46. Quoted in ibid., p. 574.
47. Quoted in ibid., p. 576.
48. Quoted in ibid., p. 581.
49. Quoted in ibid., p. 585.
50. Letter from Matthew Meselson to General W. B. Rosson, Deputy Commander, U.S. Military Assistance Command, Vietnam, August 12, 1970. (From interview with Meselson.)
51. *New York Times,* December 17, 1970, p. 13.
52. U.S. Army, Office of the Chief of Army Engineers, *Herbicides and Military Operations,* Engineer Strategic Studies Group, February 1972. The first two volumes are unclassified. The third, which discusses primarily possible future wars in which herbicides would be useful, is classified but was reviewed in "Defoliation: Secret Army Study Urges Use in Future Wars," *Science and Government Report,* August 18, 1972. See also Deborah Shapley, "Herbicides: DOD Study of Viet Use Damns With Faint Praise," *Science* 177 (1972): 776.
53. Matthew S. Meselson, Arthur H. Westing, John D. Constable, and James E. Cook, "Preliminary Report of the Herbicide Assessment Commission," presented at the AAAS annual meeting, Chicago, December 30, 1970; reprinted in *Congressional Record* 118 (1972):S3226-33. See also Phillip Boffey, "Herbicides in Vietnam: AAAS Study Runs into a Military Roadblock," *Science* 170 (1970):42; "Herbicides in Vietnam: AAAS Study Finds Widespread Devastation," ibid., 171 (1972):43.
54. Quoted in *New York Times,* December 27, 1970, p. 5.
55. Quoted in *The Effects of Herbicides in South Vietnam: Summary and Conclusions* (Washington: National Academy of Sciences, 1974), p. vii. The best available figures for the total sprayed areas in South Vietnam are given in this report.
56. Ibid., p. S-12.
57. Ibid., p. S-13.
58. Deborah Shapley, "Herbicides: Academy Finds Damage in Vietnam after a Fight of Its Own," *Science* 183 (1974):1177.

CHAPTER 12

Watching the Federal Government in Colorado: The Colorado Committee for Enviromental Information

The history of the Colorado Committee for Environmental Information provides an excellent illustration of the impact that a public interest science group can have at the state level. The committee was most active during the period 1968-1970, when it initiated and informed major debates in Colorado on the hazards connected with three federal programs: (1) the storage of huge quantities of nerve gas at the Rocky Mountain Arsenal near downtown Denver, (2) the continued operation of Dow Chemical's Rocky Flats Plant outside Denver after a disastrous release of intensely radioactive plutonium smoke from the facility had almost occurred and (3) the developmental tests of a method to stimulate the production of natural gas by underground nuclear explosions.

The Rocky Mountain Arsenal

At the Rocky Mountain Arsenal on the outskirts of Denver, the army has manufactured and stored vast amounts of nerve gas and other war gases; in 1968 this stockpile included more than 20,000 nerve-gas cluster bombs containing about 20 gallons of nerve gas apiece.[1] At the height of the cold war, the commander of the arsenal had bragged to a local newspaper reporter that

the gas from a single bomb the size of a quart fruit jar could kill every living thing within a cubic mile, depending on the wind and weather conditions. . . . A

tiny drop of the gas in its liquid form on the back of a man's hand will paralyze his nerves instantly and deaden his brain in a few seconds. Death will follow in 30 seconds.[2]

In the wake of the 1968 Dugway incident—in which nerve gas accidentally released during an army test in Utah killed over 6,000 sheep (see Chapter 11)—a more soothing sort of public relations effort seemed to be called for. An article based on an interview with the current arsenal commander appeared in the *Denver Post* beneath a picture showing steel storage tanks of nerve gas neatly stacked like cordwood in an uncovered pile stretching off into the distance. In the story the commander was quoted to the effect that even if "a plane crashed into the drums with sufficient force to release the liquid, it is believed most of it would be absorbed in the ground. A fire would quickly consume the deadly mist."[3]

