SIX

Nuclear Power

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Industries and the products they produce are the backbone of our economy and the principal support for our high standard of living. Historically, inventors and entrepreneurs developed them, motivated largely by incentives for profits, with little or no attention to subtle environmental or public health impacts. When large fossil-fueled electric power plants were first built in the late nineteenth century and the automobile became the dominant mode of transportation in the early twentieth century, no one worried about the air pollution they caused, and there were few such concerns, largely unexpressed until long after the public became irreversibly dependent on these technologies. By that time, abandoning them was completely out of the question, and only incremental improvements could be introduced to lessen their impacts.

The Original Plan for Development

The nuclear power industry was intended to be very different. It was conceived and developed by idealistic scientists, with the backing of a powerful congressional committee providing generous funding, and had the goal of providing the blessings of unlimited low-cost energy to mankind. The nuclear scientists' and engineers' high-minded idealism led them to place heavy emphasis on environmental and health impacts. In fact, one of the major motivations of the program was to eliminate the environmental degradation associated with fossil fuel burning. Nuclear scientists were instrumental in establishing very large basic research programs (that continue to this day) to investigate the health impacts of radiation. These programs heavily emphasized safety issues and elevated the science of risk analysis to unprecedented heights.

All this research, of course, led to a very extensive scientific literature that described and projected health effects of radiation, imagined potential accident scenarios, and estimated numbers of deaths from these combinations.[1] The scientists and engineers who carried out the research gave no consideration to the fact that the public was not ready to understand the concept of a technology potentially killing people, and in any case, this literature was intended for the scientific community, not for the public. It was valuable for the scientists and engineers in their design efforts, guiding them to implement additional safety measures against low probability–high consequence failures. A byproduct of this work was conclusive evidence that nuclear power is en-

1. U.S. Nuclear Regulatory Commission (NRC), *Reactor Safety Study* (document NUREG-75/014) (Washington, D.C.: Nuclear Regulatory Commission, 1975).

vironmentally vastly superior to fossil fuel burning, the only real alternative.[2]

The electric utilities, led by conservative businessmen, were at first reluctant to become involved in this new technology, but congressional pressure, including threats of government programs to compete with their fossil fuel plants, got them involved. They brought nuclear experts into high positions in their organizations, and they eventually became enthusiastic. Nuclear power construction projects blossomed, reaching a peak of close to fifty new plants per year ordered in the 1973–74 time period. Then suddenly the ax fell.

The Opposition

Around 1970, the environmental movement, dealing with both technical and political aspects of various environmental problems, sprang to life in the United States. American public opinion widely supported the movement, as did I. I taught courses on environmental problems, sponsored a student environmental action club, and became involved with a local group that went out in small boats to collect samples of steel mill discharges that I analyzed pro bono in my laboratory.

Most of the groups that were active in the early days of the environmental movement consisted of enthusiastic, idealistic young people contributing their time and energy, which was enough to sustain them for a year or two. As some groups grew larger, they recruited dues-paying members from the public and began looking for larger-scale support from nonprofit foundations. They needed issues to attract public attention, and they soon found that questioning the health and environmental impacts of

2. Ibid.; B. L. Cohen, *The Nuclear Energy Option* (New York: Plenum, 1990).

nuclear power served that purpose very well. Nuclear power was a very new technology, with associations to the horrors of Hiroshima and Nagasaki, so it was not difficult to scare the public. Moreover, nuclear reactors were being constructed by large corporations that idealistic young people viewed as impersonal seekers after profits, callous to any environmental degradation and human suffering that they may cause. The environmentalists identified the nuclear power industry as their natural enemy.

To attack nuclear power, they needed ammunition, and it was readily found. They only had to go through the nuclear power risk analysis literature and pick out some of the imagined accident scenarios with the number of deaths expected from them. Of course, they ignored the very tiny probabilities of occurrence attached to these scenarios, and they never considered the fact that alternative technologies were causing far more deaths. Quoting from the published scientific analyses gave the environmentalists credibility and even made them seem like technical experts.

They also benefited from a timely lucky break. In the late 1960s, the scientific risk analysis community was focused on a potential "reactor meltdown" accident resulting from a hypothetical sudden loss of cooling water. Without cooling, the fuel would become very hot, accelerating chemical reactions that would generate still more heat, until the fuel would melt. Such a meltdown accident would release very large amounts of radioactivity, with the containment structure left as the only barrier to radioactivity getting out into the environment.

To protect against such events, reactors are fitted with a very elaborate and highly redundant emergency [reactor] core cooling system (ECCS) for rapidly injecting replacement water if the regular cooling water should be lost. When the first of this replacement water reaches the hot fuel rods, it would boil very rapidly, instantaneously building up a local region of high-pressure steam. There was some concern that this high-pressure steam might

repel additional incoming cooling water, preventing it from reaching the fuel and thus failing to protect against a meltdown. To investigate this possibility, very crude small-scale mock-up experiments were performed in 1970–71, and they seemed to indicate that the ECCS might fail in this way.

