

Monsanto, PCBs, and the creation of a “world-wide ecological problem”

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Abstract For the past three decades, we have written on the history of occupational and environmental health, authoring books and articles on lead poisoning, silicosis, asbestosis, and angiosarcoma of the liver, among other diseases. One book, *Deceit and Denial*, focused specifically on the chemical and lead industries. Because of the rarity of historians who study this history, we have been asked to testify on behalf of workers who allege harm from these industrial materials and by state, county, and local governments who seek redress for environmental damages and funds to prevent future harm to children. In about 2010, we began testifying in law suits brought by individuals who claimed that they had suffered from cancers, specifically non-Hodgkin’s lymphoma, because of polychlorinated biphenyls (PCBs) in their bodies. At that time, we wrote a Report to the Court about industry knowledge of the dangers of PCBs to workers and the environment. More recently, we have been approached by attorneys representing government agencies on the West Coast of the United States which are seeking funds to abate PCB pollution in their ports, bays, and waterways. The focus of these lawsuits is the Monsanto Corporation, the sole producer of PCBs in the United States from the 1930s through 1977. Through these law suits, an enormous trove of previously private Monsanto reports, papers, memos, letters, and studies have been made available to us and this paper is

See also, Special Section: ToxicDocs: Opening a new era of evidence for policies to protect public health in J Public Health Pol (2018) 39:1 at <https://link.springer.com/article/10.1057/s41271-017-0102-z>, starting with an explanation of the www.ToxicDocs.org website and its many uses.

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the result of our examination of these hundreds of thousands of pages. The documents from this collection (with the exception of privileged materials that Monsanto has not made public, and upon which we have not relied) are available on www.ToxicDocs.org, the website we have developed with Professor Merlin Chowkwanyun of Columbia's Mailman School of Public Health. (Almost all of the references that are from this collection can be accessed by readers by clicking on the reference hyperlink.) This monograph is adapted from a report to the court that was originally produced for litigation on behalf of plaintiffs in PCB lawsuits. We are grateful to the *Journal of Public Health Policy* for publishing this detailed examination of these documents and we hope it will stimulate further research into this important, and now public, archive of industry records.

Keywords Monsanto · PCBs · Pollution · Cancer · Industry · Chemicals · Public health

Introduction

Industrially produced chemicals have become an essential ingredient in virtually all of our lives. Our kitchens are filled with detergents; household sprays are made from a variety of solvents; our walls and floors are made of 'vinyl'; our foods are packaged in wrappings made of clear plastics; our vegetables are grown with synthetic fertilizers and covered with pesticides; our computers, desks, and mechanical devices are filled with synthetic materials. It is not surprising that chemicals are in our bodies as well, where literally hundreds of chemicals have been identified.

Scientists barely understand what long-term dangers these substances may present to human health and the environment. Some of these chemicals are especially worrisome: bisphenol a (BPA) used as a plasticizer in hundreds of products from the lining of canned food to the receipts we receive for our credit card payments, is a known endocrine disruptor. Formaldehyde, a colorless chemical used in mortuaries as a preservative, can also be found as a fungicide, germicide, and disinfectant in, for example, plywood, particle board, hardwood paneling, and the "medium density fiberboard" commonly used for the fronts of drawers and cabinets or the tops of furniture [1].

As these materials age, formaldehyde evaporates into the home releasing a cancer-producing vapor, that slowly accumulates in our bodies. The National Cancer Institute (NCI) at the United States (US) National Institutes of Health (NIH) suggests that homeowners "purchasing pressed-wood products, including building material, cabinetry, and furniture... should ask about the formaldehyde content of these products." Flame retardants commonly used in sofas, chairs, carpets, love seats, curtains, baby products, and even TVs, which sounded like a good idea when widely introduced in the 1970s, turn out to pose hidden dangers that we're only now beginning to grasp [2]. Researchers have, for instance, linked one of the most common flame retardants—polybrominated diphenyl ethers—to a wide variety of potentially undesirable health effects, including thyroid disruption, memory and learning



problems, delayed mental and physical development, lower IQ, and the early onset of puberty. (This introduction is drawn from: Gerald Markowitz and David Rosner, “Your Body is a Corporate Test Tube,” *Tom Dispatch*, April 28, 2013, available at: <http://www.tomdispatch.com/blog/175693/>.)

