Notes

Epigraphs

1. "Muskie Hearings": Hearings before a subcommittee on air and water pollution of the committee on public works of the U.S. Senate, 59th Congress, June 7–15, 1966 (Washington, DC: U.S. Government Printing Office), pp. 113–343.

Note on Terminology

1. For volatility: "At atmospheric pressure C-216 may combine with almost all known elements, with almost explosive rapidity, giving off extreme heat." Manhattan Project Memo, "Safety and Health Conference on Hazards of C-216 (Code for Fluorine)" To: Safety Section Files. RHTG Classified Doc., 1944-94, Box 166, Building 2714-H, Vault #82761. Such violence also makes fluorine difficult to isolate. Although it is the thirteenth-most abundant element in the earth's crust, it was not until 1886 that a French scientist, Henri Moissan, was finally able to segregate the volatile element. R. E. Banks, "Isolation of Fluorine by Moissan: Setting the Scene," *J. Fluorine Chem.*, vol. 33 (1986), pp. 1–26.
2. J. Emsley et al., "An unexpectedly strong hydrogen bond: Ab initio calculations and spectroscopic studies of amide-fluoride systems," *J. Am. Chemical Soc.*, vol. 103, (1981), pp. 24–28.
3. The National Research Council, for example, "uses the term 'fluoride' as a general term everywhere, where exact differentiation between ionic and molecular forms or between gaseous and particulate forms is uncertain or unnecessary." *Biological Effects of Atmospheric Pollutants: Fluorides* (National Academy of Sciences, 1971), p. 3.

Acknowledgments

1. Said Ralph Nader: "Once the U.S. government fifty years ago decided to push fluoridation, they stopped doing what Alfred North Whitehead once said was the cardinal principle of the scientific method, and that is to leave options open for revisions, and it became a party line, it became a dogma, and they weren't interested in criticism."

Introduction

1. L. Tye, *The Father of Spin: Edward L. Bernays and the Birth of Public Relations* (New York: Crown, 1998).

2. From 1957 to 1968, fluoride was responsible for more damage claims than all twenty other major air pollutants combined, according to U.S. National Academy of Sciences member Edward Groth. N. Groth, "Air Is Fluoridated," *Peninsula Observer*, January 27–February 3, 1969. See chapter 15 for a list of fluoride damage suits and comparison with other air pollutants.
3. See chapters 7, 9, 10, and 11.
4. For fluoride synergy, see A. S. Rozhkov and T. A. Mikhailova, "The Effect of Fluorine-Containing Emissions on Conifers," The Siberian Institute of Plant Physiology and Biochemistry, Siberian Branch of the Russian Academy of Sciences, trans. L. Kashhenko (Springer-Verlag, 1993), excerpted on the Fluoride Action Network website. Also, Herbert E. Stokinger et al., "The Enhancing Effect of the Inhalation of Hydrogen Fluoride Vapor on Beryllium Sulfate Poisoning in Animals," UR-68, University of Rochester, unclassified; and N. Groth, "Fluoride Pollution," *Environment,* vol. 17, no. 3 (April/May 1975) pp. 22–38. For "Greatest health advance," see *A Century of Public Health: From Fluoridation to Food Safety*, CDC, Division of Media Relations, April 2, 1999. For "Pollution and chemical poisoning of children," see chapters 1, 2, and 16.
5. See chapter 3.
6. See chapters 9 and 3.
7. See chapters 4 through 8.
8. *Wall Street Journal,* September 27, 2001, section A, p. 1.
9. See chapters 9 through 16.
10. The papers of Dr. Harold Hodge of the University of Rochester are closed. Archibald T. Hodge to Mr. J. B. Lloyd, University Archives and Special Collections, Hoskins Library (University of Tennessee), July 7, 1996: "Regarding your letter of June 19, 1996, concerning my father Harold C. Hodge's archives, they will be deposited in total at the University of Rochester Medical Center when a room dedicated to his files is ready." Those of Dr. Ray Weidlein, director of the Mellon Institute, are missing. Gabrielle V. Michalek, the head of archive centers at Carnegie Mellon University, which holds some of the Mellon Institute papers, explained to me that Weidlein had instructed a previous archivist to "throw the papers in the Dumpster." For more on blackballing, see chapter 12.
11. Nile Southern interviewed by Russ Honicker, transcript supplied by Honicker.
12. See chapter 12.
13. Holland discontinued fluoridation in 1976. Water fluoridation was discontinued in West Germany after 1950s. B. Hileman, "Fluoridation of Water," *Chemical and Engineering News*, vol. 66 (August 1, 1988), pp. 26–42. It was also banned in the former East Germany following reunification.
14. "A systematic review of public water fluoridation," *The York Review*, NHS Centre for Reviews and Dissemination, University of York (2000). For the 65 percent reduction in cavities claim, see Oscar Ewing's rationalization for national water fluoridation: Oscar Ewing, "Oral History Interview ," by

J. R. Fuchs of the Truman Library, Chapel Hill, NC, April and May 1969 (interview available online).

15. Interview with Paul Connett, posted on the Fluoride Action Network website.
16. For example, "Recommendations for Using Fluoride to Prevent and Control Dental Caries in the United States," Fluoride Recommendations Work Group, CDC (*MMWR*, vol. 50, no. RR 14, pp. 1–42), August 17, 2001.
17. G. L. Waldbott, A. W. Burgstahler, and H. L. McKinney, *Fluoridation: The Great Dilemma* (Lawrence, KS: Coronado Press, 1978), 149–151.

Chapter 1

1. Jack Hein, author interview, March 21, 2001. Reluctant to give me a formal interview, Hein nevertheless made several comments that have been incorporated here. Mullenix had been teaching at Harvard and doing research in the laboratory of Dr. Herbert Needleman, who was famous for proving that low levels of lead in gasoline would harm children's intelligence.
2. Hein told the British TV journalist Bob Woffinden in 1997 that the compound had been invented by a German chemist, Willy Lange, who was working in Cincinnati. A chemist from the Ozark Mahoning company, Wayne White, had then brought MFP to Rochester. According to Hein, "When Wayne White first came to Rochester with the compound, Harold Hodge looked at it and said, 'Well, I wonder if it's a nerve gas or is it going to prevent tooth decay?'" (tape time code, 04.31.15, 1997). See also the important essay discussing the ability of fluoro-chemicals to inhibit enzyme activity. Willy Lange (The Procter and Gamble Company), "The Chemistry of Fluoro Acids of Fourth, Fifth, and Sixth Group Elements," *Fluorine Chemistry,* vol. 1, ed. J. H. Simons (New York, NY: Academic Press, 1950), 125.
3. Hein was also a luminary in such influential dental organizations as the International Association for Dental Research (IADR). According to Phyllis Mullenix, he had raised funds to build a Washington headquarters for IADR.
4. Hein had been a graduate student under Harold Hodge at the University of Rochester in the 1950s. He told the British TV journalist Bob Woffinden, "We got involved with fluoride because Harold Hodge was interested from his connection over at the Manhattan Project." Interview tape time code 04.26.49, 1997.
5. V. O. Hurme, "An Examination of the Scientific Basis for Fluoridating Populations," *Dent. Items of Interest*, vol. 74 (1952), pp. 518–534.
6. Commemorative plaque at the annex entrance, noting that the industrial donors listed had "insured completion." Also, p. 7 of Forsyth Dental Center brochure, undated: "from 1969 through 1979 . . . federal support for the research programs at Forsyth increased threefold and support from industrial grants increased twofold."
7. *Wall Street Journal*, June 13, 1986, p. 25.
8. Ibid.

9. Letter of recommendation from Mehlman on Agency for Toxic Substances and Disease Registry letterhead, May 31, 1992. "Of the many scientists with whom I have worked, I consider Professor Mullenix to be one of the most talented I have known. I have the highest regard for her scientific ability and integrity," Melman added.
10. In 1994 Phyllis Mullenix sued the dental center alleging, among other things, sexual discrimination. The suit was settled out of court under terms which neither Mullenix not Forsyth are permitted to discuss. Although Mullenix will not discuss her lawsuit, Karen Snapp is blunt about the "dark side" of Forsyth, describing "an old boys club" where chauvinism and bad science mixed freely. She described to this writer several instances of crude sexual harassment at Forsyth and the occasionally sloppy professionalism of some of her colleagues. "I would not describe the atmosphere [at Forsyth] as being highly scientific," she said. "It was very strange, it was very uncomfortable. There were totally incompetent people there who were doing quite well because they played the game. They kind of decided what the results were going to be. If they did not get the result, they would either modify the experiment to give them the result, or just forget about it."

Chapter 2

1. Harold Hodge died on October 8, 1990.
2. The *New York Times*, December 16, 2002, obituary of Florence S. Mahoney.
3. In the 1920s in the United States, for example, between 11 and 16 million out of 22 million school children had defective teeth. Similar conditions were found in the United Kingdom. "In the England of the past the teeth were not as frail or as troublesome as today," Sir James Crichton-Brown told dentists in 1892, after describing the many studies that had found uniformly bad teeth among British children. Dental health in 1920s, estimate of the Joint Committee on Health Problems of the National Educational Association and the AMA, cited in letter from Dr. William Gies to Dr. F. C. Keppel of the Carnegie Corporation, November 18, 1927, Dental Research Program, Box 121, Carnegie Grants IIIa, Carnegie Archive Collection. For United Kingdom, see J. Crichton-Browne, "An address on tooth culture," *Lancet*, vol. II (1892), p. 6.
4. J. S. Lawson, J. H. Brown, J. H. and T. I. Oliver, *Med. J. Aust.*, vol. 1 (1978), pp. 124–125. Cited in M. Diesendorf, "The Mystery of Declining Tooth Decay," *Nature*, vol. 32 (July 1986), pp. 125–129. Falling dental-decay rates presented a dilemma for some in the United States, it seems. A researcher at the Forsyth Dental Center apparently warned, "Recall the European data, for example, which shows declines in caries which are occurring without fluoridation and, indeed, seem to rival the effects obtainable with fluoridation. This could easily become ammunition for the antifluoridationists." Cited in e-mail to

Hardy Limeback dated May 15, 2003, from Myron Coplan, of Natick, MA, who explained that he had received the comments directly by mail from the office of Paul DePaola at the Forsyth Center in the early 1980s.

5. See especially J. D. B. Featherstone, "Prevention and Reversal of Dental Caries: Role of Low Level Fluoride," *Community Dent. Oral Epidemiol.,* vol. 27 (1999), pp. 31–40. Also, "Recommendations for Using Fluoride to Prevent and Control Dental Caries in the United States," Fluoride Recommendations Work Group, CDC (August 2001).
6. Linking fluoride to better teeth was not a new idea. As early as 1892 there had been medical speculation that because fluoride was found in dental enamel, it was necessary for strong teeth. In 1925 scientists at Johns Hopkins University tested that theory by feeding rats fluoride. They were disappointed; the fluoride made the teeth weaker, not stronger. They found, "contrary to our expectations, that the ingestion of fluorine in amounts but little above those which have been reported to occur in natural foods, markedly disturbs the structure of the tooth." E. V. McCollum, N. J. E. Simmonds, and R. W. Bunting, "The Effect of Addition of Fluorine to the Diet of the Rat on the Quality of the Teeth," *J. Biol. Chem*., vol. 63 (1925), p. 553. In 1938 the biochemist Wallace Armstrong of the University of Minnesota may well have contributed to the confusion. He reported that teeth with fewer cavities had more fluoride in them. W. D. Armstrong and P. J. Brekhus, "Chemical Composition of Enamel and Dentin. II. Fluorine Content," *J. Dent. Res*., vol. 17 (1938), p. 27.

   That data was, in turn, cited by Gerald Cox (whom we will meet in the next chapter) along with Dean's work and his own, permitting him to conclude that "the case for fluoride should be regarded as proved." That was not the conclusion of the editorial writers at the *Journal of the American Medical Association (JAMA)*, who noted after reading Dean's study that "the possibility is not excluded that the composition of the water in other respects may be the principal factor." Dean also said that other differences in the mineral composition of the water in the study cities—especially calcium and phosphorus—were a factor that should not be overlooked. H. T. Dean, "Endemic fluorosis and Its Relation to Dental Caries," *Public Health Reports*, vol. 53 (August 19, 1938), p. 1452. Cited in G. L. Waldbott, *A Struggle with Titans* (New York: Carlton Press, 1965), p. 13. But in 1963 one of the three planks in Cox's argument collapsed when Wallace Armstrong realized that he had gotten it wrong—increased fluoride in the teeth was a function of age and his earlier simple equation of fewer cavities and greater fluoride content was therefore invalid. "Age as a factor in fluoride content was not then (in 1938) appreciated." W. D. Armstrong and L. Singer, "Fluoride Contents of Enamel of Sound and Carious Teeth: A Reinvestigation," *J. Dental Res*., vol. 42 (1963), p. 133. Cited in Waldbott, *A Struggle with Titans*, p. 119.
7. As we shall see, fluoride's ability to poison enzymes has long been fingered by scientists as a main pathway of its various toxic effects.

8. Fluoridation has been routinely used by bureaucrats to win tax dollars for the NIH and private research institutions. For example, while seeking funding for the entire NIH, Director Dr. Harold Varmus said in 1994 testimony before the Senate Appropriations Subcommittee on Labor, Health and Human Services, Education and Related Agencies, that fluoridation had been the most cost-effective health advance in the history of the NIH. Cited in letter from Gert Quigley of the Forsyth Institute to National Affairs Committee Cohorts, American Association for Dental Research, April 25, 1994. The Quigley memo, presumably reflecting how Varmus's comments had once again endorsed the worth of funding fluoride dental research, is titled "It couldn't have been better if we had written the script." The following month, May 1994, Mullenix was fired from Forsyth.
9. P. M. Mullenix, P. K. DenBesten, A. Schunior, and W. J. Kernan, "Neurotoxicity of Sodium Fluoride in Rats," *Neurotoxicology and Teratology*, vol. 2 (1995), pp. 169–177. (*Teratology* means "the study of malformations.")
10. Letter from Harald Löe, NIDR, to Jack Hein, October 23, 1990.
11. The mixed messages continued. Another official 1996 communication to Mullenix from NIH, rejecting a grant application, nevertheless stated, "The proposal addresses an extremely important question related to public health—whether the officially recommended safe levels of fluoride intake pose risks of adverse health effects, especially impairment of central nervous system function." Cheryl Kitt, PhD, Neurological Disorders and Stroke, to Mullenix, "Clinical Sciences Special Emphasis Panel," August 15, 1996.
12. That was not the impression of Professor Albert Burgstahler. The University of Kansas chemist was a member of the official review committee that examined Mullenix's proposal for NIH funding for further studies. He is also the author of several scientific papers and books on the injurious health effects of small amounts of fluoride and is a past president of the International Society for Fluoride Research. Dr. Burgstahler blamed fear of a "loss of face" at the Public Health Service and among other scientists on the review committee for rejecting her research request. In a letter, July 11, 1996, Burgstahler wrote to Dr. Antonio Noronha of the NIH, "You are well aware of the enormous amount of controversy and sensitivity to loss of face that surrounds the issue of the Mullenix proposal and the very upsetting character of the work she has published on the 50th anniversary of the start of fluoridation in the United States and Canada." He asked, "If any member of the Special Review Committee were to have given a more favorable rating to the proposal, and their names became known to those in funding-decision levels of the USPHS . . . might they not risk jeopardizing further funding from the USPHS for having supported a proposal for research that has already revealed serious errors in USPHS thinking and policy regarding the health hazards of current levels of fluoride exposure in the general population?"

13. M. Hertsgaard and P. Frazer, "Are We Brushing Aside Fluoride's Dangers?" *Salon.com*, February 17, 1999, http://www.salon.com/news/1999/02/17news.html.
14. Tony Volpe and Sal Mazzanobile, who had attended the fluoride toxicity meeting in Jack Hein's office, were installed as Overseers. Forsyth Dental Center brochure, undated, p. 10.
15. Hodge's boss, Manhattan Project Captain John L. Ferry, is the memo's author. Colonel Warren approved the request the same day and allocated a budget of $7,500. Md 3, Md 700, General Essays, Lectures, Medical Report, Box 34, Manhattan Engineer District Accession #4nn 326-85-005, Atlanta FRC, RG 326. (Hodge's two-part research proposal, however, listed as an enclosure "Outline—proposed research project—nervous effects of T and F products," is missing from the files.)
16. At Rochester during the cold war, "The toxicology studies were very comprehensive. They were looking for toxic effects on the bone, the blood, and the nervous system. . . . Without the Manhattan Project and the atomic bomb, we wouldn't know anywhere near as much as we do about the physiological effects of fluoride." Interview with Bob Woffinden and Mark Watts, Channel Four (UK) Transcript, 1997.

Chapter 3

1. Family data from Danish newspaper clippings in Roholm family scrapbook, read in translation by Roholm's daughter-in-law, Karin Roholm. Personal meeting in New York, May 2001.
2. Brun was then ninety-five years old. He published a paper with Roholm on fluoride excretion in workers' urine. *Nordisk Medicin*, vol. 9 (1941), pp. 810–814. Also found at: George C. Brun, H. Buchwald, and Kaj Roholm, "Die Fluorausscheidung im Harn bei chronischer Fluorvergiftung von Kryolitharbeitern," *Acta Medica Scandinavica*, vol. CVI, fasc. III (1941). Citation, photocopy of paper, and several Roholm biographical details provided by Donald Jerne of the Danish Library of Medicine.
3. J. H. Simons, ed., *Fluorine Chemistry*, vol. IV (New York and London: Academic Press, 1965), p. vii.
4. *Fluorine Chemistry*, vol. IV, p. viii. Roholm's memberships included The Society for Health Care, The Younger Doctors' Committee for Continuation Courses in Socialized Medicine, The Danish Association for the Prevention of Venereal Disease, a Committee to Organize a Permanent Hygiene Exhibition, and the Pharmacopeial Revision Committee. Letter to author on January 31, 2002, from Donald Jerne, medical adviser, The Danish National Library of Science and Medicine.
5. Letter from Frank J. McClure (U.S. National Institute of Dental Research) to Lisa Broe Christiansen (Roholm's daughter) on September 19, 1956. (Letter provided to author by daughter-in-law Karin Roholm.)
6. For history of cryolite exploitation, see K. E. Roholm, *Fluorine Intoxication: A Clinical-Hygienic Study, with a Review of the Literature and Some*

Experimental Investigation (London: H. K. Lewis and Co. Ltd., 1937) and R. K. Leavitt, "Prologue to Tomorrow: A History of the First Hundred Years in the Life of the Pennsylvania Salt Manufacturing Company" (The Pennsylvania Salt Company, 1950). The Danish state owned the Greenland cryolite. There were only two buyers, the Øresund Chemical Works of Copenhagen and the Pennsylvania Salt Company of Philadelphia, who held a valuable monopoly for Danish cryolite in the United States and Canada.

7. P. F. Møller and Sk. V. Gudjonsson, "Massive Fluorosis of Bones and Ligaments," *Acta radio,* vol. 13 (1932), p. 269.
8. Kaj Roholm, *Fluorine Intoxication,* pp. 192 and 205.
9. Ibid., pp. 150, 202, 143, and fig 26.
10. Ibid., pp. 142–143, and 178. The U.S. nuclear worker Joe Harding, who suffered from fluoride poisoning, might have recognized this kind of skeletal poisoning; bony outgrowths covered Harding's palms and feet. No American doctor diagnosed these bony outgrowths as a symptom of fluorine intoxication, despite Harding's work in the fluoride gaseous diffusion plant. See chapter 18. See also Joe Harding interview:

> In 1970, I also began noticing and developing something else that was very unusual and new. I had always had perfectly normal and good fingernails and toenails and never any trouble with them. But, along during the summer and fall of 1970, I got some sore places on the balls of my thumb tips and fingertips, where your fingerprints are, that felt like I had maybe stuck a thorn or a splinter real down deep into them. When I would rub my other finger over it, I could feel it way down in there, but yet I couldn't see anything. These kept getting a little more sore, and finally, when the soreness got up near enough to the surface, I kind of dug in. I found something kind of like a piece of fingernail sticking through there. This was very, very painful. I would trim it off back just about as deep as I could reach. It would come back again. It really didn't dawn on me for sure just what this might be at first. But, it didn't take too long till I began to realize that from over on the other side, near the base of my regular fingernails, I was growing fingernails straight through my fingers and coming out on the wrong side. This was pretty painful. I had these on my thumbs and three or four of my fingers. This was the beginning of another very unusual thing for me, which I will talk more about later. . . . In 1971, then, I was still working in the 35 control room, and knee and lungs and hemoglobin in my blood all about the same, skin slowly worse, this fingernail business a little worse, and by this spring, I first noticed that I had something sore under the arch of my right foot. And then I had something getting sore up on the top of the arch bone of my right foot. As time got on, I discovered, I suppose you would call these toenails growing out from under the arch of my right foot, and out under the peak of the arch bone of my

right foot. It was pretty hard for me to keep my shoe tied very tight on that one, and I had to keep digging these things out. (Interview with Dolph Honicker, tape 13.)

11. Roholm, *Fluorine Intoxication*, pp. 138–139. The Dane especially noted an illness called neurasthenia, a condition defined as "an emotional and psychic disorder that is characterized by impaired functioning in interpersonal relationships and often by fatigue, depression, feelings of inadequacy, headaches, hypersensitivity to sensory stimulation (as by light or noise), and psychosomatic symptoms (as disturbances of digestion and circulation)" (ref on pp. 178 and 193). Definition in *Webster's New World Collegiate Dictionary* (New York: Pocket Star Books, 1990).
12. While this field had been "little explored," Roholm added, "it is extremely probable that fluorine acts on the metabolism in various ways and that the symptoms of chronic intoxication have a complicated genesis." Roholm, *Fluorine Intoxication*, p. 286.
13. J. Crichton-Browne, "An Address on Tooth Culture," *Lancet*, vol. 2 (1892), p. 6. Crichton-Browne wrote, "I think it well worthy of consideration whether the reintroduction into our diet, and especially into the diet of childbearing women and of children, of a supplement of fluorine in some natural form . . . might not do something to fortify the teeth of the next generation."
14. E. V. McCollum, N. J. E. Simmonds, and R. W. Bunting, "The Effect of Addition of Fluorine to the Diet of the Rat on the Quality of the Teeth," *J. Biol. Chem.*, vol. 63 (1925), p. 553.
15. For more fluoride in bad teeth, see K. E. Roholm, *Fluorine Intoxication*, p. 150. In mother's milk, ibid., p. 199.

    Earlier speculation from J. Crichton-Browne "An Address on Tooth Culture," was tested experimentally and rejected by McCollum, Simmonds, and Bunting in "The Effect of Addition of Fluorine," *J. Biol. Chem*. Roholm cited both references in his bibliography. The folk notion persisted, however, that fluorine might help teeth. See the suggestions that apparently followed the Alcoa chemist H. V. Churchill's announcement that fluorine caused dental mottling. "At the very meeting where Churchill announced his discovery of large amounts of fluorine in a water supply which caused ugly mottling of teeth a chemist from Hollywood, California, said he felt there must be a threshold point up to which fluorine was desirable. . . . In June 1931, a fellow townsman of Churchill's, a dentist, suggested that fluorine might prevent dental cavities." Donald McNeil, *The Fight for Fluoridation* (New York: Oxford University Press, 1957), p. 37.
16 Roholm, *Fluorine Intoxication*, p. 315.
17. Ibid., p. 321. Further, "Every form of fluorine ingestion is counter-indicated in children when the permanent teeth are calcifying," Roholm wrote on p. 311.
18. Ibid., vi. Also, e-mail, March 8, 2001, to author from Donald Jerne, medical advisor, Danish National Library of Science and Medicine.

19. Volcanic activity in the United States also brings fluoride to the surface. The Old Faithful geyser in Yellowstone National Park shoots forth steam and water poisoned with extraordinarily high levels of fluoride (20 ppm.) See: J. Cholak, "Current Information on the Quantities of Fluoride Found in Air, Food, and Water" (Kettering Symposium, 1957), RAK Collection.
20. In North Africa, scientists blamed fluoride in the soil for crippling local people, Roholm learned. Speder: L'Osteopetrose generalize out "Marmmorskelett" n'est pas une maladie rare. Sa frequence dans l'intoxication fluoree." *J. Radiol. Electrol.*, vol. 20 (1936), p. 1, and *J. Belg. Radiol.*, vol. 140 (1936). In parts of the world today such skeletal fluorosis is endemic. In India, for example, thousands of fresh-water wells drilled by the United Nations during the International Water Decade of the 1980s—to improve local access to clean water and better sanitation—have instead produced a public-health crisis, with many thousands now suffering from skeletal fluorosis. "The problem is enormous, unbelievable," noted Andezhath Susheela, of the Fluorosis Research and Rural Development Foundation in Delhi. Quoted in Fred Pearce, "Wells That Bring Nothing But Ills," *Guardian* (UK), August 2, 1998. See also, Omer Farooq, BBC correspondent in Hyderabad, "Indian Villagers Crippled by Fluoride," *BBCi*, UK Edition, News Front Page News, April 7, 2003.
21. Roholm, *Fluorine Intoxication*, p. 297.
22. H. Ost, "The Fight Against Injurious Industrial Gases," *Ztschr. Agnew. Chem.*, vol. 20 (1907), pp. 1689–1693.
23. K. Roholm, "The Fog Disaster in the Meuse Valley, 1930: A Fluorine Intoxication," *J. Hygiene and Toxicology* (March 1937), p. 131.
24. "In the industrial smoke problem investigators have been interested mostly in the very frequent occurrence of sulfurous waste products . . . but little in fluorine," Roholm remarked. But fluorine compounds were much more toxic that the sulfur compounds, he explained, while "man is more sensitive to fluorine than other mammals." K. Roholm, "The Fog Disaster in the Meuse Valley, 1930: A Fluorine Intoxication," p. 126. Also, G. L. Waldbott, "Fluoride Versus Sulfur Oxides in Air Pollution," *Fluoride*, vol. 7, no. 4 (October 1974), pp. 174–176.
25. "The immense masses of soot and dust emanating from the works have served to promote condensation. Fluorine compounds must have been present in dissolved form in microscopic particles of water and consequently in a very active and easily absorbable form." He added, "It is quite probable that the affection from which these people suffered was an acute intoxication by gaseous fluorine compounds emanating from certain factories in the region." K. Roholm, "The Fog Disaster in the Meuse Valley," p. 126.
26. Ibid., p. 133.
27. H. Christiani and R. Gautier, *Am. Med. Legale*, vol. 94 (1926), p. 821. Cited in F. DeEds, "Chronic Fluorine Intoxication: A Review," *Medicine*, vol. XII, no. 1 (1933). Roholm, *Fluorine Intoxication*, pp. 38–39. P. Bardelli and C. Menzani, "Richerche sulla fluorosis spontanea dei ruminanti," *Ann. D'Igiene*, vol. 45

(1935), p. 399. For worker conditions, see A. W. Frostad, "Fluorforgiftning hos norske aluminiumfabrikkarbejdere," *Tiskr. F. Den norske Laegefor*, vol. 56 (1936), p. 179. Both cited in Roholm.

28. Roholm, *Fluorine Intoxication*, p. 37.
29. Roholm, "The Fog Disaster in the Meuse Valley," p. 136.
30. Roholm, *Fluorine Intoxication*, p. 310. "Physicians should be obliged to notify all diseases acquired while working with fluorine compounds. This is only practiced in USSR and Sweden, where all occupation diseases are notifiable." Roholm notes the Soviet practice approvingly: "In the labour legislation of the USSR great consideration is given to personnel working with fluorine compounds (shorter days, extra holidays, lower pension age, increased pension in the event of invalidity)." See, however, the probable unhappy fate of gaseous diffusion workers in Russia's nuclear program, in David Holloway, *Stalin and the Bomb* (New Haven, CT: Yale University Press, 1994), pp. 189–195.
31. Roholm, *Fluoride Intoxication,* p. 321. Drug reference at p. 311.
32. The Buhl foundation gives grants for education, economics, recreation, and social research. It was established in 1927 by Henry Buhl Jr., owner of Pittsburgh's Boggs and Buhl department store. Weidlein wrote to Charles Lewis, director of the Buhl Foundation, on March 25, 1935: "This investigation was in its origin a part of the Sugar Institute's Industrial Fellowship work but this phase of that problem is no longer related to sugar." Folder 8, Dental Study 1935, Box 32, Buhl Foundation Records, Library and Archives Division, Historical Society of Western Pennsylvania.
33. The estimate of Gauley Bridge deaths is conservative, according to Martin Cherniak's epidemiological study in his *The Hawks Nest Incident* (New Haven, CT: Yale University Press, 1986). For both the scale of the legal threat facing corporations and the key role of the Mellon Institute, see especially D. Rosner and G. Markowitz, *Deadly Dust: Silicosis and the Politics of Occupational Disease in Twentieth-Century America* (Princeton, NJ: Princeton University Press, 1991). For the essential obfuscatory and public relations role of the Mellon Institute in the silicosis debate, see also Rachel Scott, *Muscle and Blood* (New York: E. P. Dutton and Co., Inc., 1974).
34. John F. McMahon to Ray Weidlein, January 16, 1939, Carnegie Mellon Archives, cited in *Deadly Dust*, p. 107.
35. See chapter 4 of *Deadly Dust* for fuller description of Ray Weidlein's key leadership role in forming the Air Hygiene Foundation and shaping its agenda. The Foundation—renamed the Industrial Hygiene Foundation in 1941—would continue to exert a powerful corporate influence in the national debate over air pollution and occupational hazards, including a key early role in the Donora tragedy.
36. E. R. Weidlein, "Plan for Study of Dust Problems," cited in *Deadly Dust*, p. 108.
37. Paul Gross, Lewis J. Cralley, and Robert T. P. DeTreville, "Asbestos Bodies: Their Nonspecificity," *Am. Industrial Hygiene Assoc. J.* (November–December 1967), pp. 541–542.

38. An excellent discussion of the role of Paul Gross and the Mellon Institute in the asbestos story—including the dissent of his fellow scientists—can be found in Rachel Scott, *Muscle and Blood*, pp. 185–189.
39. For scale of asbestos damage awards, see *New York Times*, December 31, 2002, section C, p. 1. Further, recent big asbestos court trials, which have awarded huge sums to plaintiffs, have cited Industrial Hygiene Foundation documents.
40. Alcoa's Francis Frary sat on the membership committee, and the prominent fluoride attorney Theodore C. Waters was a member of the Air Hygiene Foundation's legal committee. An August 30, 1956, letter to Waters from Alcoa's attorney Frank Seamans illustrates their mutual interest in fluoride: "You will recall the occasion of our meeting together in Washington with a group of lawyers who have clients interested in the fluorine problem, at which time we were discussing the U.S. Public Health Service." Waters was also sent information on the 1953 Kettering Fluoride Symposium. See note attached to symposium program, in Kettering files, RAK Collection.
41. Dr. Paul Bovard, "Radiologic Considerations," Symposium on Fluorides, May 13, 1953, paper, p. 2, in Kettering Institute, RAK Collection.
42. G. D. Smith, *From Monopoly to Competition: The Transformation of Alcoa* (New York: Cambridge University Press, 1988), pp. 165 and 175.
43. Russell D. Parker, "Alcoa, Tennessee; the Early Years, 1919–1939," *The East Tennessee Historical Society*, vol. 48 (1946), p. 88. Also, "It was in the hot potrooms of the South Plant—in the smelting or reduction process—that blacks were to be employed on a permanent basis." Smith, *From Monopoly to Competition*, p. 176. Conditions at Massena were so horrendous for workers, and management was so indifferent to their fate, that one young MIT graduate, Arthur Johnson, quit in disgust, he told Smith. Also, in May and June 1948, scientists from the Kettering Laboratory at the University of Cincinnati discovered serious injury and disability among workers in another Alcoa plant, at Niagara Falls, New York. The factory had been producing aluminum since 1912. The investigators confirmed just how dangerous the Alcoa plant had long been. "There can be no doubt that hazardous exposure to fluorides is (and for years has been) present," stated a scientist for Kettering, Dr. William Ashe. He studied 128 men in the "pot" room where the aluminum was smelted: "The most outstanding characteristic of this group," Ashe reported, "is the occurrence of 91 cases of fluorosis of the bone." At least thirty-three of these X-rayed workers "showed evidences of disability ranging in estimated degree up to 100 percent," Ashe concluded. His findings paralleled Kaj Roholm's study of cryolite workers in Denmark. Serious tooth decay, gum disease, and heart problems were common in the Alcoa workers; the scientists added that "an abnormal amount of lung fibrosis among the employees of the pot room was found." Also, "one sees hypertrophic changes in bone along the shafts of the long bones, along the crests of the ilia, the ribs, and the rami of the ischium, in the form of stalagmite-like excrescences which appear similar to changes seen in experimental animals with bone fluorosis. The

interosseous membranes are often ossified. These changes, in no way related to arthritic processes, are believed to be due solely to fluorosis and to indicate that changes about joints may be expected in this disease. Therefore, when one finds, in cases of severe fluorosis of the bone, limitation of motion of the elbow and the X-ray reveals exostoses of unusual density about the elbow, one is probably entirely justified in concluding that the deformity and dysfunction are due to fluorosis, and that disability exists in association with and because of this disease, whether or not the man is aware of it, and whether or not he continues to do his job at the plant." Aluminum Company of America, Niagara Falls Works Health Survey, p. 13, File 4, Box 82, RAK Collection. The Kettering team included the scientist William F. Ashe, who five months later would lead the confidential Kettering investigation of the Donora air pollution disaster. Ashe would receive secret autopsy blood tests from Donora victims, performed by Alcoa, showing high levels of fluoride.

44. The membership of committees of the National Research Council is a guide to some of these relationships: Both Frary and Kettering were members of a Joint Committee, for example, representing the NRC's Science Advisory Board, advising on railway policy. Other members were Frank Jewett, vice president, AT&T; E. K. Bolton, chemical director, DuPont; John Johnston, director of research, U.S. Steel; and Isaiah Bowman, chairman of the NRC and director of the American Geographical Society. Charles Kettering papers, Office Files, Box 96, 87-11.2-296b, and 296f, Scharchburg Archives.
45. Frary was also a poison gas expert, making phosgene poison for the Oldbury Chemical Company in Niagara Falls, before working for the U.S. Army during World War I and then joining Alcoa. See G. D. Smith, op. cit. Also, Margaret B. W. Graham and Bettye H. Pruitt, *R & D for Industry: A Century of Technical Innovation at Alcoa* (New York: Cambridge University Press, 1990).
46. F. DeEds, "Chronic Fluorine Intoxication—A Review," *Medicine*, vol. XII, no. 1 (1933). On industry, F. DeEds: "The possibility of a fluorine hazard should, therefore, be recognized in industry where this element is dealt with or where it is discharged into the air as an apparently worthless by-product. For instance it has been shown by Cristiani and Gautier that the gases evolved at aluminum plants, using cryolite as a raw material, contain sufficient quantities of fluorine to cause an increased fluorine content of the neighboring vegetation, and that cattle feeding on such vegetation develop a cachetic condition," p. 2. His reference is to H. Cristiani and R. Gautier, *Am. Med. Legale*, vol. 6 (1926), p. 336. Further, DeEds calculated that each year 25,000 tons of pure fluorine was "pouring into the atmosphere" from the U.S. superphosphate fertilizer industry alone. He was concerned about where all the fluorine added to soil as phosphate fertilizer ended up. "Assuming an average fluorine content of 4 percent for phosphate rock, and that 75 percent of the fluorine remains in the superphosphate used as fertilizer, it is seen that 90,000 tons of fluorine are being added annually to the top soil. This sizeable quantity gives pause for thought of the potential toxicities concerned therewith." DeEds did not include the 1933 report of thickened bones in Danish cryolite workers, by P. F.

Møller and Sk. V.Gudjonsson, which prompted Roholm's massive study and determination of fluorine intoxication. P. F. Møller and Sk. V. Gudjonsson, "A Study of 78 Workers Exposed to Inhalation of Cryolite Dust," *J. Ind. Hyg.*, vol. 15 (1933), p. 27.

47. One of those studies had been done by Alcoa's H. V. Churchill, who found dental mottling and high levels of fluoride in the well water of Bauxite, Arkansas. Churchill's study was reported in 1931, the same year H. Velu in North Africa and the Smiths in Arizona made the same discovery. (Very curious are the apparently unsuccessful efforts by "Pittsburgh interests" to fund the Smith study in Arizona. That fragmented history is related in McNeil, *The Fight for Fluoridation*, p. 31.) H. Velu, "Le Darmous (oudermes)," *Arch Inst. Pasteur d'Algerie*, vol. 10, no. 41 (1932).
48. "As requested in your letter of June 8th, we have questioned three of our local dentists as to the prevalence of cases of mottled enamel in Massena. All of the dentists stated that they have treated such cases here." Exchange of letters between V. C. Doerschuk, Massena Works, and H. V. Churchill, Aluminum Research Laboratories, June 1931, in Alcoa letters, McNeil Collection, Wisconsin Historical Society.
49. See exchange of letters between H. V. Churchill and C. F. Drake of the City of Pittsburgh Bureau of Water, June 1931. Drake had noted the "Pittsburgh spasmodic fluorine content which appears to have no explanation." He informed Churchill that "an industrial plant not far from New Kensington had been discharging fluorine in the Allegheny River. The officials of that plant discontinued such discharge when requested." Several glass and steel plants were in the vicinity of New Kensington. H. V. Churchill responded, tellingly, "the presence of fluorine in water is apparently not necessarily proof of industrial contamination since it occurs in small amounts in so many water supplies." (In Alcoa letters, McNeil collection, Wisconsin Historical Society.) In 1950, Alcoa was fined for dumping fluoride waste at Vancouver, Washington, into the Columbia River, *Seattle Times*, December 16, 1952. (Cited in Waldbott et al., *Fluoridation: The Great Dilemma* (Lawrence, KS: Coronado Press, 1978), p. 296.)
50. The following decade, an English scientist, Margaret Murray, would call similar dental mottling found near an aluminum smelter in the United Kingdom "neighborhood fluorosis." M. Murray and D. Wilson, "Fluorine Hazards," *Lancet*, December 7, 1946, p. 822. Referring to studies near an aluminum factory in Scotland, they wrote, "In the same part of Invernessshire we found that the local water supply had a very low fluorine content (0.2 ppm), but we observed "moderate" dental fluorosis in the milk teeth of young children whose homes lay within the district contaminated by vapours from the factory chimneys. Such a condition in the temporary dentition is usually associated with a high maternal intake of fluorine. Children using the same water, whose homes lay outside the affected area, did not show the mottled enamel."

Mottled teeth in children in the factory town of Donora, Pennsylvania, in 1948 was also blamed by Philip Sadtler on fluoride smoke and fumes (author interview), an association that was confirmed around the country by the U.S. Department of Agriculture (USDA) in 1970. The USDA report states: "Where ever domestic animals exhibited fluorosis, several cases of human fluorosis were reported, the symptoms of which were one or more of the following: dental mottling, respiratory distress, stiffness in the knees or elbows or both, a skin lesion, or high levels of F in teeth or urine [six references cited]. Man is much more sensitive that domestic animals to F intoxication." R. J. Lillie, "Air Pollutants Affecting the Performance of Domestic Animals. A Literature Review," Agricultural Research Service, *U.S. Dept. Agric. Handbook,* no. 380 (Washington, DC, August 1970).

Mottling was also seen in children living near DuPont's wartime fluoride operation at Penns Grove, New Jersey. A scientitst active on the Manhattan Project, Harold Hodge, was quick to blame fluoride in water supplies. Roholm reported dental mottling in the children of fluoride workers. Their mothers had transported it from the workplace in breast milk. See *Fluorine Intoxication*, p. 199. The Cornell veterinarian Lennart Krook also sent me photographs of mottled teeth from children on the Akwesasne Mohawk reservation, near the Reynolds aluminum smelter in upstate New York.