To a group of scientists in the university town of Boulder, outside Denver, these reassurances smacked of wishful thinking. These scientists were members of an evening discussion group, the "Crossfield Seminar." Led by Dr. Michael McClintock, a physicist at a National Bureau of Standards laboratory in Boulder, they did some simple calculations of what might happen if a fire did not so obligingly "consume" all of the "deadly mist." It seemed quite plausible to them that, in a hypothetical accident like that described above, perhaps 1 percent of the contents of ten ruptured tanks might be blown 150 feet into the air "by the impact of the crash, the accompanying explosion, and convection due to flames."[4] Then, by comparing to the Dugway incident, they found that the resulting "area of lethality" might extend ten miles or so downwind, i.e., possibly into the heart of Denver. The conclusions that McClintock and his collaborators in the discussion group had arrived at were so fearsome that they felt compelled to make their concerns public. After studying the reports on the Dugway incident and the available literature on chemical-warfare agents and weapons, they wrote up a seven-page memorandum on the situation which they released to the press on August 15, 1968.[5]

The memorandum had a substantial impact, receiving both local and national coverage.[6] After a week's silence, the Army let it be known that it had decided to remove the offending nerve gas to a less populated area.[7] Then the public learned, in May 1969, that the Army's plan was to ship the nerve gas bombs by train across the country for eventual dumping into the Atlantic, and there was a new uproar—this time national—with the sequel which we have already described in Chapter 11.

By early 1969, while the nerve-gas controversy was still approaching its climax, the Crossfield Seminar scientists concluded that the nerve gas episode dramatized a more general problem—the public's lack of access to independent technical advice on the environmental and public health implications of governmental programs. To be sure, this was not a new insight. In particular, in the late 1950s there had been massive efforts by scientists to educate the public about the hazards of fallout from nuclear testing. (These efforts paved the way for negotiation of the Partial Nuclear Test-Ban Treaty of 1963.) Certain

organizations which were formed in that struggle became permanent and have continued the effort of public education on issues relating to the impact and control of technology. Among these are the St. Louis-based Committee for Environmental Information, which founded the magazine *Environment*, and the New York-based Scientists' Institute for Public Information (SIPI), which acts as a national umbrella organization for the St. Louis committee and about twenty other science information committees in other parts of the country.

In March 1969 the Colorado group decided to organize itself as the Colorado Committee for Environmental Information (CCEI), a nonprofit corporation affiliated with SIPI.[8]

The CCEI almost immediately found itself embroiled in two new issues: the danger of plutonium contamination of the Denver area resulting from activities at a nearby Atomic Energy Commission (AEC) nuclear weapons fabrication plant, and the danger of radioactive pollution from an AEC-promoted program to increase the production of natural gas from certain Colorado rock formations by fracturing them with underground nuclear explosions.

Plutonium Pollution

On May 11, 1969, a fire in the Dow Chemical Company's Rocky Flats plant, sixteen miles from downtown Denver, caused about $100 million worth of damage.[9] This was not an ordinary factory nor an ordinary fire: the plant, run by Dow for the AEC, makes plutonium nuclear triggers for thermonuclear weapons, and the fire, the largest industrial accident in history, involved about 1,000 pounds of plutonium.[10]

The artificial element plutonium is terribly dangerous in the form of smoke or dust. Less than a millionth of a gram of tiny particles of plutonium oxide lodged in a human lung will intensely irradiate the neighboring tissues with short-ranged alpha particles over a period of years, with lung cancer a likely result. If a significant fraction of the plutonium involved in the Rocky Flats fire had escaped to the outside air, the result might well have been, as the AEC later acknowledged, a public health catastrophe for the entire Denver area.[11] The public was immediately reassured by spokesmen for the AEC, Dow, and the Colorado Department of Health, however, that the plant's air-filtration system had worked effectively during the fire and that there had been no release of plutonium into the atmosphere.

The CCEI group first learned about the fire from a newspaper which one of the scientists brought to their regular meeting the next day. The discussion which ensued quickly focused on two questions: (1) Was it possible that the smoke from such a major fire could really have been contained so effectively? (2) Would it not be tempting fate to continue the Rocky Flats plant in operation so near to a major population center after this near-disaster? A subcommittee

was set up to look into these questions under the chairmanship of Dr. E. A. Martell, a nuclear chemist at the National Center for Atmospheric Research in Boulder and a world-recognized expert in the methods of detecting trace amounts of radioactive isotopes in the environment. Two weeks later the CCEI made its concerns public—this time in the form of an open letter to Colorado's Governor John Love:

> Since published reports contained no information indicating that an adequate survey has been made of the large areas outside of [the Rocky Flats plant], it is possible that large amounts of toxic plutonium oxide could have been deposited as fallout from the smoke plume miles downwind from the plant.
>
> The wisdom of the AEC in keeping such a facility in the center of the largest metropolitan area between the Missouri River and the West Coast must be seriously questioned.[12]

The letter then went on to list a number of detailed questions concerning the technical basis for the claim that no plutonium had escaped from the plant. The scientists questioned whether either Dow or the Colorado Department of Health had used the specialized equipment necessary to detect plutonium contamination. Copies of the letter were hand-delivered to the media by Peter Metzger, president of the CCEI.

