA), 78-79, 141-44, 196-97, 200, 203, 218, 261
Harrisburg (PA), 223, 232, 235-36, 247-249, 251, 254
    fetal and infant mortality in, 252-59
Harrowsmith magazine, 249, 261
Harvard University, 52, 109, 130, 149, 152
    Medical School, 128, 246
Hawaii, 31, 46, 49, 83, 86, 99, 165
Hayward, Susan, 81
H-Bomb. *See* Nuclear weapons tests
Health Insurance Plan of New York, 132
Health Physics magazine, 141-43
Health Physics Society, 109-160
Helms, Clifford, 13

Hendrie, Joseph, 236, 247, 249, 254
Hiroshima, 3-7, 54, 103, 142, 209, 212, 259, 261, 266
  ABCC study and, 145-47
  radiation and, 95, 276
  size of bomb, 59, 71, 83, 103
  U.S veterans and, 3-33
Hiroshima and Nagasaki Physical, Medical, and Social Effects of Atomic Bombing, 46
Hodgkin's Disease. *See* Radiation
Hollywood (CA), 80-81
Hong Kong, 152
Honolulu (HI), 103
Hughes, Howard, 80
Human Resources Research Office, 67
Humboldt. *See* Nuclear power plants
Hyaline membrane disease. *See* Radiation
Hypothyroidism. *See* Radiation

Idaho, 54, 73, 108, 118
Idaho Nuclear Engineering Laboratory (INEL), 167-68, 196, 200, 203
Idaho Statesman, The, 168
Illinois 3, 21, 24-26, 45, 72, 198
  Radium Dial Co. and, 152-53
Indian Health Service, 180, 186
Indian Point. *See* Nuclear power plants
Indiana, 24, 72
Infant mortality. *See* Radiation
Iodine, 74, 100, 167, 209-10, 249, 278
  TMI and, 231-36
  prenatal development and, 110, 213, 217, 247
  weapons tests and, 76, 89, 101, 114-17, 171
Ionizing radiation. *See* Radiation
Iowa, 35, 166
Iraq, 196, 267
Isotopes, 110, 183, 196; defined, 237
Israel, 196, 267

Jacobs, Paul, 112
Japan, 3, 23-26, 29, 34, 38, 44, 57, 195, 212
  ABCC Study and, 145
  fallout and, 96
  fishing industry and, 87-88
  protests and, 98, 269
Jefferson County (CO), 174-75, 182
Jesus Christ of the Latter-Day Saints, Church of (Mormon), 60-64, 215
Johns Hopkins University, 127, 133
Johnson, Carl, 174-76, 182, 234, 265
Johnson, Lyndon, 208
Joint Committee on Atomic Energy (JCAE). *See* U. S. Congress
Journal of the American Medical Association (JAMA), 33, 134

Kansas, 49, 72
Karkenan, Dan, 161; Miriam, 161
Kellex Corporation, 56
Kelly, Orville, 34-36; Wanda, 34-36
Kemeny Commission, 160, 181, 232-233, 235, 248, 259, 264
Kennedy, Edward M., 65, 118, 151
Kennedy, John F., 107, 208
Kentucky, 157-58, 197
Kerr-McGee Corporation, 180, 183
Knapp, Harold, 77, 100, 209, 265

Knapp Report, 77, 100-101
Kneale, George, 141-43, 265
Korea, 43, 58, 73
Krumback, Florence, 162-5; Leroy, 162-5
Krypton gas, 167, 260, 262
Kyshtym (USSR), 200, 203, 261, 268