51. The notoriously close-knit international aluminum industry could follow accounts of litigation following World War I, which alleged fluoride damage outside an aluminum smelter in Switzerland. They could read the slew of new medical information about chronic health effects, summarized by DeEds. Or they could look inside their own factories. A 1932 study published in English had found "fluorosis" in cryolite workers in Denmark. (P. F. Moller and Sk. V. Gudjonsson, "Massive Fluorosis of Bones and Ligaments," *Acta radiol,* vol. 13 [1932], p. 269.) Sickness was reported in a Norwegian aluminum smelter in 1936: A. W. Frostad, "Fluorforgiftning hos norske aluminiumfabrikkarbejdere," *Tiskr. F. Den norske Legefor*, vol. 56 (1936), p. 179. The following year an investigation at DuPont found "high" fluoride levels in workers' urine. (Letter from Willard Machle, MD, of the University of Cincinnati to Dr. E. E. Evans, Dye Works Hospital, Penns Grove, New Jersey, December 28, 1937, DuPont file, Kettering Papers, RAK Collection.) And a confidential 1948 study of Alcoa's plant at Niagara Falls, New York, confirmed that horribly crippled workers were the result of a fluoride dust hazard that had existed for years. Alcoa may also have faced liability in its flurospar mines. The Franklin Fluorspar Company was an Alcoa subsidiary (see *Mellon's Millions, The Biography of a Fortune: The Life and Times of Andrew W. Mellon*, by Harvey O'Conner [New York: Blue Ribbon Books, Inc., 1933], p. 390). Fluorspar miners in Hardin County, Illinois, wrote to Alice Hamilton about their plight. See *Deadly Dust*, 80, fn 10: D. Rosner and G. Markowitz. The entire issue of how much fluoride contributed to industrial silicosis, or how much fluorosis was misdiagnosed as silicosis, is beyond the scope of

this book. Fluoride was widely used in the foundry place and is found in much mineral ore.

52. By the end of 1935 Gerald Cox's tooth study at the Mellon Institute was not going well. Despite the spring press release trumpeting the imminent discovery of a "factor" preventing decay, Cox's data still "did not reveal any positive effects," he stated in a confidential memo to the Institute's director, Ray Weidlein. On March 24, 1936, almost a year after his Buhl Foundation study had begun, Cox reported to Weidlein that feeding a milk extract, known as XXX liquor, to rats had failed to find the positive results claimed in the previous year's press release. "The data at that time did not reveal any positive effects," Cox told Weidlein, and required therefore "intensive work to re-score all of our sets of teeth. With the new and discriminating system, we have been able to show some positive effects." In April 1936, following Francis Frary's September 1935 suggestion that fluoride had a role in dental health, Cox announced to his Buhl Foundation sponsors that he was proposing to "investigate the effects of dietary fluorine on caries susceptibility." See Mellon Institute Special Report, April 6, 1936, "A study of Tooth Decay," marked *Confidential*. Cox later claimed, somewhat confusingly, that the XXX liquor had contained enough fluorine "to explain the beneficial effects of the early experiments in which it was fed to the mothers." Buhl Foundation Records, Box 33, Folder 7, Dental Study 1936, Library and Archives Division, Historical Society of Western Pennsylvania.
53. The letter linking Alcoa's Francis Frary to Gerald Cox's historic suggestion that fluoride was responsible for good teeth was found in McNeil's personal papers. Cox to author Donald McNeil, August 19, 1956. "The first time I ever gave fluorine a thought was in answer to a question of Dr. Francis C. Frary, who was at that time and until about three or four years ago, Director of Research at Alcoa. He asked if our finding,—I was the speaker in the September 1935 meeting of the Pittsburgh Section of the American Chemical Society—of less caries in rats from mothers on XXX liquor could be due to fluorine." File ADA 53–56, McNeil Papers, Wisconsin Historical Society.

    Whether this is indeed the first time Cox wondered about the usefulness of fluoride in preventing tooth decay is not clear. It is clear, however, that the aluminum industry had been mulling the idea for a while. In the 1931 letter to C. F. Drake, cited above, H. V. Churchill of Alcoa stated that fluorine in low doses "may be positively beneficial."
54. E. R. Weidlein, *Ind. Eng. Chem.*, News Ed., vol. 15 (1937), p. 147. See also G. J. Cox, "Experimental Dental Caries. I. Nutrition in Relation to the Development of Dental Caries," *Dental Rays*, vol. 13 (1937), pp. 8–10, and "Discussion," *JAMA*, vol. 113 (1938), p. 1753.
55. Cox et al., "Resume of the Fluorine-Caries Relationship," *Fluorine and Dental Health*, Publication of the American Association for the Advancement of Science, no. 19 (1942): "The first experimental results, using sodium fluoride were obtained in August 1937."

56. P. C. Lowery to C. F. Kettering, April 25, 1936, filed by letter and year, Office Files, Personal Correspondence, Scharchburg Archive.
57. DuPont had become so wealthy selling munitions during World War I that the company had bought a controlling interest in General Motors. The giant enterprise was only pried apart in the 1950s, following federal antitrust action.
58. D. Rosner and G. E. Markowitz, *Deceit and Denial: The Deadly Politics of Industrial Pollution* (Berkeley: University of California Press, 2002).
59. "Organized Opposition . . . Particularly by the American Standards Association and the New York City Fire Department," Report on Operations of Kinetic Chemicals, Inc., from 1930 through 1943, p. 15. Including "History of Development of Fluorine Chemicals from 1928 through 1930," for presentation to the General Motors Policy Committee, by Donaldson Brown. Prepared by E. F. Johnson and E. R. Godfrey, October 1944. Files of Charles Kettering, Scharchburg Archive.

    Also, "Freon . . . coming in contact with open flames will decompose and you get a certain amount of fluorine and a certain amount of chlorine, and you also, just by happen-stance, get a slight amount of phosgene." Direct examination of DuPont director Willis Harrington, chairman of Kinetic Chemicals. *United States* vs. *DuPont*, Civil Action No. 49 C-1071, p. 3922 (U.S. District Court for the Northern District of Illinois, Eastern Division, 1953).

    There were other concerns, as well. The manufacture of Freon required huge quantities of the extraordinarily corrosive and toxic hydrofluoric acid, and "high" levels of fluoride were soon reported in DuPont workers' urine. Willard Machle, MD, of the University of Cincinnati to Dr. E. E. Evans, Dye Works Hospital, Penns Grove, New Jersey, December 28, 1937, DuPont file, Kettering Papers, RAK Collection.
60. Kehoe et al., "A Study of the Health Hazards Associated with the Distribution and Use of Ethyl Gasoline" (April 1928), from the Eichberg Laboratory of Physiology, University of Cincinnati, Cincinnati, OH, National Archives RG 70, 101869, File 725; cited in Rosner and Markowitz, *Deceit and Denial*, p. 313. Kehoe's essential hypothesis, that low levels of lead in blood were safe and normal, was undercut in the late 1960s by the scientist Clair Patterson of the California Institute of Technology, who examined polar ice and concluded that industrialization had greatly increased lead in the human environment. Kehoe's defense of lead safety was dealt a coup de grâce in the 1970s by Harvard's Herbert Needleman, whose studies with children showed lead to be far more toxic than Kehoe had claimed.

    For Kehoe's contribution to industry profitability, see L. P. Snyder, "'The Death Dealing Smog Over Donora, Pennsylvania': Industrial Air Pollution, Public Health, and Federal Policy, 1915–1963," 1994 PhD thesis available from University Microfilms. See especially chapter 5. Also, J. L. Kitman, "The Secret History of Lead," *The Nation*, March 20, 2000. See also chapter 8 of this book for further discussion of lead.

61. W. F. Ashe, "Robert Arthur Kehoe, M.D.," *Archives of Environmental Health*, vol. 13 (August 1966), p. 139. Cited in Snyder.
62. Ethyl had been established by Standard Oil and General Motors to market TEL.
63. "Studies of the Combination Products of Di-Fluoro-Dichloro Methane" and "Notes on the Toxicity of Decomposition Products from Dichlorodifluoromethane" in Kettering Unpublished Reports, vol. 1.d., RAK Collection. Kehoe dismisses the risk from phosgene, arguing that the presence of irritating HF acid would force prompt evacuation from the danger zone. He does not address the risk to firefighters or to subjects unable to flee the gases. "The only experimental situation which has been found to be responsible for the production of significant proportions of phosgene in the decomposition products of CCl_2F_2 was the result of rapid discharge of the refrigerant in high concentration, through the flame of an oil fire in an enclosed chamber—that is, the conditions were those of a conflagration. Situations which correspond to those which might develop from a leak in a home or building, are uniformly found to produce such relatively low concentrations of phosgene, that no amount of dilution of the decomposition products could eliminate the irritating and warning properties of the acids without eliminating the toxic effects of phosgene."

    At a private three-day "Symposium on Fluorides" given for industry at the Kettering Laboratory at the University of Cincinnati in May 1953 Kehoe discussed details of secret human experiments he had performed to test Freon's toxicity for the U.S. government during World War II. He had used himself as one of the gas-chamber test subjects. (See: General Work on Project P.D.R.C. 377 (SECRET) for the Office of Scientific Research and Development, U.S. Government Washington, DC, 7-15-43, unpublished Volumes 1-d, RAK Collection.) Freon produced "unconsciousness after some minutes of exposure to concentrations of the order of magnitude of 11 percent or more," Kehoe recounted. He added, "As the subject of the experiments carried out at the higher concentrations, I was alarmed, fleetingly, at the point of rapid ebb of consciousness, being convinced that the observers outside the chamber were not aware of what was happening to me. Another subject, exposed to much lower concentrations, had considerably less assurance than I and became apprehensive and aggrieved . . . he became quite sure that we were exposing him to a risk which he felt we were concealing from him.

    "I describe these as yet unpublished experiments," he told the gathered industry doctors, "since it is something you, as physicians, should know. It is believed, generally, that exposure to Freon 12 is of negligible importance, and that the material is quite harmless. The significance of the matter relates primarily to the repairman, who can get into situations involving the escape of the material from equipment into small enclosures. Such a workman may become unconscious and receive serious physical injury, or even be killed. *It is not true that this is a harmless material.*" Kehoe left unexplained why the repairman himself should not have the information

on Freon toxicity. Several of the papers given at the symposium were later published. Kehoe's was not.

64. Kehoe died in November 1992, at the age of ninety-nine. An obituary in the *Cincinnati Enquirer*, November 29, 1992, noted that he had retired from the Laboratory in 1965.
65. W. Langewiesche, "American Ground," *The Atlantic Monthly* (July–August 2002), pp. 44–79. Also published in full as *American Ground: Unbuilding the World Trade Center* (New York: North Point Press, 2002).
66. Numerous and multiple phosgene injuries were reported as a result of chlorofluorocarbon decomposition by the Manhattan Project. Chlorofluorocarbons were used in massive quantities in the K-25 plant at Oak Ridge.

    Freon caused deaths and injuries in the home, too: "Dahlman encountered two [poisoning cases] resulting from heating fluorocarbons above the decomposition temperatures. In the first case, a mechanic operated with an acetylene torch on a refrigerator leaking Freon 12. He developed dyspnea, vomiting, and malaise and required hospital treatment for five days. In the second, an agricultural worker sprayed his bedroom with aerosol Freon fly spray. He then switched on the electric heater and went to bed. During the night he developed vomiting, diarrhea, and malaise and died on the following day." T. Dahlmann; *Nord. Hyg. Tidskr.*, vol. 39 (1958), p. 165. Cited in R. Y. Eagers, *Toxic Properties of Inorganic Fluorine Compounds* (Amsterdam and New York: Elsevier, 1969). (DuPont's New Jersey Chamber Works plant also was blamed for poisoning local farmers and workers with fluoride pollution in the 1940s.) The ozone-depleting gas was scheduled to be phased out by the 1987 Montreal Protocol.
67. One Kettering study monitored fluoride levels in DuPont workers' urine and confirmed that "these results have been high." Letter from Willard Machle, MD, of the University of Cincinnati to Dr. E. E. Evans, Dye Works Hospital, Penns Grove, NJ, December 28, 1937, Report on Operations of Kinetic Chemicals, Inc., from 1930 through 1943, p. 17, RAK Collection. Including "History of Development of Fluorine Chemicals from 1928 Through 1930," for presentation to General Motors Policy Committee, by Donaldson Brown. Scharchburg Archive.

    Freon sales again skyrocketed higher during World War II, with Freon used as a coolant in the K-25 gaseous diffusion plant and as a propellant in DDT antimalaria bug bombs.
68. W. Machle et al., "The Effects of the Inhalation of Hydrogen Fluoride. 1. The Response to High Concentrations. 2. The Response to Low Concentrations," *J. Industrial Hygiene*, vol. 16, no. 2 (1934), p. 129; and vol. 17, no. 5 (1935), p. 221.
69. The Advisory Committee on Research in Dental Caries (Daniel F. Lynch, chairman; Charles F. Kettering, counselor; and William J. Gies, secretary), *Dental Caries: Findings and Conclusions on its Causes and Controls. Stated in 195 Summaries by Observers and Investigators in Twenty-five Countries*, The Research Commission of The American Dental Association (New York, 1939).

70. P. C. Lowery to C. Kettering, Kettering Office Files 1937, "L", 87-11, 1-412, Scharchburg Archive.
71. "Armed with a letter from Dr. Weidlein of Mellon Institute to Mr. A. W. Mellon, he [Friesell] went to Washington to enlist the support of the Public Health Service. Mr. Mellon referred him to Surgeon General Cummings." Letter from H. V. Churchill of Alcoa to Dr. Frederick McKay of the Rockefeller Foundation, May 20, 1931, discussing the role of H. E. Friesell, dean of the University of Pittsburgh's Dental School. Alcoa Documents, Wisconsin Historical Society. Friesell sought to have naturally occurring dental fluorosis studied in Arizona, by University of Arizona scientists H. V. and Margaret Smith (far from the industrial centers of the East).

    See also the letter of August 6, 1930, from C. T. Messner of the Public Health Service to Friesell: "You are probably aware of the fact that the U.S. Public Health Service is a Bureau in the Treasury Department therefore, it might be advisable, especially as our Secretary is from your city, to also urge his endorsement of this program. The slightest interest on his part would influence the Service to a great degree in taking up this problem. I am sure you will hold this statement in strict confidence . . . after your letter is received here I will keep you advised as to how things are going along." File 9, Box 2, McNeil Collection, Wisconsin State Historical Society.

    The following year, in the spring of 1931, the same Captain C. T. Messner at the Public Health Service told H. Trendley Dean he would be studying mottled enamel. Dean stated that he was "assigned" to conduct the epidemiological studies that resulted in the key "fluorine caries hypothesis,"—the scientific basis for U.S. water fluoridation. See Don McNeil interview with Dean, May 3, 1955, in File 13, Box 2, McNeil Collection, Wisconsin State Historical Society.
72. How long Alcoa had known that fluoride produced dental mottling is not clear. (Alcoa was also concerned that the bad teeth in its company town of Bauxite would be linked to aluminum salts and further tarnish the public image of aluminum kitchenware. See McNeil, *The Fight for Fluoridation*, p. 27.) Perhaps it was coincidence that the Alcoa chemist H. V. Churchill's 1931 correlation of bad teeth with fluoride-contaminated well water in the company town of Bauxite appeared in the scientific press just weeks before separate studies confirming fluoride's link to mottled teeth were also published (by Smith and by Velu). What is certain, however, is that as soon as fluoride's links to mottled teeth were public knowledge, Alcoa privately confirmed that dental fluorosis was also found near its aluminum smelter in Massena, New York. See earlier note.
73. H. T. Dean, "Chronic Endemic Dental Fluorosis (Mottled Enamel)," *JAMA*, vol. 107 (1936), pp. 1269–1272.
74. "Ordered" and "hunch" quoted from Don McNeil interview with Dean, May 3, 1955. Dean told McNeil that in 1931, before he began his work, he "had a hunch" there would be fewer cavities in mottled teeth. McNeil Collection, Box 2, File 13. It is not known how Dean arrived at this hunch. Nor

is it known whether Dean had been ordered to "discover" some good news about fluoride. Of interest, however: the man who gave Dean his marching orders, the PHS's C. T. Messner, was the same official who, five years later, met in Detroit with the Freon gas magnate Charles Kettering. This meeting helped to produce the book *Dental Caries*, which also favorably introduced many dentists to fluoride. Indeed, Dean's "hunch" flew in the face of a study done at John Hopkins in 1925 by E. V. McCollum, who was hopeful that fluoride would strengthen teeth but had instead concluded that "the results showed, contrary to our expectations, that the ingestion of fluorine, in amounts but little above those which have been reported to occur in natural foods, markedly disturbs the structure of the teeth." E. V. McCollum, N. Simmons, J. E. Becker, and R. W. Bunting, *J. Biol. Chem.*, vol. 63 (1925), pp. 553–561.

75. H. T. Dean, "Endemic Fluorosis and Its Relation to Dental Caries," *Public Health Rep.*, vol. 53 (1938), pp. 1443–1452. Also H. T. Dean et al., "Domestic Water and Dental Caries," *Pub. Health Rep.*, vol. 56 (April 11, 1941), pp. 756–792. Dean was cross-examined in the 1960 *Schuringa* vs. *Chicago* lawsuit, to enjoin the city from fluoridating water supplies. According to the critic Dr. Richard G. Foulkes, Dean, under cross-examination by Mr. Dilling and aided by F. B. Exner, a radiologist and critic of fluoridation, was forced to admit that his early studies of Galesburg, Quincy, Monmouth, and Macomb and his later studies in twenty-one cities of 7,257 children, did not meet his own criteria of "lifetime exposure" and "unchanged water supply" and were, therefore, worthless. Dr. Exner prepared an "Analytical Commentary" on Dean's testimony. Exner "refers to the transcript and exhibits that show that not only were the basic criteria lacking in Dean's work, but also random variations found in both high and low fluoride areas cancelled out any 'benefits' that appeared in the high fluoride vs. lower fluoride cities,"according to Foulkes. *State of Wisconsin Circuit Court Fond Du Lac County Safe Water Association, Inc., Plaintiff,* vs. *City of Fond Du Lac, Defendant* Case No. 92 CV 579, Affidavit of Dr. Richard G. Foulkes in Support of Motion for Summary Judgment.

76. G. J. Cox, "New Knowledge of Fluorine in Relation to the Development of Dental Caries." *J. Am. Water Works Assoc.*, vol. 31 (1939), pp. 1926–1930. PHS regulations for 1939 stated, for example: "The presence of . . . fluoride in excess of 1 ppm . . . shall constitute grounds for the rejection of water supply." PHS, "Public Health Service Drinking Water Standards," *Public Health Rep.*, vol. 58 (1943), pp. 69–111 (at p. 80). A tenfold margin of safety required that fluoride in water be no higher than 1 part per million, water works engineers agreed. H. E. Babbitt and J. J. Doland, *Quality of Water Supplies in Water Supply Engineering.* 3rd Edition (New York: McGraw Hill, 1939), p. 454. Cited in Waldbott et al., *Fluoridation: The Great Dilemma*, p. 302.

Chapter 4

1. Richard Rhodes, *The Making of the Atomic Bomb* (New York: Touchstone, 1986). On p. 605 Rhodes quotes the French chemist Bertrand Goldschmidt, who wrote that the Manhattan Engineering District was "the astonishing American creation in three years, at a cost of $2 billion, of a formidable array of factories and laboratories—as large as the entire automobile industry of the United States at that date." On congressional secrecy, L. Groves, *Now It Can Be Told* (New York: Da Capo, 1962), p. 362.
2. Lt. Col. E. Marsden to Gen. Groves, December 3, 1943, Memorandum, "Obtaining of Information from C.W.S. on Phosgene, Fluorine, and Fluorine Compounds": "It is requested . . . for the Medical Section of the Manhattan District to be in full possession of all the information on phosgene, fluorine, and fluorine compounds that is presently in possession of the War Department." File EIDM D-2-b. MD 723.13 Memo to the Commanding General, Army Service Forces, Washington, DC, December 3, 1943, from Brigadier General L. R. Groves: "It is requested that Colonel Stafford L. Warren, M.C., be authorized to contact the Chief, Chemical Warfare Service, to obtain all information that may be available in the files of the Chemical Warfare Service . . . on the detection of, and protection against, phosgene, fluorine, and fluorine chemicals." EIDM D-2-a.
3. The enrichment factor was 1.0043. Rhodes, *The Making of the Atomic Bomb*, p. 340. At first, the K-25 plant produced only partially enriched uranium, which was further enriched at Eastman Kodak's Oak Ridge Y-12 plant and then transported as uranium tetrafluoride to Los Alamos. See also Rhodes, 552, 553, and 602.
4. Uranium hexafluoride quantities: "Considerable amounts of special fluorinated chemicals will be supplied to the K-25 plant," including "Uranium hexafluoride 33 tons per month—required by October 1944." See "Functions of Madison Square Area," Md 319.1, Box 26, Report Madison Square Accession #4nn 326-85-005, Atlanta FRC, RG 326. Also memo, "Storage Facilities at the Site For C-616," where Captain L. C. Burman, Corps of Engineers, notes a "2150 lb daily requirement" for hexafluoride. Md 3, Md 700, General Essays, Lectures, Box 34, Manhattan Engineer District Accession #4nn 326-85-005, Atlanta FRC, RG 326. Work force and power consumption: *AEC Handbook on Oak Ridge Operations* (1961), Oak Ridge Public Library.
5. Fresh air: University of Chicago, Metallurgical Laboratory, October 30, 1942, Memorandum to C. M. Cooper from R. S. Apple. Also, memorandum: "Medical Considerations of Work in the Pilot Plant, Philadelphia Naval Yard" from Col. Warren to Rear Admiral Mills, October 25, 1944. C-216 refers to the substance referred to as "fresh air." Md 702.1, Medical Exams Specimens, Box 54, Medical Considerations Accession #4nn 326-85-005, Atlanta FRC, RG 326.

   "Madison Square Area functions as the Materials Section of the Manhattan District to obtain special materials. The principal projects are the location, procurement and refining of uranium ore, preparation of uranium

oxide, uranium hexafluoride and uranium metal, and production of fluorinated hydrocarbons." "Functions of Madison Square Area," Md 319.1, Box 26, Report Madison Square Accession #4nn 326-85-005, Atlanta FRC, RG 326. How well the fluoride secrets were kept, at least from foreign governments, is unclear. The Soviet spy Klaus Fuchs had worked on fluorine diffusion at the University of Birmingham in England and spent several crucial months in New York in 1944 with the British Diffusion Mission. He gave the Russians key details of the U.S. fluoride diffusion process, including information about the top-secret sintered nickel barriers through which the gas diffused. See Holloway, *Stalin and the Atomic Bomb*, p. 104.

6. See Rhodes, 494 for K-25 size and complexity. See L. Groves, *Now It Can Be Told* (New York: Da Capo, 1962), pp. 114–115 for corrosion and need to "condition" equipment. Also, at an October 23, 1942, presentation to the S-1 Committee of the OSRD, a precursor to the Manhattan Project, Mr. Z. G. Deutsch of the Standard Oil company, which was building a pilot centrifuge plant to separate uranium at Standard's Bayway refinery in Linden, NJ, stated, "All development work, toward a design of plant for the separation of our isotopes has visualized working with a single material—uranium hexafluoride." He added, "The principal objection to it is its extreme chemical reactivity." See *Manhattan District History*, Book I, vol. 4, chapter 14.
7. On October 19, 1943, top doctors from the Manhattan Project met in Captain John L. Ferry's Madison Square Area offices in New York. Harold Hodge from the University of Rochester was there. So were several doctors from Du Pont, Chrysler, and the Kellex Corporation, as well as the top medical officers for the Manhattan Project, including Col. Stafford Warren. Their secret agenda: "fluorine hazards to workers." Pure fluorine "would consume the skin and flesh," of exposed men, the doctors were warned. Ordinary protective clothing was "not satisfactory." A fluorine explosion would produce a terrifying mix of hydrofluoric acid and "oxygen fluorides." The acid burn might go undetected for twelve hours but would be followed by "extreme pain." Eventually the fluoride "penetrates to the bone, and then will spread along the bone and require amputation," the doctors were told. No one was then certain what the oxygen fluorides might do. Memo: Safety and Health Conference on Hazards of C-216 [code for F] October 19, 1943, Oak Ridge Records Holding Task Group Box 166 Building 2714-H, Vault, #82,761.

   See also, for UF6, Union Carbide Safety Bulletin No S-1, June 16, 1945. UF6 breaks down into HF and uranyl fluoride [UO_2F_2]. The latter, the bulletin notes, "has an action both as a surface irritant and as a poisonous agent acting internally." "When inhaled as a fine dust or fume, it readily goes into solution on the moist linings of the respiratory tract from which it is readily absorbed . . . all of the UO_2F_2 absorbed from any surface is eliminated by the kidneys, which causes kidney damage." "Deep penetrating burns" were produced by surface skin exposure to hydrolysis products, HF and UO_2F_2, Safety Reports, Bulletins, Box 55, Accession #4nn 326-85-005, Atlanta FRC, RG 326.

8. "Prior to the existence of the District, elemental fluorine was a laboratory curiosity." *The Manhattan District Official History*, p. 3.13, Book 1 General, vol. 7, Medical Program. For most reactive element, R. E. Banks, "Isolation of Fluorine by Moissan: Setting the Scene," *J. Fluorine Chem.*, vol. 33 (1986), pp. 3–26. For action on steel, above reference, "Memo: Safety and Health Conference on Hazards of C-216" [code for F], October 19, 1943. "Mild steel valves and pipes have been used [to handle fluorine] but it seems that any impurity or foreign substance in the pipe or valve may be the activating agent to start a reaction. Dr. Benning [from Du Pont] exhibited a steel valve . . . which had been consumed by action of C-216. The heat generated by the reaction is tremendous and a considerable flash hazard is present as the reaction is almost instantaneous."
9. These companies and their roles are described in greater detail in *The Manhattan District Official History*, Book 1, General, vol. 7, Medical Program.
10. The liquid was named after Professor Joseph Simons of Penn State University, who invented a process known as "electro-chemical fluorination," which used electricity to replace the hydrogen with fluoride in hydrogen-carbon bonds, producing fluorocarbons. (After the war the technology would be licensed to the 3M corporation, which would use it to make, among other things, the fabric protector Scotchgard. See chapter 17.) See J. H. Simons, ed., *Fluorine Chemistry*, vol. 1 (New York: Academic Press, 1950), p. 423.
11. H. Goldwhite, *J. Fluorine Chem.*, vol. 33, p. 113.
12. See "Report on the Fluoro Carbon work" by Harold Urey, September 26, 1942, S-1 files. Further, see Goldwhite. See also *Industrial and Engineering Chem.*, vol. 39, no. 3, p. 292.
13. For example, 35,000 pounds a month of "polytetrafluorethylene" (Teflon); 1,600,000 pounds of "hexafluorxylene"; and 1,400 lbs of "fluorinated lubricating oil." For delivery schedule of fluorocarbons, see "Functions of Madison Square Area," Md 319.1, Report Madison Square, Box 26, Accession #4nn 326-85-005, Atlanta FRC, RG 326.
14. Rhodes, *The Making of the Atomic Bomb*; p. 494. Dick Powell author interview; and also Goldwhite, *J. Fluorine Chem.*, above reference.
15. Groves, *Now It Can Be Told*, p. 8.
16. The plant was built in the basement of the Schermerhorn Laboratory in January 1943. Rhodes, *The Making of the Atomic Bomb*, p. 494.
17. "Initiation of Medical Program for Project at Columbia University," Friedell to the District Engineer, U.S. Engineer Office, Manhattan District, January 20, 1943.
18. Capt. John Ferry to Col. Stafford Warren, November 10, 1943; and Capt. John Ferry to the Area Engineer, Columbia Area, July 14, 1944. "It would be difficult to prove that his illness had not been aggravated by his fume exposure," Ferry concluded in Spelton's case. Illness of Mr. Christian Spelton, Md 726.2, Occupational Diseases, Box 55, Accession #4nn 326-85-005, Atlanta FRC, RG 326. For pulmonary fibrosis as symptom, see Roholm, *Fluorine Intoxication*, p. 150.

19. On teeth falling out, see New York Operations Research and Medicine Division, Correspondence 1945–1952, Box 28–47, Box 36 ,"Du Pont File," Atlanta FRC, RG 326. For Priest's fluorine work at Columbia, see *Industrial and Engineering Chem.*, March 1947.
20. Princeton account at Md 319.1, Ferry Report Medical, Box 25, Accession #4nn 326-85-005, Atlanta FRC, RG 326. For Iowa State, case of Max Rankin see Md 702.1, Medical Exams Specimens, Box 54, Accession #4nn 326-85-005, Atlanta FRC, RG 326. For case of Dr. Oscar N. Carlson, report of Allan P. Scoog: Carlson had worked at Ames since 1943. He worked with beryllium fluoride. Multiple hospitalizations were followed with a diagnosis of "diffuse fibronodular pathologic process throughout both lungs . . . occupational fibrosis." *Medicine, Health and Safety, Beryllium*, July 1951–December 1951. NARA II. The gassed Purdue researchers had lung injuries resembling those in soldiers exposed to the World War I poison gas phosgene. Capt. John Ferry to Col. Stafford Warren, May 22, 1944. Also, Capt. John Ferry to Col. Stafford Warren, June 23, 1944, Md 319.1, Report Medical Ferry, Box 25, Accession #4nn 326-85-005, Atlanta FRC, RG 326.
21. Memorandum to Col. Warren from Capt. John Ferry, November 15, 1943, "Visit to DuPont": "The prevailing opinion is that the irritating properties of the HF also formed, will not be a satisfactory guide against the toxicity of the oxyfluoride." "DuPont" File, New York Operations Research and Medicine Division, Correspondence 1945–1952, Box 28–47, Box 36, Atlanta FRC, RG 326; "DuPont," Box 14, Accession #72C2386, Atlanta FRC, RG 326.
22. Memo to Col. E. H. Marsden from Col. Warren. January 6, 1945, "Safety of Operations at S-50," C-616, Box 28, Accession #72C2386, Atlanta FRC, RG 326.
23. "One is impressed," noted Captain John L. Ferry, senior medical officer for the Madison Square Area, "by the similarity between these cases and persons dying from work in beryllium plants." He reminded his boss that "one explanation of the beryllium deaths was that they resulted from exposure to beryllium oxyfluoride." Capt. Ferry to Col. Warren, February 2, 1944. "Fatalities Occurring from a By-Product of T.F.E.," Md 729.3, Safety Program Protection Against Hazards, Book 1, 6/25/42–7/31/44, Box 55, Accession #4nn 326-85-005, Atlanta FRC, RG 326.
24. Dr. G. H. Gehrman, DuPont Medical Director, to Capt. Ferry, May 5, 1944. Md 319.1, General Essays, Lectures, Medical Report, Box 34, #4nn 326-85-005, Atlanta FRC, RG 326.
25. Capt. Ferry to Col. Warren, February 2, 1944. "Fatalities Occurring from a By-Product of T.F.E." Also, DuPont was reluctant to have the government test "their own commercially developed material since several of the components thus far identified give good promise for commercial uses other than that contemplated here." District Engineer Ruhoff to Dr. H. T. Wensel, Clinton Engineer Works, March 30, 1944, Documents 366 and 367, RG 227.3.1.
26. Capt. Ferry to Col. Warren, February 2, 1944. "Fatalities Occurring from a By-Product of T.F.E."

27. Richard Powell, "Fluorine Chemistry: The ICI legacy," in *Fascinated by Fluorine* (Amsterdam and New York: Elsevier, 2000). He quotes the visiting ICI scientist J. H. Brown on p. 345.
28. Kramish, A., "They Were Heroes Too," *Washington Post*, December 15, 1991.
29. The secret facility was a pilot version of the massive S-50 "thermal diffusion" factory being readied at Oak Ridge, Tennessee. The plant at Oak Ridge appears also to have presented considerable fluoride health risks to workers, according to the official history. Each time a new hexafluoride cylinder was attached to the S-50 equipment, "the danger of breathing UF6 and of being burned by it in this operation is considerable." *The Manhattan District Official History*, Book 1, General, vol. 7, Medical Program, p. 3.22.
30. Conant had responded to Col. Warren's request for information, sending him reports on fluoride from the Chicago Toxicity Laboratory, and OSRD Report #3285 "The Toxicity of Compounds Containing Fluorine." Conant to H. T. Wensel, October 6, 1943, RG 227.3.1, Document #0398, and Ruth Jenkins (Conant's secretary) to Wensel, February 15, 1945, RG 227.3.1, Document #0341. Conant sought to keep specialized information about fluoride out of scientific journals during the war. He wrote to the editor of the *Journal of the American Chemical Society*, Arthur Lamb, on December 29, 1943: "I should appreciate it if you would send any papers concerning fluorine compounds to me if they are submitted in the future, and I will try and get in touch with the more conservative reviewers." Document 0114, RG 227.3.1.
31. TDMR-628 (Technical Division Memorandum Report from Edgewood Arsenal) cited p. 20, OSRD Report 3285. "Among the effects noted were photophobia, headaches . . . as well as difficulty and pain in accommodation."
32. Low concentrations of the organic compound cited produced "marked weariness, very strong mental depression, reluctance for any physical effort. Quite distinct periods of nervous irritation difficult to control, followed by periods of physical and mental exhaustion, drowsiness and giddiness." Sporzynski Y.5682 May 5, 1943, cited in OSRD Report 3285, p. 37.
33. E. C. Andrus, D. W. Bronk, G. A. Carden Jr., et al., eds., *Advances in Military Medicine*, 2 vols. (Boston: Little, Brown, 1948), p. 561. See also *Fascinated by Fluorine*, p. 347; and author interview with former Imperial Chemical Industries (ICI) scientist Dick Powell.
34. J. Conant to Dr. H. T. Wensel, Clinton Engineering Works, October 6, 1943. RG 227.3.1 Document 0398.
35. Author interview, July 27, 2003.
36. Capt. Joe Howland, "Studies on Human Exposure to Uranium Compounds," in Harold Hodge and Carl Voegtlin, eds., *Pharmacology and Toxicology of Uranium Compounds, with a Section on the Pharmacology and Toxicology of Fluorine and Hydrogen Fluoride* (New York: McGraw Hill, 1949), p. 1005. The official history of the Manhattan Project, like Gen. Groves, gives a conflicting account of the disaster. On p. 5.3, Book VI, Section 5, it states only that "several persons were injured." However, Book I, vol. 6, p. 3.19 notes that,

"Douglas P. Meigs died as a result of burns due to steam. The Aetna, insurance carrier for Fercleve [the contractor], was not permitted to investigate the cause, nor the scene of the accident, but was permitted to make a routine dependency investigation. After complete facts were available to the Insurance Section, the insurance carrier was instructed to make payment as awarded to Meigs's widow by the Bureau of Workmen's Compensation, State of Pennsylvania."

37. A. Kramish, "They Were Heroes Too," *Washington Post,* December 15, 1991. Kramish told me that the Manhattan Project officer, "Dusty" Rhodes was sent to silence the press. The *Philadelphia Record* may have gone to press before he arrived, Kramish thinks. The following morning the newspaper reported that two "specialists" had been killed in an accident. "Gas was released," the newspaper added.
38. Leslie Groves, *Now It Can Be Told* (New York: Da Capo, 1962), p. 121.
39. *Washington Post*, December 15, 1991.
40. At one beryllium factory in Ohio doing secret fluoride work for the Manhattan Project, skin lesions and a crippling lung disease called berylliosis produced an employee turnover rate of 100 percent each month. Captain Mears to Major Ferry, July 30, 1945. He reports on "chemical dermatitis . . . resulting from the fluoride compounds entering through a hair follicle, contaminating a wound, or through a puncture wound by a sharp crystal. In these cases a papule develops slowly with some of the lesions ending in ulceration taking months to heal. Some of the workmen's hands and forearms are covered with inflamed hair follicles, papules, and depressed sharply circumscribed scars." Md 319.1, General Essays, Lectures, Medical Report, Box 34, Accession #4nn 326-85-005, Atlanta FRC, RG 326.
41. "Never before had such quantities of elemental fluorine gas been handled daily," wrote a Manhattan Project doctor, Herbert Stokinger, who saw the daily health risk to American workers. "Continuous exposure to low concentrations from unavoidable losses from the equipment was a source of considerable concern," he added. Hodge and Voegtlin, eds., *Pharmacology and Toxicology of Uranium Compounds*, p. 1024.
42. "Fluorine: Precautions to be Observed in Handling, Shipping and Storage." *Manhattan Project Official History,* Occupational Hazards, Book 1, General.
43. Herbert Stokinger reported that animal deaths were seen in laboratory experiments at 0.3-mg/cu m for fluorine. Hodge and Voegtlin, eds., *Pharmacology and Toxicology of Uranium Compounds*, p. 1033. Also, "The toxicity of oxyfluorides occurring from the liberation of fluorine in the atmosphere" was given a high priority for research. Memo to Col. Warren from Capt. John L. Ferry, November 29, 1943, Md 3, Md 700, General Essays, Lectures, Medical Reports, Box 34, Manhattan Engineer District Accession #4nn 326-85-005, Atlanta FRC, RG 326.

    That toxicity data, only declassified in 1994, is truly spectacular. While exposure of laboratory animals to 0.5 parts per million of pure fluorine for

thirty days was considered "safe," a similar, microscopic quantity of oxygen fluoride "was lethal after 14 hours," the scientists reported. See "*Detailed Duties of Harold Hodge*," list of "problems" and "results" encountered by the Rochester Division of Pharmacology and Toxicology. Folder 2, Box SOFO1B219, ACHRE, RG 220; also, C-212 [code for oxygen fluoride]—1 ppm killed all animals (rats and mice), in "Toxicity of C-616, C-212 and C-216" 'Memo to Files' by Capt. B. J. Mears. Medical Crops, Md 3, Md 700, General Essays, Lectures, Medical Reports, Box 34, Manhattan Engineer District Accession #4nn 326-85-005, Atlanta FRC, RG 326. (By comparison, this toxicity appears at least as bad as the World War I poison gas phosgene, which was also found in the bomb plants, as a result of the heating of Freon.) The Chemical Warfare Service had reported to Col. Stafford Warren that, when exposed to phosgene, "mice succumb to chronic exposure of one part per million.") Memorandum for the Files, "Subject: Survey of Phosgene Effects" by Stafford Warren, February 23, 1944, A2, Box 26, Accession #72C2386, Atlanta FRC, RG 326.

Although the Manhattan Project had given a high priority to the experimental investigation of such oxyfluorides, the official and published work does not mention the results—perhaps a worrisome omission, given that the scientists suspected that the compounds might be encountered in the vicinity of bomb plants. The standard text, *Pharmacology and Toxicology of Uranium Compounds*, edited by Carl Voegtlin and Harold Hodge, has no mention of oxygen fluoride. Also, for evidence that scientists suspected oxygen fluoride would be encountered by citizens and workers, after an industrial hygiene survey at Harshaw Chemical in Cleveland in May 1947, Rochester scientists reported that "the results are on the low side, since the efficiency of the sampling procedure we used is not too good for fluorine and oxyfluoride; if considerable quantities of these two gases were present in the air, we probably missed a part of them." See Pharmacology Report #558, The University of Rochester Atomic Energy Project, Box S09F01B227, ACHRE, RG 220.