Alarmed by these results, in 1972 a group of Boston-area scientists called for urgent action and formed a Union of Concerned Scientists to publicize the problem and demand action on it. Government regulators responded by introducing changes in reactor operating procedures and instigating a crash research program costing hundreds of millions of dollars to settle the unresolved questions. As more sophisticated experimental tests and computer analyses were developed, it became increasingly clear in the latter part of the 1973–78 time period that the ECCS would perform well, and in 1979 absolutely conclusive tests were completed that showed that the ECCS would work very well, even much better than had been expected. But by then, it was too late; the damage had been done.

By 1973, all but one of the original UCS scientist-founders became satisfied that their concerns were being adequately addressed, and they resigned from the organization. That one dissenter, Henry Kendall, joined by two nonscientists, continued to attack on the ECCS issue and built UCS into a powerful organization with thousands of dues-paying members and substantial support from nonprofit foundations. In 1974, Ralph Nader created his Critical Mass organization uniting dozens of environmental groups, with UCS as its technical adviser on nuclear issues. The supposed failure of the ECCS attracted very wide media coverage and became the most powerful and effective tool in the battle against nuclear power.

Eventually UCS leadership saw the handwriting on the wall and, long before the final resolution of the ECCS issue in 1979, had gone on to other issues. They (and the media) neglected to

publicize the conclusive proof that the ECCS would perform very well. For many years, I often encountered enthusiastic young environmental activists who had never heard about the conclusive tests and were eager to explain in some detail why the ECCS could never work!

Two scientists provided further ammunition for the antinuclear activists. John Gofman and Arthur Tamplin, of the Livermore National Laboratory, claimed that the cancer risk from radiation was much larger than the risk accepted by the consensus of the scientific community. They never published their ideas, analyses, and conclusions in scientific journals, and their contentions were rejected by prestigious national and international scientific bodies, including the U.S. National Academy of Sciences, United Nations scientific committees, the International Commission on Radiological Protection, the U.S. National Council on Radiation Protection, and similar official advisory bodies in most technologically advanced nations. But to this day, Gofman and Tamplin remain heroes of the antinuclear activists, a status they share with a few other scientists—Alice Stewart, Karl Morgan, Rosalie Bertell, Ernest Sternglass, Thomas Mancuso, Irwin Bross—no more than a dozen in all. Each pursued a separate issue to reach the conclusion that the cancer risk from radiation was being underestimated, but with minor exceptions, no one of them openly supported any of the others. All got heavy media coverage for their claims, and they convinced Ralph Nader, who as a sworn enemy of nuclear power was more than eager to be convinced. But most important, they convinced the media and the public.

They failed to convince other scientists. A 1982 poll of scientific professionals specializing in health impacts of radiation found that 82 percent believed that television coverage substantially or grossly exaggerated the dangers of radiation, 76 percent believed the same about newspaper and magazine coverage, and

82 percent of them considered the public's fear of radiation to be substantially or grossly greater than is realistic.[3]

The antinuclear power enterprise raised several other issues. The technically trivial problem of radioactive waste disposal was elevated to an "unsolved problem," and it remained unsolved because of their efforts to block action. The solution, recognized and approved repeatedly by National Academy of Sciences committees for fifty years, is to convert the material into a rocklike form and place it in the natural habitat of rocks, deep underground. We know all about how rocks behave, and using this knowledge it is straightforward to show that the health effects of the buried waste will be negligible in comparison with those of burning coal or other fossil fuels to generate the equivalent electricity, even if these effects of nuclear waste are added up over millions of years.[4] In fact, there are several types of waste from coal burning, air pollution, carcinogenic chemicals released into the ground, and naturally radioactive precursors of radon, each of which will cause at least a thousand times as many fatalities as the buried nuclear waste.[5]

Theft of fissionable materials from nuclear plants was put forward as a method by which terrorists or rogue nations could obtain materials for the manufacture of nuclear weapons. Not only would such a theft be extremely difficult and dangerous to the perpetrators, but such material would be of little use in weapons. A bomb made with plutonium derived from the U.S. nuclear power industry would require a high degree of technical expertise to construct. It would be unreliable and give low explosive yield, and no bomb made from such material has ever been detonated.

3. B. L. Cohen, "Risk Analysis of Buried Waste from Electricity Generation," *American Journal of Physics* 54 (1986): 38ff.

4. Bernard L. Cohen, "A Poll of Radiation Health Scientists," *Health Physics* 50 (1986): 639ff.

5. Ibid.

The very real and much more potentially drastic proliferation problems resulting from the collapse of the Soviet Union and its nuclear weapons program is now given less public attention than was then accorded to the infinitely less important problems presented by nuclear power operations.