Metzger's dealings with the media deserve a discussion in their own right. A tall, balding, playfully contentious biochemist who at the time was 38 and employed by Ball Brothers, a research laboratory in Boulder, Metzger recalls that when he first began delivering CCEI releases to local newsrooms he was generally regarded with profound suspicion. The tidings he bore were so disturbing that some of his contacts accused him of being a "Communist." It was only when Metzger interested outside newspapers—notably the *New York Times* and the *Los Angeles Times*—in covering CCEI stories that the local media people started to listen too when he came around. Metzger's rounds with each CCEI press release eventually expanded to twenty-three stops, including every newspaper and every television and radio station in Denver. He soon learned that newsmen rapidly lose interest in a story if they feel that they have been or will be scooped. He therefore adjusted the timing on the releases so that the news would come out at about the same time from as many sources as possible. (Ultimately, Metzger enjoyed his dealings with the press so much that he began writing articles on the controversies for the *New York Times Magazine.* He then dropped his career in biochemistry altogether to write a book, *The Atomic Establishment,* and do a weekly column of "science and technology muckraking" for the *New York Times* syndicate.) Before long Colorado newsmen began coming to CCEI for information. The scientists then learned, after one or two bad experiences, that it was important to have a well-informed contact man on each issue. The problem was that the newsmen would tend to go to the CCEI signatory whose name they knew best, but that scientist might not be the best informed on that particular issue. To avoid this, Metzger and Dr. Robert Williams, an energetic and articulate young physicist at the Environmental

Sciences Services Administration Research Laboratories in Boulder, were usually indicated on the CCEI releases as press contacts.

Metzger did his work well: the letter from the CCEI to Governor Love about the Rocky Flats plutonium fire was widely reported in the Colorado press. As might be expected, AEC and Dow spokesmen reassured the public about the extensive observations on which the claims of no plutonium escape were based.[13] But Governor Love called up General Edward B. Giller, director of the AEC's Military Applications Division, to ask him for a briefing on the matter. General Giller in turn called Dr. Martell, whom he knew from an earlier period when they had both been involved in the nuclear weapons testing program in the Pacific. (Martell, a retired Air Force colonel, had been program director of the Armed Forces Special Weapons Project.) Two meetings were arranged for Giller and other AEC and Dow officials—one with the governor and one with the CCEI scientists.

After his briefing Governor Love emerged to report that General Giller had assured him that there was no danger to the public as a result of the Rocky Flats fire. This announcement effectively undercut the CCEI position that the public health should be safeguarded by more than the assurances of the agency whose operation was being questioned. Giller's visit did have some compensations for the CCEI scientists, however: in their meeting with him they were able to exact his commitment to have Dow answer a list of specific technical questions concerning its measurements of plutonium losses from the plant and the extent of contamination of the area surrounding the plant.[14]

The answers to the CCEI questions came back with a key omission: the AEC, Dow, and the Colorado Department of Health had all refused to check soil samples in the area around the Rocky Flats plant for plutonium contamination. They argued that the significance of such samples would be difficult to evaluate and that, anyway, the level of airborne radioactivity was a much more direct measure of the public health hazard.[15]

Fortunately, however, the CCEI had the means for breaking this impasse: Dr. Martell was a master of the delicate techniques required to detect traces of plutonium. Martell therefore undertook an extended program of measurements in his laboratory on more than 100 soil samples taken at various locations from two to ten miles from the Rocky Flats plant. In February 1970, after months of work, he made his results public: at least 1,000 times as much plutonium had escaped from the Rocky Flats plant as could be accounted for by Dow figures for the previous year, including those for the May fire.[16] (Martell's subsequent measurements revealed that most of the excess plutonium in the Rocky Flats area was not due to the May 1969 fire but rather had been released in a series of accidents over a period of years prior to that date.[17]) Meanwhile Giller, having learned of Martell's study, had commissioned a similar soil-sampling program himself; and the results of this study essentially corroborated Martell's findings. (It is amusing to note that Rocky Flats personnel contacted Martell for technical advice on how to do the study.) But the AEC nevertheless insisted that the level of plutonium contamination involved still constituted an insignificant

health hazard, while Dow Company spokesmen pointed to upgraded safety features being incorporated into the plant as it was being rebuilt.