44. "HF is a protoplasmic poison with great penetrating power and causes deep-seated burns that heal very slowly. . . . When HF comes into contact with the skin, a burn results. If HF is not removed, it tends to keep penetrating with the production of a deep, slow-healing painful ulceration." Capt. John L. Ferry to Dr. Ralph Rosen, Kellex Corp, January 24, 1944, Md 729.3 Safety Program Protection Against Hazards, Book 1, 6/25/42–7/31/44, Box 55, Accession #4nn 326-85-005, Atlanta FRC, RG 326. Also, the chemical was described by Dr. Stokinger as "possibly the greatest single source of minor incapacitation of workers" in the bomb plants. Hodge and Voegtlin, eds., *Pharmacology and Toxicology of Uranium Compounds*.
45. Confirmed in author interview with the ICI fluoride scientist Dick Powell. Such "conditioning" was a massive industrial undertaking. The uranium hexafluoride gas was so corrosive that thousands of pumps, blowers, and piping first had to be treated with either chlorine trifluoride, or elemental

fluorine, leaving a thin film of fluoride on the machinery, protecting it from future corrosion. Joe Harding likened the process to "seasoning the interior of process equipment, like some people have heard of 'burning-in' an old cast iron skillet." Memorandum to Lt. David Goldring from Birchard M. Brundage 1st Lt., Medical Corps, July 13, 1945. "Subject: S-50 Medical Check-ups": Item I. "Definitions 1. Conditioning Area—Building in which parts and apparatus to be used in the Process Area are treated chemically before being placed in operational use." Item II. "Conditioning shop operator—handles the chemical preparation of equipment before it is handled for operations. He also cleans used equipment before its reconditioning and reuse in operations." Item III. "Hazard Classifications. 1. Most serious. A. Transfer room operator. B. Conditioning shop operator." S-50, Box 14. Also, "Conditioning of Equipment," *Manhattan Project Official History*, book VI, p. 5.17.

46. Joe Harding interviewed by Dolph Honicker, undated transcript supplied by his son, Cliff Honicker.

47. Stokinger et al., *The Enhancing Effect of the Inhalation of Hydrogen Fluoride Vapor on Beryllium Sulfate Poisoning in Animals*, UR-68 University of Rochester, unclassified, June 13, 1949. Also, "Fluoride materials are undoubtedly significantly more toxic from the standpoint of acute disease than any other beryllium material now being handled at the Luckey plant." Memo from Merril Eisenbud to W. B. Harris, 2/27/51, Box 3353, MHS 2 Beryllium, Germantown DOE History Archive. Eisenbud also estimated that 50 micrograms of beryllium—inhaled as beryllium fluoride—had "produced acute disease in three individuals" in just twenty minutes, and that "to produce injury by phosgene in a comparable period of time one would have to inhale approximately 50 milligrams!" Health Hazards from Beryllium, Merril Eisenbud, speech presented at a meeting of the American Society for Metals, Boston, March 1954. Document DOE #051094-A-312, ACHRE, RG 220.

48. For deaths: M. Eisenbud, "Origins of the Standards for Control of Beryllium Disease (1947–1949)," *Environmental Research,* vol. 27, no. 1 (February 1982). By June 1949 Robert Hasterlik, the top doctor at Argonne National Laboratory, reported about sixty death from beryllium. *Physics Today* (June 1949), p. 14.

    For sickness: "By far the greatest number of cases occurred in the fluoride handling operations," noted one government report on sickness at the Brush Beryllium Company in Lucky, Pennsylvania. Memo from Merril Eisenbud to W. B. Harris, stamped February 27, 1951: "Acute Beryllium Toxicity—Brush Beryllium Company—Lucky Experience," Div. Biology and Medicine, folder MHS 2 and Beryllium, Box 335, RG 326. At Brush Beryllium Plant in Lorain, Ohio, "In July, 1947, 24 percent of employees in the beryllium metal department were stricken with dermatitis or respiratory disease, compared to 6.4 percent for all other departments. The apparent increase in rates may possibly be explained by the shifts in production to pure metals as the result of AEC contracts." Bob Tumbleson, "Public Relations Problems in Connection with Occupational Diseases in the Beryllium Industry."

The Rochester Atomic Energy Project's Industrial Hygiene Section surveyed the Brush Beryllium Company in Lorain, Ohio, in December 1946 and found up to 64.1 mg/m^3 fluoride, with particle sizes below 0.1 micron (a crucial factor in determining toxicity). "The authors conclude that the relatively high fluoride concentrations obtained in the surveyed areas are of particular significance since they may represent a hazard by themselves and also suggest a combined action with beryllium. Further study of this factor is suggested, especially near the beryllium fluoride furnace where the relative fluoride concentration was 1000 times that of beryllium." Bob Tumbleson, Public and Technical Information Service. "Public Relations Problems in Connection with Occupational Diseases in the Beryllium Industry," p. 18, Medicine, Health and Safety—Beryllium (1947–1948), RG 326.

49. Memo from Bob Tumbleson to Morse Salisbury, "Current Status of the Beryllium Problem," January 26, 1948. "Although the four neighborhood cases appeared at Brush in Lorain, the reporter from the Cleveland PRESS interviewed [AEC official] Wyndecker at Clifton, Painesville. . . . Wyndecker tried to quiet him by saying that a large part of their work was being done for AEC and hence was secret." RG 326 Medicine, Health and Safety—Beryllium (1947–1948) National Archive.
50. Turner reported: "Control experiments with electrolytic dust produced with fluorides, but in the absence of Beryllium, caused the same symptoms and mortality. It is evident, therefore, that electrolytic dust owes its toxicity primarily to the halogen radical [fluoride] and not to its content of Beryllium." Robert A. N. Turner, Resident Safety Engineer, Madison Square Area, Manhattan Engineer District, "The Toxicity of Beryllium and Its Salts," p. 2, "Oak Ridge Copy," Box 39, Accession #4nn 326-85-005, Atlanta FRC, RG 326.
51. Robert A. N. Turner, Resident Safety Engineer, Madison Square Area, Manhattan Engineer District, "Poisoning by Vapors of Beryllium Oxyfluorides," p. 1, "Oak Ridge Copy," Box 39, Accession #4nn 326-85-005, Atlanta FRC, RG 326.
52. See Rochester AEP, minutes of "The Second Progress Meeting on Beryllium Toxicity," February 5 and 6, 1947. Also, "The First Progress Meeting on Beryllium Toxicity": 0.5 mg/kg of "5BeO-7BeF2" killed rats, while 0.75 mg/kg of intravenous beryllium fluoride and beryllium oxyfluoride killed rabbits. "Injection of beryllium oxyfluoride . . . caused histologic damage to the kidney probably as a result of the fluoride moiety." (5.0 mg/kg BeSO4, beryllium sulfate, killed rats.) This meeting produced a crucial determination of a permissible limit of 1.5 mg *of beryllium compound* (underlined in original) per 10 m^3 of air. By not specifying which compound, public notice was not made of the specific and more toxic nature of the fluoride compounds, it seems. Indeed, just days later, the head of the Rochester AEP, Herbert Stokinger, made a recommendation of 1.5 mg of beryllium per 10 m^3 to the AEC for the "Maximal permissible Limit of Exposure to Beryllium." He does not mention nor cite the fluoride toxicity results but rather uses figures from the beryllium sulfate compound, which Rochester had

determined to be ten times less toxic. Stokinger adds, "The suggested level permits an easily attained limit both as regards ventilator and ventilating system." H. E. Stokinger to Fred Bryan, February 18, 1947, Rochester, 400.112 (Pharmacology) Beryllium, Box 48, New York Operations Office, 68F0036, Accession #4kr 326-83-010, Atlanta FRC, RG 326.

Also, researchers at Rochester and at the PHS did not find much toxic effect, chronic or acute, with pure beryllium, which fact allowed industry to deny that there was any great problem from beryllium poisoning. A hint at the agenda of the Rochester group and of Dr. Harold Hodge in particular comes from one of the leading scientists on beryllium toxicity, Dr. Harriet Hardy. "Those responsible for the medico-legal affairs of the AEC should consider the problem of the disability involved in the growing group of individuals with chronic beryllium disease," she writes and adds that "cases of chronic beryllium poisoning are being uncovered daily from a variety of remote and apparently slight beryllium exposures." However, Hardy writes, while "The chronic disease is certainly our most pressing problem, and at present the whole weight of the Rochester work, if I understood Dr. Hodge, is on the acute manifestation. . . . I cannot understand the defeatist attitude about producing chronic changes in animals with beryllium compounds sufficiently approximate to the human pathology." Dr. Hardy to Dr. Warren "Recent trips to Cleveland and Rochester," September 13, 1949, DOE Opennet #1153735.

"Thus, we have a kind of explosive action with the formation of fluorine in status nascendi," Turner stated. "Hence the deeper and most important, more prolonged action of this gas in comparison with that which we see following the inhalation not only of oxides of nitrogen and chlorine but also vapors of fluorine or hydrofluoric acid," p. 6 "The action of the fluorine in such conditions is especially strong and prolonged," Turner adds, "which in fact conditions the specificity of the picture of poisoning by Beryllium oxyfluoride." Robert A. N. Turner, Resident Safety Engineer, Madison Square Area, Manhattan Engineer District "Poisoning by Vapors of Beryllium Oxyfluorides."

53. Although the Maximum Allowable Concentration (MAC) for UO_2F_2 had been officially set by the government at 50 micrograms of uranium per cubic meter, nevertheless, "the lowest concentration of these compounds that will give a uniformly positive response in all animals has not been critically established." Hodge and Voegtlin, eds., *Pharmacology and Toxicology of Uranium Compounds*, p. 2203. Hodge's researchers produced renal injury in a dog at even 50 micrograms/cu m. Dogs were judged to have "unusual susceptibility." Also, Harold C. Hodge and Carl Voegtlin at the University of Rochester to Lt. Col. H. L. Friedell at Oak Ridge, April 26, 1945. Md 3, Md 700, General Essays, Lectures, Box 34, Manhattan Engineer District Accession #4nn 326-85-005, Atlanta FRC, RG 326.
54. "Uranyl fluoride is considered one of the most toxic uranium compounds," wrote Harold Hodge, *Pharmacology and Toxicology of Uranium Compounds*,

p. 33. Also, "It was envisioned that exposures of human beings to this compound would occur mostly by inhalation and almost solely to the fumes, UO_2FO_2 and HF, produced upon its release into the air. Such exposure might take the form of either accidental high concentrations for a relatively short time, possibly repeated several times during a month, or of low level, continuous exposures throughout the period of employment arising from the loss of small amounts of material from systems containing UF_6." *Pharmacology and Toxicology of Uranium Compounds*, p. 1492.

Dangerous levels of fluoride were quickly detected in K25 plant workers' urine. In the early summer of 1952, for example, almost 10 percent of employees tested had too much fluoride in their bodies, doctors reported. And the poisoning was getting worse, "the result of an increase in the magnitude and frequency of individual exposure to fluoride and fluorinated compounds," officials added. Of 535 workers, 58 tested. "Sanitized version of K-25 Plant Quarterly Report for Fourth Fiscal Quarter April 1–June 30, 1952," p. E-9, ORF1000605, Oak Ridge, DOE Public Reading Room.

55. Letter to Ralph Rosen of the Kellex Corporation, which built the K-25 plant. Ferry told Dr. Rosen it was "likely" that the concentrations of gas would be at or "near" the level set for chronic exposure. (However, the MAC for UO_2F_2 was then set at 150 micrograms per cubic meter. That level was reduced to 50 micrograms in 1948, although University of Rochester scientists found kidney damage in dogs at that level too; see note 53 above. No information was found on whether the conditions inside the cold trap chamber changed after 1948 as the MAC was raised.) Captain John L. Ferry to Dr. Ralph Rosen, Kellex Corporation, June 16, 1944. Safety Program Protection Against Hazards, Book 1, 6/25/42–7/31/44, Md 729.3, Box 55, Accession #4nn 326-85-005, Atlanta FRC, RG 326. A similar hazard faced workers at the Harshaw Chemical plant, who made uranium hexafluoride for shipment to Oak Ridge. "Workmen inhale 616 [code for hexafluoride] when disconnecting the receivers from the reactors," noted a report. "A cloud of hydrolyzed 616 escapes during this operation and is not entirely vented," the memo added. Memo from Capt. B. J. Mears, the Madison Square Area, October 11, 1945, to Captain Fred A. Bryan, Medical Section, Manhattan District, Oak Ridge Tennessee. Subject: Urinalysis on Harshaw Chemical Company Workers.
56. Tape-recorded interview with Joe Harding.
57. Several accounts mention the noise and heat inside the gaseous diffusion plant. An early report determining how long men could tolerate working in the "cells" notes temperatures of 118 degrees F and states that "Entrance into a cell which is in operation is a dramatic experience to the uninitiated, apt to be associated with some emotionalism. The noise within the cell might be responsible for part of the light headedness experienced, although the symptom is also recognized as a result of severe heat exposure." "Permissible Work Periods in Cells," Box 9, Accession #72C2386, Atlanta FRC, RG 326.
58. Accidents were frequent at K-25. For example, "On April 1, a release occurred in Building K-1004-A when a cylinder containing 2,559 grams of uranium

hexafluoride became overheated during a material transferring operation, releasing the entire contents of the cylinder." Sanitized version of K-25 Plant Quarterly Report for Fourth Fiscal Quarter April 1–June 30, 1952. In ORF 100605 Oak Ridge DOE Public Reading Room. Also, "On December 30th [1953] . . . a total of 2,506 pounds of uranium hexafluoride . . . was released [when a cylinder failed], contaminating all of Building K-27 . . . the gas was spread widely before the ventilating system could be shut down." K-959—Plant Quarterly Report for Second Fiscal Quarter, October 1–December 31, 1952, p. C-12, in ORF 18729, Oak Ridge, DOE Public Reading Room.

59. Another worker, Sam Ray of Lucasville, Ohio, told Congress in September 2000 that "Compressors would malfunction and process gas (UF6) would leak to the atmosphere. On one occasion, it was so bad that it looked like a fog moving up the mile long building. . . . We have had many small releases that were never reported, as well as documented large releases. Inside of the withdrawal room we had a major release. There were green 'icicles' hanging in the room from crystallize uranium hexafluoride." He also told them that "process gases were routinely vented to the atmosphere" and "fluorine gases from the plant stack area were frequent and resulted in numerous complaints from workers in the area, especially during temperature inversions." Compensation for Illnesses Realized by Department of Energy Workers Due to Exposure to Hazardous Materials. Hearing before the Subcommittee on Immigration and Claims of the Committee on the Judiciary House of Representatives 106th Congress, serial no. 132, p. 210.
60. Col. Stafford Warren to Dr. Fred Bryan, September 24, 1947, DOE stamp 000019, ACHRE, RG 220.
61. Report of Meeting of Classification Board During Week of September 8, 1947, Box SO9FO1B22, ACHRE, RG 220. See also handwritten letter in ACHRE files from an unnamed fluoride worker who worked at Portsmouth Gaseous Diffusion Plant in Piketon, Ohio, in the 1950s. He writes: "In the early years we used to talk about young people dying from cancer and leukemia that worked at the plant and wondered if it was due to working there." DOE document #000010, Box S0901B146, ACHRE, RG 220.
62. An additional five workers were poisoned by "fluorine analogs of phosgene," plant operators at Union Carbide claimed, caused by "pyrolysis of fluorocarbons and fluorolubes." Phosgene can be produced when Freon gas is exposed to very high temperatures. "Summary of K-25 chemical hazards," RHTG 101001, Box 219, RG 326. The document was only declassified in 1997. "Poisoning" was one of the health effects reported at K-25, along with respiratory irritation, burns, and dermatitis.
63. Work Report for June 1944. To: The Chief of the Medical Section, U.S. Engineer Office, Oak Ridge, Tennessee; From: 2nd Lt. Richard Tybout, Corp of Engineers, Medical Section. Document via Pete Eisler, *USA Today*.
64. "A distinct hazard does exist in Area C" that left the Atomic Energy Commission "very vulnerable," Kelly concluded. The government especially feared "pulmonary damage" in workers. While safety levels for uranium

hexafluoride had been set at 40 micrograms per cubic meter, tests showed that on September 30, 1944, dust levels in Area C were as high as 9,130 micrograms per cubic meter—228 times the official tolerance level. March 1, 1945, letter to Harshaw manager Fred Becker from Richard Tybout, 1st Lt. Corps of Engineers Medical Section, via Pete Eisler.

65. Roholm, *Fluorine Intoxication*, p. 26.
66. Analysis of the kidney tissue of one of the victims by the University of Rochester confirmed severe fluoride damage. "The pathological changes in the kidney are accounted for by the overwhelming dose of HF and the acute asphyxia." Capt. B. J. Mears to the District Engineer, Manhattan District, Oak Ridge (Attention: Major J. L. Ferry.) November 1, 1945. Oak Ridge Operations Records Holding Task Group. Classified Documents 1944–1994, RHTG document #38,658, OR0034167, Box 214, Vault, Bldg. 2714-H.
67. Rochester kidney report: "This report is of particular interest because (name redacted) was employed in the C-616 [uranium hexafluoride] plant and his duties required him to remove the receiver from the reactors. It is in this procedure that the employees come in contact with a cloud of PG [process gas] . . . he was exposed to C-616 to the same extent as any other single employee." Capt. B. J. Mears to the District Engineer, Manhattan District, Oak Ridge (Attention: Major J. L. Ferry.) November 1, 1945. Oak Ridge Operations Records Holding Task Group, classified documents 1944–1994, RHTG document #38,658, OR0034167, Box 214, Vault, Bldg. 2714-H.
68. P. Dale and H. B. McCauley, "A Study of Dental Conditions in Workers Exposed to Dilute and Anhydrous Hydrofluoric Acid in Production," December 31, 1943, File G-118, New York Operations Research and Medicine Division, Correspondence 1945–1952, Box 28–47, Atlanta FRC, RG 326.

    Also, on race: "Specimens showing large amount of T [code for uranium] are usually from the colored employees," noted an October 1945 memo from Manhattan Project Capt. B. J. Mears. "Because of their lack of personal responsibility," Mears complained, "this officer recommended that these specimens be collected before the employee starts to work." Of course, if workers gave urine specimens before their shift began, it would have the effect of measuring and recording lower levels of toxic exposure than they were actually receiving. Capt. Mears discriminated between the black workers and "employees who can be trusted." They were allowed to give urine at the end of their shift. Perhaps more importantly, those "trusted" workers, "consistently show T values well below 1 mg per liter." Memo from Capt. B. J. Mears, the Madison Square Area, October 11, 1945, to Captain Fred A. Bryan, Medical Section, Manhattan District, Oak Ridge Tennessee. Subject: Urinalysis on Harshaw Chemical Company Workers, via Pete Eisler.
69. P. Dale and H. B. McCauley, *J. Am. Dent. Assoc.*, vol. 37, no. 2 (August 1948), p. 132.
70. Fedor formed a union safety committee, then contacted the Ohio Division of Safety and Health and persuaded that office to do a study of conditions in

the fluoride plant. The state inspectors found fluoride levels as high as 6 and even 18 ppm. State regulation permitted 3 parts per million. In 1949 Fedor submitted the first motion to an American Federation of Labor national convention, seeking greater union involvement in occupational safety issues. Author interview, October 2001.

71. Despite multiple warnings from federal and state government, the industrial accidents, and pressure from John Fedor's safety committee, Harshaw's management seemed strangely unmoved. "Our plant hourly safety committee has been quite concerned about our HF problems, and I believe are exaggerating them, as I believe the hazards in Area C have been exaggerated," Vice President C. S. Parke wrote to the AEC official W. E. Kelly on February 3, 1948. "I speak somewhat as a layman, but we have manufactured HF fluorides for forty years. It is only lately that occupational disease has been suspected. Two of our men are reputed to have fluorosis, but nobody can tell us how this has harmed them. In fact, the inference by some doctors is that they have benefited. Certainly the situation is nothing to get alarmed at." C. S. Parke to W. E. Kelly, February 3, 1948. AEC document via Pete Eisler.

72. Secretly the government was intensely interested in the medical fate of the Area C workers. When the plant finally closed in 1952, AEC doctors proposed covertly "keeping tabs" on former employees—without letting the men and women know why they were being watched. "The ultimate objective is to determine the incidence of lung cancer . . . to justify the current M.A.C.'s [maximum allowable concentrations in the other AEC plants]," Dr. Roy E. Albert, the Assistant Chief of the Division of Biology and Medicine, explained in a 1955 letter to the University of Rochester's Dr. Louis H. Hempleman. "We have racked our brains for any useful subterfuge in carrying out the study but none came to mind which could possibly hold water for any length of time," he added.

    The subterfuge they used in the end to examine former workers at the Cleveland City Hospital was explained to a hospital doctor, Dr. Robert R. Stahl. "To put it baldly," Albert wrote Dr. Stahl on August 1, 1955, "I think we are fundamentally interested in the autopsy data, the examination program being a mechanism to keep tabs on the people involved in the survey." Extreme care was needed. If too much medical data were gathered from the workers, "there would be a distinct risk of stimulating lawsuits against the Atomic Energy Commission," Dr. Albert emphasized to Dr. Joseph T. Wearn at the School of Medicine at Western Reserve University in Cleveland, who would supervise the "study."

    The plan fell through. Dr. Stahl was appalled when he read the AEC proposal. He pushed the government men away, with an admonition about medical ethics. "The project protocol . . . grossly misrepresents the type of information that AEC is apparently attempting to obtain," Dr. Stahl told Dr. Albert. "Basically," he added, "a health survey is being used as a 'front' for obtaining such autopsy data . . . since this is the basic motive involved

neither Dr. Scott nor myself are interested in such a project." The AEC had wanted to keep the men's records secret. "Allow me to remind you," Stahl added, "that a physician has a legal responsibility toward any patient seen to keep this patient's records in his files." File 092694-a, Box S09501B196, ACHRE, RG 220.

One disturbing aspect of this proposed study is the number of people who appear to have known of the gravity of the workers' exposure. For example, a May 7, 1953, memo to the Executive office of the CDC, from Alexander D. Longmuir, chief of the PHS Epidemiology Branch, states, "Thursday morning I received a telephone call from Dr. Roy E. Albert, Medical Officer, New York Operations Office, AEC, 70 Columbus Avenue, New York City. Dr. Albert called me at the suggestion of my personal friend, Dr. David D. Rutstein, Professor of Preventive Medicine Harvard Medical School, because he felt we might be interested in a proposal he had to make. His proposal was the desirability of a follow up of between 400 and 600 employees of the Harshaw Chemical Company in Cleveland, Ohio. These employees were exposed for a period of from one to three years in 1945, 1946, and 1947 to 600 times the tolerance dose of radioactive dust, resulting from the processing of uranium and radon. . . . In view of reports from Europe, that uranium miners suffer an exceptionally high incidence of cancer of the lung, Dr. Albert and his advisory groups recommend that these employees also be studied for the same condition." Memo cc'd Dr. Roy E Albert and Dr. Alexander Gilliam. Medicine Health and Safety, AEC, RG 326.

73. Stafford L. Warren, *The Role of Radiology in the Development of the Atomic Bomb,* p. 856. DOE Opennet accession #NV0729054.
74. In the official review of the material releases from Oak Ridge and the relationship to community health effects, fluoride emissions were not even considered, an omission that concerned at least one top scientist. Letter to Dr. Kowetha A. Davidson, Chair Oak Ridge Reservation Health Effects Subcommittee, Oak Ridge National Laboratory, from Kathleen M. Thiessen, PhD Senior Scientist, SENES, Oak Ridge, January 16, 2001. Re: Oak Ridge Reservation Health Effects Subcommittee and review of the Oak Ridge Dose Reconstruction. Thiessen wrote that "there are a number of contaminants that were never evaluated quantitatively during either the Oak Ridge Dose Reconstruction (1994–2000) or the preceding Phase I Dose Reconstruction Feasibility Study (1992–1993). . . . [I]t is clear . . . that the fluorine and fluoride releases from K-25 alone were very large. . . . It is my professional opinion that the historical fluorine and fluoride releases from the K-25 and Y-12 sites should be assessed quantitatively, both with respect to the amounts of material used and released, and with respect to the potential health implications for off-site individuals." cc: Rear Admiral Robert Williams, ATSDR, Mr. Jack Hanley, ATSDR.
75. Paducah began production in 1954. At Portsmouth, Ohio, which opened in 1954, "the quantity of fluorine to be released was steadily increasing and that this fluorine could not be contained in any holding drum, but must be vented

to keep the cascade in proper operation." Memo to H. L Caterson to K. H. Hart, "Venting of Fluorine from the X-326 Building, October 3, 1955, 1089/120" cited in Arjun Makhijani, Bernd Franke, and Milton Hoenig, *Preliminary Estimates of Emissions of Radioactive Materials and Fluorides to the Air from the Portsmouth Gaseous Diffusion Plant, 1954–1984* (unpublished), p. 19.

76. Several of the Area C workers referred to the bridge damage and to the paint tarnishing on cars. The Sierra Club filed a lawsuit for $9,960,000 in Cuyahoga County Common Pleas Court alleging "fluoride fumes from the plant at 1000 Harvard Ave., SE over the past twenty-two years, have destroyed the nearby Harvard Dennison Bridge." *National Fluoridation News* (January–February, 1971), p. 2.
77. Pharmacology Report #558, Monthly Progress Report for June 1947, Box S09F01B227, ACHRE, RG 220.
78. AEC Monthly Status and Progress Reports, July 1949, via Pete Eisler, *USA Today*. The same document notes the "disastrous Donora episode of last winter."
79. Sadtler told me that after World War II, "I was lecturing to the American Chemical Society in Cleveland . . . [on] 'smoke, dust, fumes and fellow travellers.' . . . And a lawyer came up to me and said the judge wants to do something for the monsignor in a certain section of Cleveland. And we agreed that I would investigate. . . . I did find out that Harshaw Chemical was letting off, I believe, HF."
80. "At the present time, at least 10 percent of the fluorine generated for use in the manufacture of uranium hexafluoride is unavoidably lost in the vent gases from the process. The recovery of this fluorine has become of prime importance since the expansion of the uranium hexafluoride manufacturing facilities to the 48 tons of uranium per day production level. The estimated cost of the vented fluorine will amount to $400,000 per year based on the above percentage lost and a cost per pound of $0.65." Memo, "Recovery of Fluorine from Feed Plant Vent Gases," March 2, 1955, ORF14753, ORF18718 for plant damage. Both in Oak Ridge DOE Public Reading Room.

    For dumping, see Capt. Bernard Blum to Lt. Col. Luvern W. Kehe, "Contamination of Water in Poplar Creek," August 10, 1945, Md 319.1, General Essays, Lectures, Box 34, Manhattan Engineer District Accession #4nn 326-85-005, Atlanta FRC, RG 326.
81. See also Chapters 5 and 8. For accounts of pollution in New Jersey and Pennsylvania, see "The Peach Crop Cases." See also, for litigation, E. J. Largent, *Fluorosis: The Health Aspects of Fluorine Compounds* (Columbus, OH: Ohio State University Press, 1961), p. 124. "Claims of damage to plants and animals appeared in almost epidemic numbers along the Delaware River in the Philadelphia area in 1944 and 1945. . . . Since the beginning of this same period of time, a series of claims of fluoride induced damage have appeared in Tennessee."
82. "Fluorine is an extremely toxic and hazardous chemical. There are three potential liabilities associated with its release to the atmosphere. The first

and most significant is the potential effect on agriculture crops and livestock in the surrounding area. . . . The second significant liability is a hazard to personnel in the immediate area, both employees and the general public. The maximum allowable concentration of fluorine in the air as recommended by the national advisory group, the American Conference of Governmental Industrial Hygienists, is 0.1 part per million. Any appreciable release of fluorine to the atmosphere will in all probability result in some concentrations in excess of this level. Although concentrations considerably in excess of this level can be tolerated without permanent injury, a basis for complaint and possible legal action does exist." Letter A. J. Garcia to C. L. Becker, "Fluorine Air Pollution at GAT Plant Site, August 30, 1954, 1089/124." Cited in Arjun Makhijani et al., *Preliminary Estimates*.

83. A. Stern, *Air Pollution* (New York: Academic Press, 1962), p. 391.
84. J. G. Rogers et al., *Environmental Surveillance of the U.S. Department of Energy Portsmouth Gaseous Diffusion Plant and Surrounding Environs during 1987, April 1988*, (ES/ESH-4/V4), 18. See also Makhijani, Franke, and Hoenig, *Preliminary Estimates of Emissions of Radioactive Materials and Fluorides*, p. 20.

    Also, for later HF releases at the Portsmouth, Ohio gaseous diffusion plant, although Ohio had no standards for gaseous fluorides: "As of 1986, Kentucky's seven day ambient air standard was .8 microgram HF/m^3 . . . in comparison data recording sheets from 1973 show individual fluoride measurements as high as 5 micrograms/m^3. 1982 and 1983 measurements also exceeded the above standard, with the maximum off-site average monthly concentrations of fluorides as HF around the plant varying between 1.94 and 6.09 microgram/m^3 in 1982, and between 1.83 and 15.1 microgram/m^3 in 1983." Cited in Makhijani et al., *Preliminary Estimates*, p. 21.

Chapter 5

1. Three years later Harold Hodge would look out over another spectacular view as an official observer of the 1946 atomic bomb blast at Bikini Atoll in the South Pacific. H. Hodge, *J. Dental Res.*, vol. 26 (1947), pp. 435–439.
2. Md 600.914, Progress Reports Rochester, Box 47, Accession #4nn 326-85-005, Atlanta FRC, RG 326.
3. Priorities were determined by combining the rating of: "(1) the toxicity and (2) the number of persons who had real or potential exposure to each compound." The top toxicological priorities were (uranium compounds) UO_2F_2 and (nonuranium) F_2 and HF. Harold Hodge and Carl Voegtlin, eds., *Pharmacology and Toxicology of Uranium Compounds, with a Section on the Pharmacology and Toxicology of Fluorine and Hydrogen Fluoride* (New York: McGraw Hill, 1949), historical foreword, p. 5.
4. Hein interview with Bob Woffinden, timecode 04.21.13, 1997.
5. Hodge was a lead author with R. E. Gosselin, R. P. Smith, and M. E. Gleason of *Clinical Toxicology of Commercial Products*, 5th ed. (Baltimore, MD: Williams and Wilkins, 1984).

6. "Harold C. Hodge, 1904–1990, Pharmacology and Experimental Therapeutics: Oral Biology: San Francisco." In Memoriam. E. Newbrun et al., University of California, web posting.
7. Biographical details in P. Morrow et al., "Profiles in Toxicology—Harold Carpenter Hodge (1904–1990)," *Toxicological Sciences*, vol. 53 (2000), pp. 157–158.
8. A once secret document, "Detailed Duties of Dr. Harold C. Hodge," lists the problems his Pharmacology Section helped to solve. One problem, the "necessity of stated daily maximum intake of fluoride to avoid poisoning," was solved at the Conference on Fluorine Metabolism at the Hotel Pennsylvania in New York in January 1944. Hodge was one of the experts who set the maximum allowable concentration of "6 ppm as *project* allowable exposure per day" (emphasis in original). Folder 2, Box S09FO1B219, ACHRE, RG 220.

   Hodge was elsewhere also clearly conscious of the health toll the war's haste imposed upon workers. For example, in April 1945 he explained to Col. Hymer Friedell the reasons for increasing the maximum allowable concentration of uranium tetrafluoride and several other uranium compounds in bomb factories from 150 to 500 micrograms of uranium per cubic meter of factory air. It was an "emergency war measure to expedite industrial production," he explained, "a compromise between the air concentration which can be maintained during maximum production and the chance of injury to plant workers." Carl Voegtlin and Harold Hodge to Hymer Friedell, April 26, 1945. (Voegtlin was the retired head of the National Cancer Institute at the University of Rochester during the war.) This measure was implemented, directly affecting the work environment of thousands of Manhattan Project industrial workers. Col. Warren explained the new standard more bluntly: "In view of the extreme difficulty in maintaining concentrations of 150 micrograms per cubic meter in industry, it is felt that such a change will be of definite benefit in expediting the war effort." Warren to the Area Engineers, June 1945. Both documents in Mm 3, Md 700, General Essays, Lectures, Box 34, Manhattan Engineer District Accession #4nn 326-85-005, Atlanta FRC, RG 326.
9. A key text is Hodge and Voegtlin, eds., *Pharmacology and Toxicology of Uranium Compounds*. See also, J. H. Simons, *Fluorine Chemistry*, vol. IV, by Harold C. Hodge and Frank A. Smith (New York: Academic Press, 1965) supported in part by a contract with the U.S. AEC at the University of Rochester Atomic Energy Project.
10. Hodge and Voegtlin, eds., *Pharmacology and Toxicology of Uranium Compounds*, historical foreword, p. 1.
11. Hein interview with Mark Watts for Channel 4 Television in the United Kingdom. Interview recorded for "Don't Swallow Your Toothpaste," a program that aired in June 1997.
12. Lansing Lamont, *Day of Trinity* (New York: Atheneum, 1985), p. 251: "The specter of endless lawsuits haunted the military." See also Groves's memo,

cited in chapter 4, note 2, asking for toxicity data. According to the Harvard professor Phillip Drinker, a member of the AEC Stack Gas Committee and an AEC litigation consultant, "In 1947 AEC was apprehensive about damage suits from personnel allegedly injured by radiations or by exposure to various chemicals used." Phillip Drinker to Dr. Thomas Shipman, Health Division Leader, Los Alamos, November 14, 1950, Medicine Health and Safety, RG 326.

For insurance, see article for Aetna's internal magazine *The Aetna-izer*, submitted by Vice President Clifford B. Morcom to Col. K. D. Nichols, August 31, 1945, for review. "The billion-dollar atomic bomb plant at Oak Ridge, Tenn., is probably the most interesting and important of the large number of war projects on which the Aetna Casualty and Surety Company provided coverage in whole or in part, in the last few years. . . . As a result of this need for iron-clad secrecy, the representatives of the Manhattan Project could not even hint to us, or to anyone else, as to what the product of the Clinton Engineer Works was going to be, or what exposures or hazards there would be in its manufacture. It was manifestly impossible for us to provide insurance on any regular basis in view of these circumstances; but the government had asked for our help, and we were anxious to comply." The following passage is scratched out: "in essence, the plan placed the facilities of our organization at the disposal of our policyholders; and, in return for this, the Government agreed to reimburse us for any losses we might sustain." Aetna, Office of Public Information 1944–1967, Box 12, Accession #73A0898, Atlanta FRC, RG 326.

For Travelers, see memo to Col. Warren from Capt. Ferry, March 25, 1944, "Conference in Wilmington, 20th March 1944." Five DuPont officials, two majors from the Manhattan Project, and Mr. Wm. M. Worrell of the Travelers Insurance Co. "Item 3. In a number of instances, men working on construction have been exposed to fumes from processes which give off HF in concentrations sufficient to make them leave their work temporarily. In at least one case illness followed the exposure." Md 700.2, Univ. of Rochester (Medical), Box 54, Accession #4nn 326-85-005, Atlanta FRC, RG 326.

Groves, *Now It Can Be Told*, p. 57: "To facilitate the handling of claims not resulting from a major catastrophe a special fund was established. This fund was placed under the control of du Pont so that it could continue to be available for many years." And on March 28, 1944, at a conference on Extra-Hazardous Insurance attended by the military officials and industrial contractors readying the K-25 plant, Kellex management stated that they were "especially concerned" about the health risk from fluoride exposures. The K-25 employees were, accordingly, defined by a simple criterion, their exposure to fluoride, and categorized "into three (3) groups; those having regular, casual or no exposure to C616 and C216 [codes for uranium hexafluoride and fluorine gas]." At the conference Col. Warren was informed that "the decision was made by Kellex officials that the names of all employees would be submitted to the [Manhattan Project's] District Insurance Sec-

tion, with estimates of the amount of their exposure." Memo to Col. Stafford Warren from Capt Ferry, April 4, 1944. "Conference on Extra-Hazardous Insurance 28 March 1944." Md 337, New York Meetings and Conferences, Box 30, Accession #4nn 326-85-005, Atlanta FRC, RG 326.

13. Several of the Manhattan Project's biggest industrial contractors had been badly exposed to worker lawsuits before the war. In the mid-1930s Union Carbide—now running the K-25 gaseous diffusion plant at Oak Ridge—had endured congressional scrutiny and legal claims following the Gauley Bridge silicosis deaths. DuPont, too, had won cruel headlines in the early 1930s from the New York press following an epidemic of death and injury at its New Jersey tetra ethyl lead plants.

    Bomb-program officials also recalled the prewar litigation and public scandal over female workers who had died following their employment at the U.S. Radium Corporation in Orange, New Jersey, their jaws eaten by cancer after licking radium from the brushes they had wetted to paint luminescent watch dials. See, for example, "Review of Document" by L. F. Spalding of the Insurance Branch to Charles A. Keller, Declassification Officer, February 5, 1948: "We have reviewed ["Biochemical Studies Relating to the Effects of Radiation and Metals" by Samuel Schwartz] from a nontechnical point of view and although it is conceivable that the contents thereof might arouse some claim consciousness on the part of former employees we are unable to predict that the Commission's interests would be unjustifiably prejudiced by its publication. However, in the event latent disabilities due to exposures reported in this document should result in publicity similar to that which arose out of the 'radium dial' industry, the public relations division would be involved." Document SO9FO1b22, File DOE 120994-A #1, ACHRE, RG 220.

    See also Hodge, *J. Dent. Res.*, vol. 26 (1947), pp. 435–439. "These women, despite all safeguards, persisted in tipping on their tongues the brushes they were using to apply radium paint to airplane dials. Those unfortunate enough to retain lethal amounts of radioactive material died of cancer from radium deposited in the bones; deaths were recorded five, ten, fifteen years later." For an excellent summary of the radium dial painters, see Eileen Welsome, *The Plutonium Files* (New York: Dial Press, 1999), p. 47.

14. See for example, "The Medical Section has been charged with the responsibility of obtaining toxicological data which will insure the District's being in a favorable position in case litigation develops from exposure to the materials," Col. Stafford Warren to Dr. John Foulgar of DuPont's Haskell Laboratory in a letter dated August 12, 1944. Box 25, Accession #72C2386, Atlanta FRC, RG 326. Also, it appears that some studies were simply not performed, or at least that data were not published. Where are the published studies of the toxicity of oxygen fluoride, a chemical that Hodge's team referred to as "the most toxic substance known" and was listed as a high priority for bomb program investigation? Where are the chronic studies on the various fluorocarbon compounds being used in the diffusion plants? The reluctance

of Hodge's team to perform such studies, which of course better resembled the actual conditions workers faced, was a frustration of Harvard University's Harriet Hardy, a leading beryllium researcher. "The chronic disease is certainly our most pressing problem, and at present the whole weight of the Rochester work, if I understood Dr. Hodge, is on the acute manifestation. . . . I cannot understand the defeatist attitude about producing chronic changes in animals with beryllium compounds sufficiently approximate to the human pathology." Dr. Hardy to Dr. Warren, "Recent trips to Cleveland and Rochester," September 13, 1949, DOE Opennet #1153735.

15. Col. Stafford Warren, Memorandum to the Files, "Purpose and Limitations of the Biological and Health Physics Research Program," July 30, 1945, p. 3, Medical and Health Problems, Box 36, Accession #72C2386, Atlanta FRC, RG 326.
16. Lt. Col. Hymer Friedell, Memo, "Future Medical Research Program," February 26, 1946, is found as the third item in a file located at 0712317 in the Department of Energy's HREX electronic search engine.
17. The Rockefeller Foundation and the Carnegie Corporation had funded broad programs of dental research at Rochester, Yale, and Harvard during the Depression, seeking to improve the terrible condition of teeth in the United States. There is no indication in the files seen by this author that the prewar granting was anything other than philanthropic in nature.