The antinuclear crusaders raised several other issues to prominence for brief periods. At one time they publicized "thermal pollution," the raising of the temperature of rivers, lakes, and near-shore ocean waters by a few degrees from the discharge of nuclear plant cooling water, as a threat to aquatic life, but it was quickly resolved by technical fixes, usually use of cooling towers. Low-level radioactive waste, suitably packaged and buried in shallow trenches, was somehow built up into a serious threat to public health, although even if it were distributed through the soil in disposal areas and picked up via plant roots by well-understood processes to get into our food, health impacts would be 50,000 times less than those of coal burning.[6] The media lavished heavy coverage on risks from emissions of radon gas from the waste piles generated by uranium ore processing, largely ignoring the fact that technical remedies were being instigated. In any case, it is questionable if any health impacts were experienced, and uranium mining in the U.S. has essentially stopped because far richer ores are available in remote regions of Canada and Australia.

The Battle

The decisive battle over nuclear power between nuclear scientists and antinuclear activists was waged in the 1973–80 time period. First, let's consider the cast of characters in the battle. The participants on the two sides were of entirely different ilks. The main interest in life for a typical antinuclear activist is political fighting,

6. Ibid.; Cohen, *Nuclear Energy Option*.

whereas most nuclear scientists have no interest in such political activity. Even if the scientists had the interest, they generally had little native ability and still less educational preparation for it. While a typical antinuclear activist was taking college courses in writing, debate, political science, and social psychology, the typical nuclear scientist was taking courses in advanced calculus, quantum and radiation physics, and molecular biology. After graduation, the former built on his education by participating in political campaigns, anti–Vietnam war protests during the 1960s and 1970s, and environmental activism, while the latter developed his scientific expertise working out mathematical complexities in neutron transport theories, studying the biological processes in the development of tumors, and devising solutions to technical problems in nuclear power plant design. While the former was making political contacts and learning how to secure media cooperation, the latter was absorbed in laboratory or field problems with no thought of politics or media involvement. At this juncture, the former went out looking for a new battle to fight and decided to attack the latter. It was a lion attacking a lamb.

From the beginning of the development of nuclear power, nuclear scientists had agonized about what safety measures were needed in power plants and what health impacts radioactivity releases might cause. They published their analyses and arguments for all to see, and it took little effort for the antinuclear activists to collect, organize selectively, and distort this information into ammunition for their battle. People experienced in debate and political fights are well prepared to do that.

When the antinuclear activists charged into battle wildly firing this ammunition, the nuclear scientists at first laughed at the naïveté of the arguments used, but they didn't laugh for long. The scientists could explain the scientific and technical invalidity of the attacks, but no one listened to their explanations. The phony charges of the attackers, dressed up with considerable public re-

lations skills, sounded much better to the media and to members of the public with no scientific knowledge or experience. When people wanted to hear from scientists, the attackers supplied their own—there are always one or two eager to present any point of view—and who was to know that they represented only a minuscule minority of the scientific community with little or no credibility among their peers?

It was never even made clear to the public who the combatants were. The battle was not billed as scientifically illiterate political activists attacking the community of nuclear scientists, which was the true situation. Rather, it was represented as "environmentalists"—what a good, sweet, and pure connotation that name carried—attacking "big business" interests (the nuclear industry), who were willing to sacrifice the public's health and safety in their quest for profit. Jane Fonda, a prominent actress recruited for the antinuclear army, refused to debate with nuclear scientists. Her antagonists, she said, were the corporation executives.

When the media wanted to present both sides of an issue, they usually brought in corporation executives to present the pro-nuclear viewpoint. Not only were these executives limited in their knowledge and understanding, but the very fact that they represented a corporation trying to make profits from nuclear power substantially reduced their credibility.

The Three Mile Island accident, rated as one of the top media events of the century, was a crowning blow in the battle. The media consistently portrayed the accident as a close call on a public health disaster, and continue to do so to this day, although none of the studies done after the accident gives any reason to believe that to be the case. As demonstrated in those studies, the containment building would have prevented release of large amounts of the radioactivity regardless of what might have hap-

pened to the reactor.[7] The tiny amounts of radioactivity that were released received extensive media coverage, although the health impacts were completely negligible, perhaps a single extra cancer case among the 2 million people in the area.

The battle over nuclear power waxed hot and heavy for several years, swaying back and forth as incidents unfolded. The publication of the government-sponsored Reactor Safety Study in 1975, which showed that there would be very modest consequences from nearly all reactor accidents, was a positive event. The report concluded that the average number of fatalities from a meltdown would be about 400 and that there might be one meltdown in every 20,000 years of plant operation, or 0.02 deaths per year versus about 25 deaths per year due to air pollution from a coal-burning plant.[8] It received little notice outside the scientific community. The movie *The China Syndrome* (released in 1979), which implied that a reactor meltdown accident would have—not possibly might have—very horrible consequences, was an important negative event.

The Role of the Media

The antinuclear activists won a complete victory. That was no surprise; the nuclear scientists were seldom allowed on the battlefield. The battlefield here was the media, which alone has the power to influence public opinion.