Lake Mead (AZ), 178, 183-84
Lake Ontario Ordnance Works, 198-99
Lapp, Ralph, 9, 88, 96, 100
Lasky, Alvin, 24-25, 30
Las Vegas (NV), 58, 64, 67, 73, 91-92, 118, 178, 183
Las Vegas Review Journal The, 91-92
Lawrence Livermore Laboratory, 52, 84, 146, 209-212, 214
Lead, 147, 177-78
Lebanon (OR), 10
Lee, Jane, 223-24, 237-38, 241, 260-62
Leukemia. *See* Radiation
Lewis, E. B., 95-96, 109, 127, 274
Lewiston (NY), 199-200, 203
Libby, Willard F., 89-90, 93-97, 104
Lifton, Robert Jay, 6
Lilienthal, David, 57
Limited Test Ban Treaty, 112
Little Rock (AK), 227
Liverman, James, 144
London (UK), 170
Los Alamos (NM), 6, 48, 141
Los Alamos County (NM), 154
Los Alamos Laboratory, 184, 276
    Operation Sandstone and, 50, 56, 58, 74
    studies and, 78, 84, 153-54
Los Angeles (CA), 64, 73, 107, 178, 184, 235
Los Angeles Times, The, 201, 267
Los Angeles Herald Examiner, The, 93, 121
Love Canal (NY), 199-200
Low-level radiation. *See* Radiation
Lloyd, David, 49, Scotty, 49
Luminous Processes Co., 152-53
Lymphoma. *See* Radiation

Mackelprang, Gayneld, 62-63, 113; Rose, 62-63, 113
MacLeod, Gordon, 246-48, 251-55, 264-65
MacMahon, Brian, 109, 130, 142
Maine, 118, 236
Mancuso, Thomas, 141-47, 156, 159, 265
Manhattan Project, 5-6, 47, 109-10, 153-55, 199
Mariana Islands, 3
Martell, Edward, 36, 115, 154, 172, 265
Maryland, 37, 54, 133, 138, 195, 216, 218, 253
Marshall Islands, 75, 99, 207, 252. *See also* Nuclear weapons tests
Massachusetts, 72
Matayoshi, Almira, 86
Matheson, Scott M., 121
Maughan, Alan, 186; Dale, 186
Mechanicsburg (PA), 237, 244
Medina Weapons Plant (TX), 166
Mediterranean, 166
Medvedev, Zhores, 200-201, 265
Mennonites, 223

Mesa (AZ), 43, 187
Metropolitan Edison Company, 223, 231, 234-35, 247 264
    citizen opposition to, 237, 254, 260-61
Miami (FL), 184, 203
Michigan, 19, 24, 194, 215, 267
Michigan, University of, 159-60
Middletown (PA), 224, 233, 238, 259, 261-62
Milham, Samuel, 142-43
Military Liaison Committee, 47-48, 53, 68
Millirems, 237, 249; defined, 277
Millstone. *See* Nuclear power plants
Milk. *See* Radiation
Milliroentgens, 72-73, 92
    defined, 277
Minnesota, 43, 46, 118, 133
Miscarriage. *See* Radiation
Mississippi, 116, 122, 188, 249
Missouri, 72, 97, 99-100
Mixon, Lloyd, 173-76, 186, 190, 225, 228, 245
Monsanto Chemical Co., 56
Montana, 118, 137
Moorehead, Agnes, 81
Morgan, Karl Z, 93, 97, 128-30, 162, 220-21, 232
Mormons. *See* Jesus Christ of Latter-Day Saints, Church of
Multiple myeloma. *See* Radiation
Myelofibrosis. *See* Radiation