    For Hodge's résumé, see his testimony before Cong. Wier. HR 2341: "A Bill to Protect the Public Health from the Dangers of Fluorination of Water." Hearings Before the Committee on Interstate and Foreign Commerce, House of Representatives, 83rd Congress, May 25, 26, and 27, 1954, p. 470. "Since 1937 I have been continuously engaged part time as a consultant toxicologist for a number of industrial companies."
18. Hodge links to Eastman from author interview with toxicologist and Rochester alumnus Robert Phalen.
19. The University of Rochester's Manhattan Project medical budget included specific funding for Rockefeller projects. Rochester Organizational Chart. Also, ESSO labs, Standard Oil, and the Rockefeller Institute were working on various projects, including the hexafluoride gas centrifuge. "PB authorizations as of March 9, 1942, 1/14/42 Standard Oil Development Co. 'Centrifuge method of separation leading to design of plant' PB #2 amount $100,000'" and "3/9/42 Standard Oil Development Co. 'Pilot Plant Building' PB #12 $250,000." Doc #310, Records of Section S-1 Executive Committee, RG 227.3.1. The Carnegie Institute of Washington had fluoride interests, as well. It investigated liquid thermal diffusion with Philip Abelson as early as 1941, in a precursor project to the Philadelphia Navy Yard project, which was itself a prototype of the S-50 complex at Oak Ridge. Amato, I., "Pushing the Horizon. Seventy-Five Years of High Stakes Science and Technology at the Naval Research Laboratory."

    See also Harold Urey, Program Chief, Columbia University to James Conant, January 19, 1942: "I wish to recommend that a contract be drawn

to the Rockefeller Institute for Medical Research, New York, NY for work on the separation of the uranium isotopes by the mobility method, this work to be done under the direction of Dr. Duncan A MacInnes and Dr. Lewis G Longsworth." And November 19, 1942, to Dr. Wensel from Urey: "I have asked the Rockefeller Institute people under Dr. MacInnis to do some work on the chemical separation work . . . I wonder if it would be possible to amend their contract." Doc #336, Records of Section S-1, Executive Committee, RG 227.3.1.

20. Col. Warren to Dr. John Foulger Box 25, Accession #72C2386, Atlanta FRC, RG 326.
21. Much of this account was cowritten with Joel Griffiths and first appeared in 1997 in various alternative media outlets, including *Earth Island Journal*, eventually winning a 1999 Project Censored Award.
22. Garfield Clark was measured at 25.6 ppm blood fluoride, Ollie Danner at 31.0 ppm. Farmer Willard Kille, diagnosed by his doctor as fluoride poisoned, had 15.0 ppm. Report submitted by Philip Sadtler, December 11, 1945. In Groves papers, NARA. That these levels are high can be seen from H. Hodge and F. A. Smith, *Fluorine Chemistry*, vol. IV, p. 15. (The New York Examiner's office made available for autopsy the bodies of fatal fluoride poisonings from 1935 to 1949. Those data showed fluoride blood levels of between 3.5 and 15.5 ppm.)
23. The company's giant Chamber Works at Deepwater, New Jersey, near the mouth of the Delaware River, has long handled some of the company's most dangerous chemicals, with workers and the local community traditionally paying the price. During World War I as many as 10,000 workers had been employed there making munitions and poison gas, according to G. Colby, *DuPont Dynasty: Behind the Nylon Curtain* (Secaucus, NJ: Lyle Stuart, 1984), p. 195.

    Referring to World War I aftermath, Colby writes, "In DuPont's Deepwater, New Jersey, plant across the river from Wilmington, workers died from poisonous fumes of the lethal benzol series, their bodies turning a steel blue. At the Penns Grove, New Jersey, plant workers were called 'canaries': picric acid had actually dyed their skins yellow. Picric acid poisons the mucous membranes of the respiratory tract, attacks the intestinal tract, and destroys the kidneys and nerve centers." In the 1920s several Deepwater workers had also been killed and hundreds injured in an horrific and months-long episode, dubbed by the New York press "the loony gas" poisoning, as DuPont began making the highly toxic gasoline additive tetra ethyl lead (TEL). Salem County, where the plant is located, had the highest rate of bladder cancer for white males in the United States from 1950 to 1969, according to the National Cancer Institute. Also, the *New York Times*' Mary Churchill learned in January 1975 that since 1919, 330 employees at the plant had contracted bladder cancer.

    See also the testimony of Willis F. Harrington, former Chair of DuPont's Kinetic Chemicals, *United States* vs. *DuPont* (1953), p. 693. *United States of*

America vs. *E. I. DuPont de Nemours, General Motors, United States Rubber, et al.*, Civil Action No. 49 C-1071, U.S. District Court for the Northern District of Illinois, Eastern Division, before Judge LaBuy, April 13, 1953, p. 3798. For Manhattan Project employees during World War II, William C. Bernstein, Captain Medical Corps. Memorandum To Colonel Stafford L. Warren, Chief Medical Section. November 3, 1944. Subject: Report on Medical Section in Wilmington, Delaware. November 3, 1944, Box 14, Wilmington Area, Accession #72C2386, Atlanta FRC, RG 326. (Note attached from Howland, "total engaged in work of Manhattan District 1122.")

24. William C. Bernstein, Captain Medical Corps. Memorandum to Colonel Stafford L. Warren, Chief Medical Section. November 3, 1944. Subject: Report on Medical Section in Wilmington, Delaware. November 3, 1944, Wilmington Area, Box 14, Accession #72C2386, Atlanta FRC, RG 326.
25. B. J. Mears, Captain, Medical Corps, Assistant. Medical Clearance on Terminated Madison Square Area Contracts. To: The District Engineer, Manhattan District, Oak Ridge, Tennessee. (Attention: Major J. E. Ferry). October 5, 1945, Medical Clearances, Terminated Madison Square Contracts, Box 36, Accession #4nn 326-87-6, Atlanta FRC, RG 326.
26. William C. Bernstein Captain, Medical Corps, Memorandum to Col. Stafford L. Warren, Chief, Medical Section, Subject: Occupational Disability Cases Observed. November 3, 1944, Wilmington Area, Box 14, Accession #72C2386, Atlanta FRC, RG 326.
27. To Stafford Warren, Subject: Supplementary Report of Medical Examination at X-Works [code for Chamber Works] February 2, 1945, Wilmington Area, Box 14, Accession #72C2386, Atlanta FRC, RG 326.
28. William C. Bernstein, Captain, Medical Corps. Memorandum to Col. Stafford L. Warren, Chief Medical Section. November 3, 1944. Subject: Report on Medical Section in Wilmington, Delaware. November 3, 1944. Wilmington Area, Box 14, Accession #72C2386, Atlanta FRC, RG 326.
29. "Memorandum to the files, Subject: Recapitulation of Work Accomplished During Temporary Duty at X Works." 1st. Lt. Birchard M. Brundage, February 17, 1945.
30. Memo to Capt. B. Brundage (through Col. Warren), November 23, 1945 (draft version, accompanied by handwritten notes detailing other "nuisance claims"). General Correspondence, Box 36, New York Operations Research and Medicine Division, Accession #72C2386, Atlanta FRC, RG 326.
31. Hodge to Warren, March 11, 1946. Md 700.2, Division of Rochester, Atlanta FRC, RG 326. For volume of fluoride in air pollution, see example, "In the Kinetics plant, Mr Knowles described the practice of ten years back in which SiF_4 was vented to the air. SiF_4 is quite poisonous." Hodge to Warren, May 1, 1946, cc Lt. Col. Rhodes, Crop Contamination (New Jersey), Box 33, Accession #72C2386, Atlanta FRC, RG 326.
32. Hodge to Warren, May 1, 1946, cc. Lt. Col. Rhodes, Crop Contamination (New Jersey), Box 33, Accession #72C2386, Atlanta FRC, RG 326.

33. Lt. Col. Cooper Rhodes memo to General Nichols, "Subject: Conference with Mr. Willard B. Kille." March 25, 1946. Groves Papers, NARA, via Griffiths and Honicker.
34. Conference on Fluorine Residues, February 12, 1946, Groves Papers, NARA, via Griffiths and Honicker.
35. Cooper B. Rhodes, Lt. Col. "Memorandum for the Files. Subject: Peach Crop Cases (*Kille et al.* vs. *DuPont*), 2 May 1946. . . . Cc: General Groves, General Nichols." Groves Papers, NARA, via Honicker and Griffiths.
36. Groves to the Commanding General, Army Service Forces, Pentagon Building, Washington, DC, August 27, 1945, Groves Papers, NARA.
37. Gen. Groves to Sen. McMahon, February 18, 1946, Groves Papers, NARA.
38. The note to Groves's senior deputy includes a response, dated February 25, 1946. "General Groves: That firm of consulting chemists has been employed by the plaintiffs in the 'peach crop' suits against DuPont, and Mr. Sadtler has been very active in gathering evidence to present on behalf of the plaintiffs in those suits." Groves Papers, NARA, via Honicker and Griffiths.
39. Multiple taped author interviews with Philip Sadtler, March 1993. Also, account from *The Chemist* (1965), pp. 349–350; that the Sadtler firm had testified on behalf of Coca-Cola to say that cocaine was not a chemical ingredient of the beverage.
40. Sadtler recalled that one of the agents he had met in the New Jersey orchards later gave an account of their wartime sleuthing to the media. Joseph Marshall, "How We Kept the Atomic Bomb Secret," *Saturday Evening Post*, November 10, 1945, includes the following story: "Once, in an East Coast city, Agents Harold Jensen and Harold Zindle were maintaining constant surveillance of an individual under suspicion of being involved with enemy agents." The *Post* story does not give the name of the person being tailed but reports that the government agents believed the "subject . . . apparently suspected he was under surveillance," and so they built a fence to block escape from the house via the rear. The published account concludes, "It is presumed that the subject is still wondering why his neighbor decided to put up the fence so suddenly, and his neighbor is wondering why the subject did. And Security is still wondering whether the subject is a spy." Sadtler told this writer that he had no idea he was under surveillance but that on one occasion, "I decided to take the car rather than the train and I jumped the fence so they did not see me come out." Sadtler was gutsy. He rented a plane and flew over the DuPont works, to investigate the pollution, further displeasing authorities. Author interview.
41. Interview with Joel Griffiths, first published in Griffiths and Bryson, "Fluoride, Teeth, and the Atomic Bomb," *Waste Not: The Reporter for Rational Resource Management*, September 1997.
42. File. Lt. Col. Cooper B. Rhodes, "Kille et al. (12 Separate Cases) vs. DuPont." February 13, 1946, Groves Papers, NARA.
43. Groves to the Commanding General, Army Service Forces, Pentagon Building, Washington, DC, August 27, 1945. Groves Papers, NARA.

44. Gen. Groves to Sen. McMahon, February 18, 1946, Groves Papers, NARA.
45. Giordano interviews conducted in 1997 by Joel Griffiths and Clifford Honicker on a trip to the peach orchards. Clemente interview conducted by telephone and e-mail with the author in 2002.
46. C. A. Taney Jr., Major, Corps of Engineers, to William C. Gotshalk, September 24, 1945, cc. General Groves, in Groves file on New Jersey pollution, NARA, via Joel Griffiths.
47. William Gotshalk to Maj. C. A. Taney, U.S. Engineer Office, New York, NY, August 28, 1945, Groves Papers, NARA.
48. Maj. C. A. Taney to Gen. L. R. Groves, June 1, 1945, Groves Papers, NARA.
49. Thiessen, interviewed several times for this book, is a senior scientist with SENES Oak Ridge, Inc., Center for Risk Analysis. She is the author of *Summary Review of Health Effects Associated with Hydrogen Fluoride and Related Compounds*. U.S. Environmental Protection Agency, December 1988.
50. Lt. Col. Cooper B. Rhodes, "Memorandum for the Files. Subject: Peach Crop Cases, *Kille et al.* vs. *DuPont*, May 2, 1946, Cc: General Groves, General Nichols." Groves Papers, NARA, via Honicker and Griffiths.

Chapter 6

1. *Time*, April 24, 1944, p. 43.
2. D. B. Ast, "A Plan to Determine the Practicability, Efficacy, and Safety of Fluorinating a Communal Water-Supply, Deficient in Fluorine, to Control Dental Caries," in W. J. Gies, ed., *Fluorine in Dental Public Health* (New York: New York Institute of Clinical Oral Pathology, 1945), p. 44.

   Ast's paper was delivered at a symposium of the New York Institute of Clinical Oral Pathology, New York City, October 30, 1944. According to the editors of *Fluorine in Dental Public Health*, "Dr. Ast's address (pp. 40–45) states the basis for, and the procedure in, the effort in the State of New York to determine, in a comprehensive and extended research, whether mass prevention (control) of dental caries (under the conditions stated in the preceding paragraph) is attainable *without inducing toxic effects elsewhere in the body*," p. 6 (emphasis in the original). See also F. McKay, *Fluorine in Dental Public Health*, p. 18, "Newburgh has become another 'biological experiment station,' in which the rationale is applied directly to humans without previous laboratory experiments on animals."
3. Memorandum "Summary of Conference with Colonel Nichols," dated New York City, July 23, 1943, notes, "5. Agreed to farming out Fl and HF toxicity experiments to Dr. Fairhall of the U.S. Public Health Service, Bethesda, Mr [left blank] through Dr. Wenzel—with experiments outlined by Drs Hodge and Ferry." Thus, the Manhattan Project is secretly directing the wartime PHS fluoride studies. Bomb-program medical planners, including Drs. Hodge, Friedell, and Warren, decided on August 31, 1943, that there was need for an "orientation conference on fluorine toxicity under auspices of the U.S. Public Health Service or OSRD." New York Operations Research

and Medicine Division, Correspondence 1945–1952, Box 36, RG 326. The conference transcripts are in a file in the same box coded "G-118."

4. James Conant, Chairman NRDC, to Mr. J. J. Townsend, Public Health Service, Bethesda, MD, September 25, 1943; and Townsend to Conant, September 29, 1943, Documents 295 and 296, Records of Section S-1 Executive Committee, RG 227.3.1.
5. Transcript of Metabolism of Fluorides Conference, main session, Hotel Pennsylvania, New York, NY, January 6, 1944, Dr. Neal, p. 24, via Pete Eisler, *USA Today*.
6. Ibid., Dr. Calvary, Chief of the Division of Pharmacology, FDA, p. 22. On animal tests, see Memo to Safety Section files, Joseph Faust, Assoc. Engineer (Safety) January 14, 1944, Oak Ridge Reading Room, ORO #1304.
7. Transcript of "Metabolism of Fluorides" Conference, main session, Hotel Pennsylvania, New York, NY, January 6, 1944, via Pete Eisler, Ast comment at p. 27. (Interviewed by me in 1997, David Ast said that he could not remember having attended the New York conference.)
8. Memorandum to The Area Engineer, Rochester Area, Rochester, NY. Subject: Funds for Incidental Expenses of Meeting on "Fluoride Metabolism," December 31, 1943. John L. Ferry, Md 123 (729.3), File labeled G-118 (c), A2, Box 36, Accession #72C2386, Atlanta FRC, RG 326.
9. "I think it would be a definite step forward if we forgot about definite limits and called them 'control limits,'" stated Helmuth Schrenk from the U.S. Bureau of Mines. Committee on Fluoride Metabolism, Round Table Discussion During Luncheon Period, continued in the Evening, January 6, 1944. All of these quotes come from the same lunchtime conference transcript. Transcript in file labeled G-118 (c), A2, Box 36, Accession #72C2386, Atlanta FRC, RG 326.
10. E. R. Schlesinger, D. E. Overton, and H. Chase, "Newburgh-Kingston Caries-Fluorine Study II. Pediatric Aspects—Preliminary Report," *Am. J. Public Health* (June 1950), p. 725.
11. "It is unknown," for example, complained Captain Peter P. Dale of Harold Hodge's Division of Pharmacology, in September 1945, "what the critical levels of T, F or 'P' storage in man are [codes for uranium, fluoride, and plutonium], or whether they may have a potentially deleterious effect. Are such factors as the age, sex and the physical and chemical properties of the reagent important?" "Dental Research Program" Memo to Stafford L. Warren, September 24, 1945, from Capt. Peter P. Dale, Capt., DC AUS.
12. D. E. Gardner, F. A. Smith, and H. C. Hodge (with D. E. Overton and R. Feltman) *UR 200 Quarterly Technical Report* (October 1, 1951–December 31, 1951), University of Rochester, "Fluoride Concentration of Placental Tissue," p. 4. "D. E. Overton of the Newburgh Fluorine Demonstration secured the samples from patients in that city." Published version in *Science* 115 (February 22, 1952), p. 208.
13. Memo to Lt. Col. Hymer Friedell from Capt., Henry L. Barnett, February 8, 1946, "Organizational Plan for Manhattan District Personnel Assigned

to Japanese Report." Barnett had also seen the Trinity explosion, and been among the first to detect the fallout cloud. Lansing Lamont, *Day of Trinity* (New York: Atheneum, 1965), p. 244. An H. "C" Barnett is listed in charge of "special studies" at the University of Rochester, "Organization Chart of the Manhattan Department, University of Rochester," in Harold Hodge and Carl Voegtlin, eds., *Pharmacology and Toxicology of Uranium Compounds, with a Section on the Pharmacology and Toxicology of Fluorine and Hydrogen Fluoride* (New York: McGraw Hill, 1949), p. 1061. Still another member of the Newburgh Technical Advisory Committee, a Columbia University biostatistician, John Fertig, may have been connected to the bomb program. Fertig did war work for the Office of Scientific Research and Development (OSRD), the same federal bureaucracy that had sired the atomic bomb. *American Men of Science*, 9th and 10th editions.

14. For Howland's fluoride work: F. A. Smith, D. E. Gardner, and H. C. Hodge, "Investigations on the Metabolism of Fluoride," *J. Dent. Research* (October 1950), p. 596: "We are indebted to Dr. J. Howland for taking the Rochester blood samples." (The study is a comparison of the fluoride levels in blood and urine in Newburgh and Rochester.) Also, Howland wrote "Studies on Human Exposure to Uranium Compounds," which investigated the Philadelphia Navy Yard blast, blaming "the fluoride ion" for injuries. Hodge and Voegtlin, eds., *Pharmacology and Toxicology of Uranium Compounds*, p. 1005: Howland had helped to assemble the atomic bombs on the Pacific island of Tinian, then surveyed the aftermath with his Rochester colleague, Capt. Barnett.
15. Eileen Welsome, *The Plutonium Files: America's Secret Medical Experiments in the Cold War* (New York: Random House, 1999). Capt. J. W. Howland was selected as Assistant Head of the Division of Biological and Health Physics Research of the Medical Section. "The Manhattan District Official History," Book 1, General, vol. 7, Medical Program, p. 5.17.
16. Similarly, Ast could not recall a documented 1946 trip to New Jersey with Harold Hodge after the war, to study the poisoned children near the DuPont uranium hexafluoride plant. Author interview, 1997.
17. "Fluoride Metabolism: Its significance in Water Fluoridation" *J. Am. Dent. Assoc.*, vol. 52 (March 1956), p. 307.
18. As medical director, Capt. Friedell had been well aware of the Manhattan Project's concern about fluorides. On January 20, 1943, for example, after visiting the War Research Laboratories at Columbia University, where a small-scale fluoride gaseous diffusion plant had already been built, he reported that "The primary potential sources of difficulty may be present in the handling of uranium compounds . . . and the coincident use of fluorides which are an integral part of the process." "Initiation of Medical Program for Project at Columbia University," January 20, 1943, Friedell to District Engineer. Friedell had also investigated fluoride poisoning in workers at the Harshaw Chemical Company in Cleveland.
19. "Information that fluorides are not hazardous" would have been especially helpful to the bomb program's Legal Division, suggested Friedell.

20. Author interview, December 3, 2002.
21. Dean's epidemiological studies in the 1930s had given key scientific support to the idea that fluoride may play a role in dental health. As the PHS's key fluoride expert, Dean attended at least one Newburgh Advisory Committee meeting.
22. G-10 file, Correspondence 1945–1952, New York Operations Research And Medicine Division, Box 38, Atlanta FRC, RG 326.
23. Also in the G-10 file is a letter from Rochester's Harold Hodge to Dr. Edward S. Rogers of the New York Department of Health, requesting more bone X-rays of Newburgh and Kingston children. "This would give us a good check on . . . whether the general development, especially the skeletal development, in the two cities is comparable," Hodge explained. Similar information was then being sought from workers in the wartime bomb factories, where bone X-rays were an early warning of fluoride poisoning. "The purpose of X-raying the Newburgh children was, to pick up any toxic effect which would manifest itself in bone changes." Conference with members of the Technical Advisory Committee on Fluorination of Water Supplies, June 1, 1944, G-10 File.
24. G-10 file, Correspondence 1945–1952, New York Operations Research And Medicine Division, Box 38, Atlanta FRC, RG 326.
25. Dean's opposition "constituted a strong minority expression" Chairman Hodge noted. New York's leading dental official, David Ast, was furious at the Public Health Service expert's behavior that day. "It upset me a great deal," commented Ast. More than half a century later, Ast stills feels double-crossed by Dean. Ast had been planning the Newburgh experiment for more than a year. "I had conferred with him about the Newburgh study and he had encouraged me," Ast told me. Taped author interview, July 31, 2002. Ast was then "almost 100." While he said that he knew Hodge had "something" to do with the Manhattan Project, he attributed Dean's flip-flop on public-health concerns to career ambition. Behind the scenes a furious scramble was taking place to be the first to add fluoride to the United States' water. Dean had been planning his own fluoridation experiment, Ast said. "He was going to do it in Michigan. He wanted to get in before I could."
26. In an enthusiastic letter to Dr. William Davis of the Michigan Bureau of Public Health Dentistry, Dean makes no further mention of the worrisome potential "toxic effects" he had feared in Newburgh. "Let me know what you think of actually getting started on this proposition," he wrote to Davis on July 14, 1944. "I still think Grand Rapids would probably be the most desirable place for the fluorination." Money would be no problem, Dean suggested. "You would probably have little difficultly in obtaining this from a foundation, for instance the Kellogg Foundation," he wrote to Dr. Davis. Frank J. McClure, *Water Fluoridation: The Search and the Victory* (Bethesda, MD: U.S. NIDR, 1970), p. 112.
27. "Let no one think that any one of us would seriously consider exposing the population of a city of 165,000 [Grand Rapids' population in 1944] to a possible hazard of an unknown risk," the Chief Dental Officer for the PHS,

John Knutson, told the Michigan State Dental Society in 1953. J. W. Knutson, "An Evaluation of the Grand Rapids Water Fluoridation Project," *J. Michigan State Medical Sc*., vol. 53 (1954), p. 1001. Cited in McClure, *Water Fluoridation*, p. 110.

28. Multiple interviews with author. First published in Griffiths and Bryson, "Fluoride, Teeth, and the Atomic Bomb," *Waste Not: The Reporter for Rational Resource Management* (September 1997).
29. Progress Report No. 1 of Contract No. W-7401-eng-49 at the University of Rochester (report of the work for period May 1, 1943, to December 31, 1943, submitted by Andrew H. Dowdy, M.D., Director), Box S09F01B227, ACHRE, RG 220.
30. "DuPont" File, New York Operations Research and Medicine Division, Correspondence 1945–1952, Box 28–47, Box 36, Atlanta FRC, RG 326. For Priest's fluorine work at Columbia, see multiple papers in *Industrial and Engineering Chem.* (March 1947).
31. P. Dale and H. B. McCauley, "Dental Conditions in Workers Chronically Exposed to Dilute and Anhydrous Hydrofluoric Acid," *JADA*, vol. 37, no. 2 (August 1948). First presented at the twenty-fifth general meeting of the International Association of Dental Research, Chicago, June 21–22, 1947.
32. See chapter 4, notes 72 and 73.
33. The published study acknowledges the "assistance and suggestions of Drs Harold C. Hodge, . . . in the preparation of this paper." The unpublished version is via Griffiths and Honicker.
34. Division of Safety and Hygiene, March 1, 1949, John H. Fluker, Superintendent, Division of Safety and Hygiene, Columbus, OH, In Re: Harshaw Chemical Company. Memo, via John Fedor.
35. "Tabulation of results obtained from measurements of urine samples collected from workers at the Harshaw Chemical Company from 6 to 13 December 1945." Report No. 5373. From Capt. B. J. Mears to Mr. F. A. Becker, Harshaw Chemical Company, Md 319.1, General Essays, Lectures, Medical Report, Box 34, #4nn 326-85-005, Atlanta FRC, RG 326.

Chapter 7

1. J. Marks, *The Search for the Manchurian Candidate: The CIA and Mind Control* (New York: Times Books, 1979).
2. See Subproject 46 of John Marks collection at the National Security Archive. There is a second document in these files noting an interest in fluoride. A redacted November 29, 1949, letter discusses chemicals best suited to kill people. "One of these, sodium fluoacetate, when ingested in sufficient quantities to cause death does not cause characteristic pathologic lesions nor does it increase the amount of fluorine in the body to such a degree that it can be detected by quantitative methods." See Box 4, file titled "Document Indexes Abstracts and Documents," Marks Collection, National Archive.
3. "Those present at the meeting were Drs. Dowdy, Bale, Fink, McKann, Bassett, Hodge, and others representing the Rochester Group, Capt. Bryan

representing Col. Warren's office, and W. Langham representing the Santa Fe group." Folder 4, Box S0F01B230, ACHRE, RG 220.

4. "Distribution and Excretion of Plutonium Administered Intravenously to Man," September 20, 1950, Division of Health and Biology, Folder 5, Box S0F01B230, ACHRE, RG 220.
5. Welsome, *The Plutonium Files*, p. 475.
6. Details of those government experiments were declassified in 1994. On June 5, 1945, for example, a University of Rochester letter marked "Secret" details plans for "increasing the human metabolism studies." Ten additional patients are scheduled for "injection with T [code for uranium]," the letter states. "The preparation and analysis will be done by Dr. Hodge," notes the author, Dr. Andrew Dowdy, to Dr. W. F. Bale, of Rochester's "Special Problems Division." The letter is cc'd to Dr. Hodge. Dr. Andrew Dowdy to Dr. W. F. Bale, Special Problems Division. University of Rochester intramural correspondence, Box S0F01B230, ACHRE, RG 220.

   The following year, 1946, Hodge was given direct responsibility for the experiments. L. H. Hemplemann and Wright H. Langham, "Detailed Plan of Product Part of Rochester Experiment." This document has a section called "General Plan of the Rochester Experiment" at p. 5, which details Hodge's involvement in the uranium experiments. Document marked 9000528, Box S09F01B230, ACHRE, RG 220.
7. The document, titled "Detailed Plan of Product [code for plutonium] Part of Rochester Experiment," includes a section on other human experiments. The medical director, Stafford Warren, had determined that "fifty subjects" were needed, ten for each substance, the document explained, "in order to establish, on a statistically significant number of subjects, the metabolic behavior of the hazardous material, product [code for plutonium], radium, postum, tuballoy [code for uranium] and lead." Under the subheading "Personnel and Distribution of Responsibility," a single name is listed for the uranium experiments: "Harold Hodge." Both patient accounts are from University of Rochester Monthly Progress Reports, for April 1947 (M-1968) and February 1947 (M-1954), Box S09F01B230, ACHRE, RG 220.

   An internal Rochester report on the experiments, "The Tolerance of Man for Hexavalent Uranium," noted that for the final subject, the alcoholic, the experiments had been successful, and that the "rise in urinary catalase and protein" from the man's liver suggested that, for uranium exposure, "tolerance had been reached." Samuel Basset, Albert Frenkel, Nathan Cedars, Helen Can Alstine, Christine Waterhouse, and Katherine Cusson, "The Tolerance of Man for Hexavalent Uranium," Folder 4, Box S0F01B230, ACHRE, RG 220.
8. Dr. Sweet wanted to study whether uranium could be used in "therapy of brain tumors." See Bob Bernard, interviewed by Newell Stannard in 1975, for Hodge link to uranium injections on Bill Sweet's patients at Massachusetts General Hospital. DOE Opennet #0026691. However, according to an internal report from the Union Carbide Nuclear company, the Atomic Energy

Commission at Oak Ridge was "concerned with the long-term radiological effect that enriched uranium may have upon production employees who have inhaled dusts, mists and fumes of uranium." Accordingly, uranium injections were given to Massachusetts General Hospital patients following their tumor operations, in order to obtain "data on the distribution and excretion of uranium in these patients" and to "determine the permissible intravenous dose." S. R. Bernard and E. G. Struxness, *A Study of the Distribution and Excretion of Uranium in Man, An Interim Report*, ORNL-2304, Box S09F01B294, ACHRE, RG 220.

9. Morgan interview, January 6, 1995, by Gil Wittemore and Miriam Bowling, p. 109, ACHRE, RG 220.
10. And as an early member of a group of scientists known as the American Conference of Government and Industrial Hygienists (ACGIH), Hodge helped set standards for the "threshold" levels of chemicals and contaminants that millions of citizens breathe in factories and mills.
11. Advisory Committee on Human Radiation Experiments, *Final Report* (Washington, DC: Government Printing Office, 1995).
12. The biomedical work had continued during the cold war at the Rochester Atomic Energy Project (AEP), funded with millions of dollars from the federal Atomic Energy Commission.
13. In the 1930s generally workers had contracted jaw cancer from licking their brushes as they painted radium onto watch dials. The poisoning was widely reported in the press and guided the Manhattan Project in its insistence on secrecy to prevent similar lawsuits or bad publicity. For example, in a letter to Charles Keller of the AEC Declassification Branch, L. F. Spalding of the Insurance Branch contemplates declassifying a medical document "Biochemical Studies Relating to the Effects of Radiation and Metals" by Samuel Schwartz. Spalding warns that "the contents thereof might arouse some claim consciousness on the part of former employees" and writes that "in the event latent disabilities due to the exposures reported in this document should result in publicity similar to that which arose out of the "radium dial" industry, the public relations section would be involved." When Guttman's team asked in 1995 for the files of the AEC Insurance Branch, he recalled, nobody at today's DOE had even heard of the Insurance Branch. Finding the old documents was like "asking my nephew for his grandfather's stamp collection," Guttman said.
14. AEC Memorandum dated October 8, 1947, to Advisory Board on Medicine and Biology, "Subject: MEDICAL POLICY," Document DOE #1019707, also marked RHTG Classified Docs, Box RHA 248-7 2 of 3, Building 2714.H, Vault. Via Peter Eisler, *USA Today*.
15. "Questions of General Policy," November 16, 1943, Md 319.1 Report Medical Ferry Box 25, Manhattan Engineer District Accession #4nn 326-85-005, Atlanta FRC, RG 326. See also Jack Hein interview with UK journalist Bob Woffinden, at timecode 04:18:55 1997; "They also did extensive studies on

the people working in the atomic energy plants that might be exposed to fluoride."

16. "Memorandum to Major J. L. Ferry, Manhattan District Oak Ridge, from Capt. B. J. Mears, July 5, 1945, subject, Visit to E. I. DuPont de Nemours & Co." "Preparation of the IBM cards will be done by Dr. Evans [DuPont] after he has received his new equipment and the operators have been instructed by Mr. M. Wantman [Rochester]. . . . The results of the statistical survey will be available only to the Medical Section of the Manhattan District," Md 701, Medical Attendance, Box 54, Accession #4nn 326-85-005, Atlanta FRC, RG 326.
17. Whether fluoride damaged kidneys, and whether fluoride in urine would therefore be a good measurement of occupational fluoride exposure, was key information sought by the bomb program. (Extra fluoride was stored in the bones of those injured patients, the government scientists found.) AEC No. UR-38, 1948, Quarterly Technical Report. Also cited in Kettering Lab unpublished report, "Annual Report of Observations on Fluorides. October 25, 1954." Kettering did similar experiments on patients with damaged kidneys, according to this report.
18. Special Report 454, "Report on the Work of the Pharmacology Division," included in summarized subsection "The Toxicology of Special Materials," via Joel Griffiths.
19. Roholm to Col. J. P. Hubbard, Public Health Section, Dagmarhus, July 20, 1945. Hubbard is probably an Allied occupation official. The letter is in the files of the Rockefeller Archive, Folder 2102, Box 310, RF RG2 713. Roholm explained that he wanted to recontact H. T. Dean at the National Institute of Health and Margaret C. Smith at the University of Arizona, who had discovered that fluoride causes dental mottling.
20. Roholm to Frank J. McClure (U.S. National Institutes of Dental Research), June 13, 1946. On Roholm's attitudes toward American health care: Danish newspaper clipping in Roholm family scrapbook, translated by daughter-in-law Karin Roholm. Personal meeting in New York, May 2001.
21. "Fluorine interferes with the normal calcification of the teeth during the process of their formation," the U.S. Department of Agriculture claimed in 1939, "so that affected teeth, in addition to being unusually discolored and ugly in appearance, are structurally weak and deteriorate early in life. For this reason, it is especially important that fluorine be avoided during the period of tooth formation, that is from birth to the age of 12 years . . . this dental disease is found when water containing even as little as 1 part per million is used." *Yearbook of Agriculture* (1939), p. 212.

    "Fluorides are general protoplasmic poisons," the American Medical Association warned in 1943, "probably because of their capacity to modify the metabolism of cells by changing the permeability of the cell membrane and by inhibiting certain enzyme systems. . . . The sources of fluorine intoxication are drinking water containing 1 part per million or more of fluorine. . . . Another source of fluorine intoxication is from the fluorides used in the

smelting of many metals, such as steel and aluminum, and in production of glass, enamel and brick." *JAMA*, vol. 123 (September 18, 1943), p. 150. Even the American Dental Association had editorialized in October 1944, "our knowledge of the subject certainly does not warrant the introduction of fluorine in community water supplies," the association's magazine stated, "we do know that the use of the drinking water containing as little as 1.2 to 3.0 parts per million of fluorine will cause such developmental disturbances in bones as osteosclerosis, spondylosis and osteopetrosis, as well as goiter." (Today, the EPA permits 4 parts per million of fluoride in water, a standard vigorously resisted by some EPA scientists, including the former senior toxicologist of the Office of Drinking Water, Dr. William Marcus.) Marcus interview with author.

22. K. Roholm, *Rejsebreve Indtryk Fra USA* (Efteraar 1945); *Ugeskrift For Laeger*, vol. 108 (1946), pp. 234–243.
23. Ibid. Before the war, Roholm recalled, "it was discovered that the concentration of fluoride; 1 milligram of fluoride per 1 liter drinking water; causes mottled teeth amongst those who drink the water, while the permanent teeth calcify, i.e., during infancy. The enamel become indistinct, chalklike and sometimes dark colored and fragile. The disease has since been discovered throughout the entire world and continues to be a serious problem of sanitary reasons, which makes it necessary to change the water supply."
24. Ibid., pp. 234–243.
25. In early 2001 Roholm's daughter-in-law, Karin, showed me a scrapbook of news stories collected by a family friend during his lifetime. She translated them for me over coffee at the New York YMCA at West Sixty-third Street. In his address Roholm made a single reference to fluoride. "In recent years, we have learned that a small quantity of the element fluoride in the drinking water significantly seems to protect against caries," he said. *Ugeskrift For Laeger*, vol. 110 (1948), pp. 221–226.

Chapter 8

1. Jamie Lincoln Kitman, "The Secret History of Lead," Part 1, *The Nation* (March 20, 2000), in which a 1985 EPA study is cited for heart-disease deaths. Kitman wrote, "According to a 1988 report to Congress on childhood lead poisoning in America by the government's Agency for Toxic Substances and Disease Registry, one can estimate that the blood-lead levels of up to 2 million children were reduced every year to below toxic levels between 1970 and 1987 as leaded gasoline use was reduced. From that report and elsewhere, one can conservatively estimate that a total of about 68 million young children had toxic exposures to lead from gasoline from 1927 to 1987."
2. Humor and ancestry; Interview with Edward Largent Jr. Arrogance: interview with Dr. Albert Burgstahler.
3. Kehoe testimony at Martin trial, p. 965.
4. For example, he was an associate editor of the American Medical Association's *Archives of Industrial Hygiene and Occupational Medicine.*

5. From 1925 to 1958 Kehoe was the medical director of the Ethyl Corporation, the partnership between Standard and General Motors that distributed the DuPont-manufactured antiknock gasoline additive known as tetra ethyl lead (TEL). In 1966 he told Congress that he "had been looking for 30 years for evidence of bad effects from leaded gasoline in the general population and had found none." Kitman, "The Secret History of Lead." Kehoe's work would take him to Germany immediately after World War II, from which he sent home photographs of the Nazi death camps. See also diary, RAK Collection.

   The German industrial conglomerate I. G. Farben had operated the Auschwitz camp with Hitler's SS. Before the war Farben had partnered in Germany and the United States with Standard Oil. Shortly before European hostilities broke out, Ethyl Corporation transferred the technology for making TEL to its German partner, greatly aiding the Nazi war effort. According to Farben official August von Knieriem at the Nuremberg war crimes trial, "Without tetraethyl lead the present method of warfare would have been impossible. The fact that since the beginning of the war we could produce tetraethyl lead is entirely due to the circumstance that shortly before, the Americans presented us with the production plans, complete with their know how." J. Borkin, *The Crime and Punishment of I. G. Farben* (New York: The Free Press, 1978), p. 78.
6. On April 17, 1952, Kehoe wrote to Seward Miller—medical director of the Division of Industrial Hygiene, Public Health Service—on behalf of nine corporations then sponsoring his fluoride research, to request that the PHS perform some fluoride safety studies on animals. The industry groups, Kehoe noted, "are concerned mainly with the results of exposure to fluorides in various occupations." These industries included "The Pennsylvania Salt Manufacturing Company, Aluminum Company of America, Reynolds Metals Company, Universal Oil Products Company, American Petroleum Institute, Kaiser Aluminum and Chemical Corporation, Tennessee Valley Authority, The Harshaw Chemical Company, [and] Minnesota Mining and Manufacturing Corporation." RAK Collection.
7. A great number of claims were settled out of court. The following is a partial listing of legal actions against U.S. corporations following the war, and during the early cold war, in which fluoride was suspected as a poison. These data are culled from press accounts and this author's research. See also E. J. Largent, "Fluorosis—The Health Aspects of Fluorine Compounds," for the difficulty of comprehensively tracking the frequency and number of fluoride lawsuits. Also, M. J. Prival and F. Fisher, "Fluorides in the Air," *Environment*, vol. 15, no. 3 (April 1973), pp. 25–32. "The number of out of court settlements of claims of fluoride damage to vegetation is impossible to determine, although it certainly exceeds the number of court-ordered payments."
   - 1946. The "Peach Crop Cases" by New Jersey farmers in Gloucester and Salem County, claiming $430,000 against DuPont and the U.S. government.