Many nuclear scientists tried hard to engage in the battle. For

7. *United States President's Commission on the Accident at Three Mile Island* (Washington, D.C: U.S. Government Printing Office, 1979).; U.S. Nuclear Regulatory Commission, M. Rogovin (director), *Three Mile Island: A Report to the Commissioners and to the Public* (Washington, D.C.: Nuclear Regulatory Commission, 1980).

8. NRC, 1975.

a while I was averaging forty public lectures per year, talking to any audience that invited me. In these forty lectures, I reached perhaps 3,000 people per year, but a single TV program, produced by professionals skilled at gripping an audience, with large budgets, plentiful personnel, and excellent facilities, may reach 30 million, ten thousand times as many.

A prominent media tactic was gross overcoverage of radiation, giving the public the impression that its dangers are important and omnipresent. Using the New York Times Information Bank, which is an index to the news covered in that paper, I compared the number of times various types of accidents were covered in the newspaper with the number of deaths per year from those accidents in the U.S. I examined the years 1974–1978 so as not to include the extraordinary coverage of the 1979 Three Mile Island accident. On average, there were

- 120 entries per year on motor vehicle accidents which were killing 50,000,
- 50 entries per year on industrial accidents which were killing 12,000,
- 20 entries per year on asphyxiation accidents that were killing 4,500.

Note that the amount of coverage was roughly proportional to the number of deaths they were causing.

In contrast, for accidents involving radiation, there were

- 200 entries per year, despite the fact that there had not been a single death from such accidents, and not even an exposure that might eventually cause a cancer, during the previous fifteen years.

Not only was radiation overcovered, it was linked with inflammatory words like “deadly radiation” or “lethal radioactivity.”

The media never talked about "lethal electricity," although 1,200 Americans die annually from electrocution, or about "deadly natural gas," which kills 500 per year from asphyxiation and hundreds more from fires and explosions. A nuclear waste repository is a carefully researched, highly engineered facility for the disposal of packages of radioactive waste deep underground at a cost of $5 million per truckload, but the media constantly refer to it as a "waste dump," conjuring up a picture of a truck simply tilting back to let its contents slide down into a hole in the ground. Is that a $5 million operation?

The overcoverage was heavily unbalanced. For example, Tom Najarian, a Boston physician, got the impression from talking to patients that there were excess leukemias among workers in the Portsmouth, New Hampshire, naval shipyard that services nuclear-powered submarines. Newspapers picked up the story and it soon became a national issue, with congressional hearings, government agency investigations, media debates on action alternatives, and so on. Eventually, in accordance with congressional edict, the Centers for Disease Control (CDC) did a two-year, million-dollar study. The CDC scientists concluded that there was no excess of leukemias or any other cancers among the shipyard workers

The *New York Times* ran fourteen articles, most of them on page 1, covering the original claims and reiterating assertions of large excesses of leukemias among the workers, but it covered the CDC study, which settled the issue, with a single story on page 37 of a weekday edition. The first 16 lines of the story were introductory, reviewing the original claims; then there were 9 lines on the CDC million-dollar study stating its negative findings, and the story concluded with 15 lines casting doubt on these findings by quoting reactions from antinuclear activists. Incidentally, a follow-up $10 million study of shipyard workers by CDC found fewer leukemias and other cancers among those involved with nuclear-

powered ships than among those with nonnuclear ships.[9] The statistical accuracy of that conclusion was indisputable, but the *New York Times* published not a word about it.

Emotion, freely used in media coverage, had no balancing rational analysis. For example, a TV special featured beautiful twin baby girls afflicted with Hurler's syndrome, a devastating genetic disease. All sorts of details of the horrors were described —they will be blind and deaf by the time they are five years old, and then suffer from problems with their hearts, lungs, livers, and kidneys before they die at about age ten. Their father, who had worked with radiation for a short time, told the audience that he was sure that his occupational radiation exposure was the cause of this tragedy. There was no mention of the fact that his total occupational radiation exposure up to the time of conception was less than half of his exposure to natural radiation, or that a simple calculation indicates that there is only one chance in a thousand that the problem was caused by his job-related exposure. The *New York Times* ran a feature story about these babies, complete with pictures, giving the reader every reason to believe that the problem was caused by the father's occupational exposure. No evidence to the contrary was even hinted at; such evidence was presumably not part of "all the news that's fit to print."

I will never forget the TV evening news program where the lead story was the conclusion by a government agency that there might some day be a single, unrecognizable cancer death among the millions of people exposed to radioactivity released in the Three Mile Island accident. This was followed by interviews with citizens expressing great anguish over the possibility that one of

9. U.S. Department of Energy, G. M. Matanoski (director of the study), *Health Effects of Low-Level Radiation in Shipyard Workers* (Report no. DOE DE-AC02-79 EV 100995) (Washington, D.C.: Department of Energy, 1991), see tables 3.6B and 3.6D.

their loved ones might be that single victim. There was no mention of all the other industries and diverse human activities that will cause tens of thousands of cancer deaths among these same people.