Nagasaki, 3-33, 169, 203, 261, 266, 276
    production of bomb, 142, 153, 207
    studies of, 145-47, 209
Najarian, Thomas, 25, 155-56, 265
Nation magazine, *The,* 54, 255
National Academy of Sciences, 127, 275
    Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR), 146, 219, 275
National Association of Atomic Veterans (NAAV), 34-37
National Broadcasting Company (NBC), 56-57, 91
National Cancer Institute, 30, 132-34, 138, 141, 147
National Center for Atmospheric Research, 36, 154, 172
National Council on Radiation Protection (NCRP), 97, 148
National Institute for Occupational Safety and Health (NIOSH), 144, 156
Native Americans, 65-66, 81, 148, 177, 179, 182
Nebraska, 118, 126
Nevada Test Site, 58-59, 67, 113, 116-18, 215, 245
    fallout and, 72-73, 75, 89, 100-101, 116
    health effects, 59, 64-65, 68, 104, 120
    public and, 62, 66, 80-81, 90, 111
New England Journal of Medicine, The, 25, 65, 127
New Hampshire, 155, 173, 225, 228
New Jersey, 112, 151, 184
New Mexico, 48, 50, 58, 89, 161, 179, 181
    health studies, 141, 154, 181
    bomb tests in, 5, 84, 89-90, 122, 178
    uranium mining in, 177-84, 186
New Scientist, The, 200, 202
Newsweek magazine, 16, 38, 42, 54
New York (state), 21, 24, 56, 167, 226, 245, 267
    cancer rates in, 100, 109
    fallout in, 72-73, 96s, 109
    infant mortality in, 110, 215, 218
    radiation doses and, 108, 126, 133-35, 159, 173, 249

wastes and, 72-73, 96, 109
New York, State University of, 100, 197
New York City (NY), 57, 99, 133, 184, 218, 229, 241
fallout and, 279
wastes and, 194
New York Times, The, 47, 54, 106, 214, 250-51
radiation reports in, 116, 199, 260
TMI and, 239, 242, 253
New York Times News Service, 87
New York Public Interest Group (NYPIRG), 130, 135
New York University, 100, 259
New Zealand, 3
Nikoloff, John, 235, 238-40, 243 44
Nine Mile Point. *See* Nuclear power plants
Nixon, Richard M., 149, 211, 246
Noble gases; defined, 249
North Carolina, 13, 21, 58, 70, 166
North Dakota, 97
Nuclear Fuel Services (NFS), 159, 198
Nuclear power plants, 12, 134, 266
Arkansas Nuclear One, 228-29
Beaver Valley (PA), 160
Browns Ferry (AL), 229-30
Calder Hall (UK), 170
Diablo Canyon (CA), 254, 267, 268
Dresden (IL), 54, 218, 261
Fermi I (MI), 208, 229-30, 267
Fitzpatrick (NY), 226, 229, 261
Humboldt (CA), 218, 261, 267
Indian Point (NY), 218, 261, 267
Millstone (CT), 230, 261
Nine Mile Point (NY), 226-28, 249, 261
Peach Bottom (PA), 253
Seabrook (NH), 228
Shippingport (PA), 156, 159-60, 207-23, 244, 250, 255, 261
contamination around, 226-27
statistical deception and, 221.
See also Shapp Report
Three Mile Island (PA), 177, 179, 190, 214, 246-56, 261, 267-68
Animals and, 64, 222-25, 239-43
infant mortality and, 255-63
licensing of, 184
public reaction to, 236-37
radiation and, 74, 160, 169, 171, 231-32, 278
Vermont Yankee, 225-28, 244-45, 261-62
Waltz Mills (PA), 219
Nuclear Utilities Services (NUS), 216-26
Nuclear weapons tests, 3-122, 134, 190, 194, 269, 274
Bikini Islands
Able, 31-33, 39, 42, 45-46
Baker, 2, 39-45, 67, 102
Operation Castle, 84-87
Operation Crossroads, 31, 37-38, 40-49, 104
Hiroshima, 6. *See also* Hiroshima
Marshall Islands
Bravo, 84-88
George, 82
Mike, 83-84
Oak, 104
Operation Greenhouse, 82-83

        Operation Sandstone, 49-50
        Yoke, 50
    Nagasaki, 6. *See also* Nagasaki
    Nevada Test Site
        Baker, 11, 67
        Baneberry, 117-18, 120
        Bee, 90
        Buster Jangle, 67
        Climax, 71
        Easy, 68
        Exercise Desert Rock, 67
        Harry ("Dirty Harry"), 73-74
        Hood, 105-106
        Operation Knothole, 70-72
        Operation Plumbbob, 105
        Operation Ranger, 67
        Operation Teapot, 89-90
        Operation Tumbler-Snapper, 69-70
        Priscilla, 106
        Schooner, 116
        Sedan, 114-15
        Simon, 72-73, 96, 108
        Smoky, 33, 36
        Turk, 90
    New Mexico (Gnome), 122
    Project Plowshare, 115-16, 210
    Underwater
        Swordfish, 104
        Wigwam, 103-1 04