- *1946. Suit "exceeding half a million dollars" mounted against the Pennsylvania Salt Company, Sun Oil, and the General Chemical Company by some 41 farmers near the town of Delran, New Jersey, on the Delaware River.* Pennsylvania Salt was being sued along with Sun Oil and General Chemical for more than a half-million dollars by as many as forty-one different farmers in New Jersey and Pennsylvania. The farmers claimed that they had been poisoned by fluoride—their crops and farm animals killed. Downwind of the Pennsylvania Salt Company's plant in Cornwall Heights, built by the government during the war, lay a half-mile-square zone just across the Delaware River, "where all trees have been killed." Another of the company's fluoride plants in Easton, Pennsylvania, "revealed an almost identical picture of damage." John H. Claypool to Edward Largent, 10/19/45; "Recently the first actions in bringing suit have been taken in behalf of 26, out of an original 41, peach growers." Also Largent to R. W. Champion, Harshaw Chemical, 4/25/1946, File 13, Box 32, RAK Collection.
- *Immediately postwar. A Philadelphia gun club filed suit against the nearby Pennsylvania Salt Company.* According to Philip Sadtler: "The Plant had damaged the Philadelphia gun club which was next door—that was a relatively simple case. The gun club won because of my testimony, and all I had done was gather some of the vegetation and measured the fluorine." Taped author interview, March 23, 1993.
- *1948. Claims filed by a group of horticulturist farmers against phosphate fertilizer manufacturers in Bradenton, Florida, on the Gulf Coast, alleging agricultural damage*. "They won a large settlement," according to lead investigator Philip Sadtler. "The vegetation showed [damage] around the edges. One farmer named the (claprood?) family grew a large number of gladioli which were shipped all over the United States. For at least two years they were ruined by the phosphate roasting. Therefore, I was asked to go down to Bradenton to investigate the problem. I took samples and came home and analyzed them. They were no different from [what Sadtler had found in the fluorine poisoning from industry in] New Jersey. They won a large settlement. It took several years but they got repaid for what they had lost."
- *October 1948. Donora, Pennsylvania. Four and half million dollars in legal claims against U.S. Steel following some two dozen fatalities and thousand of injuries, blamed by one investigator on fluoride*. The legal action did not focus on fluoride.
- *1949. Lawsuits filed against the Tennessee Valley Authority (TVA) alleging fluoride pollution.* For example, "In connection with the plaintiffs living in the Columbia area who should be examined for possible fluorosis," Edward Largent to Joseph C. Swidler, General Counsel, TVA, Knoxville, Tennessee. Also, Kettering's William Ashe performed a pilot study in 1950 of conditions at TVA's phosphate fertilizer plant at the Wilson Dam. While most of the men had worked in the plant "a relatively short time

(a few months to 7 years; av. 2.6 years)," X-ray and urine analysis of the men found widespread bone fluorosis, urine values as high as 27.28 mgs of fluoride per liter, and concluded "1) There was a fluoride problem in the fertilizer plants at Wilson Dam 2) Some workmen are absorbing abnormal amounts of fluoride in quantities sufficient to produce fluorosis of the bone." Ashe to Dr E. L. Bishop, Director of Health TVA, File 14, Box 15, RAK Collection.

- *1950 Alcoa was fined for dumping fluorides into the Columbia River. Airborne fluorides heavily contaminated the grass and animal forage "which resulted in injury and death to cattle" and a claim for $200,000 compensation, according to newspaper accounts.* "Oregon Rancher asks $200,000 of Aluminum Company," *Seattle Times*, December 16, 1952. Cited in G. L. Waldbott et al., *Fluoridation: The Great Dilemma*, p. 296. Alcoa had dumped between 1,000 and 7,000 pounds of fluorides per month into the Columbia before 1950, according to *National Fluoridation News* (March–April, 1967), p. 3.
- *1950. Mr. and Mrs. Julius Lampert won suit against Reynolds' Troutdale, Oregon, plant for fluoride damage to gladiolus crops*. Cited in Waldbott et al., *Fluoridation*, p. 298, "Damages for Crop Burns," *Lewiston (ID) Morning Tribune*, February 6, 1962.
- Alcoa had compensated 141 farmers and cattle raisers in Blount County, Tennessee, prior to January 1, 1953, when another suit charged that fluoride fumes had damaged farmlands and injured cattle. Cited in Waldbott, *Fluoride*, p. 298, "Jury Decides Alcoa Liability Ended in 1955," *Knoxville (Tenn.) Journal*, July 30, 1955. Cited in Waldbott et al., *Fluoridation*, p. 298, "Alcoa Sued for Nearly $3 Million," *Knoxville (TN) Journal*, October 29, 1970.
- Also in Tennessee, by 1953 Monsanto was "faced with a number of claims for personal and property damage which total a considerable amount" including "claims for personal injury due to fluoride-containing effluents released from the stacks of the plant at Columbia owned by Monsanto." ("Last week when Mr. Wheeler was in Cincinnati he talked briefly with Dr. Heyroth about Monsanto's fluoride problems. As you know, Monsanto is faced with a number of claims for personal and property damage which total a considerable amount. These cases have accumulated over quite a period and have been pending for three or four years. It now appears that they may come to trial this fall." R. Emmet Kelly, M.D., Monsanto's medical director, to Robert Kehoe, July 7, 1953, File 26, Box 38, RAK Collection. Also: "Two couples, a man and a wife in each case, have filed claims for personal injury due to fluoride-containing effluents released from the stacks of the plant at Columbia owned by Monsanto . . . Symptoms described by the plaintiffs in part fit the description of acute fluoride poisoning, in part fit the description of chronic fluoride poisoning, and in part they appear so bizarre as to fit neither." Memorandum of meeting held August 19, 1953 between Edward Largent, Dr.

Francis Heyroth, Mr. John Jewell. Monsanto Chemical Company, and their attorney, Mr. Lon McFarland, August 20, 1953, File 26, Box 38, RAK Collection.

- *In Utah, by 1957, U.S. Steel had settled 880 damage claims totaling $4,450,234 with farmers in Utah County. An additional 305 claims for a further $25,000,000 were filed against the company.* D. A. Greenwood, "Background for Studies in Utah County." Unpublished paper given at the 1957 Kettering Fluoride Symposium, File 17, Box 42, RAK Collection. Another figure states that the legal claims against U.S. Steel in Utah were for $30 million. C. Butler, Discussion in: *Proceedings: Nat'l. Conf. on Air Pollution, Nov. 18–20, 1958* (Washington, DC: Government Printing Office), p. 268. Also, Prival and Fisher: "U.S. Steel paid $4 million to cattle ranchers around its steel mill near Provo, Utah, before spending $9 million on pollution control devices," citing *Chemical and Engineering*, vol. 65, no. 4, p. 66, February 24, 1958, and W. T. Purvance, *Chem. Eng. Prog.*, vol. 55, no. 7 (July 1959), p. 49, . This writer did not delve into the legal papers surrounding these cases. However, a clue as to their ultimate fate may be found in an essay by Keith E. Taylor Esq., senior partner, Parsons, Behle, and Latimer, Salt Lake City. He writes in 1982 of a proceeding "of nearly 25 years ago [in which] farmers and ranchers, approximately 300 strong, sought damages in a Federal Court for claimed injury to thousands of cattle and sheep and to numerous types of vegetation from fluorides emitted from an industrial facility." According to Taylor, Utah State scientists examined a dairy cow, Ms. Penelope, "ear tag No. G-571023," that plaintiffs claimed had been poisoned by fluoride; these scientists then "testified on behalf of the defendant, [and] came up with opposite conclusions. They found no evidence of fluorosis. The cause of her poor health was a wire that she had ingested, which had punctured her heart. . . . Except for that research . . . the result would probably have been different. Cows like Penelope would have continued to be diagnosed as dying of fluorosis. The farmers would not have had a compelling reason to clean the nails and wire from cattle feed, and to correct the various other problems that were contributing culprits. In the long run even the farmers would have been the losers." K. E. Taylor "Research Needs—A Lawyer's View" in J. L. Shupe, H. B. Peterson, and N. C. Leone, eds., *Fluorides: Effects on Vegetation, Animals, and Humans* (Salt Lake City, UT: Paragon Press, 1983), p. 359.

8. At a gathering of industry scientists and profluoride dental researchers in 1983, Seamans explained how wartime production had propelled a wave of fluoride pollution lawsuits against industry. "After the German bombing of Coventry had knocked out the English aluminum production," Seamans began, "President Roosevelt announced that America would build 50,000 planes. This was an unbelievable number and required a tremendous amount of aluminum, far more than existing capacity could produce. Accordingly, through a government agency known as the Defense Plant

Corporation, aluminum smelters were built wherever the needed electricity could be obtained . . . one DPC plant was built in the San Joaquin Valley of California. . . . There were, of course, no controls of any kind on this plant. As you can expect, there was a great consternation in the San Joaquin Valley. Vigilante committees were formed, and an injunction suit was filed. In August 1943, as a young lawyer for Alcoa I was sent out there to find out what the problem was all about. . . . Fortunately, Dr. Francis C. Frary, who was then director of research at Alcoa, had seen Roholm's book describing some of the consequences of cryolite mining in Greenland and this led him to wonder whether fluorides were the culprit . . . we all finally became convinced that there had been undue exposure to fluorides. Because we had the injunction suit and other claims to handle, as soon as possible we persuaded the Defense Plant Corporation to close the San Joaquin Plant. Thereafter, over a period of years we were able to settle all the cases, and thus the 'Riverbank, California' nightmare came to an end. After this experience however, knowledge quickly spread and soon we had claims and lawsuits around aluminum smelters from coast to coast. These required prodigious effort and great expenditures of time and money to settle. During the course of events, many significant and extended lawsuits were tried. Some of the more crucial were the Fraser case involving the Vancouver, Washington, plant and the Hitch case involving the Alcoa, Tennessee, Plant." Seamans continued, "There was very little solid information on the subject about what harm fluorides could do, what harm they did not do and what the tolerance levels were for people." Accordingly, "research was encouraged and supported at the University of Wisconsin, Utah State, Stanford Research Institute, University of Tennessee, Kettering Institute, the Boyce Thompson Institute for Plant research and other noted scientific centers." F. L. Seamans, "Historical, Economic and Legal aspects of Fluoride," in Shupe et al., eds., *Fluorides*, p. 5.

9. Frank Seamans to attorney Theodore C. Waters, August 30, 1956. "You will recall the occasion of our meeting together in Washington with a group of lawyers who have clients interested in the fluoride problem, at which time we were discussing the U.S. Public Health Service. The group, which in the past has consisted of representatives of Aluminum Company of Canada, Food Machinery and Chemical Corporation, U.S. Steel, Kaiser Aluminum and Steel, Tennessee Corporation and subsidiaries, Monsanto Chemical, Victor Chemical, Reynolds Metals Company, T.V.A. and Alcoa has had some discussions with Dr. Kehoe relative to some research and regarding the effect of fluorides on human beings." File 5, Box 76, RAK Collection.
10. On the relationship of Medical Advisory Committee to the Fluorine Lawyers, Seamans to Medical Advisory Committee, April 16, 1957: "The legal representatives of the several companies interested in the Kettering Research project have agreed that it would be advantageous if the principal liaison with Kettering were undertaken by persons of competent technical background . . . [to] conduct the necessary liaison between the Kettering Insti-

tute and the lawyers' group by a system of regularly scheduled visitations to Kettering and regular reports to the lawyer's group." File 17, Box 42, RAK Collection.

11. Memorandum on the Meeting of the Pittsburgh Section of the Industrial Hygiene Association, April 30, 1946, marked "Confidential."
12. During the key wartime Manhattan Project–sponsored "Conference on Fluoride Metabolism" at New York's Hotel Pennsylvania on January 6, 1944, Largent was a member of an inner-sanctum group of experts—along with Harold Hodge from the University of Rochester—that had decided how much fluoride U.S. workers could be "safely" exposed to inside the giant wartime atomic-bomb factories.
13. The phrase is from Francis McClure of the National Institutes of Dental Research. Largent's human experiments, McClure said, "provided much basic information not only for appraisal of industrial fluoride hazards but for resolution of a public health hazard which might be associated with use of fluoride drinking waters." F. J. McClure, *Fluoridation* (NIH publication, 1970), p. 200.
14. From the 1933 level of 1.43 mg F/Kg, raised in 1944 to 7 mg F/Kg. K. Roholm, *Rejsebreve Indtryk Fra USA* (Efteraar, 1945); *Ugeskrift For Laeger*, vol. 108 (1946), pp. 234–243.
15. Mellon guests were told that fluoride air concentrations of up to 4 parts per million had been found inside Alcoa plants, according to Dr. Lester Crawley of Alcoa. Memorandum on the Meeting of the Pittsburgh Section of the Industrial Hygiene Association, April 30, 1946. Stamped "Confidential." File 13, Box 38, RAK Collection.
16. See note 7 above. Also, E. J. Largent, *Fluorosis: The Health Aspects of Fluorine Compounds* (Columbus, OH: Ohio State University Press, 1961), p. 124.
17. "We have on file in our laboratory evidence of bone changes in employees in manufacturing operations where there are known atmospheric contaminations from fluorides," Largent noted. Attending the Mellon conference might help industry confront such threats, Largent added. The aluminum industry, in particular, had long ago seen the danger of workers' lawsuits for fluoride exposure and had taken preemptive action. "It was in anticipation of such an eventuality that Aluminum Company of America set out several years ago to obtain all possible data with which to meet such a situation," Largent told the Harshaw Chemical Company. Edward Largent to R. W. Champion, assistant sales manager, Harshaw Chemical Company, April 25, 1946, File 13, Box 38, RAK Collection.
18. Bovard announced at the Pittsburgh conference that there was "no evidence to prove that there was any relation between ankylosing spondylitis [the fusing of spinal vertebra] and the deposition of fluorides in the osseous tissue," Largent reported. Memorandum on the Meeting of the Pittsburgh Section of the Industrial Hygiene Association, April 30, 1946. Stamped "Confidential." RAK Collection Box 38 File 13. Bovard would regularly consult for the Kettering Laboratory and industry during the cold war, helping the TVA, for

example, in preparing its 1953 report, "Study of Fluoride Hazards—Final Report—Project Authorization 408."

19. Edward Largent to Dr. S. C. Ogburn Jr., manager, Research and Development Department, Pennsylvania Salt Company, May 8, 1946, File 13, Box 38, RAK Collection.
20. Memorandum on the meeting of the Pittsburgh Section of the Industrial Hygiene Association, April 30, 1946. Stamped "Confidential," File 13, Box 38, RAK Collection.
21. "Suggestions have been made both by Dr. Frary and by some of the du Pont group, including their medical director . . . that it might be advisable for representatives of du Pont, Aluminum Company, and Pennsylvania Salt to get together and to discuss carefully the whole problem." Robert Kehoe to S. C. Ogburn Jr., Pennsylvania Salt Company, May 25, 1946, File 13, Box 38, RAK Collection.
22. Joel Griffiths interview.
23. George Blakstone said that Maurice and Elmo had both participated in the lead experiments. He recalled that Maurice "would go in a chamber and inhale." Gentry Blackstone, who inhaled hydrogen fluoride gas, was also "drinking something, I think," according to George.
24. "Summary of Investigations of the Metabolism of Fluorides by Man and Dogs," Nov. 1, 1950, Unpublished Reports, vol. 24 b, RAK Collection.
25. Gerald Markowitz and David Rosner, *Deceit and Denial: The Deadly Politics of Industrial Pollution* (Berkeley: University of California Press, 2002), p. 110.
26. E. K. Largent, P. G. Bovard, and F. F. Heyroth, "Roetgenographic Changes and Urinary Fluoride Excretion among Workmen Engaged in the Manufacture of Inorganic Fluorides," *Amer. J. Roentgenol*, vol. 65 (1951), p. 42.
27. The dueling European and American medical theories had an odd transatlantic symmetry. Both scientists had studied workers handling cryolite, mined in the Danish colony of Greenland. Most of Europe's cryolite arrived via Roholm's hometown port of Copenhagen, while an old Philadelphia Quaker firm, the Pennsylvania Salt Manufacturing Company, whose workers Largent studied, had been granted sole rights to sell Danish cryolite in the U.S. During World War II, when the Nazis occupied Denmark, Greenland was governed by the Danish minister in Washington and a committee of five advisers, one of whom was Leonard T. Beale, the President of Pennsylvania Salt. R. K. Leavitt, *Prologue to Tomorrow: A History of the First Hundred Years in the Life of the Pennsylvania Salt Manufacturing Company* (The Pennsylvania Salt Company, 1950), chapter on fluorine, "Bad Actor turns Patriot," p. 78.
28. From 1939 to 1944, for example, industrial consumption of the most voluminous fluoride mineral, fluorspar, had more than doubled. It rose from 176,000 tons of fluorspar in 1939 to 410,000 tons in 1944. See Largent, Table 4, "The Occurrence and Use of Inorganic Fluorides." Paper given at 1953 Fluoride Symposium, in Unpublished Reports 32b, RAK Collection.

29. National Institute for Occupational Safety and Health, 1975 DHEW/NIOSH-76-103. Cited in "Summary Review of Health Effects" EPA/600/8-89/002F, December 1988, pp. 3–5.
30. Largent spent a career doubting Roholm. Roholm's findings were not "authenticated" and "cannot be generally accepted," Largent insisted. The Dane had failed to show "a causal relationship" between fluoride and injury, he told a Kettering roundtable of industry doctors. 1957 Kettering Fluoride Symposium, Box 63, RAK Collection.
31. H. C. Hodge and F. A. Smith, *Fluorine Chemistry*, vol. IV, p. 385. Also, "Largent's research is often quoted as evidence that bone changes, of the kind encountered in high fluoride areas and in industry, are never associated with harm elsewhere in the human organism and therefore have no significance." G. L. Waldbott, *A Struggle with Titans* (New York: Carlton Press, 1965), p. 289.
32. "When one finds, in cases of severe fluorosis of the bone, limitation of motion of the elbow and the X-ray reveals exostoses of unusual density about the elbow, one is probably entirely justified in concluding that the deformity and dysfunction are due to fluorosis, and that disability exists in association with and because of this disease, whether or not the man is aware of it, and whether or not he continues to do his job at the plant." Aluminum Company of America, Niagara Falls Works Health Survey, File 4, Box 82, RAK Collection.
33. "An exostoses (a bony outgrowth from the surface of the bone) on one of the bones of the right forearm and some calcification of the ligaments of the lower vertebrae were noted" in Ira Templeton's X-rays, according to Dr Smyth. He also found "In several instances bony outgrowths which seemed very much like the bone changes seen by Roholm in the monograph, 'Fluorine Intoxication,'" Largent told the Pennsylvania Salt Company. "On the basis of the data and the conclusions of that book alone, one would accept the presence of these outgrowths as evidence of the existence of fluorine intoxication. The conclusions of Dr. Smyth, who used the expression 'fluorine intoxication,' in the interpretation of his findings, would seem to follow this thesis," Largent added. Edward Largent, "Report to the Pennsylvania Salt Company," May 8, 1948, File 13, Box 38, RAK Collection.
34. Bovard to Kehoe, February 28, 1946. Also, Bovard X-ray interpretation, February 19, 1946, File 13, Box 38, RAK Collection.
35. J. Russell Davey, M.D., to Pennsylvania Salt Co., In Re: Ira Templeton. January 31, 1947, File 13, Box 38, RAK Collection.
36. S. C. Ogburn Jr., manager, Research and Development Department, Pennsylvania Salt Company, to Kehoe, February 10, 1947, File 13, Box 38, RAK Collection.
37. Kehoe to S. C. Ogburn Jr., February 12, 1947, File 13, Box 38, RAK Collection.
38. "Final Report of the Results of Investigations Relating to Fluoride Metabolism Conducted Under the Sponsorship of the Pennsylvania Salt Company." Unpublished Reports vol. 24-a, Kettering Laboratory, p. 13, RAK Collection.

39. Largent was familiar with Roholm's research, of course, and knew about the subtle effects of fluoride poisoning. During the war, for example, Largent told a 1943 industry conference at the Mellon Institute that "it seems probable that exposure to fluoride dusts may be capable of lowering the efficiency and well-being of workmen without inducing any very specific and dramatic symptoms." Proceedings of the Eighth Annual Meeting of Industrial Hygiene Foundation of America, Inc., November 10–11, 1943, p. 32.
40. E. J. Largent, P. G. Bovard, and F. F. Heyroth, "Roetgenographic Changes and Urinary Fluoride Excretion among Workmen Engaged in the Manufacture of Inorganic Fluorides," *Am. J. Roentgenol.*, vol. 65 (1951), p. 42.
41. See chapter 6 for the January 1944 fluoride conference held at the Hotel Pennsylvania in New York.
42. The Kettering Laboratory's "investigation of the metabolism of fluorides in the human body" was funded in 1953 by Alcoa, Reynolds, Kaiser, Harshaw Chemical, Minnesota Mining and Manufacturing, Universal Oil Products, the Tennessee Valley Authority, and the American Petroleum Institute. Kehoe to Seward E. Miller Medical Director, Division of Industrial Hygiene, Public Health Service, April 17, 1952, RAK Collection.
43. H. E. Stokinger, "Toxicity Following Inhalation of Fluorine and Hydrogen Fluoride," *The Pharmacology and Toxicology of Uranium Compounds* (New York: McGraw Hill, 1949), p. 1021. (Stokinger was a former Kettering scientist who went to Rochester during the war. Largent called him Herb). Also, in 1909 Ronzani had done HF inhalation studies on animals. He found no harm at 3 ppm, during a month's exposure, but was unable to report the same at 5 and 7.5 ppm. The Kettering Laboratory had abstracted Ronzani in their Kettering Abstracts series.
44. Among the attendees were the medical directors of DuPont, Alcoa, and TVA. Alcoa's attorney, Frank Seamans, from the Pittsburgh firm of Smith, Buchanan, Ingersoll, Rodewald, and Eckert, was also in attendance. File 13, Box 38, RAK Collection.
45. Largent had suggested in 1943 that 1.5–2.00 mg/liter of fluoride in urine might be associated with deposition in worker's bones. "Proceedings of the Eighth Annual Meeting of Industrial Hygiene Foundation of America, Inc," November 10–11, 1943, p. 32.
46. "If there were any changes in the bone as a consequence of 3 ppm it was beneficial deposition of fluoride, not harmful," he told writer Joel Griffiths. Griffiths interview.
47. Largent, "Absorption and Elimination of Fluorides by Man," Kettering Fluoride Symposium 1953, p. 92. Also, Largent reported in the unpublished "Industrial Health Surveys in Plants Processing Inorganic Fluorides," that in "a plant dealing with hydrogen fluoride . . . One man, who had an average urinary fluoride concentration of 9 mg. per liter, gave evidence of a moderate increase in radiopacity." He continued, "If all threats of medico-legal problems are to be avoided it seems probable that average urinary fluoride levels must be kept below 10 mg. per liter." Fluoride Symposium, 11.1, RAK Collection.

48. See 2001 ACGIH TLV, data summary for HF, "based on results of controlled inhalation studies in human volunteers" (Largent cited). ACGIH also cite E. Ronzani, "Influence of the Inhalation of Irritant Industrial Gases on the Resistance of the Organism to Infectious Disease. Experimental Investigations. II. Hydrofluoric Acid Gas, Ammonia, Hydrochloric Acid Gas," *Arch. Hyg.*, vol. 70 (1909), pp. 217–269. Ronzani was prompted to his studies because "disputes about the duties of factory and workshop owners towards their neighbors are brought to the court in rising frequency." He therefore sought a "no effect" level to help resolution of such disputes. He studied animals at various concentrations of HF, including 7.5 ppm and 5.0 ppm, but was forced to go to 3 ppm to find a no-effect level over 31 days—little comfort surely almost a century later for workers breathing HF today at 3 ppm *for all of a working life*.

    In the NIOSH "Criteria Document for a Recommended Standard: Occupational Exposure to Hydrogen Fluoride," Publication 76-143, it is noted that Elkins had found "workers in the etching process had nosebleeds as did welders exposed to 0.4–0.7 mg F/cu m who were excreting 2–6 mg F/liter of urine . . . other workers exposed to 0.1–0.35 mg F/cu m and excreting, on the average, 4.5 mg F/liter reportedly experienced sinus trouble. The ACGIH suggested that the urinary excretion values reported by Elkins seemed 'inconsistently high' relative to airborne HF levels, and that dietary F was suggested as a possible factor." Citation, H. B. Elkins, *The Chemistry of Industrial Toxicology*, 2nd ed. (New York: John Wiley and Sons, Inc., 1959), pp. 71–73.

    The ramifications of the ACGIH reliance on Largent and Ronzani can perhaps be seen in the U.S. standard for HF occupational exposure of 2.5 mg HF/cu m, compared to other countries (cited in NIOSH, above document, 1976): The (former) Soviet Union, 0.5 mg HF/cu m, Hungary and Poland 0.5 mg HF/cu m, (the former) East Germany and Czechoslovakia, 1 mg HF/ cu m, and Bulgaria 1 mg HF/cu m.

49. In that second interview, Largent became aware that the interviewer Joel Griffiths might not view his experimental work favorably. The verbatim exchange continued as follows:

    EL: I never did develop osteofluorosis.
    JG: Excuse me?
    EL: I never developed personally any aspect of osteofluorosis—you just got through saying I developed osteofluorosis.
    JG: Because I think that is what you told me the last time we talked.
    EL: No—I would have talked about skeletal deposition, and that is not osteofluorosis.
    JG: Well, skeletal deposition, right—that led to some difficulties with your knees.
    EL: Not in the slightest.
    JG: Well, this doesn't seem to jibe with what you told me the first time.
    EL: That's not true—I was developing more like osteoporosis—I have arthritic difficulties in my extremities serious enough that the right knee was

replaced with a prosthesis but that was more on the side toward osteoporosis than fluorosis—I didn't get enough to do me any good, I can tell you that. [Osteosclerosis, thickening of the bone, is a sign of a small amount of additional fluoride exposure; osteoporosis is an indication of massive fluoride exposure, Roholm and others reported.]

JG: Because you said to me quite distinctly the first time that it was osteofluorosis.

EL: No.

JG: And that fluoride can cause this condition.

EL: No.

JG: And that as far as you were concerned that was what it was.

EL: No.

JG: And that you believed it could have possibly come from the drinking water in the high school you attended in Fort Ames, Iowa, back in nineteen-whatever-it-was.

EL: Yeah.

JG: And also that the fluoride that you absorbed in your experiments might possibly have been a contributing factor.

EL: Factor—what factor?

JG: To the osteofluorosis.

EL: I didn't have osteofluorosis—at any time.

JG: I see, because the first time I'm certain that you said you did.

EL: No—I don't think that I did.

JG: In other words, you're not saying it now.

EL: I don't know what I said then, but if I said it then I was wrong. . . . If you say I developed osteofluorosis I will challenge that . . . I didn't get enough fluoride to do me any good.

JG: Well, let me see if I can find the tape and see I'll see if I misheard you.

EL: You may not have misheard me, but you may be able to correct me if I misspoke.

50. Fluoride appears to carry aluminum over the blood-brain barrier; the aluminofluoride complexes then damage the brain structure. See esp. J. A. Varner, K. F. Jensen, W. Horvath, and R. L. Isaacson, "Chronic Administration of Aluminum-Fluoride or Sodium-Fluoride to Rats in Drinking Water: Alterations in Neuronal and Cerebrovascular Integrity," *Brain Research*, vol. 784 (1998), pp. 284–298. "There are striking parallels between al-induced alterations in cerebrovasculature [and] those associated with Alzheimer's disease and other forms of dementia."

Chapter 9

1. Collected by Dan Hoffman, "Three Ballads of the Donora Smog," *New York Folklore Quarterly*, no. 5 (spring 1949), pp. 58–59. Quoted in Lynne Page Snyder, "'The Death Dealing Smog over Donora, Pennsylvania': Industrial Air Pollution, Public Policy, and Federal Policy, 1915–1963" (1994). Available from UMI Dissertation Services.

2. *Bulletin No. 306, Air Pollution in Donora, PA, Epidemiology of the Unusual Smog Episode of October 1948* (Public Health Service).
3. Donora is often referred to as the worst recorded air-pollution disaster in U.S. history. This may or may not be entirely true. During a similar seasonal temperature inversion from November 12 to 22, 1953, between 175 and 260 people were killed in New York City from air pollution, according to Howard R. Lewis, *With Every Breath You Take* (New York: Crown Publishers, 1965), p. 19. Although there were numerous complaints of eye irritation and coughing, the total number of New York deaths from the smog incident was only revealed later by statistical analysis, Lewis writes.
4. A key source for this chapter is Lynne Page Snyder's excellent "'The Death Dealing Smog over Donora.'"
5. The 1949 official Public Health Service report, *Bulletin No. 306, Air Pollution in Donora, PA*, lists twenty deaths. However, Snyder refers to "dozens" of deaths, p. viii. Residents report many additional deaths in the weeks after the disaster. For example, "The death of an estimated 100 people in the following year was attributed to the smog. Also, there were a lot of people who were affected in other ways. They were sick with respiratory problems. Internal illness and a couple of cases of blindness occurred." Account of former resident Joe Battilana, submitted as a 1970 report to Professor Gerard Judd of Phoenix Community College.
6. Berton Roueché, article in *The New Yorker*, September 30, 1950.
7. Roueché, case 11, p. 51; and from PHS Bulletin No. 306. Ceh's name is from *The New Yorker* article.
8. Roueché, case 9, p. 50 ; PHS Bulletin No. 306.
9. Author's taped interview, March 24, 1993.
10. Snyder, p. 25.
11. Roueché, p. 41.
12. Author's taped interview, March 24, 1993.
13. Recollections of Mayor John Lignelli, who attended the game, in "Donora's Killer Smog Noted at 50," *Pittsburgh Tribune*, October 25, 1998. See also PHS report and Snyder, p. 27, for death tally.
14. Snyder, p. 28.
15. *New York Times*, November 1, 1948; cited in Snyder, p. 29.
16. Snyder, p. 33.
17. For employment data, see Snyder, p. 35. For profit data, see Ross Bassett, "Air Pollution in Donora, PA" (December 6, 1990), unpublished paper, pp. 11, 21–41. Paper from Allen Kline. See also Paul A. Tiffany, *The Decline of American Steel: How Management, Labor, and Government Went Wrong* (New York: Oxford University Press, 1988).
18. The main thoroughfare, McKean Avenue, was named for Andrew Mellon's banker James S. McKean, who had brought Mellon and Donner together with coke baron Henry Clay Frick and whose combined investment of $20 million raised the first steel works on the virgin site in 1901. *Pittsburgh Press*,

March 18, 1934, Society Section, p. 11. Also, H. O'Conner, *Mellon's Millions* (New York: Blue Ribbon Books, 1933).

19. Bassett, "Air Pollution in Donora, PA."
20. Snyder, p. 71. Also, author interview with Bill and Gladys Shempp.
21. K. E. Roholm, "The Fog Disaster in the Meuse Valley, 1930: A Fluorine Intoxication," *J. Hygiene and Toxicology* (March 1937), p. 126. Also, W. S. Leeuwen, "Fog Catastrophe in Industrial Section South of Liege," abstracted in *J. Ind. Hygiene*, vol. 13, no. 7 (September 1931), pp. 159–160 (abstract section).
22. Sadtler gathered vegetation from across the region, tested it, and found that fluoride pollution was endemic and serious. "Buttonwood leaves had anywhere up to twelve hundred parts per million of fluorine," Sadtler noted. Further afield there was much less fluoride in the environment. "To get clean air with no fluorine damage, I had a friend who was a professor at Penn State University and he picked up leaves for me and they had ten parts per million," Sadtler said. Author interview.
23. Although coal was a source of fluoride, this knowledge was poorly disseminated. (Francis Frary announced the discovery to the Air Hygiene Foundation in 1946, as we saw in chapter 8.) Roholm makes no mention of coal in his discussion of the Meuse Valley disaster, for example. And the role that fluoride from coal may have played in the London smog disasters is almost entirely ignored.
24. K. E. Roholm, *Fluorine Intoxication: A Clinical-Hygienic Study, with a Review of the Literature and Some Experimental Investigations* (London: H. K. Lewis and Co. Ltd, 1937), chapter 13.
25. When the senior U.S. Steel metallurgist Glen Howis, who was born in Donora, had a routine medical exam before attending Penn State, a college doctor told him, "I can always tell you boys from the valley from the looks of your X-rays. Your lungs are always clouded," Howis recalled. Author interview in Donora.
26. The U.S. steel industry emitted 64,600 tons of fluoride in "1968 or 1972," according to EPA figures, cited by the Canadian National Research Council, NRCC #16081, ISSN 0316-0114. "Coal for power" is next at 26,000 tons, phosphate rock processing at 21,200 tons, and then aluminum smelting, at 16,230 tons. See similar data in "Summary Review of Health Effects Associated with Hydrogen Fluoride and Related Compounds" (U.S. Environmental Protection Agency, December 1988). For characterization of fluoride as "worst," see citations for fluoride toxicity and damage in chapter 15. For example: "From 1957 to 1968, fluoride was responsible for more damage claims than all twenty other air pollutants combined." N. Groth, "Air Is Fluoridated," *Peninsula Observer*, January 27–February 3, 1969. See also chapter 8, citations on lawsuits against the steel industry, and chapter 15's reference to fluoride's synergistic potential to worsen the toxicity of such pollutants as sulfur dioxide.
27. For fluoride's chronic health effects in Donora, see account of resident Devra Lee Davis, *When Smoke Ran Like Water* (New York: Perseus Press, 2002).

28. B. Davidson, *Collier's* (October 23, 1948). But other air pollution experts, such as Harvard Professor Philip Drinker, had scorned the idea that a Meuse Valley–type disaster could occur in the United States. "We have no districts in which there is even a reasonable chance of such a catastrophe taking place," he asserted. P. Drinker, *Industrial and Engineering Chem.* (November 1939).
29. Medical exams of plaintiffs by Kettering physicians, July 1950, William Ashe physician in charge. Box 5, RAK Collection.
30. Snyder, p. 28.
31. Dudley A. Irwin, Aluminum Company of America, minutes of meeting, Air Pollution Abatement Committee, the Chemists Club, New York City, January 11, 1950. Minutes of Manufacturing Chemists Association, from searchable database of the Environmental Working Group.
32. Oscar Ewing also led a semisecret group of administration insiders known informally as the Monday Night Steak Group. These men met most weeks at Ewing's Wardman Park apartment in Washington, DC, to plot strategy and discuss government policy over dinner and cigars. Clark Clifford, a military confidante and Truman favorite, was a regular at the Monday night meetings. See Ewing interview and Clark Clifford's in the Truman Library (available online).
33. P. Healy, "The Man the Doctors Hate," *Saturday Evening Post*, July 8, 1950.
34. Ewing's war years were spent in a Washington hotel suite with Alcoa senior management, defending the company's strategic interests from upstart companies such as Reynolds and Kaiser, who were fighting Alcoa's nearly fifty-year monopoly on aluminum production. After the war Ewing was invited to an intimate Washington dinner with Alcoa's president, Arthur Vining Davis, and senior officials from the Alcoa "family." Arthur Hall to Ewing, September 4, 1945. Personal Correspondence: August 1, 1944–September 20, 1945.
35. In early 1947 Ewing was a special assistant to the attorney general. He became FSA administrator in August 1947. See oral history interview, Truman Library, available online.
36. Ewing to Ingersoll, June 30, 1947, Political File, Correspondence, Ewing Collection. Ewing helped family members gain from trading fluoride. On July 8, 1946, he arranged a meeting for a relative, Thomas Batchelor, and Paul Collom, president of the Farmers Bank of Frankfort, Indiana, with President Allen B. Williams of the Aluminum Ore Company, in regard to "some fluorspar property in Kentucky" that Collum had acquired. Personal Correspondence, Ewing Collection.
37. *Pittsburg Press*, November 3, 1948. John Bloomfield was no stranger to Donora. Twenty years earlier, as a public official, he had helped American Steel and Wire attorneys to prepare a legal defense against pollution-damage claims by area residents. His job had been to test air quality. Bloomfield now told the newspaper that he recalled that his old measurements in Donora had shown that industrial emissions were safely diluted. Snyder, p. 40.

38. "Therefore the Company comes to us." Kehoe handwritten note, with the word "Mr. Jordan" (president of American Steel and Wire) at the top. Box 5, RAK Collection.
39. Snyder, p. 148.
40. On Schrenk's participation, see "Committee on Fluoride Metabolism, Round Table Discussion During Luncheon Period, Continued in the Evening, January 6, 1944." Conference on Fluoride Metabolism, Hotel Pennsylvania, New York. File Labeled G-118 (c), A2, Box 36, Accession #72C2386, Atlanta FRC, RG 326. Also, James Conant wrote to the Bureau of Mines, at Col. Warren's request, to have Schrenk go to the Rochester bomb program during the war. Conant to R. R. Sayers, February 3, 1944, Document #0291, Records of Section S-1 Executive Committee, RG 227.3.1.
41. Snyder, p. 152.
42. Snyder, p. 152.
43. *Chemical and Engineering News* (December 18, 1948) and author interview. The PHS report on Donora did not find excessive dental mottling. Author visit to Donora in 1993 noted severe mottling. For preexisting community health problems, see Donora resident Devra Lee Davis's *When Smoke Ran Like Water: Tales of Environmental Deception and the Battle Against Pollution* (New York: Basic Books, 2003).
44. U.S. Steel officials knew of the Meuse Valley disaster and of Roholm's report that blamed fluoride. Court Brief, "Evidence of Foreseeability," Box 5, RAK Collection.
45. Snyder, p. 29.
46. Pete Eisler, "Poisoned Workers and Poisoned Places," multipart series, *USA Today*, September 6–8, 2000.
47. All correspondence, Box 5, RAK Collection.
48. W.F.A to Dr. Kehoe, undated, RAK Collection.
49. Box 5, RAK Collection.
50. Ashe, of course, was well acquainted with Alcoa officials and their concerns with fluoride. That summer he had performed an investigation of health conditions for Kettering in Alcoa's Niagara Falls aluminum plant and found widespread injury and disability in workers that he attributed to fluoride. Aluminum Company of America, Niagara Falls Works Health Survey, File 4, Box 82, RAK Collection.
51. Not a conclusion shared by Phyllis Mullenix, who said that if the fluorine had been in soluble gaseous form, then it might readily have passed into the blood, leaving no trace in the lung tissue.
52. The meeting had been arranged in advance through a family friend, Sadtler explained. Author interview.
53. After meeting directly with the FSA in Washington, the CIO allocated $10,000 for the investigation. Oscar Ewing was close to labor leaders and had been an associate of Sidney Hillman, boss of the CIO. Hillman died in 1946.

54. PHS memorandum, November 16, 1948: "Report of Investigation at Donora, Pennsylvania," to Chief of Industrial Hygiene Division from Chief of the Field Unit, Duncan A. Holaday. PHS, Air Pollution Medical Branch, Special Projects, Folder 542.1 (1956). National Archives.

Chapter 10

1. Snyder, p. 70.
2. Author interview with Allen Kline, March 23, 1993.
3. "The Donora Smog Disaster," *Hygia, The Health Magazine* (AMA), October 1949.
4. Thomas Bell, *Out of This Furnace* (Boston: Little Brown and Co., 1941; reprinted Pittsburgh: University of Pittsburgh Press, 1976), pp. 356–357, cited in Ross Bassett, "Air Pollution in Donora, PA," unpublished paper, December 6, 1990.
5. Snyder, p. 217.
6. Following the smog, "Not a single adjustment was made in the production system—no pollution control devices, nothing, and there was nothing ten years later," Allen Kline told me.
7. Snyder, p. 219.
8. Kehoe to J. G. Townsend, Townsend to Kehoe, and data for Ashe, Box 5, RAK Collection. Also, Snyder, p. 258.
9. See chapter 9.
10. *Air Pollution in Donora, PA*, Bulletin 306, USPHS, p. 161.
11. Box 5, RAK Collection.
12. W. F. Ashe to E. Soles, July 11, 1949, and Largent's report from August 8, 1949, which found 110 mgs f/kilo (dry basis) in elm leaves three quarters of a mile opposite the open-hearth furnace. Box 5, RAK Collection.
13. F. A. Exner, "Economic Motives Behind Fluoridation," address to the Western Conference of Natural Food Associates, Salt Lake City, Utah, October 27, 1961.
14. *Monessen Daily Independent*, November 18, 1949, cited in Snyder, p. 170.
15. She has evaluated the health threat from several government Department of Energy nuclear sites, including Oak Ridge. She wrote the government monograph "Summary Review of Health Effects Associated with Hydrogen Fluoride and Related Compounds." (U.S. Environmental Protection Agency, December 1988).
16. So did the Society for Better Living, which charged the mill with reducing effluents during the test smog by staggering the run of mill processes rather than performing them simultaneously, as was standard practice. Snyder, p. 170.
17. Drinker, too, was well aware of the fluoride problem facing the AEC, since he serviced the agency as a litigation consultant on stack "waste gases." Phillip Drinker to Dr. Thomas Shipman, Health Division Leader, Los Alamos, November 14, 1950. RG 326. Medicine Health and Safety. NARA.