The CCEI scientists took advantage of the new burst of public attention resulting from Martell's findings to attempt to communicate once more what they felt were the major issues which should be confronted by the state and federal government. First, they pointed out that there was disagreement within the scientific community about the danger associated with what the AEC considered a "permissible lung burden" of plutonium. Some scientists were arguing that the AEC's level had been set too high by a factor of 100. Second, they raised once again the question of whether the Rocky Flats plant constituted such a public health hazard that it should be relocated away from the Denver area. Martell commented: "We can't afford to wait until we are in trouble, because then Denver will have to move instead of Rocky Flats."[18]

In fact, after Martell's findings were made public there came some very disturbing revelations concerning plutonium-handling practices at Rocky Flats. For example, it seemed that some of the plutonium contamination detected by Martell was due to leakage of contaminated oil onto the ground in a storage area: some of the oil-soaked dirt had dried and blown away.[19] Another revelation following the May 1969 fire was that the Rocky Flats plant had been suffering an average of more than one plutonium fire per month.[20] A CCEI press release commented that while "it is not possible to make realistic predictions about the number and magnitude of plutonium releases in the future, . . . it can only be stated that the record up to now is not very reassuring."[21]

Despite the tumult following the publication of Martell's findings, the issues which the CCEI had raised soon began to fade again unresolved. Governor Love easily beat back the political challenge of Lieutenant Governor Hogan who had tried to make the governor's passive attitude toward the AEC into an election issue; and the state legislature, following the governor's wishes, refused to assert Colorado's right to set safety standards higher than those of the AEC.[22] The public appeared generally willing to accept Dow's assurances that safety-motivated design changes which were being incorporated into the Rocky Flats plant would prevent another major fire. It thus appears that the main effect of the controversy was to make both the AEC and Dow management much more concerned about fire prevention and plutonium-handling practices at Rocky Flats.[23] They were also put on notice that their public relations statements were subject to check by independent scientists.

Nuclear Stimulation of Natural Gas Production

"Plowshare" is the AEC's name for its program for developing peaceful applications of nuclear explosives. One proposal is to liberate natural gas trapped in relatively impervious rock formations by fracturing the rock with such

explosives. A test of this method, Project Rulison, was scheduled to take place in Colorado's Rulison natural-gas field in the fall of 1969.

Underground nuclear explosions are no novelty. Since the United States signed the Partial Nuclear Test-Ban Treaty in 1963, the AEC has announced an average of about thirty underground nuclear weapons tests in Nevada each year.[24] However, use of the nuclear gas-stimulation technique in the production of a significant proportion of U.S. natural gas would require many thousands of nuclear explosions.[25] To the CCEI scientists, the environmental impact of such an unprecedented program seemed well worth studying. A subcommittee made up of Metzger, Martell, and Williams was set up to look into the matter.

The CCEI scientists were mainly concerned about the fate of the large amount of radioactivity released in each nuclear explosion. Other potential hazards—landslides, mine cave-ins, bursting dams, falling chimneys, and cracking plaster—would be all too evident to those who lived and worked in an area where nuclear gas stimulation was in progress. But radioactivity is invisible; its health effects, such as cancer and gene damage, are delayed for decades or generations; it might take many decades before the radioactive poisons left underground by the explosions were leached out by water and brought to the surface to contaminate man's food and water. Independent scientists were needed who could evaluate and explain these hazards to the public.