Oak Ridge (TN), 141, 157, 162
Oak Ridge Associated University, 144
Oak Ridge Health Physics Lab., 93
Oak Ridge National Lab., 146, 183, 202, 225
Occupational Safety and Health Administration, 158
Ohio, 72, 131, 141, 157
Ohio River, 217, 219, 227
Oil, Chemical and Atomic Workers Union, 158
Okajima, Shungo, 29
Okinawa (Japan), 3, 11
Oklahoma, 85
Ontario (Canada), 249
Oppenheimer, Robert, 49, 51-52, 84, 93, 153
Oregon, 44, 118, 228
Oxford University (UK), 25, 96, 129

Pacific Ocean, 3, 82, 84, 89, 212
    dump sites in, 195
    nuclear tests in, 31, 58, 67, 103-104, 107, 207, 261
Paducah (KY), 157-58, 261
Palladino, Nunzio, 242, 268
Pantex Weapons Plant (TX), 166
Pauling, Linus, 94-98, 209, 213, 265
Peach Bottom. *See* Nuclear power plants
Pearl Harbor (HI), 3, 44, 118
Pendleton, Robert, 81, 108, 114-17, 265
Pennsylvania, 65, 72, 136, 210, 223, 232, 241, 246
    Nuclear reactors in. *See* Nuclear power plants
    Uranium in, 178, 184, 188
Pennsylvania, Government of

    Department of Agriculture, 235, 238-43
    Department of Energy, 235-36, 238-42
    Department of Epidemiological Research, 219, 250
    Department of Health, 246, 251-59, 264
    Department of Radiation Protection, 231
    Department of Radiological Health, 219
    Medical College, 136
    Public Utilities Commission, 237
    State College, 184
    State College of Engineering, 242
    State University, 126, 184, 235
Pensacola (FL), 71
Philadelphia (PA), 139, 223
Philadelphia Electric Co., 235
Philippines, 44, 49
Piketon (OH), 157-58, 261
Pittsburgh (PA), 10, 188, 197, 208, 212, 218
    strontium in, 110, 137, 219
Pittsburgh, University of, 141, 144, 189, 212, 251, 253
    Medical School, 108
    School of Public Health, 246
Pittsburgh Press, The, 188
Plutonium, 79, 111, 181, 194, 196-197
    airborne, 165, 172
    bombs, 6, 9, 31, 41, 166
    concentration of, 29, 175, 266
    defined, 271
    exposure to, 36, 119, 153-54, 160-62, 176
    half-life, 171, 196
    health effects, 12, 22, 271
    ocean dumping, 196
    at Rocky Flats, 168-70, 173
    wastes, 194, 197, 203
Polonium, 147, 177
Polycythemia vera, 10
Portland (OR), 7, 9-11
Portsmouth Naval Shipyard, 155-57, 261
Potassium-40, 279
Potassium iodide, 247
Potomac River, 69
Powell, Dick, 81; Ellen 81
Princeton University, 106, 214
Provo (UT), 115
Public Health Service, 114, 117, 136, 149-50,