18. A. Ciocco and D. J. Thompson, "A follow-up of Donora ten years after: methodology and findings," *Am. J. Public Health*, vol. 51 (1961), pp. 155–64. H. Lewis, *With Every Breath You Take*, p. 201
19. Memorandum: "Discussion with Mr. Rumford on his 'Study of the Correlation of Meteorological Conditions and Morbidity in Donora' during his recent one day visit to Washington," from Nicholas Manos, Chief Statistician, Air Pollution Medical Program, Division of Special Health Services, to Records File, November 18, 1957, Box 13, File 542.1, RG 90 Records of the Public Health Service, Air Pollution Medical Branch Project Records, 1953–1960.
20. Snyder describes Rumford as a "consultant." He is described as being "assigned" to Dr. Ciocco in the memorandum "Mr. Rumford's Report on Donora" from Nicholas Manos, Chief Statistician, Air Pollution Medical Program, to Chief, Air Pollution Medical Program, January 29, 1958, Box 13 File 542.1, RG 90 Records of the Public Health Service, Air Pollution Medical Branch Project Records, 1953–1960.

Chapter 11

1. In 1946 Congress passed the Strategic and Critical Materials Stockpiling Act. In 2001 the Defense Nation Stockpile, maintained by the Pentagon, held 112,000 tons of fluoride in sites around the country. U.S. Geological Survey, *Minerals Yearbook*, 2001.
2. The task force was known formally as the President's Materials Policy Commission; its report was published in five volumes as *Resources for Freedom* in June 1952. (An annex to this report, referred to in several commission documents found in the Truman Library, is not in the National Archives holdings, and researchers were not able to find a reference for it. "The final report of the Paley Commission consists of only 5 volumes, all of which are open," stated an e-mail from NARA archivist Tab Lewis, June 26, 2001.)
3. D. M. Lion, "Fluorspar, Draft Commodity Study," marked "Restricted," Box 12, Folder "Fluorspar," PMPC, Truman Library. Fluorspar's use increased a hundredfold from 1887 to 1950—annual consumption from 5,000 short tons to 426,000 thousand short tons. D. M. Lion, "Commodity Studies, Fluorspar," NSRB 6109, Paley Commission, Truman Archive.
4. Haman and Anderson to PMPC. Haman noted especially "the comparatively new use of fluorspar in the production of uranium hexafluoride for the manufacture of the atomic bomb." PMPC, Truman Library, Box 113, Fluorspar.
5. D. M. Lion, "Fluorspar, Draft Commodity Study." Also, H. Mendershausen, "Review of Strategic Stockpiling." Only 28,671 tons of bomb-quality "acid grade" fluoride was stockpiled in October 1951, just 11 percent of desired levels, Menderhausen reported. PMPC, Truman Library.
6. Analysts were enthusiastic about the phosphate beds as a source of fluorine. "If economic methods can be developed and applied for recovering most of this fluorine as a byproduct of phosphate processing, the yield would amount to the equivalent of about 600,000 to 700,000 tones of 100 percent

calcium fluoride . . . Such an annual increment would more than make up our potential deficit 10 years hence," the Paley Commission stated. "All the resources of technology must be enlisted to solve the problems of assuring ample supplies of fluorspar, or fluorine containing materials," the report added. *Resources for Freedom*, June 1952.

7. A. F. Blakey, *The Florida Phosphate Industry* (Cambridge, MA: Harvard University Press, 1973), p. 112 citing the Florida Air Pollution Control Commission.
8. Paul Manning to Donor M. Lion, August 13, 1951, PMPC, Truman Library, Box 113, Fluorspar.
9. For an account of this longstanding battle, see A. F. Blakey, *The Florida Phosphate Industry*, citing the Florida Air Pollution Control Commission. Also interview with Philip Sadtler and Congressional hearings chaired by Senator Ed Muskie. Subcommittee on Air and Water Pollution of the Committee on Public Works of the United States Senate, 59th Congress, June 7–15, 1966 (Washington, DC: U.S. Government Printing Office), pp. 113–343.

   Paul Manning was well aware of the scale of the fluoride-pollution problem around the country. He was an associate of both Robert Kehoe and the head of the Fluorine Lawyers Committee, Frank Seamans, who invited him to participate in the sponsored research at the Kettering laboratory. "On behalf of our client, Alcoa, I have for some time been participating in an informal group of lawyers, all of whom have clients involved in fluoride claims of one kind or another. . . . I know that your company is interested in this problem to some extent and that conversations have occurred between myself and other Alcoa representatives and personnel of your company." Seamans to Paul D. V. Manning, International Minerals and Chemical Corporaton, August 30, 1956. File 76, Box 5, RAK Collection.
10. The Tennessee Valley Authority was also interested. "A recovery system that would pay its own way should be attractive . . . the present price of sodium fluosilicate and increased demand for it will very likely encourage more manufactures to recover it" said TVA's T. P. Hignett. PMPC, Truman Library, Box 113, Fluorspar.
11. Elias, Technology Reports, p. 9, PMCC, Truman Library, Box 130.
12. It was beyond my resources to probe deeply the Florida cold-war uranium story. How much additional fluoride was produced by such production, and whether money was saved by using fluorsilicic acid as a water fluoridation agent remains to be reported. For Florida as source of cold-war uranium, see P. Eisler, "Poisoned Workers and Poisoned Places," *USA Today*, multipart series, September 6–8, 2000. Of interest, two companies producing uranium from phosphate included International Minerals and Chemical Corporation and the Olin Mathieson Corporation. The former is cited in the text and notes above, while Olin was one of the companies that joined Reynolds in the amicus curie brief for the Martin trial appeal (see chapter 13).
13. Rebecca Hanmer, Deputy Assistant Administrator for Water, to Leslie A Russell, DMD, March 3, 1983.

14. D. McNeil, *Fight for Fluoridation*,(New York: Oxford University Press, 1957), p. 209, n. 22.
15. "By the end of the fifth year a reexamination of the school pupils in Newburgh and Kingston showed that the Newburgh children had approximately 65 percent fewer cavities than the children of Kingston. The report of these findings was made public over my name . . . ," Oscar Ewing, Oral History Interview with J. R. Fuchs of the Truman Library in Chapel Hill, North Carolina, April and May 1969. Truman Library.
16. Philip R. N. Sutton, *Fluoridation; Errors and Omissions in Experimental Trials* (Carlton: Melbourne University Press, 1959), p. 49, for calcium in water, citing E.W. Lohr and S. K. Love., 1954, "The Industrial Utility of Public Water Supplies in the United States, 1952" (U.S. Geological Survey), and United Kingdom Mission Report, *The Fluoridation of Domestic Water Supplies in North America as a Means of Controlling Dental Caries* (London: HM Stationary Office, 1953). John A. Forst, MD, The University of the State of New York, the State Education Department, Albany, NY, Division of Pupil Services, to Dr. James G. Kerwin, the Department of Health, Passaic, New Jersey, October 26, 1954. Via Martha Bevis.
17. See chapters 9 and 10 for Ewing's profile. Clifford had helped to write the National Security Act of 1947, which had authorized the CIA. See his interview at the Truman Library.
18. Letter from H. V. Smith to George Waldbott, January 6, 1964, cited in *A Struggle with Titans*, p. 65 . See also, "Beyond certain limits, fluorides are toxic and that the first evidence of toxicity manifests itself in the form of mottled enamel," B. Bibby, "Effects of Topical Application of Fluorides on on Dental Caries." In *Fluorine in Dental Public Health* (New York Institute of Clinical Oral Pathology Inc, A Symposium, 1944).
19. D. McNeil, *Fight for Fluoridation*, p. 74.
20. M. C. Smith and H. V. Smith, "Observations on the Durability of Mottled Teeth," *Am. J. Public Health*, 30 (1940), p. 1050, cited in Waldbott, *A Struggle with Titans*, p. 12.
21. B. Lee, "Boon or Blunder?" *Toronto Globe and Mail*, January 1954, cited in G. L. Waldbott, *A Struggle with Titans*, p. 11.
22. Waldbott had emigrated to the United States in 1923. His father, Leo Waldbott, barely escaped the terror of Hitler's regime, in December 1938 joining George and an elder brother Emil in Detroit, Michigan. For several generations the Waldbotts had been important members of the community of Speyer, on the Rhine. Leo Waldbott was chairman of the Speyer teachers' and cantors' club, and treasurer of the local Jewish home for the elderly, which was burned to the ground by the Nazis on November 10, 1938. "My Life Before and After Jan. 30, 1933," by Leo Waldbott, via Elizabeth Ramsay, George Waldbott's daughter.
23. For pollen, "In Memoriam—G. L. Waldbott (January 14, 1898–July 17, 1982)," *Fluoride* vol. 15, no. 4 (1982); *Contact Dermatitis* (Springfield, IL: Charles C. Thomas, 1935); "Anaphylactic Death from Penicillin," *J. Am. Med. Assoc.*,

vol. 139 (1949), pp. 526–527; *Time*, March 7, 1949; "Smoker's Respiratory Syndrome," *J. Am. Med. Assoc.*, vol. 151 (1953), pp. 1398–1400.

24. Edith Waldbott referred her husband to the hearings chaired by New York Congressman James Delaney (Dem.) in February 1952, before the House Select Committee to Investigate the Use of Chemicals in Food and Cosmetics. (Congressman A. L. Miller here exposed Oscar Ewing's vested interest as a former Alcoa attorney.) She pointed to a January 1954 eight-part series called "Boon or Blunder" in the *Toronto Globe and Mail*. She had also seen a *Seattle Times* story of December 16, 1952, which detailed Alcoa's efforts to fund fluoride research, according to Waldbott, *A Struggle with Titans*. The first article Edith Waldbott gave her husband was James Rorty's "The Truth About Fluoridation" in *The Freeman* (Irvington-on-Hudson, NY: June 1953).
25. G. L. Waldbott, "Chronic Fluorine Intoxication from Drinking Water," *Int. Arch. Allergy Appl. Immunol.*, 7 (1955), pp. 70–74. "Incipient Chronic Fluorine Intoxication from Drinking Water," *Acta Med. Scand.*, 156 (1956), pp. 157–168. "Tetaniform Convulsions Precipitated By Fluoridated Drinking Water," *Confin. Neurol.*, 17 (1957), pp. 339–347.
26. G. L. Waldbott, "Allergic Reactions to Fluorides," *Intern. Arch. Allergy*, 12 (1958), p. 347, and "Urticaria Due to Fluoride," *Acta Allergologica*, 13 (1959), p. 456.
27. R. Feltman and G. Kosel, "Prenatal and Postnatal Ingestion of Fluorides—Fourteen years of Investigation—Final Report," *J. Dent Med.*, 16 (1961), pp. 190–199. See also double blind tests in Haarlem, Holland, by Moolenburgh and others. G. W. Grimbergen, "A Double Blind Test for Determination of Intolerance to Fluoridated Water (Preliminary Report)," *Fluoride*, 7 (1974), pp. 147–152.
28. The director of the Forsyth Dental Infirmary for Children in Boston, V. O. Hurme, warned in 1952, "Medical researchers have paid relatively little attention to the problem of chronic fluoride toxicosis." He worried about fluoride's potential effect on teeth and gums. "Among the very inadequately studied physical signs of fluoride toxicosis are inflammation and destruction of gingival and periodontal (gum) tissue. Published and unpublished observations by many men suggest rather strongly that periodontoclasia (gum disease) may be induced by certain chemicals, including fluoride," noted Hurme. V. O. Hurme, "An Examination of the Scientific Basis for Fluoridating Populations," *Dent. Items of Interest*, 74 (1952): pp. 518–534.
29. G. W. Rapp, "The Pharmacology of Fluoride," *The Bur* (April 1950). Cited in Walbott, *A Struggle with Titans*, p. 19.
30. H. T. Dean,"Chronic Endemic Dental Fluorosis," *JAMA,* 107 (October 17, 1936), pp. 1269–1273. Also, H. T. Dean, F. S. McKay, and E. Elvove, "Mottled Enamel Survey of Bauxite, Arkansas Ten Years After Change in the Common Water Supply," *Pub. Health Rep,* 53 (September 30, 1938), pp. 1736–1748.
31. H. C. Hodge and F. A. Smith, "Some Public Health Aspects of Water Fluoridation," in James H. Shaw, ed., *Fluoridation as a Public Health Measure* (AAAS, 1954), and *The Problem of Providing Optimum Intake for Prevention*

of Dental Caries: A Report of the Committee on Dental Health of the Food and Nutrition Board, Prepared by the Subcommittee on Optimal Fluoride Levels (NRC Publication 294, 1953).

32. Hodge relied on the unpublished personal assertions of Alcoa's top fluoride expert, Dr. Dudley Irwin, for his frequently reiterated assurances that industrial workers, and by extension the general population, were not being injured by fluoride. "In industrial populations, Irwin (REF: Irwin, Dudley. Personal communication) has come to the conclusion that if the urine contains less than 5 mg. per liter (presumably indicating a fluoride intake of less than 5 to 10 mg per day), osteosclerosis never develops. *On this basis*, it can be predicted that persons drinking fluoridated water and excreting approximately 1 mg of fluoride per day will never develop demonstrable osteosclerosis." (Emphasis added)–H. C. Hodge, "Fluoride metabolism: its significance in water fluoridation," *JADA*, vol. 52 (1956) pp. 307–314. Such reassurances flew in the face of the work of Siddiqui (1955), for example, who measured the urine F in skeletal fluorosis: "The urinary fluoride excretion varied between 1.2 and 5.8 ppm . . . The mean values for blood and urinary fluoride were 0.34 and 2.75 ppm respectively." A. H. Siddiqui, "Fluorosis in Nalgonda district, Hyderabad-Deccan," *British Medical Journal* (December 10, 1955), pp. 1408–1413. There are a number of additional and obvious problems with relying on Dr. Dudley Irwin for medical reassurances. The aluminum industry was one of leading fluoride polluters in the country, with an enormous interest in 'proving' fluoride safe. And Alcoa in particular had failed to disclose a great deal of health information about fluoride. For example, their discovery of high fluoride levels in the blood of one of the Donora dead was never made public (see chapter 9). Their 1948 study of aluminum workers in Niagara Falls, NY, in which high incidence of disability was reported was also never disclosed (see chapter 3). Additionally, Dr. Irwin was the head of the Medical Advisory Committee, which had been constituted by the Fluorine Lawyers Committee in order to help industry fight and defend against legal claims of fluoride injury from workers (see chapter 8). Nor would the threshold injury level for skeletal fluorosis be the only serious misstatement by Hodge relating to fluoride analysis. Astonishingly, and with surely devastating consequences for public health, he claimed, "Serious kidney injury or disease does not interfere with fluoride excretion, e.g., in rabbits given near-fatal doses of uranium (a kidney poison), in rats poisoned with fluoride, in elderly patients and in children suffering from kidney diseases (Hodge and Smith 1954)." H. C. Hodge. "Safety factors in water fluoridation based on the toxicology of fluorides." *Proceedings of the Nutrition Society* 22 (1963), pp. 111–117.
33. D. McNeil, *The Fight for Fluoridation*, p. 184.
34. HR 2341 "A Bill to Protect the Public Health From the Dangers of Fluorination of Water." Hearings Before the Committee on Interstate and Foreign Commerce. House of Representatives, 83rd Congress. May 25–27, 1954. Fred-

erick Exner of Seattle and Dr. Veikko Hurme of the Forsyth Dental Infirmary also testified against fluoridation.

35. Hearings, HR 2341, p. 472.
36. *Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride*. Institute of Medicine (Washington, DC: National Academy Press, 1997), p. 311, citing H. C. Hodge and F. A. Smith, "Occupational Fluoride Exposure," *J. Occup. Med*., 19 (1977), pp. 12–39.

Chapter 12

1. "Outlook," November 22, 1991, BBC Word Service.
2. Although a favorite Bernays strategy was to harness liberal ideals such as women's suffrage for clients, it was often done with cynical or mercenary intent. Privately he was contemptuous of those with average intelligence and won corporate clients by warning them of the dangers of democracy and socialism. See the account of his speech to oil executives: "Eddie led the oil boys up to the brink of the public ownership precipice, and let them look into the yawning abyss. Oh my, hold on tight!" E. L. Bernays, *Biography of an Idea: Memoirs of Public Relations Counsel Edward L. Bernays* (New York: Simon and Schuster, 1965), p. 780.

   Bernays's "hallucination of democracy" was described by writer Stuart Ewen as a hierarchical world in which "an intelligent few" had the responsibility of "adjusting the mental scenery from which the public mind, with its limited intellect, derives its opinions." S. Ewen, *PR: A Social History of Spin* (New York: Basic Books, 1996), p. 10.
3. Bernays does not mention the fluoride campaign in his autobiography, *Biography of an Idea*. He was reluctant to discuss it with this author, at first denying his involvement. When confronted with his own prior admissions to the medical writer Joel Griffiths, Bernays agreed to discuss several aspects of his involvement. Second taped author interview at Bernays home, December 11, 1993.
4. L. Tye, *The Father of Spin: Edward L. Bernays and the Birth of Public Relations* (New York: Crown, 1998); for Crisco: Procter and Gamble file in ELB Archive, Library of Congress.
5. E. L. Bernays, *Propaganda* (New York: Horace Liveright, 1928).
6. Chapter 11.
7. Bernays to Dr. Leona Baumgartner, commissioner of health, the City of New York, December 8, 1960. City officials were also advised by Dr. Edward A. Suchman, a social scientist employed by the Health Department, on how "to obtain fluoridation by edict rather than referendum" because, he explained, "the opposition seems to get a better reception from the public in any battle of propaganda or public debate." E. Suchman to Dr. Paul Densen, December 13, 1960.

   Fluoridation could be achieved, Suchman added, by "a systematic targeted campaign directed at those specific officials who had voted against fluoridation" and by lobbying "ethnic groups of political importance." E. Suchman

to Dr. Arthur Bushel, Director of the Bureau of Dentistry, New York Health Department, February 9, 1961. Suchman suggests several "courses of action." The first: "Remove the fluoridation issue from the arena of public opinion. Make the decision a health ruling form the Board of Health and/or secure enough votes from the Board of Estimate to back up this ruling." The second item: "Change the balance of public opinion so that the political leader can be convinced that a large majority of his supporters favors this action. This is difficult to do on a mass basis, but should be possible in terms of specific group pressures, especially from those groups carrying political weight. This is behind our current attempt to determine the major ethnic groups of political importance in particular communities." This memo is cc'd to Leona Baumgartner, Paul Densen, and Edward Bernays. Leona Baumgartner file, ELB Collection, Library of Congress.

8. Baumgartner wrote Bernays: "The problem of equal time has been a continual headache with the networks. I don't know what to do about this." Baumgartner to Bernays, February 14, 1961, Baumgartner file, ELB papers, Library of Congress. He responded on February 16, 1961.
9. Robert Kehoe wrote, "The question of the public safety of fluoridation is non-existent from the viewpoint of medical science." *Our Children's Teeth* (New York: Committee to Protect our Children's Teeth, 1957), p. 31.
10. The committee received a $25,350 grant from Kellogg Foundation and "a second" $2,500 grant from the Rockefeller Brothers Fund. Bethuel Webster to Detlev Bronk, January 13, 1958. Folder 42, Correspondence, Box 21, Detlev Bronk Collection, Rockefeller Archive, RG 303-U.
11. Beginning in May 1940, Webster had been present at luncheon meetings of the prestigious Century Association, an elite club of powerbrokers and wealthy families, whose members have included eight presidents of the United States. Those luncheons, "resulted in the organization of the wartime Office of Scientific Research and Development, led by Centurions Vannevar Bush and James Conant," according to a chronicler of the group, William J. Vanden Heuvel. See "Franklin Delano Roosevelt: A Man of the Century," an address by William J. Vanden Heuvel to the Monthly Meeting of The Century Association, April 4, 2002, press release of the Franklin and Eleanor Roosevelt Institute.

    Also, Webster worked with Vannevar Bush and Carroll L. Wilson (the AEC's first general manager) to help shape the direction of scientific research in the immediate postwar period. See J. D. Kevles,"The National Science Foundation and the debate over Postwar Research Policy—A Political Interpretation of Science—the Endless Frontier," in R. L. Numbers and C. Rosenberg, eds., *The Scientific Enterprise in America:Readings from Isis* (Chicago: University of Chicago Press, 1996), p. 313.

    Webster wanted to win the public battle for fluoridation in New York and thus persuade the entire nation. See Webster's letter to Robert Kehoe, asking him to contribute to the Committee's booklet: "Local authorities must be more than convinced. . . . For the good of the cause I hope you

will not be unduly modest . . . they must be furnished with irrefutable evidence in a popular form to protect them from criticism of the favorable action which we hope they will take. . . . By conclusively demonstrating to local authorities our ability to meet and demolish the opposition, fluoridation and future public health measures may be saved from the impossible requirements of mass scientific education, popular referenda, etc." Webster to Kehoe, December 11, 1956, Box 42. File: "Committee to Protect Our Children's Teeth," RAK Collection.

12. Listening as Bronk dictated his contribution to *Our Children's Teeth* was Shields Warren, the former director of the AEC's Division of Biology and Medicine. Dr. Warren "was in agreement with all that I have said," wrote Bronk in his contribution. Bronk was president of the Rockefeller Institute for Medical Research.
13. Bernays, *Biography of an Idea*, p. 380.
14. New York's Board of Estimate voted for fluoridation after a marathon public hearing, which lasted for twenty hours.
15. Dr. J. Knutson, Assistant Surgeon General, Chief Dental Officer PHS to E. L. Bernays, February 14, 1961, and Bernays to Knutson, February 16, 1961, in Baumgartner file, E. L. Bernays papers, Library of Congress.
16. In the summer of 1951, just one year after the PHS endorsement, Dr. John Knutson—then the top official at the National Institutes of Dental Health—summoned state dental directors to Washington. It was time for a sales pitch. The officials gathered at 9:40 AM in the Washington, DC, offices of the Federal Security Administration on Wednesday, June 6, 1951. Sitting in the meeting were the surgeon general, Leonard Scheele, Katherine Bain of the Children's Bureau, Phil Phair from the American Dental Association, and a top official from the Kellogg Foundation, Phil Blackerby.

    The keynote speaker was Wisconsin's state dental director, Dr. Frank Bull. He had recently fought a furious but losing battle for fluoridation in the town of Seven Points. He now outlined a game plan for state authorities. "Keep fluoridation from going to a referendum," advised Bull. "Are we trying to promote this thing, or do we want to argue about it? When we are inviting the public in and the press in, don't have anybody on the program who is going to go ahead and oppose us because he wants to study it some more. . . . You are like any salesman," Bull told his fellow dental directors, "You have got to be positive." He added, "Don't put any ifs, ands or buts, or maybes in the thing . . . you have got to get a policy that says 'Do it.' That is what the public wants, you know."

    Health officials had to choose their words carefully, Bull advised. If asked, "Isn't fluoride the thing that causes mottled enamel or fluorosis?" Bull suggested, "Tell them this, that at one part per million dental fluorosis brings about the most beautiful teeth that anyone ever had. And we show them some pictures of such teeth. We don't try to say that there is no such thing as fluorosis, even at 1.2 parts per million, which we are recommending, but you have got to have an answer. Maybe you have a better one. . . . We never

use the term 'artificial fluoridation,'" he added. "There is something about that term that means a phony. . . . We call it controlled fluoridation."

Bull especially chided Katherine Bain of the Children's Bureau. Fluoride toxicity was probably the toughest issue facing promoters, he noted. "I noticed that Dr. Bain used the term 'adding sodium fluoride.' We never do that. That is rat poison," Bull said. "You add fluorides. Never mind that sodium fluoride business . . . all of those things give the opposition something to pick at, and they have got enough to pick at without our giving them any more. But this toxicity question is a difficult one. I can't give you the answer on it."

17. Some of the best information on this spying comes from the archive of author Donald McNeil. While writing influential articles on fluoride for *The Nation*, among others, McNeil had compiled an extensive list of antifluoride opponents. He was helped in his list-keeping by the American Water Works Association. He had written to its executive secretary Raymond J. Faust, on May 5, 1954, asking for the names of fluoride opponents: "I have a dossier on every anti I have ever heard of in the country. This includes even names and what background I know about of a person who might only have written a letter to the editor. By collecting the background on EVERYONE I hope to find a pattern which will eventually lead to an intelligent labeling of the opposition" (emphasis in original).

    Faust wrote to McNeil in reply, "We have from time to time developed some background information on some opponents of fluoridation. I will send you a copy of the material we have produced, however, it is sent to you with the understanding that it must be kept confidential or if used the source of the material must not be made public. We have been very careful to keep this material under lock and key as you may well understand." A document entitled "List of Rabid Opponents of Fluoridation" is found alongside. Faust to McNeil, May 13, 1954, File ADA 53–56, and ADA Misc, Box 1, McNeil Collection, Wisconsin State Historical Society.
18. *Science*, vol. 153 (September 23, 1966), p. 1498. See also letter from Donald McNeil to Peter Goulding, Director of Public Information, ADA, February 24, 1961. "Dear Pete . . . I see your powerful hand at work. . . . Today, along with your letter, I received one from Dr. Van Rensselaer Sill, Information Officer, Division of Dental Public Health and Resources, Department of Health, Education, and Welfare. He wrote to me care of *The Nation*, which was strange, but because of what he said, I can only conclude that he has been in touch with you or someone from the ADA. He said that he was interested in the 'paperback on the opponents' [a book McNeil was then shopping] and that he had 'some material on these learned gentlemen.' He hoped that I would call on him for any of the information they had in their offices." File 15, ADA Correspondence 60–63, Box 1, McNeil Collection, Wisconsin State Historical Society.
19. Several examples of professional censure for opposing fluoridation are cited in G. L. Waldbott et al., *Fluoridation: The Great Dilemma* (Lawrence, KS:

Coronado Press, 1978), p. 324. "In 1961 Dr. Max Ginns of Worcester, Massachusetts was dropped from his state dental society after he refused to discontinue use of a petition, circulated in 1953, which listed 119 dentists and 59 physicians in Worcester who opposed fluoridation. . . . [In 1962] the ADA House of Delegates voted to uphold the expulsion."

20. F. B. Exner and G. L. Waldbott, *The American Fluoridation Experiment* (New York: Devin-Adair, 1957), p. 232, letter exchange between John W. Knutson, assistant surgeon general, chief dental officer PHS, and Mr. James Rorty. Feltman was charged in his PHS grant, according to Knutson, with determining "the efficiency (in preventing dental caries) of the addition of measured doses of fluoride salts to pregnant women and children." His funding was cut off because he had "not reached his objective and was not likely to do so." Letter to Rorty from Knutson, August 9, 1956.
21. Waldbott's books on fluoride include *Fluoridation: The Great Dilemma*, with Albert W. Burgstahler and H. Lewis McKinney; *The American Fluoridation Experiment,* with F. B. Exner and James Rorty; and *A Struggle with Titans.*
22. B. Hileman, "Fluoridation of Water," *Chemical and Engineering News*, vol. 66 (August 1, 1988), pp. 26–42.
23. Dr. Exner had served six terms as secretary of the Association of American Physicians and Surgeons. For McNeil's subterfuge, see File ADA 53-56, McNeil Collection, Wisconsin State Historical Society.
24. Irene R. Campbell, *The Role of Fluoride in Public Health: The Soundness of Fluoridation of Communal Water Supplies, A Selected Bibliography*, Supported by Research Grant DE-01493 (Formerly D-1493) from the National Institute of Dental Research, Public Health Service, U.S. Department of Health, Education, and Welfare. As an example of the censorship in the bibliography, there is not a solitary citation for the published works of Dr. George Waldbott discussing fluoride's toxic effects in low doses, nor of the published studies of French epidemiologist Ionel Rapaport, who linked fluoride in water to mongolism, also known as Down syndrome.

    Rapaport's work is discussed in Waldbott et al., *Fluoridation*. The following citation of Rapaport's work included: "Rapaport, I.: 'Les opacifications du crystalline mongolisme et cataracte senile.' *Rev. Anthropol. (Paris)*, Ser. 2,3: 133–135, 1957. 'Contribution a l'etude du mongolisme. Role pathogenique du fluor.' *Bull. Acad. Natl. Med. (Paris)*, 140: 529–531, 1956. 'Contribution a l'etude etiologique du mongolisme. Role des inhibiteurs enzymatiques. *Encephale,* 46: 468–481, 1957. 'Nouvelles recherches sur le mongolism. A propos du role pathogenique du fluor.' *Bull. Acad. Nat. Med. (Paris)*, 143:367–370, 1959. 'Oligophrenie mongolienne et ectodermoses congenitatles. *Ann. Dermatol. Syphiligr.*, 87: 263–278, 1960. 'A propos du mongolisme infantile. Une deviation du metabolisme de tryptophane ches es enfants mongoliens. C. R. Hebd. *Acad. Sci.* 251: 474–476, 1960. 'Oligophrenie mongolienne et caries dentaires.' *Rev. Stomatol.* 64: 207–218, 1963."
25. From 1957 to 1973 the ADA received $6,453,816 from the federal government, according to Waldbott et al., *Fluoridation,* p. 294, citing "Directory

of Dental Consultants and Executive Personnel and Representatives of the American Dental Association to National Agencies and Societies," Bureau of Public Information, Am. Dent. Assoc., October 19, 1955. Direct funding for fluoridation from the PHS is harder to ascertain. According to S. J. Kreshover, director of the National Institute of Dental Research, the Office of Management and Budget "advises that a breakdown of budgeted funds spent specifically on such programs or portions of projects dealing with fluorides is not available." Cited in *National Fluoridation News,* vol. 21. no. 1 (October–December 1975), p. 4.

26. American Dental Association Radio Script, National Children's Health Day, "Fluoridation Fights Tooth Decay," ADA Duplicates, Box 1.
27. This note was found in Donald McNeil's papers. It is marked "ADA Files." The newspapers identified as carrying the identical story are listed as: Hot Springs, AR, *Sentinel Record*, August 20, 1952; Lead, SD, *Daily Call*, August 19, 1952; *Idaho Evening Statesman*, Boise, Idaho, August 18, 1952; Poplar Bluff, MO, *American Republic*, August 21, 1952; *Newton Daily News* (Iowa) reprinted in Boone, Iowa *News-Republican* on August 22, 1952. The note is in a file marked "ADA duplicates," Box 1, McNeil Collection, Wisconsin State Historical Society.

Chapter 13

1. See *Reynolds Metals Company* vs. *Paul Martin*. Appellant's Brief, Appeal from Final Judgements of the District Court for the District of Oregon, Honorable William G. East, Judge. May 14, 1956, p. 3. U.S. Court of Appeals, 9th Circuit Ct. of Appeals, San Francisco, Court Case Papers and Printed Matter, Case #14990, transcript of Record in six volumes, Folder 14990–14992, Box 5888–5890, RG 276.
2. The attorneys were Frank Seamans, for Alcoa; Gordon Martin, for Kaiser Aluminum and Chemical Corporation; E. J. Epielman, Louis C. Viereck, and Lawrence A. Harvey, for Harvey Aluminum; B. W. Davis, for West Vaco Chemical Division of Food Machinery and Chemical Corporation; Lon P. MacFarland, for Monsanto Chemical Company; and R. E. McCormick and Francis R. Kirkham, for Olin Mathieson Chemical Corportaion. Brief Amicus Curiae, In the US Court of Appeals for the Ninth Circuit, Rehearing en banc on Appeal from Final Judgments of the District Court for the District of Oregon, File 18, Box 63, RAK Collection.
3. At Harvard, Hunter had studied with Dr. Philip Drinker. *Reynolds Metals Company* vs. *Paul Martin*, plaintiffs direct examination, p. 471, US Court of Appeals, 9th Circuit Ct. of Appeals, San Francisco, Court Case Papers and Printed Matter, Case #14990, transcript of Record in six volumes, Folders 14990–14992, Boxes 5888–5890, RG 276.
4. Testimony of Dr. Donald Hunter, p. 492.
5. Ibid., p. 473.
6. Ibid., p. 475.

7. Ibid., p. 476. Hunter was an examiner at Cambridge University. Cambridge had been a fluoride poison gas research center during the war. Sir Rudolph Peters also did his enzyme studies at Cambridge. R. E. Banks, ed., *Fluorine Chemistry at the Millenium* (Amsterdam and New York Elsevier, 2000), R. E. Banks (ed) p. 500.]
8. University of Rochester, Progress Report for October, 1944—Abstracts, Dr. Harold Hodge, p. 478. "The results indicated that the inhibition of esterase activity produced by T [code for uranium] was small compared with that by C-216 [code for fluorine]. Thus 0.025 ppm C-216 caused the same percentage inhibition of esterase activity as 100 ppm T (33 percent). From these results it is concluded that in a mixture of T and C-216 in which the amount (by weight) of T is not more than 50-fold that of C-216 the effect of the T upon the activity of liver esterase can be neglected." Also, "The useful range of this curve for determining C-216 concentrations was from 0–0.5 ppm, C-216." Document #SO9FO1B227, p. 19, ACHRE, RG 220. For a discussion of the role of fluoride on enzyme inhibition, and for comprehensive citations, see Waldbott et al., *Fluoridation: The Great Dilemma.*
9. Court of Appeals for 9th Circuit, , Brief Answer to Petition for Rehearing, Appeals from the Final Judgements of the District Court for the District of Oregon, p. 5, Folders 14990–14992.
10. *Reynolds Metals Company* vs. *Paul Martin*. Plaintiffs direct examination, p. 500, U.S. Court of Appeals, 9th Circuit Ct. of Appeals, San Francisco, Court Case Papers and Printed Matter, Case #14990, transcript of record in six volumes, Folders 14990–14992,Boxes 5888–5890, RG 276.
11. Ibid., p. 492.
12. Ibid., p. 1913, deposition of Paula Martin.
13. Ibid., pp. 259 and 213, direct and cross examination of Richard Capps.
14. Ibid., p. 245.
15. Ibid., p. 197.
16. See chapters 3 and 9.
17. Direct examination of Robert Kehoe, *Reynolds Metal Company* vs. *Paul Martin*, pp. 995 and 997.
18. Robert Kehoe to Edward Largent, February 13, 1956, File 5, Box 76, RAK Collection.
19. Manufacturing Chemists Association, Inc. Minutes of the Air Pollution Abatement Committee, November 2, 1955. Via Environmental Working Group searchable database.
20. Appellant's Brief, Appeal from Final Judgments of the District Court for the District of Oregon, Honorable William G. East, Judge. May 14, 1956, p. 7.
21. Following the Martin trial, the company put Largent directly on its payroll as a health and environment consultant. In the years to come Reynolds and its health consultants would be preoccupied with another citizen protest, this time from Mohawk Indians on the Akwesasne reservation on the New York–Canada border, who lived downwind of a newly built Reynolds alu-

minum plant and who claimed that their health and economy were being destroyed by fluoride (see chapter 15).

Chapter 14

1. *Reynolds Metals Company* vs. *Paul Martin*. Petition for Rehearing en banc, p. 6, and Appellant's Brief, p. 32 Appeal from Final Judgments of the District Court for the District of Oregon, Honorable William G. East, Judge. May 14, 1956. P. 3. RG 276, US Court of Appeals, 9th Circuit Ct. of Appeals, San Francisco, Court Case Papers and Printed Matter, Box 5888–5890, Folder 14990 to 14992, case #14990, transcript of record in six volumes.
2. The judges were told that *Our Children's Teeth* included "the statements of one medical and scientific expert after another, all to the effect that fluorides in low concentrations (such as are present around aluminum and other industrial plants) present no hazard to man." Brief Amicus Curiae, In the U.S. Court of Appeals for the Ninth Circuit, Rehearing en banc on Appeal from Final Judgements of the District Court for the District of Oregon, p. 8, File 18, Box 63, RAK Collection.
3. Statement of Robert Kehoe, *Our Children's Teeth, A Digest of Current Scientific Opinion Based on Studies of Fluorides in Public Water Supplies*, prepared by the Committee to Protect Our Children's Teeth, Inc., submitted to the Mayor and the Board of Estimate of the City of New York (1957), p. 31.
4. R. Kehoe, "Memorandum on the Present Status and the Future Needs, with Respect to Information Deriving from Observation and Investigation of the Behavior of Inorganic Compounds of Fluorine in the Animal Organism," February 1, 1956, File 5, Box 76, RAK Collection.
5. Robert Kehoe to James M. McMillan, September 20, 1961, cc: Mr. Frank Seamans, Box 63, RAK Collection.
6. R. Kehoe, "Memorandum on the Present Status and the Future Needs, with Respect to Information Deriving from Observation and Investigation of the Behavior of Inorganic Compounds of Fluorine in the Animal Organism," February 1, 1956, File 5, Box 76, Kettering Files.
7. The corporations "which are concerned mainly with the results of exposure to fluorides in various occupations" included "The Pennsylvania Salt Manufacturing Company, Aluminum Company of America, Reynolds Metals Company, Universal Oil Products Company, American Petroleum Institute, Kaiser Aluminum and Chemical Corporation, Tennessee Valley Authority, The Harshaw Chemical Company, [and] Minnesota Mining and Manufacturing Corporation," Kehoe told the Medical Director of the Division of Industrial Hygiene, Dr. Seward Miller.
8. "In a meeting a little while ago," Kehoe wrote to Dr. Miller, "the question was raised, naturally, as to the long-term influence of small quantities of fluorides, such as those which might be taken in with drinking water, both in areas in which fluorides occur in somewhat unusual concentrations in the drinking water as well as those areas in which fluorides are being added to community water supplies . . . I feel that I should transmit to you the

opinions expressed by this group and by the industries for whom they speak, not as a matter of their right to request any activity on the part of the Public Health Service, but rather as evidence of their interest in a broad problem of public health," Kehoe wrote. "That this interest has been aroused by their concern for the employees of their own companies, is a phenomenon which seems to me to be of some public consequence." Kehoe to Miller, May 20, 1952, RAK Collection.

9. The Bartlett Cameron study examined the health of 116 people in Bartlett and 113 from Cameron. George Waldbott noted that there was no information about how much fluoride the Cameron residents might have consumed in food, which had perhaps been grown in the nearby Bartlett area, or elsewhere in Western Texas, known as a high fluoride region. Although the study reported no "significant differences" in the health status of the two populations, there was a high incidence of cataracts, bone changes, arthritis and deafness in *both communities*, compared to the national average. Also, mortality in Bartlett was 265 percent higher in Bartlett than in Cameron. Furthermore, using data on just 116 individuals to justify adding fluoride to the drinking water of 50 million people meant that, according to George Waldbott, "if 1 in 117 were to suffer ill effect from fluoride in water, the number of those so afflicted among the fifty million citizens would be 427,350—a sizable incidence. Thus the sampling in the Bartlett survey was far too small to assure the safety of millions of people drinking fluoridated water." G. L. Waldbott, *A Struggle with Titans*, p. 296. (Leone's Bartlett research was published as "Medical Aspects of Excessive Fluoride in a Water Supply," *Public Health Report*, vol. 69, no. 10 (October 1954). Submitted as part of the amicus curiae brief in the Martin trial, it was additionally published as N. C. Leone, et al. 1955. "Review of the Bartlett-Cameron survey: A Ten-Year Fluoride Study," *J. Amer. Dent. Assoc.*, vol. 50, pp. 277–281. And Leone et al., *Am J. Roentgen*, vol. 74 (1955), p. 874.
10. "This undoubtedly was the paper Dr. Leone referred to in our long distance telephone conversation while I was engaged in the trial of the Martin personal injury case." W. T. Lennon to Robert Kehoe, March 15, 1957, cc: R. W. Anderson, Alcoa, File 5/6, Box 76, RAK Collection.
11. Leone had given Lennon the reference to a version of the Bartlett Cameron study, published as "A Roentgenologic Study of a Human Population Exposed to High-Fluoride Domestic Water" in *Am. J. Roentgenology, Radium Therapy and Nuclear Medicine,* vol. 74, no. 5, November 1955. The paper included reference to an autopsy, Lennon wrote Kehoe. "Evidently the autopsy was only complete to the extent of bone analysis as the paper contained no comment on soft tissue. I was wondering whether or not you had any talks with Dr. Leone regarding this autopsy and whether or not any examination was made of soft tissue." W. T. Lennon to Robert Kehoe, March 15, 1956, cc: R. W. Anderson, Alcoa, File 5/6, Box 76, RAK Collection.
12. Dr. Leone to Dr. Irwin, letter sent on March 5, 1957, File 5/6, Box 76, RAK Collection.