Of special concern are a variety of chlorinated hydrocarbons, including DDT and other pesticides that were once spread freely across the United States. Despite being banned decades ago, they have accumulated in the bones, brains, and fatty tissue of virtually all of us. Their close chemical carcinogenic cousins, polychlorinated biphenyls (PCBs), were found in innumerable household and consumer products—like carbonless copy paper, adhesives, paints, and electrical equipment—from the 1950s through the 1970s. We are still paying the price for that industrial binge today, as these odorless, tasteless compounds have become persistent pollutants in the natural environment and, as a result, in all of us.

A case study of PCBs (1930s–1970s) begins to answer broader questions

How did we get into a situation where we only try to remedy a problem after the horse has left the stable? How did we learn to accept the introduction of thousands of chemicals into the environment and into our bodies before knowing they were safe? This case study of PCBs begins to answer those questions. Here we will outline the history of a material that was as recently as the 1930s in none of us but which today is documented to be literally in all of us. The brief story is that PCBs were invented, found to be useful, and to be profitable to one company, Monsanto, which had a monopoly in the United States and was distributing it widely before most Americans had ever heard of it. By the time it was banned in the late 1970s, it was already a worldwide environmental pollutant and part of our bodies.

The presence of PCBs in our bodies is often presented as data, and thus implicitly, an inevitable product of the development of an industrial society. In this review of the history of this universal pollutant, we can discern a different narrative of decisions and interests that overcame good judgement. Although Monsanto has argued that PCBs were placed in closed systems that posed little risk of contamination of the broader environment, this study reveals that from virtually the very first moments of PCBs manufacture in the 1930s, PCBs were envisioned as ingredients in a wide variety of products that ultimately would be used, handled, and consumed in ways that would make it virtually inevitable that they would enter the environment and into human bodies [3]. Further, this article demonstrates that despite commitments of United States (US) industries, Monsanto included, to fully test substances and products that were widely distributed, and despite the fact that such testing was conducted by many companies including Monsanto, the company never did long-term evaluations of this product until 1969, and only after others had already found it to be a world-wide ecological contaminant. The company’s initial reaction to the others’ discovery of the universal presence of PCBs in the environment and in human beings was not to reduce the production of PCBs designed for ‘open’ applications, but to increase production and, in the words of one company official, to “sell the hell out of ‘em.”



Despite Monsanto's claim that it 'voluntarily' got out of the business in 1977, it was the concerted efforts of environmental activists, regulators, and the media that forced Monsanto finally to make this decision because of its concern about the broad impact of the negative publicity on its image and ultimately its bottom line. Parts of this story have been told in Ellen Spears's excellent book, *Baptized in PCBs—Race, Pollution and Justice in an All-American Town*, a close examination of the impact of Monsanto on Anniston, Alabama, the site of much of its PCB production [4].

Although Spears presents some of this story in her book, we provide a broader and more detailed examination of Monsanto's PCB story based on documents not available at the time of the publication of her book.

PCBs and early warnings of danger, 1933–1949

Chlorinated naphthalenes and diphenyls are in general highly toxic compounds and must be used with extreme care. Industrial hygienists should make every effort to see that such exposures are controlled, insofar as humanly possible. In this effort, we do not believe it safe to rely on limiting atmospheric concentrations but rather to depend on a maximum of maintenance and engineering control. Leonard Greenburg [5]

Just as the country was entering the Great Depression of the 1930s, the Swann Chemical Company of Anniston, Alabama, began producing PCBs. Within a few years, it became clear that PCBs were systemic poisons. This section describes the early history and initial uses of PCBs as well as the early recognition that chemical workers exposed to chlorinated diphenyls developed chloracne, a serious skin condition, and liver abnormalities.

Monsanto acquired a majority of Swann's shares in 1933 and bought the company outright in 1935 [6]. From the very first, Monsanto understood that PCBs would be used in transformers and capacitors as well as a wide variety of products that would enter the stream of commerce, and therefore, the environment. These chlorinated diphenyls had a variety of attractive qualities for industry: they had high boiling points and were touted for their "non-flammability," they had high dielectric constant and resistivity, they were insoluble in water, the resins adhered strongly to glass and metal, and they did not oxidize in air, among other qualities [7]. PCBs were designed to be resistant to chemicals, heat, water, and to be virtually indestructible. According to a list of use codes for which PCBs were intended, PCBs were designed to be used in electrical insulation; flameproofers; paints; varnishes; adhesives; lacquers; transparent and moisture proof paper; heat transfer; impregnation; delustering rayon; plasticizers; fireproofing cloth; ink; lubrication; temperature control equipment; and chewing gum [8]. The PCB industry flourished as the New Deal national electrification projects and World War II industrial mobilization led to a booming market for insulating materials for transformers and capacitors.