Quigley, Bernice, 8, 11; Linda, 8; Lyman, 3, 7-9, 11-13, 27-28; Ron, 8

Radford, Edward, 146, 219, 265
Radiation
    animal mutations and, 198, 223-27, 237-40, 243-44
    food chain and, 40, 78, 227-28
    human diseases and
        analyzed, 270-79
        aplastic anemia, 127
        bladder cancer, 154
        bone cancer, 14, 26 133, 152
        breast cancer, 131-33, 152-54, 158
        cancer of the colon, 152, 154, 158, 162
        Down’s Syndrome, 131, 187, 261
        "Factor VIII," 12

genetic defects, 45-46, 60-61, 70, 94, 97, 134, 230, 274-75
Hodgkin's Disease, 7, 25-26, 238
hyaline membrane disease, 213
hypothyroidism, 252-54
infant mortality, 212-15, 218-20, 249-68
leukemia, 96, 104, 109, 133-34, 155, 217
exposure levels and, 211
immune systems and, 274
Nagasaki and, 25-26
Portsmouth Naval Shipyard and, 155-56
radiologists and, 127
Rocky Flats and, 65, 175
Shippingport and, 160, 221
Sternglass and, 219
Three Mile Island and, 249
thorium and, 181
uranium and, 185-86
weapons tests and, 36, 60, 63, 75, 86, 120
veterans and, 7, 33, 37
X rays and, 130
lung cancer, 133, 136, 147-51, 156-58
lymphoma, 33, 59, 106, 175
miscarriages, 46, 86, 130
multiplemyeloma, 127, 142, 152, 160, 175
veterans and, 7, 14, 19-25, 30
myelofibrosis, 7, 25-26
necrosis of the jaw, 151-52
oat-cell carcinoma, 25
pancreatic cancer, 154
prostate cancer, 158
skin cancer, 138
stomach cancer, 154
rectal cancer, 154
rheumatism, 188
thyroid cancer, 133
tuberculosis, 44, 188
measurement of, 277-78
dosimeters, 36, 41, 45-46, 71, 90, 159-60, 234
film badge, 170
Geiger counter, 60, 66, 76, 93, 119, 151 153, 236
bomb tests and, 39, 44-45, 70-72, 87
milk and, 74, 97, 100-101, 117, 268
poisoning, symptoms of, 22, 41, 49, 59-64, 69-74, 81, 83, 202, 213
types of, 270-79
alpha, 29, 36, 77, 93, 148, 152, 157, 234, 271
background, 279
beta, 36, 77-78, 93, 157, 233-34, 271
cosmic, 279
gamma, 92, 152, 157, 272-74
measurement of, 159, 210, 233-34, 277
ionizing, 25 143, 270, 275
neutron, 147, 210
low-level, 36, 95, 133-34, 147, 151
X ray, 109, 212, 266-72, 277
dose comparisons, 17-18, 27, 77, 79, 89, 93
genetic damage and, 94-96, 108, 130, 274
medical use of, 125-62, 279
workers and, 140-62, 268
veterans and, 4, 9, 13-14, 16, 23, 30
Radioisotopes, 9

defined, 270
Radionuclides, defined, 270
Radium, 40, 177-78, 180-82, 196, 222, 226,
deepwater tests and, 103
rivers and, 183
sediment samples of, 184
treatment with, 137
watch-dial painters and, 151-53
Radium Dial Co., 152
Radon daughters, 147-48, 185, 271
Radon gas, 137, 147-50, 184, 271
Ralph, Harold, 14-15, 22, 25, 30; Mike, 15; Virginia, 14-16, 18, 21-22, 27
Rasmussen Report, 230
Reagan, Ronald, 122, 136, 194-95, 264, 269
Reagan Administration, 113, 230, 254, 265, 267
Reilly, Margaret, 219, 231, 234-36
Rem (radiation equivalent man), defined, 277
Rensselaer Polytechnic Institute, 72, 219
Resnikoff, Marvin, 159, 197-99, 265
Rhode Island, 26
Richmond (VA), 70
Rickover, Hyman, 155-56, 208
Rimland, Bernard, 215, 265
Rio Puerco (NM), 177-78, 180-82
Rochester (NY), 249
Rockefeller, Happy, 132
Rockville (MD), 216
Rockwell International, 160-61
Rocky Flats (CO) Nuclear Weapons Facility, 65, 160-62, 165, 175-76, 231-32, 279
accidents and, 168-72, 190, 200-201, 234, 261-62, 268
animal mutations and, 174, 186, 225, 228, 245
human diseases and, 160-62, 165-76
Rocky Mountains, 168-70
Roentgen, Wilhelm, 125-26, 129
Rongelap Atoll, 85-87
Rongerik Atoll, 87
Roosevelt, Franklin D., 122
Roswell Park Memorial Cancer Research Institute (Buffalo), 132, 226
Russellville (AK), 227