13. D. A. Greenwood, "Background for Studies in Utah County," paper given at the 1957 Kettering Fluoride Symposium. Greenwood was Professor of Biochemistry and Pharmacology, Utah State University. Another figure claims that the legal claims against U.S. Steel in Utah were for $30 million. Butler C., Proceedings: National Conference On Air Pollution, November 18–20, 1958, p. 268.
14. Leone was an unapologetic propagandist for fluoride. For example, in 1983 he helped organize a conference at Utah State University. In the proceedings he writes, "Further publicizing the importance [of fluoride] in the treatment of selected cases of osteoporosis can help us achieve control of another facet of the fluoride problem. By emphasizing and appraising the older members of our aging population as to the beneficial aspects of fluoride at levels in the neighborhood of 5 mg per day, we can make known the obvious safety of fluoride levels at higher than the advocated (1 ppm) in the prevention of dental caries in children. The process would thus give supportive evidence as to the safety and desirability of fluorides in human diets." J. L. Shupe, H. B. Peterson, and N. C. Leone, eds., "*Fluorides: Effects on Vegetation, Animals, and Humans*" (Salt Lake City, UT: Paragon Press, 1983), p. 361.
15. Dudley Irwin to Frank Seamans, March 13, 1957, 42.17, RAK Collection.
16. *Reynolds Metals Comp* vs. *Yturbide*, 258 F. 2d 321 (9th Cir.) cert. den. 358 U.S. 840 (1958), p. 25.
17. Motion for Leave to File Brief Amicus Curiae, p. 2, and Brief, p. 5, File 18, Box 63, RAK Collection.
18. Kehoe notes of meeting, Folders 18, 19, and 23, Box 63, RAK Collection. For the relationship of the Medical Advisory Committee to the Fluorine Lawyers, see Seamans to Medical Advisory Committee, April 16, 1957: "The legal representatives of the several companies interested in the Kettering Research project have agreed that it would be advantageous if the principal liaison with Kettering were undertaken by persons of competent technical background . . . [to] conduct the necessary liaison between the Kettering Institute and the lawyers' group by a system of regularly scheduled visitations to Kettering and regular reports to the lawyer's group," File 17, Box 42, RAK Collection.
19. Leone's Bartlett Cameron study, comparing two Texas communities with low and high natural fluoride in water, was cited. So was his work in Provo, Utah, where U.S. Steel's giant plant was being blamed for widespread injury to crops and livestock, and where Leone was serving as a consultant to R. A. Call, who was studying fluoride deposition in soft tissues. Leone was also working with Harold Hodge and Frank Smith at Rochester, studying the soft tissues of people who had died in areas with varying levels of fluoride in water. Much of this work, including a summary of Call's work, was brought together in the 1957 Symposium at the Kettering Laboratory and published by editor Philip Drinker in the *Archives of Industrial Health*, vol. 21 (1960). See also *Public Health Report*., no. 80 (1965), pp. 529–538, for an expanded version of Call's report. In regards to the Call study (Leone was not

publicly listed as an author or 'consultant' on the work), George Waldbott noted, "Their grants were not renewed, according to Dr. Call's letter to the author, June 22, 1964. Therefore, the study of ill-effect of airborne fluoride on kidney disease which their research had disclosed was abandoned." G. L. Waldbott, *A Struggle with Titans: Forces Behind Water Fluoridation* (New York: Carleton Press, 1965), p. 251.

20. The final ruling of the Appeals Court on absolute liability was a victory for industry. "This case can no longer be cited for the proposition that in a case of this kind absolute liability exists. Thus, the companies filing amicus curiae briefs at least succeeded in winning the major point which they argued. This may be of doubtful value because of the view taken on proof of negligence but at least we succeeded on this point." Legal memo from Frank Seamans, sent to Robert Kehoe, June 13, 1958, File 18, Box 64, RAK Collection.
21. Ibid.
22. Kehoe to Willard Machle, May 29, 1956, Box 42; and Drinker to Kehoe, July 8, 1958, File 17, Box 42, RAK Collection.

Chapter 15

1. Boscak, 1978. EPA report No. EPA-450/3-78-109. Cited in EPA, "Summary Review of Health Effects . . . ," EPA/600/8-89/002F (December 1988), pp. 3–5. It states, regarding HF manufacturing plants and additional sources of industrial air exposure, "The figure is naturally higher when other fluoride or HF sources are considered."
2. In 1975, 350,000 men and women in 92 occupations were exposed to fluorides. National Institute for Occupational Safety and Health, 1975, DHEW/NIOSH-76-103. Cited in EPA, "Summary Review of Health Effects," pp. 3–5. Also, 22,000 workers were potentially exposed to hydrogen fluoride gas alone, in 57 occupations. Criteria For a Recommended Standard . . . Occupational Exposure to Hydrogen Fluoride, NIOSH DHEW/PUB/NIOSH-76-143, cited pp. 3–5, EPA, "Summary Review of Health Effects."
3. Kehoe to Derryberry, January 9, 1956, File 18, Box 63, RAK Collection.
4. "Memorandum Concerning the Objectives of the Investigative Program on the Behavior of Fluoride in the Human Body and Concerning the Purposes and Policies of the Kettering Laboratory and the University of Cincinnati, in the Prosecution of This Investigative Program," Prepared by Robert Kehoe, November 10, 1956. Box 42, RAK Collection.
5. Some 2,845 pounds a day of Reynolds's fluoride had spilled over the Martin ranch as hydrofluoric acid gas and also as tiny particles of fluoride dust. Memorandum from Frank Seamans summarizing the finding of the Appeals Court en banc, June 12, 1958, File 18, Box 63, RAK Collection.
6. R. Kehoe, "Memorandum on the Present Status and the Future Needs, with Respect to Information Deriving from Observation and Investigation of the Behavior of Inorganic Compounds of Fluorine in the Animal Organism," February 1, 1956, File 5, Box 76, RAK Collection.
7. Ibid.

8. Minutes of the meeting of the Fluoride Committee on October 10, 1956, at 10.00 A M in Room 207, College of Medicine, Folders 18, 19, and 23, Box 63, RAK Collection.
9. Hosted by the Kettering Laboratory, the symposium had been planned earlier in the year at the May 20 meeting at the Kettering Laboratory, following the Martin Appeals Court verdict. It was arranged by Alcoa's Dudley Irwin, Robert Kehoe, and the government's Dr. Nicholas Leone as part of their "strategic" information plan.
10. R. A. Kehoe, handwritten notes, "A World of Welcome on Behalf of the Kettering Laboratory," 1957 Fluoride Symposium, File 42, Box 17, RAK Collection.
11. For aluminum employees, see amicus curiae brief, *Reynolds* vs. *Martin*, p. 2.
12. Other papers on fluoride safety were given by NIDR officials Nicholas Leone, Isadore Zipkin, and Harold McCann. Another study by Richard A. Call on the effects of fluoride air pollution on humans was being conducted in Utah. That project had been explained by the NIDR's Dr. Leone, who described himself as a "consultant" on the project, to Alcoa's Dudley Irwin in a letter of March 5, 1957: "As you know, it has been proven beyond a question of a doubt that similar conditions have an effect upon animals," wrote Leone. He explained that the Public Health Service was financing the human studies "with funds supplied by another Bureau." They were being conducted in the laboratories of the Mormon Latter Day Saints Hospital in Provo, Utah. Urine levels were being recorded. The bones and tissues of individuals who died suddenly were examined. "Inmates of a mental institution close by comprise the study material," Leone noted. The study of forty-eight autopsied bodies that had experienced sudden death concluded that "no histologic abnormities attributable to fluorides were recognized." Nevertheless, 29.3 percent of the "major causes of death" in the study area were listed as "respiratory tract" in origin, compared with just 5.9 percent in the control group. Nicholas D. Leone, MD, Chief Medical Investigations NIDR, to Dudley A. Irwin, MD, Alcoa Medical Director, March 5, 1957, RAK Collection.
13. Kehoe to Dudley Irwin, Alcoa, December 4, 1959. "Dear Dudley: The Symposium has been accepted for publication by Phil Drinker in the [AMA] Archives [of Industrial Health] and it will appear in the April or May number. It will be made available in one volume in reprints and, therefore, it is now time to decide how and in what numbers we wish to have it assembled. . . . I would suggest that the sponsors be polled for the numbers of copies they desire, that this information, together with the addresses to which the reprints and the bill for them are to be sent, be forwarded to me, so that I can hand all of this, in a complete and orderly manner, to Phil Drinker. The sooner this is done the better it will be, I believe, since I would like to be sure that the sponsors get just what they want." File 17, Box 42, RAK Collection. (The editorial board of the Archives of Industrial Health included DuPont's John Foulger, the Mellon Institute's Helmuth Schrenk, the Kettering

Institute's Frank Princi, and Herbert Stokinger, formerly of the University of Rochester's Atomic Energy Project.) The publication of the papers was part of the post-Martin strategy drawn up by Kehoe, Alcoa, and Dr. Leone from the NIDR at their planing meeting that spring. The collected papers appeared in the *Archives of Industrial Health*, vol. 21 (1960).

14. Frank Seamans to Robert Kehoe, April 16, 1957, File 17, Box 42, Kettering Files.
15. William Jolley died of colon cancer in the 1970s, the result of what Bingham and Jolley's family believe was radiation poisoning from his earlier work at the AEC's Mound Laboratory in Miamisburg, Ohio. According to a July 15, 2002, author interview with Eula Bingham, Davis "had worked up at Mound laboratory, the radiation laboratory up in Miamisburg, Ohio, Bill Jolley worked up there also. Bill died of colon cancer in the seventies and his family tried to file a lawsuit and they didn't get anything out of it. He got out of that job—they came here to the university because they really were worried about all the radiation up there." Bingham also believed radiation killed Jolley: "I feel so, too," she said.
16. An earlier draft of the report found in Kehoe's files records the investigators' shock at the results, and the discussion section notes that even the control animals had been hurt by a small amount of fluoride, to which they had somehow been exposed. "The principal findings in the lung were of peribronchial fibrosis and scattered granulomatous (inflammatory) lesions. . . . The striking enlargement of the tracheal lymph nodes was caused by a hyperplastic lymphadenitis. In the lungs there was a strikingly large amount of cholesterol, which, at present, has no clear explanation. . . . Some degree of 'reaction to injury' was encountered even in the lungs of the control dogs which sustained only a modest degree of incidental exposure to air borne calcium fluoride." Folders 18–20, Box 63, RAK Collection.
17. Albert A. Brust, Director, Toxicology Division, to Dudley Irwin, February 10, 1960, cc: R. A. Kehoe and R. K. Davis, File 17, Box 42, RAK Collection.
18. Industry's fear of lawsuits for emphysema damage can be seen in a 1966 symposium at the Mellon Institute in which the managing director of the Industrial Hygiene Foundation, Robert T. P. deTreville, MD, announced: "The Foundation's interest in emphysema stems partly from the concern reflected by its membership that the potential for abuse in the awarding of claims for compensation could easily dwarf that for silicosis at its worst." *Emphysema in Industry*, Medical Series Bulletin No. 10, Mellon Institute Library. (See also Epilogue for discussion of emphysema in industry in 2003.)
19. Charles McCarthy to Robert Kehoe, July 9, 1962, RAK Collection.
20. Dr. Arden Pope at the University of Utah recommended Phalen. Pope described Phalen as "honest and candid."
21. Two early influential members of ACGIH were Harold Hodge and Jim Sterner. (Both had attended the Conference on Fluoride Metabolism at the Hotel Pennsylvania.) Hodge and Sterner were bread-and-butter pragmatists, in Phalen's opinion, forging compromise in the real world of industry

smokestacks and worker paychecks. "If I wanted to harm someone's health, I would put their breadwinner out of a job," Phalen said. "It has a greater health effect dropping someone below the poverty level than becoming a heavy smoker. These people realized the critical nature of someone earning a living. They had seen the Depression. ACGIH decided it would establish limits that workers could be exposed to and most workers, the vast majority, not get ill . . . Harold was of that sort," Phalen added.

22. "No studies were located regarding respiratory effects in animals following inhalation of fluoride." Draft Toxicological Profile for Fluorides 2001 (Department of Health and Social Services, Public Health Service, ATSDR). p. 50.
23. ACGIH's current 2.5 mg/m standard is based on a 1963 paper by Dr. O. M. Derryberry of the Tennessee Valley Authority, a member of the Medical Advisory Committee that had shaped the original Kettering research program.
24. "If it is a study that you are saying is very important and clearly has some relevance, I think it is unlikely that we would ignore it, so I think that you might assume [that we didn't see it] . . . but I can't say that for sure," Brossard added. Author interview, July 22, 2002.
25. Of significance is the report by Laura Trupin, an epidemiologist at the University of California, San Francisco, in the *European Respiratory Journal* vol. 22, no. 3 (September 2003), that on-the-job exposure to dust or toxic fumes may cause as many as five million cases of a group of deadly lung diseases called chronic obstructive pulmonary disease [COPD.] According to *USA Today*, "this study suggests that workplace exposure to pollutants may be a more important cause of the disease than previously suspected. The new study found that workplace exposure may cause as much as 31 percent of all cases of COPD, which kills more than 100,000 Americans each year." *USA Today*, August 26, 2003, Section D, p. 7.
26. "Compensation for Illnesses Realized by Department of Energy Workers Due to Exposure to Hazardous Materials"—Hearings before Subcommittee on Immigration and Claims, September 21, 2000, Serial No. 132, p. 147.
27. Ibid., p. 142.
28. Harding recalled, "At any time, you could see that haze of smoke and smell a strong acrid odor, and you could taste it in your mouth. So you were literally breathing and eating uranium-containing gases and dusts and powder all the time."
29. For "Buchenwald," see J. G. Hamilton, University of California, to Shields Warren, DBM, AEC, November 28, 1950 ("Unfortunately, it will not be possible for me to be at the meeting on December 8"), Document #DOE-072694-B-45, p. 1, ACHRE, RG 220.
30. Congressional testimony of Rep. Ed Whitefield of the State of Kentucky. "Compensation for Illnesses Realized by Department of Energy Workers Due to Exposure to Hazardous Materials," Hearings before Subcommittee on Immigration and Claims, September 21, 2000. Serial No. 132, p. 123.
31. Ibid., pp. 234–235.

32. However, as of August 2003, according to an Internet posting from the worker advocacy group, the Alliance for Nuclear Accountability, "DOE has received over 17,000 claims requesting assistance with state workers' compensation for occupational illnesses, but as of June 25 had processed only 45 claims through its Physicians' Panels for a determination, and none of these claims had yet been paid. DOE has advised Congress that it expects it will take another 5 years to work through its backlog of claims."
33. "The Link Between Exposure to Occupational Hazards and Illness in the Department of Energy Contractor Workforce" (The National Economic Council, 2000), p. 18. This study provided the scientific foundation upon which the legislation was based. At Oak Ridge, a K-25 worker, Sam Vest, watched his father sicken with chronic fatigue syndrome. He watched an uncle get cancer. Both had worked in the K-25 uranium production plant at Oak Ridge, and both died in their fifties and sixties. Today they are buried alongside each other in an Oak Ridge cemetery. Vest continued to work at the plant during the 1990s. He now has bladder cancer, arthritis, and memory loss, he asserts. He was placed on disability in 1998. He describes Oak Ridge as "a tragedy," where sickness stalks former workers. "They all have joint and muscular problems, skeletal problems, a lot of them have memory problems similar to mine," says Vest. "A lot of people have respiratory problems." "Nobody wanted to work in the gaseous diffusion buildings," Vest added. "Deep down they knew they were being exposed to very hazardous chemicals, the HF and the hexafluoride and all the other things."
34. Although the legislation and compensation process did not create a special category for fluoride injury, fluoride had played a leading role in hurting atomic workers, Congress heard. One government-funded study found that 20 percent of former gaseous-diffusion employees have chronic bronchitis and/or emphysema. Exposure to "hydrofluoric acid and other powerful lung irritants in the gaseous diffusion process played a significant contributing role," in causing that illness, scientists said. Congressional testimony of Steven B. Markowitz, Director of the Center for the Biology of Natural Systems, Queens College, Flushing, NY, September 21, 2000, "Compensation for Illnesses Realized by Department of Energy Workers Due to Exposure to Hazardous Materials"—Hearings before Subcommittee on Immigration and Claims, September 21, 2000, Serial No. 132, p. 163.
35. Other investigators, while seemingly aware that hazards exist, are simply unwilling to evaluate the risk communities and workers face from fluoride. Arjun Makhijani, director of the Institute for Energy and Environment Research and one of the nation's most quoted nuclear-health experts, told me that he had "made a decision not to go there" in examining fluoride's health effects, choosing instead to focus on the risks from radiation. He confirmed that little accounting has yet been made of the health damage fluoride has inflicted on nuclear workers. "I don't know how to begin thinking about this question. It is a sleeper," Makhijani said.

36. Richard Wilson and John Spengler, eds., *Particles in Our Air: Concentrations and Health Effects* (Cambridge, MA: Harvard University Press, 1996), p. 212.
37. C. Schneider, *Death, Disease, and Dirty Power: Mortality and Health Damage Due to Air Pollution from Power Plants* (The Clean Air Task Force, October 2000). This report is a summary of a fuller report done by Abt Associates for the Clean Air campaign. On p. 5 it states, "The Abt Associates report further shows that hundreds of thousands of Americans suffer from asthma attacks, cardiac problems and upper and lower respiratory ailments associated with fine particles from power plants." Lung cancer study cited in the *New York Times*, March 6, 2002, Section A, p. 14, from *JAMA* study of same date.
38. Children breathe 50 percent more air per pound of body weight than adults. Children make up 40 percent of all asthma cases, while only 25 percent of the total population. "Asthma: A Public Health Response" (U.S. CDC), cited in *Death, Disease, and Dirty Power*, p. 9.

    One study found infants in high-pollution areas were 40 percent more likely to die of respiratory causes. Another found a 26 percent increase in the risk for sudden infant death syndrome. T. J. Woodruff et al., "The Relationship Between Selected Causes of Postneonatal Infant Mortality and Particulate Air Pollution in the United States," *Environmental Health Perspectives*, vol. 105, no. 6 (June 1997); cited in *Asthma: A Public Health Response*. U.S. CDC; cited in *Death, Disease, and Dirty Power*, p. 9.
39. *New York Times*, May 12, 2000, p. 32.
40. EPA Toxic Release Inventory data—1999 data, updated as of August 1, 2001.
41. For fluoride synergy, see A. S. Rozhkov and T. A. Mikhailova, *The Effect of Fluorine-Containing Emissions on Conifers*, trans. L. Kashhenko, Siberian Institute of Plant Physiology and Biochemistry, Siberian Branch of the Russian Academy of Sciences (Frankfurt: Springer-Verlag, 1993). Part of this text was excerpted on the Fluoride Action Network website. See also Stokinger et al., "The Enhancing Effect of the Inhalation of Hydrogen Fluoride Vapor on Beryllium Sulfate Poisoning in Animals," UR-68, University of Rochester, unclassified.
42. *Florida: from the late 1940s through the 1960s, multiple lawsuits were launched against several fertilizer manufacturers mining the state's rich natural phosphate beds*. U.S. Senate hearings were prompted when 25,000 acres of citrus land in Polk County were damaged and 150,000 acres of pasture abandoned as "fluorides gushed into the orange-blossom-scented air. . . . As cattle ate the grass, they absorbed fluorine into the bloodstream. Teeth decayed, joints stiffened, and bones became brittle," the Associated Press reported. Local citizens were also injured, according to news reports. According to one news account in Florida's Polk and Hillsborough County, "17 plants are clustered abound rich deposits of phosphate rock. Fumes from these plants have destroyed 25,000 acres of citrus trees and damaged vegetation for 50 miles in all directions. Cattle in Polk county have suffered from fluoro-

sis and died and people have been afflicted with sore throats and burning eyes and nosebleeds and respiratory problems. Millions of dollars in damage suits have been filed against phosphate plants." Ned Groth, *Pennisula Observer*, January 27–February 8, 1969. In 1966 the Chemical Manufacturers Association mandated a decrease in airborne fluoride emissions from the phosphate industry in Polk County, from 17 tons to 9 tons per day, according to Dr. D. R. Hendrickson, professor of Sanitary Engineering, University of Florida. Cited in Manufacturing Chemists Association minutes, January 26–28, 1966, CMA Archives, Document 085439, Environmental Working Group searchable database.

Human effects were also claimed by an attorney in Lakeland, Florida, A. R. Carver from the firm of Carver and Langston, whose letter to Dr. Robert Kehoe refers to "air pollution litigation" on behalf of "A man, his wife and two teenage children. They have been living for several years in close proximity; that is to say, within a circle, the radius of which extends five miles, would include eight producing super triple phosphate plants." May 8, 1956, A. R. Carver to Kehoe, RAK Collection.

A Lakeland resident, Mrs. Harriet Lightfoot, told the AP about the human effects of fluoride pollution: "It seemed as she came suddenly awake that a strangler's hands were at her throat. Madly she gasped for breath. Her head was pierced by a splitting pain. Her throat and eyes burned." *Pensacola News-Journal*, December 18, 1966.

See also the account "Death in Our Air," reported in *The Saturday Evening Post* by Ben H. Bagdikian, "Donald McLean, of Polk County, Fla, told a Senate subcommittee that since phosphate plants began putting seven tons of fluoride a day into the air he has had to sell his cattle and his citrus crops because cattle died, crops that used to mature in 80 days now take 200, barbed wire that used to last 20 years rots in 4, and he doesn't dare grow vegetables for his family for fear they will pick up the same chemicals that fall onto his pastures and groves. 'It eats up the paint and etches glass, it kills trees, it kills cattle. It is an irritant to mucous membrane, and we have sore throats, tears run out of our eyes, we sneeze, we have nosebleeds. Gentlemen, am I a fool to assume that that stuff [is] injurious to humans?'" (Date missing on article.)

- *1961, The Dalles, OR: Fairview Farms Inc. received $300,000 from the Harvey Aluminum Company's reduction plant because of damage to farmlands and animals*. Orchardist W. J. Meyer and his wife Mary Ann also received $485,000 for "willful damage" to cherry, apricot, and peach crops, according to news accounts. ("Harvey Loses Fluoride Case," *Hood River (OR) News*, October 29, 1970. Cited in G. L. Waldbott et al., *Fluoridation: The Great Dilemma*, p. 298. The company argued that pollution reduction equipment would cost $15 million and require 100 extra employees. *National Fluoridation News* (March–April 1965), p. 3.
- *1962, Vancouver, WA: Alcoa paid William Fraser $60,000 and, in the same year, $20,000 to Earl Reeder because of fluoride injury to their cattle on Sau-*

vies Island. Sauvies Island. *Portland (OR) Reporter*, June 26, 1962. Cited in Waldbott et al., *Fluoridation*, p. 298.

- *1962, Contra Costa County, CA: Cattle ranchers in California sued four chemical plants for damages to their herds*. Ned Groth, *Peninsula Observer*, January 27–February 8, 1969.
- *Garrison, MT: Human harm from fluoride pollution was alleged after the Rocky Mountain phosphate plant opened in 1963, with residents complaining of, among other symptoms, heart problems and asthma*. Lawsuits for $740,000 were filed. "Smog Battle Ends in Montana Town," *New York Times*, September 17, 1967. Cited in Waldbott et al., *Fluoridation*, p. 299. See also *New York Times*, December 1966: "It is charged among other things that fluoride-laden smoke from the phosphate plant has caused malformations and deteriorating teeth in cattle and horses, that trees have been afflicted by cancerous growths and that people have developed symptoms akin to bronchitis, sinus trouble and heart attacks." See also, B. Merson, "The Town That Refused to Die," *Good Housekeeping*, January 1969, lawsuits cited in *National Fluoridation News*, March–April 1965, p. 3. "People were made so ill that many were literally driven out of their homes," according to Ned Groth in *Peninsula Observer*.
- *1968: Cominco American Phosphate Company in Douglas Creek was successfully sued for $250,000*. L. Greenall, "Industrial Fluoride Pollution in British Columbia," Canadian Scientific Pollution and Environmental Control Society, Vancouver, mimeo, January 1971. Cited in M. Prival and F. Fisher, "Fluorides in the Air," *Environment*, vol. 15, no. 3 (April 1973), pp. 25–32.
- *Columbia Falls, MT, 1970: Six damage suits for $625,402 were filed on Sept 24 by residents for alleged fluoride damage caused by the Anaconda Aluminum Company and the Anaconda Wire and Cable Co, according to news accounts*. A week earlier a $21.5 million dollar action was filed against the two companies by Dr. and Mrs. Loren Kreck of Columbia Falls, and a suit filed by Mr. and Mrs. Harold Dehibom asked $1,650,000 from the same defendants. *National Fluoridation News* (September–October 1970), p. 4.
- *Tennesse, 1970: Reports of $3 million in fluoride claims against Alcoa*. "Alcoa Sued for Nearly $3 Million," *Knoxville (TN) Journal*, October 29, 1970, Cited in Waldbott et al., *Fluoridation*, p. 298.
- *1971: $9 million lawsuit in by the Sierra Club against the Harshaw Chemical Company for fluoride pollution, which, the Club charged, had corroded a main bridge over the Cuyahoga River.*
- *Ferndale, WA, 1972: $83,060 judgment by farmer against Intalco Aluminum Company in Ferndale, WA*. R. Park, "The Italco Trial," *Bellingham (WA), Northwest Passage* March 20–April 2, 1972, cited in Prival and Fisher.
- *1980: $150 million lawsuit against Reynolds Metals and Alcoa, alleging fluoride injury to cattle on the New York–Canadian St. Regis Reservation, during the period of 1960–1975, settled for $650,000*. Karen St. Hilaire, "St.

Regis Indians to Settle Fluoride Dispute," *Syracuse Post Standard*, January 8, 1985, cited in Griffiths "Fluoride: Commie Plot or Capitalist Ploy?" *Covert Action Information Bulletin*, no. 42 (fall 1992), p. 26.

43. Ned Groth, "Capitalist Plot? Air Is Fluoridated," *Peninsula Observer*, January 27–February 3, 1969. Also, Public Law 84-159 of the 84th Congress (1955) established the PHS's first air-pollution program. "At the time Public Law 84-159 was implemented, fluorides constituted the major industrial pollutant of immediate concern to agriculture," in "Six Years of Research in Air Pollution: A review of Grants in aid, Contracts, and Direct Operations Sponsored by the Division of Air Pollution, Bureau of State Services. July 1, 1955, to June 30, 1961." U.S. Department of Health, Education and Welfare.
44. *Agriculture Handbook*, No. 380, published by the Agriculture Research Service of the U.S. Department of Agriculture (1970), cited in E. Jerard and J. B. Patrick, "The Summing of Fluoride Exposures" *Intern. J. Environmental Studies*, vol. 4 (1973), pp. 141–155. "Whenever domestic animals exhibited fluorosis, several cases of human fluorosis were reported, the symptoms of which were one of more of the following; dental mottling, respiratory distress, stiffness in knees or elbows or both, skin lesion, or high level of F in teeth and urine. Man is much more sensitive than domestic animals to F intoxication," that report added.
45. Weinstein: "Whereas threshold concentrations for ozone or sulfur dioxide that will produce an irreversible effect [upon plants] were found to be generally above 0.05 ppm for exposure periods of about 7 days, and more than double that concentration and time for nitrogen dioxide, gaseous hydrogen fluoride could cause a metabolic or physiologic change and produce lesions on leaves of the most sensitive species at 0.001 ppm (1 ppb v/v, or 0.8 Mg HF m^3) or less for similar durations of exposure. Only peroxyacetylnitrate, a constituent of photochemical smog, can rival this extreme phytotoxicity."

    Does fluoride have a role in acid rain? Weinstein, in this report in 1982, wrote, "Even less is known of effects of fluoride on soil structure and chemistry, micro- and macro flora, and on fluoride availability to the plant. Increased acidity in precipitation has heightened interest in these subjects" (p. 53). Also, "There are huge gaps in our knowledge with respect to effects on insects and other anthropods, soil microorganisms and aquatic flora and fauna" (p. 56). Weinstein's comments were made at an industry-funded conference of fluoride lawyers, government dentists, and former bomb-program scientists, held at Utah State University in 1982. L. H. Weinstein, "Effects of Fluorides on Plants and Plant Communities: An Overview," in J. L. Shupe, H. B. Peterson, and N. C. Leone, eds., *Fluorides: Effects on Vegetation, Animals and Humans* (Salt Lake City, UT: Paragon Press, 1983), p. 54. Attending this conference were Frank Seamans, Nicholas Leone, Harold Hodge, Frank Smith, David Scott (a former director of the National Institute of Dental Research), and B. D. Dinman, the vice president of health and safety for Alcoa. (Harold Hodge, Nicholas Leone, and fluoride lawyers

Frank Seamans and Keith Taylor organized that industry-funded conference, the book states.)

46. In 1966 Morris Katz, professor of atmospheric sanitation, explained at a Canadian National Conference on Pollution and Our Environment why atmospheric fluoride levels are measured in parts per billion, although maximum permissible levels for most atmospheric contaminants are calculated in parts per million. "Prolonged exposure to ambient air with concentrations of less than 1 part per thousand million part of air by volume may create a hazard. . . . In this respect fluorides are more than one-hundred times more toxic than sulfur dioxide." Elise Jerard and J. B. Patrick, "The Summing of Fluoride Exposures," *Intern. J. Environmental Studies*, vol. 4 (1973), pp. 141–155; citation from p. 143. Also see, cited in Jerard, a report in *Environmental Science and Technology* (August 1970) that states fluoride "compared to other pollutants is toxic at much lower concentration (0.5 ppb) and also acts as a cumulative poison. . . . Aside from the injury to vegetation there is a potential danger to animals and even human beings feeding on plants high in fluoride content."
47. According to historian Lynn Snyder, the U.S. military had designed the National Air Sampling Network. The network had, for example, measured protein in air as a marker for the presence of biological weapons. L. P. Snyder, *The Death-Dealing Smog*, p. 58, n. 50. According to Groth, fluoride had been one of the chemicals initially reported. After pressure from New York Congressman Richard L. Ottinger, national monitoring of fluoride pollution was reinitiated in 1968. See Groth, "Capitalist Plot? Air Is Fluoridated."
48. "Summary Review of Health Effects Associated with Hydrogen Fluoride and Related Compounds," U.S. Environmental Protection Agency, December 1988, pp. 2–9.
49. Globally that figure was an estimated 3.6 million tons in 1972. Ibid., Section 3, p. 2.
50. "Despite the fact that the further litigation which was anticipated with apprehension some years ago has failed to appear, the industries are vulnerable in the field of occupational disease hazard and in the field of community health relating to air pollution." Robert Kehoe to Reynolds's medical director, James MacMillan, September 20, 1961, cc: Frank Seamans, Box 63, RAK Collection.
51. See Taylor in *Fluorides: Effects on Vegetation, Animals, and Humans*, p. 359.
52. The six criteria pollutants were sulfur dioxide, carbon monoxide, hydrocarbons, nitrogen oxides, ozone, and particulate matter. (Lead was added in 1978.) Air pollutants were listed as hazardous by EPA according to whether those emissions, "can be expected to result in an increase in mortality or irreversible illness," according to an EPA official, D. F. Walters. In 1977 the U.S. Forestry Service asked EPA to fix a national ambient air quality standard (AAQS) for fluoride, to control fluoride damage in Montana. According to Walters, "EPA's reevaluation concluded that though there may be a number of local problems with fluoride damage to sensitive species around

industrial sources, the problem was not of a sufficiently national character to require a NAAQS. [National Ambient Air Quality Standard]." Also, for "permissive": "States may apply less stringent standards to sources when economic factors or physical limitations specific to those sources make less stringent standards significantly more reasonable," Walters added. D. F. Walters, "Regulatory, Economic, and Legal Aspects of Fluoride" in *Fluorides: Effects on Vegetation, Animals, and Humans*, pp. 351–358.

53. For D. F. Walters, see ibid. Perhaps a telling illustration of how fluoride has been "disappeared" or whitewashed as an air pollutant can be seen in the discussion surrounding the important study by Pope of the health improvement in local citizens following the temporary shuttering in the 1980s of the U.S. Steel mill in Provo, Utah. Although that plant was sued in the 1950s for some $30 million for fluoride pollution, by the time of the Pope study that history had so faded that there was little or no discussion of fluoride's role in the pollution-related health effects proved by the Pope study. C. A. Pope, "Respiratory Disease Associated with Community Air Pollution and a Steel Mill, Utah Valley," *Am. J. Public Health*, vol. 79 (May 1989), pp. 623–628.
54. The EPA concluded, "Fluoride pollutants were highly located in the vicinity of major point sources, in contrast to the other criteria pollutants which were more pervasive and widespread." See Walters, p. 351.
55. Reynolds had just concluded the Martin trial and was commissioning fresh studies at Kettering. But according to EPA official D. F. Walters, instead of instituting strict emission controls, it was not until the 1970s—a full decade after the plant was opened—that pressure from Canadian officials and lawsuits from farmers forced Reynolds to begin to install air-pollution control equipment. Ibid, Walters, p. 353.
56. J. Raloff, "The St. Regis Syndrome," *Science News*, vol. 118 (July 19, 1980), p. 42.
57. B. Carnow and S. A. Conibear, "Airborne Fluorides and Human Health, Report to the St. Regis Band on the Implications of Airborne Fluoride Contamination of Cornwall Island for the Health of its People," January 1978.
58. The transborder International Joint Commission, the U.S. Department of State, the Canadian Department of External Affairs, Canadian Department of the Environment, New York State, and the Ontario Ministry of the Environment were variously involved in addressing the dispute. See Walters, p. 353.
59. Curiously, in 1980 and 1981 the Mount Sinai School of Medicine and Selikoff received two awards totaling $446,975 from the National Institute of Dental Research to study "Long-term, low-level exposure to environmental agents (human)." See NIH CRISP awards, Project #5P30ES00928-08 and . . . 928-09.
60. "The increase noted in cardiovascular and respiratory morbidity/mortality rates in the older population (and females in particular) of the entire Band indicates a possible adverse effect from environmental exposure." Also: "The early infant mortality appears significant. Moreover, the higher number of hospital admissions . . . due to disease of the joints and connective tissue

could be related to fluorine effect." I. J. Selikoff, E. C. Hammond, and S. M. Levin, "Environmental Contaminants and the Health of the People of the St. Regis Reserve," *Fluoride: Medical Survey Findings* (Environmental Sciences Laboratory, Mount Sinai School of Medicine of the City University of New York), vol. 1, pp. 342–343.

61. "Should notable correlations between fluoride exposure and adverse health effects be found in Selikoff's epidemiological study of Cornwall Island residents, major changes in the way EPA looks at fluoride could result, including its reclassification as hazardous," *Science News*, vol. 118 (July 19, 1980), p. 43.

Chapter 16

1. The attorneys for the workers, Bruce McMath and Steve Napper of Little Rock, Arkansas, had signed up a hundred of these clients, known as the Beaty cases, for a claim against Reynolds to be mounted following the first Bareis trial, which is described in the following pages. The former group, which included Alan Williams and Jerry Jones (interviewed here), had been part of a team that developed a chemical process to dispose of the by-product waste of aluminum smelting. (The waste is called *treated spent potliner* and is described in the chapter.)
2. Author interview with EPA's Steve Silverman, June 18, 2002.
3. *Arkansas Business*, January 12, 1998, p. 23.
4. The old Reynolds Troutdale plant, which had injured the Martins, was designated a Superfund site, for example.
5. In the months after the Benton trial, Alan Williams would have open-heart and back surgery and lose most of his body hair.
6. Author interview, June 24, 2002.
7. A Reynolds memo as read in deposition states, "Alcoa expressed some concern that the actual soluble fluoride content in the kiln discharge is actually more than revealed—more than revealed by the TCLP. We are aware of this, but TCLP is the procedure used." Plaintiffs exhibit 173, in *George Bareis, et al.* vs. *Reynolds Metals*, Saline County Court, Case 97–703–2.
8. In December 1997 the EPA finally reversed course and reclassified the "treated" chemical waste as toxic. It was the first time the agency had taken back a delisting, said Peace. It was far too late, however, for Scotty and Dianne Peebles and the several hundred Hurricane Creek workers who had been breathing and handling the fluoride waste for years. And it was too late for the local environment, where thousands of tons of toxic waste had been buried in two mighty landfills. Eventually nearly 225,000 tons of treated potliner waste would be dumped in unlined pits at the Hurricane Creek site, according to the Associated Press, December, 2 1997.
9. Following the redesignation in December 1997 of the treated potliner as a hazardous material, new safety and disposal criteria were instituted.
10. The verdict, OSHRC Docket No. 98–0057, was voided on December 14, 2001 on jurisdiction grounds.

11. Kehoe to James MacMillan, medical director, Reynolds Metals, September 20, 1961, Box 63, RAK Collection.
12. Nevertheless, as Mullenix described the beagle study to the jury on October 20, 2000, McMath attempted to sneak in some history and context. Hadn't the Reynolds study been done in the 1950s, he asked Mullenix, "in connection with some litigation they had going at that time?" Johnson was ready. "Your Honor, objection," he exclaimed. "We ruled on this in chambers, didn't we?" McMath retreated. "I'll withdraw the question," he conceded.
13. In the end it seems that McMath's hunch about the jury was correct. Polled after the trial, a majority sided with Reynolds. The Benton claimants were simply looking for easy money, according to juror Marilyn Schick. "It was a situation where [workers] were exposed to a lot of dust, but as far as the ALROC [the name Reynolds had given to the treated spent potliner] being toxic to them, I just wasn't convinced that it was," she told me.

    But there were some jurors who did lean in favor of the workers against Reynolds. "It was a big company not caring about some low-class workers," said juror Sue Magness. "So what if it cost them some health problems—they had to get the job done." She blames the "excellent" Reynolds lawyers for portraying the plaintiffs as "sorry" drunks and drug addicts. "They weren't looking at them as people. They were looking at them as just bringing this lawsuit to get a buck. They didn't strike me that way," she added, about the workers. Magness had wanted a chance to talk with the other jurors and maybe influence them to rule in favor of the workers, she said. "I can be pretty persuasive. Sometimes people don't pick up on things, and when you bring it up in a jury room and they get to thinking about it, they change their minds," she said.

Chapter 17

1. "No deleterious systemic effects have occurred," he added. HR 2341 "A Bill to Protect the Public Health From the Dangers of Fluorination of Water," Hearings Before the Committee on Interstate and Foreign Commerce, House of Representatives, 83rd Congress, May 25–27, 1954, p. 470.
2. Philip R. N. Sutton, *Fluoridation: Errors and Omissions in Experimental Trials* (Melbourne: Melbourne University Press, 1959); "United Kingdom Mission Report (1953): The Fluoridation of Public Water Supplies in North America as a Means of Controlling Dental Caries" (London: Her Majesty's Stationary Office); World Health Organization (1958) Expert Committee on Water Fluoridation, First Report, Technical Report Series No. 146 (Geneva: World Health Organization); New Zealand Commission of Inquiry, "The Fluoridation of Public Water Supplies" (Wellington: Government Printer, 1957).
3. "I accept the whole of the evidence given by Professors Hodge [and others]," Justice Kenny wrote in his ruling verdict, which had the effect of imposing fluoridation on Ireland's entire population, a situation that remains to this day. M. Stanley, "Fluoridation of Public Water Supplies in Ireland," New

Jersey State Dental Soc., vol. 37 (1966), p. 242, cited in Frank McClure, *Water Fluoridation: The Search and the Victory* (NIDR, 1970), p. 275.