Perhaps the most important problem in media coverage was (and still is) failure to quantify. For example, a minor accident in a Rochester, New York, nuclear plant that led to a small release of radioactivity was the lead story on most TV network evening news programs for two days. I can understand that it could be too technical for public consumption to state the radiation doses to the public in quantitative terms, but wouldn't it have been useful to tell the public that no one received as much exposure from that accident as he gets from natural radiation every day? Scientists constantly make such comparisons with natural radiation in media interviews, information booklets, and magazine articles, but they are never put out by the mass media—it would ruin their story. In the Rochester accident, the media did everything to enhance the impression of danger, like stating the number of people living in the area (not just near the plant), with the clear implication that this was the number of people exposed to dangerous radiation.

I often ask myself why the media act that way. In the mid-1970s, when I was publishing scientific analyses of problems associated with plutonium toxicity, I read a scare story in a popular magazine about the horrible poisonous dangers of plutonium. I thought I should educate the author so I telephoned him and began to explain things, but I soon found that he was quite knowledgeable about the subject and that he knew about my analyses and did not dispute them. I finally asked him why, knowing what he did, he would write such a scare story. He replied that he was a freelance writer trying to get published. "If I had written the article your way," he asked, "do you think it would have been published?"

My crowning disillusionment along these lines came a few years later, following the Chernobyl accident. A freelance reporter with whom I thought I had a significant friendly relationship published a page 1 article in the *New York Times* making a completely false claim that the Chernobyl reactor had a protective containment structure very similar to the one enclosing U.S. reactors. I wrote to him in a goodwill effort to set him straight, but I later learned that Richard Wilson, a Harvard nuclear scientist, had spent more than an hour explaining to him the enormous difference between U.S. and Chernobyl containment structures—the latter was designed to protect only against very minor accidents while the former is designed to defend against what is almost the worst conceivable accident. But the reporter still went ahead and published his story.

Shortly thereafter the same reporter published another page 1 article in the *New York Times* stating that more radioactive cesium was released from the Chernobyl accident than from all bomb tests combined. I sent him the detailed evidence that he was wrong by an order of magnitude and chided him for misinforming the public. His response was, "I don't tell you how to do research, so you don't tell me how to do journalism." It is obviously a very important career advancement step for a freelancer to get a page 1 article in the *New York Times*.

I still thought that most media people were acting in good faith to educate the public, so I decided to try to write papers for journals serving the journalism profession, like the *Columbia Journalism Review*, explaining how they were misinforming the public about nuclear power. I submitted two such papers to three such journals in turn. Neither was published. One-sentence letters of rejection, with no explanation, arrived within a few days.

The media give widespread attention to each of the tiny handful of scientists who claim that radiation is more harmful than the consensus estimates. In one case I investigated, a single publica-

tion in a scientific journal by Thomas Mancuso making such a claim was the subject of eleven entries in the New York Times Information Bank, but there was only one entry in the Information Bank about the twenty-plus critiques of that study that appeared in the scientific literature.

On one occasion I witnessed, Mancuso gave a talk on his work at a scientific meeting. Television cameras were everywhere, recording his remarks, but by the time his critics had their turn to speak, the TV crews had packed up their equipment and left. I have seen this media behavior repeated many times on many different issues. Perhaps the most flagrant example was in government-sponsored hearings on the emergency core cooling system (ECCS), which went on for many weeks. The TV cameras were consistently turned on when Union of Concerned Scientists speakers were presenting their antinuclear case, but turned off when their opposition, or even neutral speakers, were testifying.

Mancuso's paper was first announced to the public through a press release he composed for his university public relations office. He was bombarded for many days with calls for media interviews. I happened to be publishing a paper at that time that presented data and calculations indicating that radiation is much less harmful than the consensus estimates. Since I am at the same university as Mancuso, I decided to test the system by composing a highly enthusiastic press release on my paper, and it was given the same distribution by the same university public relations office. I never got a single call from the media. The only difference media people could possibly have seen between Mancuso's work and mine was that his said that radiation was more dangerous while mine said it was less dangerous than widely accepted estimates.

At best, the media stated that the scientific community was "split down the middle" on the risks from radiation exposure. When I told interviewers that the division was completely one-

sided, the common response was, "Why should I believe you?" My reply was for them to call what they consider to be first-class universities of their choice, ask for a professor who does research on radiation health effects, and ask him the question. To the best of my knowledge, no reporter ever followed that suggestion. The media rarely reported findings of National Academy of Sciences committees, or of many other national and international committees of distinguished scientists, all of which supported the consensus estimates of radiation dangers. I will never forget the reporter who told me that he didn't care about National Academy of Sciences committees and such—he had spoken to Mancuso and could tell that what he was saying was right.