On July 28, 1969, the "Rulison Subcommittee" of the CCEI issued a press release raising "serious questions concerning the potential hazards connected with Project Rulison."[26] They emphasized the magnified hazards which would be associated with the adoption of the nuclear gas-stimulation technique on a large scale. Thus:

> If the entire Rulison field is developed by this technique, it will mean that rock beneath 60,000 acres in our state will have been fractured to facilitate the flow of natural gas and that enormous (i.e., megacurie) quantities of strontium-90 and cesium-137 will have been distributed underground. . . . If it were discovered some years later that . . . underground water contamination was occurring, it would be too late to do anything about it.[27]

In response to the CCEI press release, the AEC rushed in once again to reassure Governor Love and the Colorado public. Representatives of the private companies collaborating in the project, the AEC, the U.S. Public Health Service, the Bureau of Mines, the U.S. Geological Survey, the AEC's Los Alamos National Laboratory, and the Colorado Public Health Service all met with Governor Love to impress on him the absence of hazard from the Rulison test. They followed this meeting with a news conference in which the same reassurances were offered the public. Governor Love lent his authority to their message the next day by announcing that he was "certainly . . . impressed by the safety precautions. . . . It's my opinion they have built in a safety factor that is, in all likelihood, greater than will be required. . . . I can find no reason to object on the grounds of safety."[28]

It was now less than a month before the scheduled Rulison blast, and

Governor Love's statement seemed to confirm the impression that the state government was not willing even to explore the possibility of opposing the AEC. The only recourse for opponents of the test, then, appeared to lie in the courts. Metzger had already stirred the interest of the Colorado branch of the American Civil Liberties Union (ACLU) by inviting its representatives to discussions of the matter with CCEI scientists.[29] On August 22, 1969, ACLU lawyers filed a complaint in the Denver U.S. District Court asking for an injunction to stop the test. An environmental group, the Colorado Open Space Coordinating Council, quickly joined in the suit.[30] After hearing the case, in which Metzger and Martell appeared as witnesses along with many AEC experts, Judge Alfred A. Arraj refused to issue the requested injunction against the blast itself on the grounds that the radioactivity resulting from the blast would remain isolated underground until flaring of the released gas began. He left the way open, however, for the plaintiffs to seek another injunction later against the flaring of the gas. The decision was upheld on appeal.[31]

In the meantime the CCEI had partly succeeded in getting the AEC to make public the technical basis for its assertions that the Rulison test and later commercial application of the nuclear gas stimulation method would not result in excessive public health hazards. On August 6 the CCEI scientists had submitted to the AEC a list of detailed questions concerning the types and amounts of the radioactivity which would be created by the blast: How much radioactivity would end up in the gas, in the water, or be trapped in the glasslike rock created by the heat of the explosion? What would be the AEC's criteria for allowable radioactivity in the flared gas and later for gas which would be distributed commercially? What was the distribution of underground faults in the area of the Rulison blast? And what financial liability would the participating corporations and government agencies assume if commercial use of the nuclear gas-stimulation technique resulted in serious damage to or radioactive contamination of the local environment?[32]

No answers had been received to these questions eight days before the scheduled date of the blast, September 4, 1969, when CCEI representatives visited Governor Love, after which Love publicly expressed his interest in hearing the AEC's answers to three specific questions which the CCEI scientists had raised.[33] Two days later the AEC submitted answers to the governor's questions—as well as to many other questions which had been raised by the CCEI.[34] Governor Love seems to have been satisfied by the AEC's answers—but the CCEI was not. As Metzger explained in a letter to Love:

> The serious questions raised concerning long-range public health and safety problems have been either ignored or answered unresponsively. . . . There can be no justification for the Rulison shot if the full-scale application of nuclear gas stimulation technology involves unacceptable risks to the public and both serious damage and persistent contamination of the local environment.[35]

On September 10, 1969, after several days' delay because of adverse weather conditions and with helicopters sweeping the area in an attempt to keep protesters away from the site, the Rulison nuclear device was detonated with the

force of 40,000 tons of TNT (two Hiroshima-sized bombs) more than a mile-and-a-half beneath the earth's surface.[36] Reporter Cal Queal of the *Denver Post* later collected the following reactions of local residents to the effects on the land above:

> Lannie Dix told what it was really like as he stood on a bluff at Rifle [twelve miles away], looking west at 3 p.m., September 10.
>
> "You could see the ground swell, just like waves on the sea," he says. "There were three waves—up, then down—and the ground rolled under your feet each time."
>
> He paused and shook his head. "There's nothing under the ground that's worth that."
>
> In Grand Valley, 6½ miles from the bomb, Otto Letson sat in his automobile when the shock came.
>
> "It felt like someone picked up the car about eight inches, shook it, and then set it back down," he said. "Dust came off all those hills and rocks were rolling down everywhere."[37]