Saint George (UT), 81, 89, 100, 111-13, 260
cancer and, 86
Nevada fallout and, 61-65, 73-74, 86
Saint Louis Post-Dispatch, The, 112
Saint Paul (MN), 46
Sakharov, Andrei, 213, 265
Salt Lake City (UT), 80, 107, 114, 149
San Antonio (TX), 166
San Diego (CA), 103
San Francisco (CA), 32, 85, 195, 210
Savannah Beach (GA), 166
Savannah River (SC), 141, 167, 196, 200-03
Scholastic Aptitude Test (SAT), 215
Schroeder, Patricia, 15-17, 25-26, 122
Schweitzer, Albert, 97
Science magazine, 95-96, 108-110, 115, 126, 147, 236
Tamplin, article by, 214
Science Digest, 102, 115
Science News Letter, 38, 40
Scott, Helena, 46; Thomas, 46

Seabrook. *See* Nuclear power plants
Seattle (WA), 194, 203
Selenium, 177
Shapp, Milton, 219, 231
Shapp Commission, 219-22, 229, 231, 247, 265
Shippingport. *See* Nuclear power plants
Shiprock (NM), 186-87, 261
60 Minutes, 36-37
Snake River (ID) Aquifer, 167, 196
Sodium-24, 153, 177
Sohio, 180
South Carolina, 141, 166-67, 194-98
South Dakota, 187
Southern Piutes, 65
Spain, 166
Standard Chemical Company, 188
Standard Oil Development Co., 56
Sternglass Ernest, 108-10, 117-18, 171, 212-14, 218-19, 230, 247-55, 265
Stevenson, Adlai, 95
Stewart, Alice, 95-96, 108-109, 129-30, 134, 141-43, 146, 162, 265, 273
Strauss, Lewis, 53, 56, 84, 88-90, 94-95, 105, 108
Strontium, 9, 36, 65, 86-89, 95-99, 114, 171, 196, 210, 216, 219, 230, 249, 266
    Health effects explained, 271
Structural Ironworkers Union, 118
Susquehanna Corporation, 188
Susquehanna River, 223, 247, 260-62
Switzerland, 152
Syracuse (NY), 249

Tailings (uranium), 178, 187, 197
Tampa (FL), 44, 49
Tampa Tribune, The, 22
Tamplin, Arthur, 172, 209-11, 213, 216-18, 229, 265, 273
Teledyne Inc., 235
Teledyne Isotopes, 235
Teller, Edward, 50-53, 58, 80-84, 95, 97, 106, 108, 110, 232
Tennessee, 17 141, 146-47, 157
Tennessee Valley Authority, 17, 208, 229
Texas, 83, 166, 173
Theory of Relativity, 270
Thomas, Irma, 61, 113
Thorium, 177-78, 180, 183, 196
Thornburgh, Richard, 231, 241, 246-48
Three Mile Island. *See* Nuclear power plants
Time magazine, 38, 51
Tinian, 3
Tokuhata, George, 219-21, 250-56, 265
Tokyo (Japan), 6, 54, 146
Toledo (OH), 10
Tonawanda (NY), 199-200
Tonopah (NV), 65, 111
Tonopah Bombing and Gunnery Range, 58
Topeka (KS), 49
Transuranic wastes, 197
Trinity (NM), 178
Tri-State Leukemia Study, 133-34
Tritium, 153, 167, 190-207, 210, 270, 274
Troy (NY), 72-73, 96, 108-10, 236
Truman, Harry, 5-6, 20, 47-56, 67, 105
Tuberculosis. *See* Radiation