The media never made an effort to educate the public on quantitative risk estimates and use these to put nuclear risks into perspective. I published papers on catalogs of risks,[10] and used them constantly in public presentations and interviews with reporters. These are easily understandable to anyone, but they were never transmitted by the media.

For example, I showed that the risks of nuclear power to the average American are equal to the risk of a regular smoker smoking one extra cigarette every fifteen years, or of an overweight person increasing his weight by 0.012 ounces, or of raising the highway speed limit from 55 miles per hour to 55.006 miles per hour, and that they are two thousand times less than the risk of buying a subcompact car rather than a mid-size car. Even if the claims of the antinuclear Union of Concerned Scientists (UCS) are accepted, the risks are equal to the risk of a regular smoker smoking one extra cigarette every three months, an overweight person gaining 0.8 ounces, or raising the highway speed limit to 55.4 miles per hour, and thirty times less than the switch to a subcom-

10. B. L. Cohen, "Catalog of Risks Extended and Updated" *Health Physics* 61 (1991): 317–35.

pact car. I showed that if a person living close to a nuclear power plant worries about the radiation risks and decides to move away, his net risk is increased (due to traffic accidents) if that move increases his daily driving by a quarter mile.

Perhaps even more to the point is that the principal alternative to nuclear power is coal burning, which causes hundreds of times as many deaths owing to its air pollution alone in generating the same amount of electricity.[11] Every time a coal-burning plant is built instead of a nuclear plant, about one thousand extra innocent people are condemned to an early death, and this estimate applies even if the nuclear risks are those proposed by the antinuclear UCS. All the calculations leading to the above conclusions were published in prestigious scientific journals and never criticized in other published scientific papers (or elsewhere as far as I know). But none of this material was ever transmitted to the public by the mass media. Likewise it was never explained to the public that radiation doses from nuclear power are very much smaller than doses from natural radioactivity to which everyone is exposed (and which varies substantially with geography), and very much smaller than doses from medical X rays.

Nuclear scientists have tried very hard to get these points to the public by submitting articles for publication in magazines. I managed to get articles in lower-tier magazines like *Family Health*, *Commentary*, *National Review*, *Catholic Digest*, *Reason*, *Consumer Reports*, *American Legion Magazine*, but all my submissions to top-tier publications were rejected. To this day, none of these risk comparisons has been presented to the vast majority of the public, and the responsibility for this educational failure lies with the media.

I could give endless examples of media one-sidedness in covering the battle over nuclear power, involving reactor accidents,

11. Cohen, *Nuclear Energy Option*.

high-level radioactive wastes, low-level radioactive wastes, proliferation of nuclear weapons, and every other issue. In my book about the battle,[12] the index has far more references to "media" than to any other topic, despite the fact that my publisher's editor was constantly pressuring me to tone down attacks on the media for fear they would result in reduced book sales.

The Battle Outcome

As the battle over nuclear power was waged, the media clearly controlled the situation, and the media establishment swallowed the attackers' story hook, line, and sinker. The one-sided propaganda slowly but surely won over the public.

The public was driven insane over fear of radiation; that is, it lost contact with reality, one of the definitions of insanity, on that issue. Polls of relatively well informed groups, college students, and members of the League of Women Voters, rating causes of their "present risk of death," rated nuclear power as number one —ahead of cigarette smoking, which kills 150,000 Americans per year, ahead of motor vehicle accidents (50,000 deaths per year at that time), ahead of alcoholic beverages (100,000 per year), and ahead of hand guns (17,000 per year). Nuclear power has never killed a single member of the American public with its highly publicized radiation dangers.

Since government regulators must be responsive to public concern, they continually tightened their safety requirements on nuclear power plants. Fulfilling these constantly upgraded requirements involved substantially increased costs, and frequently necessitated changes in design in the midst of construction, an especially expensive undertaking. These changes often doubled the construction time for a plant, leading to increased interest

12. B. L. Cohen, *Before It's Too Late* (New York: Plenum, 1982).

costs on the capital investment. Several large nuclear plants were completed in the early 1970s at a typical cost of $170 million, whereas plants of the same size, constructed by the same people, but completed in 1983 cost an average of $1,700 million, ten times as much (the Consumer Price Index increased by a factor of 2.2 during that time interval). Some plants completed in the late 1980s cost as much as $5 billion because of these problems. Utilities building these plants suffered severe financial losses. The median cost of electricity from nuclear plants, which had been very competitive with costs from coal-burning plants, became 1.6 times higher than the latter. All nuclear plants ordered after 1974 were eventually canceled, and no nuclear power plants have been ordered in the U.S. since that time.

Ironically, Ralph Nader, the leader of the antinuclear activists, stated very early in the battle that the way to stop nuclear power was to make the costs escalate to the point where utilities could not afford to build them. I must admit that he fought a better battle than we nuclear scientists, and he won, very decisively. Unfortunately, the public has been the real loser from the victory of this so-called "public advocate."