The legal battle was immediately renewed as ACLU lawyers, lawyers for the Colorado Open Space Coordinating Council, and the district attorney for Colorado's 9th Judicial District joined in an attempt to obtain an injunction from Judge Arraj barring the AEC and its industrial partners from drilling back to tap the gases which had been freed and made weakly radioactive by the explosion.[38] Although the judge again ruled in favor of the AEC, the concerns expressed by the CCEI about the public health hazards which might result from a massive use of the nuclear gas-stimulation method apparently had had some impact on him. In his opinion, Judge Arraj cautioned:

> Lest our ruling today be misunderstood, some additional words are required. . . . We are not here and now approving continued detonations and flaring operations in the Rulison field. Such determination must be made in the context of a specific factual situation, in light of contemporary knowledge of science and medicine of the dangers of radioactivity, at the time such projects are conceived and executed.[39]

Judge Arraj also made legally binding the AEC's previous commitment promptly to make public the data obtained from a rather elaborate system set up to monitor the amount of radioactivity released with the gas from the Rulison field and the extent of accumulation of this radioactivity in the water, vegetation, and milk in the surrounding area.

Thus, while the challengers had not stopped the Rulison test, their efforts had not been without effect. The AEC was put on notice for the first time that the public health hazards of its activities were subject to court review. The public had been alerted to the possible hazards of the nuclear gas-stimulation technique—Colorado editors voted the debate over Project Rulison the state's number-one news issue of the year.[40] And the local press had shown itself to be no longer willing to accept reassuring press releases from the AEC without independent review of the technical facts. It is not clear how seriously the AEC took the opposition to its Rulison test, but in other parts of the government it

was taken very seriously. Following the episode, a staff report of the Federal Power Commission's Bureau of Natural Gas, after expressing doubts about the economics of the nuclear gas-stimulation method, made the following comment:

> There are political and long range environmental consequences to be considered. In order to substantially increase natural gas availability, . . . thousands of nuclear devices will have to be detonated. In view of the increasingly forceful and articulate expressions of concern being voiced for the integrity of the natural environment, such large-scale applications might not gain public acceptance.[41]

Conclusion

We have seen how the Colorado Committee for Environmental Information raised questions about the public health hazards of three federal activities in Colorado and thereby triggered intense public controversies. In each case, after the controversy had died down, the situation was substantially changed: the Army had committed itself publicly to the destruction of its nerve-gas stockpiles at the Rocky Mountain Arsenal; plutonium-handling practices at Dow's Rocky Flats plant were much upgraded; and the public acceptability of a large nuclear gas-stimulation program was thrown into considerable doubt. On the other hand: In 1973 the nerve gas was still stored next to Denver's airport, essentially as it was in 1968 when McClintok and his group first raised the issue; Dow's Rocky Flats plant was still there, on the outskirts of Denver, handling huge quantities of extremely dangerous plutonium; and the AEC carried through with the Rulison test, and in May 1973 it conducted another nuclear gas-stimulation experiment ("Rio Blanco") in Colorado.

The history of the CCEI is inspirational in that it demonstrates how a small group of scientists can make accessible to the public—at the state level, at least—technical issues which have serious implications for the public health and welfare but which would otherwise be dealt with behind closed doors—or perhaps even not be dealt with at all. Although the most active members of the CCEI are now dispersed, the committee has left as a legacy in Colorado a much more alert and resourceful news community (enriched to no small extent by the fact that in 1974 Peter Metzger became a full-time newsman for the *Rocky Mountain News*).

One of the more interesting outcomes of the CCEI's activities was its impact on the careers of its leadership. Metzger, McClintok, and Williams have all shifted their careers in the direction of public interest science.

Peter Metzger, as we have mentioned, traded in his career as a research biochemist at an industrial "think tank" for one as a "science and technology muckraking" newsman.

Michael McClintok moved to the University of Wisconsin, where he again became embroiled in a public controversy with the military—as a technical critic of the Navy's Project Sanguine.[42] In 1973 McClintok joined the Program on Technology and Man at Clark University in Worcester, Massachusetts.

Finally, Robert Williams moved to the Department of Physics at the University of Michigan, where his interests took him into energy studies. By 1972 he held a responsible position at the Washington-based Energy Policy Project, funded by the Ford Foundation.