Tucson (AZ), 153, 190-94

Udall, Morris 179-82
Union Carbide Co., 56, 157
USSR, 84, 98-99, 200-202, 213-14, 267-68
  tests and, 53, 56, 96, 107
United Auto Workers, 208-209, 229
United Kingdom (UK), 98, 101, 107, 129, 141, 143, 158, 170-71, 268
  Atomic Energy Authority, 96, 171, 200
  scientists in, 25, 49, 147
United Nations (UN), 49, 86, 94-98, 171, 207
United Nuclear Co. (UNC), 178-82
United Press International (UPI), 29, 246, 252
United States, 2, 6, 11-12, 15-17, 20, 23-24, 28
  censorship in, 134
  electricity and, 229, 241
  evacuation and, 87
  fallout and, 112, 116
  nuclear wastes and, 166, 199, 268
  off-site venting and, 117-18, 120
  radiation and, 99, 108, 115, 141, 172, 203, 279
  test subjects and, 111
  veterans and, 3-102
United States, Government of
  Air Force, 36, 51, 75, 116, 118
    veterans and, 49-50, 69, 83
  Army, 4, 7, 24, 31, 50-51, 70
  Army Corps of Engineers, 179
  Army Reserve, 174
  Atomic Bomb Casualty Commission (ABCC), 145-47
  Atomic Energy Commission (AEC), 47, 51-54, 57, 62, 68, 71, 78, 86, 99, 116, 121, 141-43, 166, 173, 208-10
      animals and, 65, 78-79
    Division of Biology and Medicine, 75, 80, 89, 96, 100, 105, 144
    Division of Military Application, 118
    Earth Sciences Branch, 217
    fallout and, 75, 77, 88, 92, 94-95, 105, 110, 248
    Fallout Studies Branch, 100
    General Advisory Committee, 109
    Gofman Study and, 211
    H-bombs and, 51-54
    Health and Safety Laboratory, 218
    Knapp Report and, 101
    Mancuso Report and, 265
    Martell and, 36
    milk confiscation and, 74, 97
    mine tailings and, 187-88
    Office of Raw Materials Operations, 148
    ocean dumping and, 172, 195
    psychological effects of bomb and, 69
    Public Health Service and, 80
    Rocky Flats and, 169, 171, 174
    Sternglass and, 212-2
    Truman and, 56
    uranium mining and, 148-50
    WASH-1520, 203
    weapons production and, 186
    weapons tests and, 58, 66, 73-74, 89, 90- 93, 102-104, 119, 231, 268
  Bureau of Animal Industry, 78
  Bureau of Fish and Wildlife, 235
  Bureau of Radiation Safety, 252