4. J. V. Kumar and P. A. Swango, *Community Dent. Oral Epidemiol.* vol. 27, no. 3 (June 1999), pp. 171–180, L. L. Lininger, G. S. Leske, E. L. Green, and V. B. Haley, "Changes in dental fluorosis and dental caries in Newburgh and Kingston, New York," *Am. J. Public Health*, vol. 88, no. 12 (December 1998), pp. 1866–1870.
5. *Boston Globe*, November 11, 1999; "Cincinnati's dental crisis," *Cincinnati Enquirer* October 6, 2002; *Washington Post*, March 5, 2002; and J. Kozol, *Savage Inequalities* (New York: HarperPerennial, 1991).
6. J. A. Lalumandier and R. G. Rozier, *Pediatric Dentistry* (January–February 1995), pp. 19–25, cited in *Medical Abstracts Newsletter*, July 1995, p. 28. Also, the University of York's fluoridation review found that up to 48 percent of children in fluoridated areas in the United Kingdom had some form of fluorosis. M. McDonagh, et al. "A Systemic Review of Public Water Fluoridation," NHS Center for Reviews and Dissemination, 2000, Executive Summary, p. 3.
7. M. Teotia, S. P. Teotia, and K. P. Singh, "Endemic chronic fluoride toxicity and dietary calcium deficiency interaction syndromes of metabolic bone disease and deformities in India: year 2000," *Indian J Pediatr.*, vol. 65, no. 3 (May–June 1998), pp. 371–381.
8. The Australian scientist Mark Diesendorf writes that "infants who are bottle fed with milk formula reconstituted with fluoridated water . . . receive 100 times the daily fluoride dose of breast-fed babies and at least 4–6 times that recommended by medial authorities for fluoride supplementation in unfluoridated areas." M. Diesendorf and A. Diesendorf, "Suppression by Medical Journals of a Warning About Overdosing Formula-Fed Infants with Fluoride," *Accountability in Research*, vol. 5 (1997), pp. 225–237. Also, the chicken in infant food can reach 8.38 micrograms per gram. J. R. Heilman et al., "Fluoride Concentrations in Infant Food," *JADA* (July 1997), p. 857. (Mechanically boned meat can include higher fluoride content. Fluoride concentrates in bone, therefore when some of that bone is found in the "boned" meat, the fluoride content can rise.)
9. The American fluoride researcher H. V. Smith, who codiscovered the fact that fluoride caused dental mottling, wrote, "Mottling, no matter how mild, is an external sign of internal distress," Letter from H. V. Smith to George Waldbott, June 1, 1964, cited in Waldbott, *A Struggle with Titans*, p. 65.
10. Christa Danielson, MD, Joseph L. Lyon, MD, et al., "Hip Fractures and Fluoridation in Utah's Elderly Population," *JAMA*, vol. 268, no. 6 (August 12, 1992), p. 746.
11. For hip fracture rate, see U.S. National Research Council, *Diet and Health* (Washington, DC: National Academy Press, 1989), p. 121. For arthritis data, see *Newsweek*, September 3, 2001, pp. 39–46.

12. See, for example, Y Li et al., "Effect of Long-Term Exposure to Fluoride in Drinking Water on Risks of Bone Fractures," *J. Bone and Mineral Research*, vol. 16 (2001), no. 5, pp. 932–939.
13. M. T. Alarcon-Herrera et al., "Well Water Fluoride, Dental Fluorosis, Bone Fractures in the Guadiana Valley of Mexico," *Fluoride*, vol. 34, no. 2 (2001), pp. 139–149.
14. One published account, quoting data from the U.S. National Center for Health Statistics, reported that bone fractures in male children and adolescents may be increasing. Joel Griffiths, "Fluoride: Commie Plot or Capitalist Ploy?" *Covert Action Information Bulletin*, no. 42 (fall 1992), p. 65.
15. *Fluoridation Facts* (published since 1956 by the American Dental Association). Paul R. Thomas, program officer at the Food and Nutrition Board of the National Academy of Sciences wrote in a March 18, 1991, letter to Darlene Sherrell, 'The statement you quote from the ADA pamphlet on water fluoridation—"The Academy found that the daily intake required to produce symptoms of chronic toxicity . . . is 20 to 80 milligrams or more . . . ' may be misleading." It was an easy lie to perpetuate, however. For example, even the "Recommended Daily Allowances for Fluoride" published in 1989 by the National Academy of Sciences, stated that "chronic toxicity . . . occurs after years of daily exposures of 20 to 80 mg of fluorine, far in excess of the average intake in the United States." That, too, was hugely disingenuous, conveying the impression that toxicity was found only at this elevated threshold.
16. H. C. Hodge, "The Safety of Fluoride Tablets or Drops," in *Continuing Evaluation of the Use of Fluorides*, eds. E. Johansen, D. R. Taves, and T. O. Olsen, AAAS Selected Symposium (Westview Press, 1979), p. 255.
17. *Review of Fluoride Benefits and Risks* (Public Health Service, Department of Health and Human Services, 1991), p. 45.
18. National Research Council, *Health Effects of Ingested Fluoride* (Washington, DC: National Academy Press, 1993), p. 59.
19. South Carolina was suing the EPA, objecting to the federal requirement to remove fluoride in water supplies that exceeded the threshold.
20. Presented in part as the David Murray-Cowie Memorial Lecture, University of Michigan, Ann Arbor, October 12, 1951. Published in full in S.Z. Levine, ed., *Advances in Pediatrics* (New York: Interscience Publishers, 1955), pp. 13–51.
21. Safe Drinking Water Committee, *Drinking Water and Health* (National Research Council, NAS, 1977), p. 389.
22. National Toxicology Program (NTP) (1990), *Toxicology and Carcinogenesis Studies of Sodium Fluoride in F344/N Rats and B6C3f1 Mice* (Technical report Series No. 393, NIH Publ. No 91-2848, National Institute of Environmental Health Studies, Research Triangle Park, NC).
23. W. Marcus, "Fluoride Conference to Review the NTP Draft Fluoride Report," Memorandum dated May 1, 1990, from Wm. L. Marcus, senior science adviser, Office of Drinking Water (ODW), U.S. EPA, to Alan B. Hais, acting direc-

tor, Criteria & Standards Division, ODW, U.S. EPA. See also: "Such a trend associated with the occurrence of a rare tumor in the tissue in which fluoride is known to accumulate cannot be causally dismissed," *Environmental Health Criteria*, no. 227 (WHO 2002), p. 169.

24. *The Lancet*, vol. 336, no. 8717 (September 22, 1990), U.S. Department of Labor, Case # 92-TSC-5, Recommended Decision and Order, p. 27.

25. There has been a great deal of information associating fluoride with cancer. Cancer has been experimentally linked to fluoride since the early 1950s, when Alfred Taylor at the University of Texas in Austin found that cancer-prone mice drinking water containing 1 ppm NaF, and eating food with a negligible fraction of fluoride, developed mammary tumors at an earlier age than similar mice fed nonfluoridated water. A. Taylor, "Sodium Fluoride in the Drinking Water of Mice," *Dental Digest*, vol. 60 (1954), pp. 170–172. Cited in Waldbott et al., *Fluoridation: The Great Dilemma* (Lawrence, KS: Coronado Press, 1978), p. 223.

    For cancer in fluoride workers and around fluoride industrial plants, see A. J. deVilliers and J. P. Windish, "Lung Cancer in a Fluorspar Mining Community. Radiation, Dust, and Mortality Experience," *Br. J. Ind. Med.*, vol. 21 (1964), pp. 94–109; N. N. Litvinov, M. S. Goldberg, and S. N. Kimina, "Morbidity and Mortality in Man Caused by Pulmonary Cancer and Its Relation to the Pollution of the Atmosphere in the Areas of Aluminum Plants," *Acta Unio Int. Contra Cancrum*, vol. 19 (1963), pp. 742–645, V. A. Celilioni, "Lung Cancer in a Steel City [Hamilton, Ontario]: Its Possible Relation to Fluoride Emission," *Fluoride*, vol. 5 (1972), pp. 172–181, cited in Waldbott et al., *Fluoridation*, p, 236.

    The late John Yiamouyiannis—a biochemist and antifluoride activist, and a retired National Cancer Institute biochemist, Dean Burke, reported more cancer in fluoridated communities in the United States. J. Yiamouyiannis and D. Burk, "Fluoridation and Cancer: Age-Dependence of Cancer Mortality Related to Artificial Fluoridation," *Fluoride*, vol. 10 (1977), pp. 102–123. And J. Yiamouyiannis, "Fluoridation and Cancer: The Biology and Epidemiology of Bone and Oral Cancer Related to Fluoridation," *Fluoride*, vol. 26 (1993), pp. 83–96.

    For bone cancer and fluoridated water, see A. Takahashi, K. Akiniwa, and K. Narita, "Regression Analysis of Cancer Incidence Rates and Water Fluoride in the U.S.A. based on IACR/IARC (WHO) data (1978–1992)," *J. Epidemiol.*, vol. 11, no. 4 (July 2001), pp. 170–179, abstracted in *Fluoride*, vol. 34, no. 3 (May 2001). In this study the researchers found that "cancers of the oral cavity and pharynx, colon and rectum, hepato-biliary and urinary organs were positively associated with FD [fluoridation of drinking water]. This was also the case for bone cancers in males, in line with results of rat experiments."

    In 1991 the National Cancer Institute found that the occurrence of osteosarcoma in young males was, in fact, significantly higher in fluoridated versus unfluoridated communities. However, the researchers concluded that the

increased was *unrelated* to water fluoridation. According to the U.S. Public Health Service, "Although the increase in rates of osteosarcoma for males during this period was greater in fluoridated than nonfluoridated areas, extensive analyses revealed that these patterns were unrelated to either the introduction or duration of fluoridation." R. N. Hoover, S. Devesa, K. Cantor, and J. F. Fraumeni Jr., "Time Trends for Bone and Joint Cancers and Osteosarcomas in the Surveillance, Epidemiology and End Results" (SEER) Program, National Cancer Institute," in *Review of Fluoride: Benefits and Risks, Report of the Ad Hoc Committee on Fluoride of the Committee to Coordinate Environmental Health and Related Programs* (U.S. Public Health Service, 1991), pp. F 1–177. Despite those assurances, similar increases in bone cancer in young men were also found in New Jersey in a 1992 study. In that report, between the years 1970 and 1989 the rate of osteosarcoma (among ten- to nineteen-year-old males) was found to be 3.5 to 6.3 times greater in the fluoridated areas versus the unfluoridated ones. P. D. Cohn, *An Epidemiologic Report on Drinking Water and Fluoridation* (Trenton, NJ: New Jersey Department of Health, 1992). The latter two references are cited on the Fluoride Action Network webpage.

26. Interview with Paul Connett, May 1998. This taped interview can be obtained from GG Video, 82 Judson Street, Canton, NY 13617.
27. The researchers reported that fluoridated drinking water helped to carry aluminum to the brain in experimental rats, producing "irregular mincing steps characteristic of senile animals." Autopsies revealed brain damage. The data are "the latest of several studies hinting at some link between aluminum in the environment and Alzheimer's," according to the *Wall Street Journal*, October 28, 1992, section B, p. 6.

    Also, J. A. Varner, C. Huie, W. Horvath, K. F. Jensen, R. L. Issacson, "Chronic AlF_3 Administration: II. Selected Histological Observations," *Neuroscience Research Communications*, vol. 13, no. 2 (1993), pp. 99–104. R. L. Isaacson, J. A. Varner, and K. F. Jensen, "Toxin-Induced Blood Vessel Inclusions Caused by the Chronic Administration of Aluminum and Sodium Fluoride and Their Implications for Dementia," *Neuroprotective Agents. Annals of the New York Academy of Sciences*, no. 825 (1997), pp. 152–166, J. A. Varner, K. F. Jensen, W. Horvath, R. L. Isaacson, "Chronic Administration of Aluminum-Fluoride or Sodium-Fluoride to Rats in Drinking Water: Alterations in Neuronal and Cerebrovascular Integrity," *Brain Research*, no. 784 (1998), pp. 284–298.
28. *Fluoride, the Pineal Gland, and Melatonin: An Interview with and Presentation by Dr. Jennifer Luke*. Videotape, length: 40 minutes. Available from GGVideo, 82 Judson Street, Canton, NY. GGVideo [Grassroots and Global Video] (1999).
29. *The Newburgh Times*, January 27, 1954: "The 283 heart deaths in Newburgh in the year were equal to a rate of 882 deaths per 100,000 population. This was more than the rate for the nation as a whole, 507 per 100,000. It was also higher than the Middle Atlantic States, 590 heart deaths per 100,000."

30. For Michigan, see T. L. Hagen, M. Pasternack, and G. C. Scholz, "Waterborne Fluorides and Mortality," *Public Health Rep*., vol. 69 (1954), pp. 450–454, cited in Waldbott et al., *Fluoridation*, p. 158; see also p. 160. For fluoride's effect on chicken embryo hearts, see also, J. D. Ebert, "The First Heartbeats," *Scientific American*, vol. 56 (1959), pp. 4–7: "At low concentrations [fluoride] primarily affects the heart. . . . At any given stage of development . . . the locations of the cells destroyed by fluoride coincide with the sites that have the greatest capacity to form heart muscle, and with the areas that have the greatest capacity for the synthesis of actin and myosin."
31. T. G. Reeves, *Water Fluoridation: A Manual for Engineers and Technicians* (U.S. Public Health Service, CDC Division of Oral Health, 1986) and *Water Fluoridation; A Manual for Water Plant Operators* (U.S. Public Health Service, CDC Division of Oral Health, April 1994), cited in M. Coplan and R. D. Masters, "Why Have U.S. Health Agencies Refused to Test Silicofluorides for Health Safety?" (unpublished, 2001), via authors.
32. For risk of cancer at the trace levels (up to 1.6 parts per billion) of arsenic found in water that is fluoridated by silicofluoride, see *Arsenic in Drinking Water: 2001 Update* (National Academies Press, 2001). See discussion on p. 7 in Summary, of linear nature of toxic effects at low doses. For lead, see R. D. Masters, M. J. Coplan, B. T. Hone, J. E. Dykes, "Association of Silicofluoride Treated Water with Elevated Blood Lead," *Neurotoxicology*, vol. 21, no. 6 (December 2000), pp. 1091–1100. See also Chairman, Subcommittee on Energy and Environment, Cong. Ken Calvert (R-CA), May 8, 2000, letter to Carol M. Browner, EPA administrator.
33. Almost no fluorspar is mined domestically. Of a reported 2001 consumption of 536,000 tons of fluorspar, 353,000 tons were imported from China. U.S. Geological Survey, *Minerals Yearbook* (2001).
34. Only a tiny fraction of the recovered silicofluoride waste is now converted for use as industrial fluoride—4,700 tons, for AlF_3, for aluminum smelting. U.S. Geological Survey, *Minerals Yearbook* (2001). (The fluosilicic acid recovered from the phosphate industry must first be converted into fluorspar, or aluminum fluoride, before being reused by industry.) But the potential of the Sunshine State as a source of industrial fluoride remains. In 2001 65,200 tons of fluosilicic acid were recovered from the phosphate industry. That's one-fifth of the nation's potential industrial fluoride needs, according the U.S. Geological Survey.
35. http://www.fluoride-journal.com/
36. University of Rochester, Progress Report for October, 1944—Abstracts, Dr. Harold Hodge, p. 478. "The results indicated that the inhibition of esterase activity produced by T [code for uranium] was small compared with that by C-216 [code for fluorine]. Thus 0.025 ppm C-216 [code for fluorine] caused the same percentage inhibition of esterase activity as 100 ppm T [code for uranium] (33 percent). From these results it is concluded that in a mixture of T and C-216 in which the amount (by weight) of T is not more than 50-fold that of C-216 the effect of the T upon the activity of liver esterase can

be neglected." Also: "The useful range of this curve for determining C-216 concentrations was from 0–0.5 ppm, C-216." Document #SO9FO1B227, ACHRE, RG 220.

37. Twenty-fifth ISFR Conference Abstracts, *Fluoride*, vol. 35, no. 4 (2002), p. 244.
38. *A Century of Public Health: From Fluoridation to Food Safety* (CDC, Division of Media Relations, April 2, 1999).

Epilogue

1. PFCs are "organic" chemicals, which means that they are based on carbon. In a PFC chemical, the fluorine atom is joined to the carbon molecule with a much stronger "covalent" bond, rather than the weak "ionic" bond in fluorides.
2. In September 2000 EPA officials met with a lobbying group known as the Fluoropolymer Manufacturers Group, composed of DuPont and Dow Chemical, plus the giant European and Japanese chemical manufacturers Elf Atofina and Asahi Glass Fluoropolymers. The industry representatives impressed upon the EPA the importance of PFOA chemicals in scores of vital commercial products, upon which industries worth an estimated $25 billion depended, from aerospace to automobiles to medical devices, according to records of that meeting. Despite "repeated attempts," industry declared, there had been "no success" in finding alternatives.
3. T. Midgley Jr. and A. L. Henne, *Ind. Eng. Chem.* vol. 22 (1930), p. 542. On December 31, 1928, General Motors' Frigidaire Division was issued the first patent for CFCs: US#1,886,339. A new company called Kinetic Chemicals, owned by DuPont and General Motors, was incorporated on August 1, 1930. By 1935, 8 million new refrigerators had been sold in the United States, filled with DuPont's patented "Freon" CFC gas. Global CFC production continued to soar; it increased from 150,000 tons in 1960 to 800,000 tons in 1974.
4. The secret PFC called "Joe's Stuff" that was delivered to Columbia University in December 1940 was named after Professor Joseph Simons from Penn State University. Simons invented a process known as "electro-chemical fluorination" which used electricity to replace the hydrogen with fluoride in hydrogen-carbon bonds, producing fluorocarbons. After the war the technology would be licensed to the 3M corporation, who would use it to make, among other things, the fabric protector Scotchgard. J. H. Simons, ed., *Fluorine Chemistry*, vol. 1 (New York: Academic Press, 1950), p. 423. T. Abe, "Electrochemical fluoridation as a locomotive for the development of fluorine chemistry at NIRIN, Nagoya," and John Colin Tatlow, "Fluorine Chemistry at the University of Birmingham: A Cradle of the Subject in the UK" in *Fascinated by Fluorine* (Amsterdam and New York: Elsevier, 2000), pp. 273 and 476. H. Goldwhite, *J. Fluorine Chem.*, vol. 33, p. 113. *Industrial and Engineering Chem.* vol. 39, no. 3 (March 1947), p. 292.
5. Colborn has since learned that some organofluorines are "really nasty" endocrine disrupters, she told me in an e-mail.

6. "It would be desirable," Col. Stafford Warren told Dr. John Foulger in a letter dated August 12, 1944, "to have the work on the toxicity of fluorocarbons being done in your laboratory parallel the investigations being made on similar compounds elsewhere. For that reason it would be appreciated if Dr. Harold Hodge of the University of Rochester could visit your laboratory in the near future and an exchange of ideas be effected. . . . The Medical Section has been charged with the responsibility of obtaining toxicological data which will insure the District's being in a favorable position in case litigation develops from exposure to the materials." Warren to Dr. John Foulger, Box 25, Accession #72C2386, Atlanta FRC, RG 326.
7. In a document titled "Research Plans for the Division of Pharmacology 1946–47," a subsection, "Industrial Hygiene," lists item "k" as "Investigation of the Nature of Fluoride in Blood." Fluoride exists in blood in "an organic and an inorganic state," while "organic fluorine compounds appear to be more toxic than the fluoride ion," the research summary noted. The Rochester team now planned "to investigate the nature of the compounds of fluorine existing in the blood, devoting special attention to the so-called organic fraction." Additional questions the bomb program researchers wanted answered were as follows:

    - An investigation of the possible relations between fluorides, iodide and calcium levels and the thyroid gland.
    - The effect of fluorine upon enzyme systems of the blood, particularly by means of an in vivo experiment.
    - The relation between fluorine and non-diffusable (protein bound) blood calcium.
    - How high can the blood fluoride level be raised before ill effects are raised in animals.

    The document concluded: "These experiments are intended to give fundamental information regarding the mode of action and metabolism of fluorine in the system. The information would appear to be of value for the following reasons. . . . Exposure to fluoride is of industrial significance, particularly since the advent of atomic energy programs," and that, "the determination of base levels is of immediate practical value in the impending litigation between the DuPont Co. and residents of New Jersey areas." DOE's HREX search engine, found at 0712317, document numbers 1075992, 1076012, 1076013. Where are the results of these experiments?
7. DuPont bulletin No. X-59a.
8. "Two types of reaction have been noted in humans as the result of accidental inhalation of the products of heated polymer. 1) a condition similar to metal fever; and 2) a condition in which there may be an irritation of the lungs leading to pulmonary edema." DuPont bulletin No. X-59a. DuPont conducted human experiments giving volunteers Teflon-laced cigarettes to investigate fume fever. J. W. Clayton, "Fluorocarbon Toxicity and Biological Action," *Fluorine Chem. Reviews*, vol. 1, no. 2 (1967), pp. 197–252.

9. Harold D. Field to the Kettering Laboratory, January 23, 1958. Albert Henne to Robert Kehoe, October 15, 1958. "Teflon Coated Cooking Utensils," File 12, Box 15, RAK Collection. In the early 1930s Henne, a Belgian immigrant, had invented a manufacturing process for the first CFC Freon gas. He had also done fluoride work for the Manhattan Project.
10. *Nature*, vol. 217 (March 16, 1968), pp. 1050–1051.
11. "Little has been published about the metabolic handling and toxicology of perfluorinated fatty acid derivatives. Computer assisted literature searches using Medline, Toxline and Chemcon developed no information on these subjects." W. S. Guy, D. R. Taves, and W. S. Brey, "Organic Fluorocompounds in Human Plasma," *Biochemistry Involving Carbon-Fluorine Bonds* (American Chemical Society, 1976), p. 132.

    On the subject of collaboration, "3M got concerned apparently," Taves told me. "They would come check with me periodically—they wouldn't tell me what they were doing," he said, "but they wanted to know what I knew."
12. Taves's 1976 observation that "little has been published" on the toxicity of PFCs deserves scrutiny. During the cold war Taves was a leading arbiter of fluoride safety for the National Academy of Sciences. (Taves is listed on p. 396 of the 1977 document "Drinking Water and Health" by his initials as an author. This research was conducted by the National Research Council for the National Academy of Sciences and the EPA.) Donald Taves may also have buried evidence of fluoride's harm to humans on behalf of his Rochester colleagues, such as Harold Hodge, who worked for the nuclear program.

    In 1963 another colleague of Dr. Taves at Rochester, Dr. Christine Waterhouse, reported a case in which a patient at the Strong Memorial Hospital, a female nurse, "convulsed, aspirated and died suddenly" following kidney dialysis. Waterhouse and a team of scientists watched as the forty-one-year-old nurse suffered a collapse of her central nervous system. "A bizarre neuromuscular irritability characterized by a twitching of the right arm with occasional generalized convulsive seizures developed five days after the third dialysis," Waterhouse reported. Kidney dialysis can greatly concentrate the amount of fluoride in blood, scientists suspected. But the Waterhouse team never mentioned fluoride as a possible cause of the woman's symptoms or death. L. H. Kretchmar, W. M. Greene, C. W. Waterhouse, and W. L. Parry, "Repeated Hemodialysis in Chronic Uremia," *J. Am. Med. Assoc.*, vol. 184, no. 41 (1962), pp. 1037–1044.

    Two years later Dr. Donald Taves reported the same case in the medical literature. He discussed the high levels of fluoride found in the patient's bones and blood. He speculated as to a possible "beneficial" effect from the fluoride. *But Taves failed to report that the patient had died an hour after dialysis, that she had died in agony, and that the fatality had been reported by his Rochester colleague a year earlier.* (He claimed that he was unaware of Dr. Waterhouse's *JAMA* paper in which she reported the patient death. However, in the acknowledgments in his own work he thanked none other than his colleague, Dr. Christine Waterhouse.)

"Did they tell you how the patient had fared?" I asked Taves. "No, I don't think I ever heard," he said. "You were interested in fluoride and dialysis but you didn't follow up or ask what had happened to the patient?" I asked. "Right," Taves replied. (D. R. Taves, R. Terry, F. A. Smith, and D. E. Gardner, "Use of Fluoridated Water in Long-Term Hemodialysis," *Chronic Uremia., J. Am. Med. Assoc.*, vol. 184 [1963], pp. 1030–1031.) Both Rochester papers were funded by the U.S. Public Health Service. Neither mentioned the secret AEC kidney studies on human patients performed at Strong Memorial Hospital nor the government's interest in fluoride.

Did Taves censor his paper at the behest of Drs. Waterhouse and Hodge? In the 1960s Dr. Waterhouse was at the center of cold-war human experimentation, monitoring Harold Hodge's Rochester patients who had been given plutonium injections. (See Eileen Welsome, *The Plutonium Files* [New York: Dial Press, 1999].) "Waterhouse was uncomfortable with me publishing [the 1965 kidney paper]," Taves told me. "She didn't want me to do anything that sounded antifluoridation. Just like Hodge didn't. They were all biased that way. Hodge had gotten on the bandwagon of being in favor of fluoridation so his blinders were up," Taves added.

Similarly, the effects of fluoride on kidneys were another critical concern of the scientists overseeing health conditions inside the nuclear factories, and Rochester and Kettering researchers each performed multiple human experiments. Hodge's researchers performed secret human experiments in the 1940s at Rochester, giving fluoride to "patients having kidney diseases" to determine how much fluoride their damaged kidneys could excrete, according to declassified papers. Extra fluoride was stored in the bones of those injured patients, the government scientists found. *Quarterly Technical Report*, AEC No. UR-38, 1948. Also cited in Kettering Laboratory unpublished report, "Annual Report of Observations on Fluorides—October 25, 1954." Kettering did similar experiments on patients with damaged kidneys, according to the unpublished report.

13. Again, there is not a solitary reference to organofluorines in the book.
14. There may also be a link between accounts of birds dying, injured humans, and carpets impregnated with fluorochemicals, such as Scotchgard. In the early 1990s CNN and other media reported on families who claimed that they had been poisoned by newly installed carpets. One family told the BBC (in an interview conducted by the author) that their caged birds had died soon after the new carpet arrived. See also U.S. Court of Appeals for the Fourth Circuit No. 94-1882 Sandra Ruffin; Catherine Ruffin, by and through her Guardian Ad Litem, C. Timothy Williford, *Plaintiffs-Appellants,* vs. *Shaw Industries, Incorporated*; Sherwin-Williams Company, Decided: July 16, 1998. "With their motion for summary judgment, defendants submitted the affidavit of Larry D. Winter, an analytical chemist for Minnesota Mining and Manufacturing Company (3M). Mr. Winter specializes in the analysis of fluorochemicals such as those used in the manufacturing of 3M's Scotchguard carpets, the type involved in the present case." The case was dismissed.

15. *Scientific American*, March 1, 2001, pp. 16–17. Also, when 3M announced that the company was phasing out Scotchgard, the EPA praised 3M's openness in sharing data about the toxicity of PFCs. But Purdy is not so sure. As soon as the ecotoxicologist arrived at 3M in 1981, he says he grew concerned about the impact of PFCs on the environment, proposing new testing. "I could see that this could be a potential problematic class of chemicals, and so did everybody else in the ecological group," says Purdy. "We were very suspicious that we were seeing the tip of an iceberg. There was a proposal to do a lot of different testing—and it wasn't done."

    Former Michigan State scientist Kurunthachalam Kannan is not sure either about the 3M announcement in 2000 to phase out PFOS chemicals. "I work closely with 3M so I know what is really going on. But in terms of the words 'phase out,' when we try to talk to them, their people are not sure what it really means [laughs]. It is only a fraction of what they really manufacture in terms of organofluorines." Author interview, 2002.

    Also on 3M's internal studies, see the collection of documents in possession of the Environmental Working Group. In 1976, 3M company medical tests showed that some employees had levels of fluorocarbons in their blood as high as 30 parts per million. Although those exposure levels fell for a while, in 1984 blood contamination "remained constant or increased," according to 3M documents. That situation prompted concern about "employee health" and "corporate liability," according to the documents (thirteen tests showed values of over 10 ppm). Subsequently 3M workers showed abnormal liver function tests and "high kidney function tests," while other workers had lung abnormalities, described as "cases of pleural thickening." (Internal memo from 3M doctor Larry Zobel to D. W. Dworak dated March 20, 1987, entitled "Medical Examinations.") Also, in the late 1970s, 3M ran toxicity tests for the fluorocarbon PFOS on rhesus monkeys. All the animals died. (J. Morris, "Did 3M and DuPont Ignore Evidence of Health Risks?" *Mother Jones*, September–October 2001, online edition.)
16. *Scientific American*, March 1, 2001, pp. 16–17.
17. "3M's Big Clean Up," *Business Week*, June 5, 2000 via online edition.
18. "3M's Big Clean Up," *Business Week*, June 5, 2000; *Scientific American*, March 1, 2001, pp. 16–17.
19. Kannan et al., "Perfluorooctane Sulphonate in Fish Eating Water Birds Including Bald Eagles and Albatrosses," *Environmental Science and Technology*, vol. 35, pp. 3065–3070.
20. *Scientific American*, March 1, 2001, pp. 16–17.
21. http://www.ewg.org/issues/pfcs/
22. It is not the first time DuPont chemicals have been linked to eye defects in children. In the early 1990s a DuPont fungicide marketed as Benlate was discovered to contain a fluorine chemical called flusalizole, which was not licensed for use in the United States. Benlate provided one of the most disastrous and expensive episodes in U.S. corporate history. Some of the lawsuits blamed Benlate for causing children to be born without eyes.

DuPont has since paid $1.3 billion in costs and settlements with farmers who used Benlate and whose crops were damaged. In July 2003 the Florida Supreme Court also reinstated a $4 million jury award to the family of a boy born without eyes, in what the Associated Press described as "a birth defect linked to the agricultural pesticide Benlate." (Associated Press, July 3, 2002.) And although another judge threw out a ruling that DuPont had engaged in "racketeering," by allegedly concealing evidence in the Benlate saga, a similar case in Atlanta was settled when DuPont agreed to pay $2.5 million dollars to each of Georgia's four law schools.

Judge Hugh Lawson explained that settlement made a statement about the importance of legal ethics, according to the *New York Times*, January 2, 1999, section A, p. 12. How much was learned about legal ethics is not clear. DuPont was also accused of destroying evidence in the West Virginia PFC litigation. "In April 2003 a Judge in West Virginia found that in 2002, DuPont had destroyed evidence relevant to ongoing litigation on PFOA brought by 3000 citizens of West Virginia and Ohio." Press Release, Environmental Working Group, June 6, 2003.

The billion-dollar DuPont/Benlate debacle may be an example of one of fluoride's best-known chemical properties gone tragically awry. As early as 1949 the Atomic Energy Commission reported that fluoride had a synergistic ability to boost the toxicity of beryllium. When fluoride was added, twice as many rats were killed, according to experiments performed at the University of Rochester. (H. Stokinger et al., "The Enhancing Effect of the Inhalation of Hydrogen Fluoride Vapor on Beryllium Sulfate Poisoning in Animals," UR-68, University of Rochester, unclassified.) Similarly, during World War II, Hitler's chemists discovered that fluoride could dramatically boost the toxicity of nerve gases. Sarin—the same gas used by Saddam Hussein on the Kurds of Halabja and used in the deadly subway attack in Tokyo—is a fluorinated chemical, named after the German scientists who invented it. (*Fascinated by Fluorine*, p. 515). Today drug companies know that adding even a single fluorine atom to a drug molecule can boost chemical potency. Numerous modern drugs now contain small amounts of fluoride, including the antidepressant Prozac and the powerful antianthrax antibiotic Cipro. "Just one fluorine placed at a strategic site in an organic molecule can hot up its activity," says the English scientist Eric Banks. "The opportunities for finding something useful for society are truly mind blowing." Unfortunately, adding fluorine to drugs may also make them quite literally "mind blowing." Cipro, for example has numerous reported side effects, including central-nervous-system problems such as acute anxiety. And recently several fluorine-containing drugs have been withdrawn because of their side effects, including:

- Baycol, a cholesterol-lowering drug taken by 700,000 Americans, and linked to 31 deaths in the United States, with at least nine other fatalities worldwide;

- Cisapride ("Propulsid"), withdrawn in 2000 because it caused severe cardiac side effects;
- Mibefradil ("Posicor"), withdrawn in 1998 after it was shown that in patients with congestive heart failure the drug produced a trend to higher mortality;
- Flosequinan, withdrawn in 1993 after it was shown that the beneficial effects on the symptoms of heart failure did not last beyond the first three months of therapy. After the first three months of therapy, patients on the drug had a higher rate of hospitalization than patients taking a placebo;
- Astemizole (allergy drug), withdrawn in 1999 because it also became associated with life-threatening cardiac adverse events;
- The "weight loss" drugs fenfluramine and dexfenfluramine, withdrawn in 1997 because of serious adverse cardiac health effects, generating almost a billion dollars in lawsuits;
- Tolrestat (antidiabetic), withdrawn in 1997 after the appearance of severe liver toxicity and deaths;
- Temafloxacin ("Omniflox"), withdrawn in 1992. The antibiotic had caused deaths and liver dysfunction;
- Grepafloxacin, removed from the market in 1999 because of serious cardiac events.

(List courtesy of Andreas Schuld and Wendy Small, Parents of Fluoride Poisoned Children [PFPC], Vancouver, BC, Canada.)

Fluoride's potential role in drug toxicity has not been well studied. An expert on the withdrawn diet drug dexfenfluramine, Dr. Kenneth Weir at the University of Minneapolis, said that he had no information on whether fluoride played a role in that drug's toxic action on the human heart. Central-nervous-system problems, such as depression, were also reported among the drug's unwanted effects. "It seems an intriguing question," notes Dr. Weir, "if you broke it down into its constituent parts, whether they would have a toxic effect." A mighty paradox exists. Just as fluoride performs some of the heaviest lifting in modern industry—but gets a glancing scrutiny from regulators and health officials—it is also routinely added to drugs to boost their chemical effect but mostly overlooked for its potential role in toxicity. Dr. Phyllis Mullenix points her finger at the not-too-distant past. She believes the sweeping cold-war-era assurances on fluoride safety from such scientists as Robert Kehoe and Harold Hodge have left a "black hole" in our understanding of fluoride's biological effects, and a failure by regulators to consider the toxicity of fluoride compounds. "Any drug that has a fluoride component should be automatically red-flagged," Mullenix says. "It simply is not done."

23. "PFOS caused postnatal deaths (and other developmental effects) in offspring in a two-generation reproductive-effects rat study," EPA official Charles Auer noted in a May 16, 2000, e-mail, referring to the PFC used in Scotchgard, "At higher doses in this study," the summary continued, "*all* progeny in the first

generation died while [at the lower level] many of the progeny from the *second* generation died. It is very unusual to see such second generation effects" (emphasis in the original). The e-mail concluded, "PFOS accumulates to a high degree in humans and animals. It has an estimated half-life of 4 years in humans. It thus appears to combine Persistence, Bioaccumulation, and Toxicity to an extraordinary degree. . . . EPA's preliminary risk assessment indicated potentially unacceptable margins of exposure (MOE's) for workers and possibly the general population."

DuPont has concerns about PFC toxicity, too. In the 1990s, for example, the company worried about the cancer risk from PFCs. "We may have a product stewardship issue if we have a [Teflon] finish that contains a suspect carcinogen," a 1994 Dupont document noted. "The worst-case scenario is that [PFOA] could be classified as a large 'C' carcinogen," a 1996 company memo added. *Mother Jones*, September-October 2001, online edition.

That "scenario" may be scientific reality. Working on a grant from the U.S. Air Force, Michigan State's Brad Upham collected evidence that the PFOS and PFOA fluorocarbons disrupt intercell communication, allowing potentially tumor-producing cells to multiply. "We have very good reasons to think that they could contribute to cancer," the scientist told me. (Author interview).

24. Richard Hefter, chief, High Production Volume Chemicals Branch, USEPA, to A. Michael Kaplan, director, Regulatory Affairs and Occupational Health, DuPont Haskell Laboratory, May 22, 2003. Andrea V. Malinowski to Richard Hefter, chief, High Production Volume Chemicals Branch, USEPA, June 20, 2003. Ken Cook, president, EWG, to EPA Administrator Christine Todd Whitman, April 11, 2003.

25. DuPont worries about a public-relations catastrophe and has shied from media attention regarding its blood-seeking fluorochemicals. When farmers Wilbur and Sandra Tennant of Parkersburg, West Virginia blamed PFC pollution from the DuPont factory for killing their cattle and harming their health, DuPont asked U.S. District Judge Joseph Goodwin to prevent the Tennants from testifying at an EPA hearing in March 2000, according to court documents cited by investigative reporter Jim Morris at *Mother Jones* magazine. (J. Morris, "Did 3M and DuPont Ignore Evidence of Health Risks?" *Mother Jones*, September-October 2001, online edition.)

DuPont's attorney, John Tinney, blamed Hollywood for the company's woes and for the necessity of a restraining order against the farmers. "The court need look no further than the movies for practical application," the lawyer told Judge Goodwin, citing "the enormous success at the box office of *Erin Brockovich* and *A Civil Action*." The company, however, need not have worried. Although no restraining order was issued, media attention was limited, according to *Mother Jones*.

DuPont also claims that there is no risk to Teflon workers. The company's recent employee monitoring has found no elevation of PFOA-class chemicals in employees directly involved in production, according to comments

by spokesperson Dave Korzeniowski in the journal *Environmental Science and Technology*. DuPont seems reassured by that data. It was 3M's discovery of high PFOS levels in its employees, for example, that helped to lead to the promised phase-out of Scotchgard. "PFOS appears to behave differently from our products," Korzeniowski states. (R. Renner, *Environmental Science and Technology*, vol. 35, no. 7 [April 1, 2001], pp. 154A–160A.)

26. Cited in letter from Kenneth Cook, president of Environmental Working Group to Mr. Richard H. Hefter, chief of High Production Volume Chemicals Branch, United States EPA, August 15, 2003. At web location www.ewg.org/issues/pfcs/20030813/.

    The company also told workers that "a female who has an organic fluorine level above background level should consult with her personal physician prior to contemplating pregnancy." Washington Works Proposed Communication to Females Who Had Worked in Fluoropolymers Area, embedded as link in above letter. Cook to EPA, August 15, 2003.

27. Q. Xiang et al., "Effect of Fluoride in Drinking Water on Children's Intelligence," *Fluoride*, May 2003, J. A. Varner, K. F. Jensen, W. Horvath, and R. L. Isaacson, "Chronic Administration of Aluminum-Fluoride or Sodium-Fluoride to Rats in Drinking Water: Alterations in Neuronal and Cerebrovascular Integrity," *Brain Research*, vol. 784 (1998), pp. 284–298.
28. *Sunday Telegraph*, November 24, 1996.
29. L. Trupin et al., "The Occupational Burden of Chronic Obstructive Pulmonary Disease," *European Respiratory Journal*, vol. 22, no. 3 (September 1, 2003), pp. 462–469.
30. March 18, 2002, comments submitted to the EPA, on DowAgroSciences petition to establish fluoride and sulfuryl fluoride tolerances for a large number (40) of raw and processed foods. *Federal Register*, February 15, 2002, U.S. EPA Docket control number PF-1068, submitted by Paul Connett, professor of Chemistry, St. Lawrence U., Canton, NY, and Ellen Connett, editor, *Waste Not*, Canton, NY.