The effects of their participation in the CCEI on these scientists' careers testifies to the excitement such an involvement generates, as well as to the almost irreversible nature of the commitment one makes when he becomes seriously involved in public interest science.

NOTES

1. As of July 1973, the inventory still included 21,115 cluster bombs containing a total of 463,000 gallons of GB nerve gas, 5.5 million pounds of mustard gas (about an equal amount had been destroyed in the previous year), 2.6 million pounds of phosgene gas, and an undisclosed amount of GB nerve gas stored in bulk tanks and unfused bombs. See James P. Sterba, "Nerve Gas to Stay in Denver Area", *New York Times*, July 5, 1973, p. 20.
2. Quoted in Seymour M. Hersh, *Chemical and Biological Warfare—America's Hidden Arsenal* (Garden City, N.Y.: Doubleday Anchor, 1969), p. 90.
3. Dan Partner, "Arsenal Nerve Gas Poses No Danger, Official Says", *Denver Post*, March 28, 1969, p. 40.
4. "Memorandum on the Possible Hazard to Denver of the Rocky Mountain Arsenal's Storage of Nerve Gas," August 15, 1968 (signed by Michael McClintock, Frank Oppenheimer, Jonathan B. Chase, Lester Goldstein, David R. Crosley, George Wm. Curtis, and Lew Trenner). This memorandum, along with other CCEI documents and clippings, was provided to the authors by Robert H. Williams.
5. *Ibid.*
6. See e.g. the *New York Times*, August 18, 1968, p. 27.
7. *New York Times*, September 8, 1968, p. 36.
8. *Boulder Daily Camera*, March 23, 1969, p. 19. A description of the activities of the St. Louis group (then called the St. Louis Committee for Nuclear Information) during the fallout controversy may be found in Barry Commoner, *Science and Survival* (New York: Viking Compass, 1966), pp. 110-120.
9. *Denver Post*, May 12, 1969, p. 3.
10. Our estimate is based on the report by an AEC spokesman (*Denver Post*, June 4, 1969, p. 19) that $20 million worth of plutonium would have to be recovered from the premises and a price of $40 per gram ($1,160 per ounce) for "weapons grade" plutonium.
11. In October 1970 General Edward B. Giller, AEC Assistant General Manager for Military Applications, justified a request for emergency appropriations to upgrade the safety features of the Rocky Flats Plant as follows: "If a major fire were to break out and break through the building, that is breach the roof, then hundreds of square miles could be involved in radiation exposure and involve cleanup at an astronomical cost as well as creating a very intense reaction by the general public exposed to this . . . In the fire we had

last year we kept it in the building. If the fire had been a little bigger it is questionable whether it could have been contained." (U.S., Congress, House Committee on Appropriations Hearings, *Supplemental Appropriation Bill, 1971*, 91st Congress, 2nd Session, October 1, 1970, p. 295). The hazardous nature of plutonium is discussed by Donald Geesaman, "Plutonium and Public Health," Lawrence Livermore Laboratory, Livermore, Calif. Report No. GT-121-70, April 19, 1970. Reprinted in U.S., Congress, Senate, Committee on Public Works Hearings, *Underground Use of Nuclear Energy, Part 2*, 91st Cong., 2nd sess., August 5, 1970, pp. 1524-1537.

12. Excerpts from the letter, dated June 4, 1969, were reprinted in a number of Colorado papers. The full text was reprinted in the June 4, 1969 edition of the Boulder newspaper, *Town and Country*. The letter was signed by E. U. Condon, Robert H. Williams, Michael McClintock, Dion W. J. Shea, Edward A. Martell, George William Curtis, and H. Peter Metzger.

13. Bob Huber, "No Contamination Reported in Rocky Flats Fire," *Denver Post*, June 8, 1969, p. 1.

14. *Denver Post*, June 18, 1969, p. 1.

15. Ken Pearce, "CCEI Pressed Dow to Find Radioactivity", *Denver Post*, February 13, 1970.

16. *New York Times*, February 11, 1970, p. 1.