Bureau of Radiological Health (BRH), 129, 131, 192
Bureau of Vital Statistics, 118, 249-50
Coast Guard, 99
Congress, 17, 54-55, 108, 130, 144, 149-50
    ABM and, 214
    Armed Services Committee, 15
    FAS and, 47
    Hanford and, 203
    House, 67, 76-77, 98, 116, 128, 264
    Joint Committee on Atomic Energy (JCAE), 48, 53, 89, 96, 98, 100, 108, 150
    nuclear wastes and, 194, 196
    radiation and, 34, 129
    Nuclear Safety and Oversight Committee, 264
    Senate, 196
    Tamplin and, 211
Department of Agriculture, 64, 78, 222-25, 236, 239-43, 253
Department of Defense, 8, 12-13, 23-25, 34-37, 48-53, 67-70, 99
    Defense Nuclear Agency (DNA), 28, 81
    fallout and, 18, 74
    Hiroshima and, 18, 21, 28
Department of Energy (DOE), 41, 111, 158, 168, 233, 264
    nuclear waste and, 188, 195-96, 199
    Rocky Flats and, 172, 174-75
    subsidies of, 208
    test sites, 87, 113, 117, 120-21
Department of Interior, 199
Department of Health, Education, and Welfare (HEW), 246
Department of Health Services, 76
Department of Justice, 62, 66, 121, 194
Department of State, 55
Department of Transportation, 40-41, 194
Environmental Protection Agency (EPA), 1, 121, 141, 159, 180, 192, 230, 236
    Nuclear wastes and, 183, 187, 195
    TMI and, 242-44
Federal Commission on Medical Malpractice, 135, 137
Federal Radiation Council, 99, 128, 212
Federal Water Pollution Control Administration, 183
General Accounting Office (GAO), 230, 265
Interagency Radiation Research Committee, 29, 65
Joint Chiefs of Staff, 53
Navy, 33, 51, 155-57, 212, 215
    Bikini tests and, 31 40, 42-46, 50, 85-86, 104
    Nagasaki and, 24, 26-27
    Seabees, 7, 13, 19, 21, 40
    U.S.S. *Coucal,* 44
    U.S.S. *Dawson,* 46
    U.S.S. *Haven,* 31-32
    U.S.S. *Hughes,* 43
    U.S.S. *Moctobi,* 104
    U.S.S. *Nevada,* 44
    U.S.S. *Ottawa,* 45
    U.S.S. *Pensacola,* 42
    U.S.S. *Phoenix,* 99
    U.S.S. *Quartz,* 43
    U.S.S. *Salt Lake City,* 45
Nuclear Regulatory Commission (NRC), 77, 152-53, 159-60, 167, 231-34, 242-44, 260, 262
    nuclear plants and, 160, 229, 231-36, 254, 264
    nuclear wastes and, 194-95, 228, 230
    radiation and, 101, 247-48, 266
Public Health Service (PHS), 63, 65, 72, 78, 114, 149-50

Supreme Court, 209, 229
Surgeon General, 107
United States News, The, 38, 87
U.S. News & World Report, 56, 93
U.S Radium Corporation, 151-52, 261
Uranium, 6, 110-11, 167, 175-77, 278
airborne, 172
Czechoslovakia, and, 140, 147
fuel pellets, 170
half-life, 270
Workers, and, 147-151, 153-54, 157-60
Wastes, 178, 180, 188, 194, 197
Utah, 58, 86, 111, 121, 183, 215, 260-62
animals in, 75-79
disease in, 60-64, 66, 81, 151, 185
fallout and, 59-62, 72, 89-92, 114-17, 209
iodine and, 100, 108, 115, 117
University of, 65, 81, 108, 114-15
Utirik Island, 86

Vanadium, 177
Vermont, 72, 173
Vermonter, The, 226
Vermont Yankee. *See* Nuclear power plants
Veterans Administration (VA), 16, 19
benefits and, 12, 43-45, 70, 82, 106
claims and, 9, 24-26, 44, 68, 104, 154
compensation and pension service, 21
hospitals, 11, 22, 70, 138, 155
protests against, 11-14, 21-22, 33-35
Virginia, 178
Voeltz, George, 154-55

Waltz Mills. *See* Nuclear power plants
Washington (State), 110, 117-18, 141-42
University of, 97
Washington (DC), 69, 80, 93, 148, 155, 184, 249
testimony in, 36, 50, 60, 83, 130, 138, 154, 209
protests in, 14-17, 19-22, 241
Washington Post, The, 28, 94, 116, 253
Wayne, John, 81; Michael, 81
Weber, Robert, 237, 241, 243 44
Weber, Nancy, 226, 229, 245
West Palm Beach (FL), 19-20
West Valley (NY), 159, 197-99, 203, 218, 245, 261
West Virginia, 55
Westinghouse, 56, 190, 208, 212
Weyerhouser Co., 14
White House, 13, 16, 21-23, 51, 53, 65, 114, 207
Windscale (UK), 101, 170-71, 200-201, 231, 261, 268
Winterer, Jorge, 180 81, 265
Wisconsin, 43
World War II, 11, 14, 43, 51, 56-57, 138, 192, 202, 212
Wyoming, 183

X ray. *See* Radiation
Xenon, 121, 167, 278