After the Battle

By about 1980, it became clear that the battle was over, and we had lost. The public seemed to be convinced that nuclear power was bad, and it was not interested in further discussion on that subject. The environmental activists turned their attention to other issues, leaving scientists no opportunities to respond. Invitations to speak or write about the subject largely disappeared.

I subdued some of my frustration by writing a book on the battle,[13] and then decided to concentrate on my scientific research,

13. Ibid.

which then involved radon in homes. I developed new and improved techniques for measuring radon levels and carried out surveys to determine the geographical distribution of radon throughout the U.S. and its variation with house characteristics, socioeconomic status of occupants, and environmental factors. I also studied methods for reducing its concentrations in homes, and became involved in estimating its health effects.

All this work was academic until radon in homes suddenly burst into national prominence with the discovery in 1986 of high radon levels in eastern Pennsylvania and in other areas soon thereafter. This led to a 1988 pronouncement by the Surgeon General's office, given heavy media coverage, that radon in homes was killing 14,000 Americans each year. The Environmental Protection Agency went all out to publicize the problem, and the National Ad Council provided frequent public service announcements on radio and TV, with the American Lung Association backing their efforts.

A huge demand arose from householders to obtain radon measurements in their homes. This led me to set up a national measurement service, providing high-quality measurements at one-fifth of what had been the going price. Many entrepreneurs visited me to learn the technology, and set up similar measurement services, causing my low price to prevail in the industry.

As a leader in the field, I received a great deal of attention from the media, getting as many as twenty calls for interviews in a single day. And this time they were on my side—what a refreshing difference! It was a good story to tell how people's lives were being threatened and what they could do about it. For me, it seemed like a golden opportunity. In every interview, I managed to work in the fact that the radiation dose from radon in their homes was a thousand-times greater than from nuclear power, that if people were worried about radiation they should do something about

radon in their homes rather than oppose nuclear power, that people who live near the Three Mile Island plant get more radiation exposure from radon in their homes every day than they got in total from the 1979 accident there, and so on.

Though other parts of my interviews were widely reported, I know of no case where the comparisons between radiation from radon in homes with radiation from nuclear power were included. They certainly never got national attention. For the media, nuclear power was the most dangerous source of radiation, and there was no way they were going to report otherwise—that would be like an attack on their religion. Of course this was a simple extension of their refusal to compare radiation from nuclear power with that from natural sources and medical X rays.

I often wondered whether the reporters were afraid to include my points about nuclear power, or whether they were edited out at a higher level. In any case, the media and the public view radiation from nuclear power and from radon in homes as entirely different and unrelated subjects. I repeatedly explained to reporters that when a cell in our bodies is hit by radiation, there is no way for it to "know" whether that radiation originated from nuclear power operations or from radon, but somehow that explanation never got reported.

My research eventually convinced me (and a great many others) that radon in homes is very much less harmful than the widely publicized estimates that were based on extrapolating from the number of excess cancers seen in uranium miners who had very high radon exposures. Those estimates were (and are) based on the assumption that the cancer risk from radiation is proportional to the dose, the so-called linear–no threshold theory (LNT).

A great deal of evidence has accumulated that the LNT grossly

overpredicts the adverse effects of low-level radiation.[14] Taken altogether, the data about health risks lead to the conclusion that the low-level radiation from nuclear power in nearly all situations, or from radon in nearly all homes, is harmless (and may even be beneficial).[15] If this were made known to the public, fears of radiation and of nuclear power should evaporate, but the media has given this matter essentially no coverage, and the public continues to believe what they were convinced of in the great battle of the 1970s.

It is necessary to emphasize that all the risk comparisons given above were based on the LNT. Given that the LNT overestimates the risks of low-level radiation, the risk from nuclear power probably is much less than the risk of a regular smoker smoking one extra cigarette every fifteen years, is much less than the risk of an overweight person increasing his weight by 0.012 ounces, and so on.

On this matter, there is some excuse for the media because the scientific community is still split on the issue of application of the LNT to low-level radiation risks. But as evidence accumulates, I believe there is a good chance that scientific opinions will soon consolidate in rejecting the LNT. When that happens, I hope the media will decide that a good headline would be "MOST RADIATION FOUND TO BE HARMLESS." That should attract the public attention they so crave.

In looking for new ways of fighting back, I decided that a good approach might be to speak and publish papers about understanding the risks in our society. This would seem to be a matter of interest to the public, and there is no problem with whether it is "politically correct." I always unobtrusively worked in examples,

14. B. L. Cohen, "The Cancer Risk From Low-Level Radiation," *Am. J. Roentgen.* (in press).
15. Ibid.

like those mentioned above, of risks from nuclear power and radioactive wastes, and comparisons of health effects from coal burning vs. nuclear power.