17. Robert Williams, private communication.

18. Robert Threlkeld, "CCEI Attacks Official Stand on Contamination," *Rocky Mountain News*, February 25, 1970.

19. *Dow Corral*, March 24, 1970. (The *Corral* is the house organ of the Rocky Flats plant.) The purpose of this edition was to "compare charges, suppositions, and conclusions made in a recent CCEI draft report with the facts." (p. 1) On page 6 the *Corral* discusses possible sources of the contamination including the leaking oil drums.

20. Roger Rapoport, "Secrecy and Safety at Rocky Flats," *Los Angeles Times*, September 7, 1969, "West" Section.

21. Robert Threlkeld, "CCEI Attacks Official Stand on Contamination."

22. See e.g. Fred Brown, "Bills to be Offered on Pollution Control," *Denver Post*, February 14, 1970, p. 24.

23. The reasons for the May 1969 fire and the measures taken to prevent its recurrence are presented in AEC reports reprinted as appendices to: U.S. Congress, Joint Committee on Atomic Energy Hearings, *AEC Authorizing Legislation, Fiscal Year 1971*, 91st Congress, 2nd Session, March 19, 1970, Part 4, pp. 1946-1997. For a criticism of the management of Rocky Flats two years after the fire and for additional valuable material on the plutonium contamination controversy see Deborah Shapley, "Rocky Flats: Credibility Gap Widens on Plutonium Safety," *Science* 174 (1971): 569-572 and a letter criticizing the article by Donald E. Michels, *Science* 177 (1972): 208.

24. The total number of U.S. underground nuclear tests announced during the period 1963-1971 is 229. See e.g. Robert Neild and J. P. Ruina, "A Comprehensive Ban on Nuclear Testing", *Science* 175 (1972): 140.

25. The number of blasts to develop just one 93,000 acre gas field in Colorado has been estimated at 1,000: Luther J. Carter, "Rio Blanco: Stimulating Gas and Conflict in Colorado," *Science* 25, 1973: 847.

26. The press release was signed by H. Peter Metzger, Robert H. Williams, and Edward A. Martell. See Bob Huber, "Closer Look at Nuclear Blast Urged", *Denver Post*, July 28, 1969, p. 40.

27. CCEI Press Release, July 28, 1969, p. 3.

28. *Denver Post*, August 13, 1969.

29. *Boulder Daily Camera*, May 15, 1969.

30. *Denver Post*, August 23, 1969, p. 28; see also *New York Times*, August 26, 1969, p. 8.

31. *Rocky Mountain News*, August 28, 1969; *Denver Post*, September 3, 1969, p. 2.

32. CCEI, "Questions Relating to the Forthcoming Rulison Underground Nuclear Explosion in Western Colorado," August 6, 1969. Signed by H. Peter Metzger, Edward A. Martell, Robert H. Williams, and A. Skumanich.

33. *Denver Post*, August 27, 1969.

34. Dick Prouty, *Denver Post*, August 31, 1969.

35. Letter to Governor Love from H. Peter Metzger dated September 5, 1969. See also CCEI press release dated August 31, 1969, quoted in many news stories including *Rocky Mountain News*, September 1, 1969, p. 67.

36. *Rocky Mountain News*, September 11, 1969, p. 1.

37. *Denver Post*, April 26, 1970.

38. A summary of the issues and testimony in this suit may be found in Judge Arraj's opinion, which is reprinted in U.S. Congress, Joint Committee on Atomic Energy Hearings, *AEC Authorizing Legislation, Fiscal Year 1971*, March 3 and 5, 1970, Part 2, pp. 1106-1130.

39. Quoted in *Ibid.*, p. 1128.

40. *Denver Post*, December 26, 1969.

41. U.S. Federal Power Commission, "Staff Report on Natural Gas Supply and Demand", September 1969, quoted in Peter Metzger, "Project Gasbuggy and Catch-85," *New York Times Magazine*, February 22, 1970, p. 26.

42. This was a Navy proposal to lay down a huge grid of cables under 6,400 square miles of Wisconsin to serve as an invulnerable broadcasting antenna to the U.S. Polaris submarine fleet. McClintok and his collaborators argued that the system would not only be a massive insult to the Wisconsin environment but that it also would be ineffective. (See Michael McClintok, Paul Rissman, and Alwyn Scott, "Talking to Ourselves," *Environment*, September 1971, p. 16.) Public opposition in Wisconsin eventually reached the point that the Navy decided to try to find a home for its antenna in another state. Subsequently the project was abandoned altogether.