I thought I had a big-time winner when John Stossel of ABC News created and hosted a one-hour, prime-time TV special on risk. He even told me it would be a TV version of my papers. I had frequent contacts with his staff over several months as the program was being developed, responding to requests for information and calculations. When aired, the program was excellent, but it did not include any of my examples dealing with radiation or nuclear power. I later found out that the program was constantly facing stiff opposition from upper-level executives, and Stossel had to fight hard to get it through. He managed to do so only with strong sympathy and backing from his immediate superior. I could tell that it was a harrowing experience for him.

When nuclear power advocates look for reasons to be hopeful, they find some justifiable optimism. The scientific community is widely supportive. When asked whether nuclear power development should proceed, 89 percent of all scientists and 95 percent of energy experts said "yes."[16] The general public is also supportive, with various professional pollsters finding that 65 percent to 75 percent favor nuclear power.[17] But turning this support into concrete actions is very difficult because the opposition is well organized, dedicated, and very vocal.

I have tried to bring some rationality to the debate by drawing attention to the benefits the public receives from nuclear technology. Economic analyses show that various nuclear applications account for 4 percent of our national GDP, provide 3 percent

16. S. Rothman and S. R. Lichter, "The Nuclear Energy Debate: Scientists, the Media, and the Public," *Public Opinion*, August 1982, p. 47ff.

17. For examples, see Cohen, *Nuclear Energy Option*.

of all jobs, and produce $45 billion per year in tax revenues.[18] Nuclear techniques have been the source of many useful innovations, including more precise machinery that provides better efficiency in manufacturing (e.g., thickness gauges controlling steel rolling mills), improved safety devices (e.g., smoke detectors in homes), enhanced convenience (e.g., disposable needles for flu shots), and improved materials (e.g., tougher plastics). One third of all patients admitted to U.S. hospitals undergo diagnostic procedures that employ radioactivity. In addition, 100 million radioimmunoassay tests are done annually, and 60,000 patients get radiation therapy for cancer.

A typical large university has 100 research projects using radioactivity, and the work supported by 40 percent of biomedical research grants, and described in 50 percent of articles in biomedical journals, uses radioactivity. I believe that food preservation by irradiation may be about to take off, providing more wholesome, better-tasting, and better-looking foods that are bound to attract public attention. Perhaps people will wonder why the benefits of irradiated food have been denied to them for so long, and come to appreciate the irrational, destructive activities of so-called environmental and consumer advocates.

Several years go, Glenn Seaborg responded enthusiastically to my request that he be the principal author of a book that categorized and demonstrated the benefits of nuclear technology. Assured of having Seaborg's name as a selling point, a publisher I knew was more than eager to cooperate, and guaranteed me that the book would get lots of publicity. A team of excellent authors for chapters was soon organized, and we were ready to go when

18. Management Information Services, Inc., *The Untold Story: The Economic Benefits of Nuclear Technology* (Washington, D.C.: Management Information Services, Inc., 1997).

Seaborg suddenly died. The project then fell apart, although there are still efforts to revive it.

Counterattacks on our environmentalist opponents have often been considered as a tactic, but few have had much impact. The most successful of these, involving a chemical agent rather than radiation, followed an attack by National Resources Defense Council (NRDC) on Alar, a chemical used in apple growing. The American Council on Science and Health showed that the scientific evidence used by NRDC was highly questionable and that the entire event was staged, with the cooperation of CBS News, by a public relations firm. This counterattack got wide publicity, including an article in *Reader's Digest*.[19] Nevertheless, it is not clear that NRDC suffered as a result. Scholarly books involving years of research have been published about the irrational behavior of antinuclear environmental groups,[20] but they have received scant publicity.

Many of us nuclear scientists are still out there fighting, despite our lack of success to date. We publish papers, teach college courses, give talks to anyone who will hear us, write letters to media people explaining their errors, organize workshops for educating grade school and high school teachers, try to develop media contacts. It will take a lot more than what we are doing to turn the situation around, but if circumstances develop that present an opportunity, we will be ready. We thought that Vice President Dick Cheney's vocal support for nuclear power might be such an opportunity, but the events of September 11 seem to have pushed that out of the realm of public interest.

Nonetheless, we realize that we must not be discouraged. Ex-

19. R. Bidinotto, "The Great Apple Scare," *Reader's Digest*, October 1990, pp. 55–56.

20. See, e.g., M. A. Benarde, *You've Been Had* (New Brunswick, N.J.: Rutgers University Press, 2002).

tensive use of nuclear power would be a great benefit to mankind, solving such important human problems as global warming, air pollution, acid rain, wars over oil supplies, oil spills in the oceans, and environmental damage from coal mining. It would allow us to preserve our precious limited supplies of fossil fuels for their unique uses, such as feedstock for producing plastics and organic chemicals. It could make deserts bloom by desalting sea water. And it can provide all the energy mankind will ever need at not much above current prices.

With all this at stake, we must fight on. Readers of this chapter can help by speaking up on behalf of nuclear power and against the fear-mongering promoted by its opponents. If opponents want to debate, we will be happy and eager to debate them, but these debates must be on a scientific basis.