Almost from the start of large-scale commercial production, there was evidence that PCBs caused harm to workers. They developed a serious dermatitis, chloracne, a condition defined by disfiguring pustules and blackheads. Initially



Swann Manufacturing believed that the men were over-exposed to dust and fumes from the heated Aroclors—the trade name of the commercial PCB mixtures manufactured by Swann (and then Monsanto) because of inadequate ventilation. They noted that when diphenyl was chlorinated it produced a very unstable compound which gave up hydrochloric acid. It was assumed that the Aroclor vapor entered the pores of the skin along with styrene dichloride. “The acid formed acted as an irritant, infection set in, and the skin disease resulted” [9].

As a result, in 1933 Swann contracted with Dr. Frederick Flinn of Columbia University to investigate “whether or not the various chlorinated diphenyl compounds submitted or some impurities contained therein might be the causative agent producing the dermatitis which had developed among some of the workmen in the plant.” Flinn suspected that styrene might be the source for the problem and that “means be provided for the men to take a bath with soap and water if they come in contact with the type of material found to be positive.” Flinn told the company that “if a leak or spillage occur[ed] the immediate bathing under these circumstances should be insisted on” [10]. After Monsanto acquired Swann, it was the sole producer of this product in the United States. By 1970, PCBs were manufactured by Prodelee in France, (called Phenochlor), and Bayer in Germany (called Colphen). Other manufacturers were located in Japan and the Soviet Union [11]. By 1970, “the market has grown to one of Monsanto’s most profitable franchises” [12].

Cecil Drinker, professor of public health and medicine and Dean of Public Health at Harvard University, followed up on these and other reports producing an article entitled “The Problem of Possible Systemic Effects from Certain Chlorinated Hydrocarbons,” which appeared in *The Journal of Industrial Hygiene and Toxicology* in September 1937. The article, first presented at a one-day “Symposium on Certain Chlorinated Hydrocarbons” at the Harvard School of Public Health, noted the growing use of PCBs in electrical equipment and the worrisome implications of widespread dispersal of this material. Drinker observed that there was a “large literature” on the “troublesome acne” caused by PCBs but his concern was “with the possibility of systemic effects following ingestion or inhalation of such products.” The previous year (1936), he pointed out, the Halowax Corporation, which was a division of the Bakelite Corporation, experienced “three fatal cases of jaundice in workmen using chlorinated naphthalenes and chlorinated diphenyl, and requested that the subject be investigated as rapidly and thoroughly as possible.” Drinker noted that there was a “meager literature upon systemic effects from these substances.” By that time there had been mention of “acute yellow atrophy” by Flinn and Jarvik and “serious liver injury” from the “most highly chlorinated of those [compounds] tested.” He believed that the very high dosage meant that these results did not “apply directly to human exposure.” Drinker noted that this earlier evidence of possible danger was “sufficient to indicate that compounds more highly chlorinated than trichlor naphthalene are capable of causing liver injury when inhaled steadily in quite low concentrations.” While he saw no sign of injury to other organs, the chlorinated diphenyl is certainly capable of doing harm “in very low concentrations and is probably the most dangerous.” He worried that constant exposure could lead workers to



acquire a substratum of liver damage upon which acute yellow atrophy may develop. Experience in a number of plants has shown how easy it is to reduce concentrations of these compounds practically to the vanishing point, and every effort should be made to attain such conditions.

He concluded that “These experiments leave no doubt as to the possibility of systemic effects from the chlorinated naphthalenes and chlorinated diphenyl. As in the case of the effects upon the skin, the degree of chlorination seems to determine the systemic toxicity.” Drinker recommended industrial hygiene and engineering controls to deal with the problem: “the solution consists in thoroughly adequate ventilation plus good housekeeping around all wax containers” [13].

Drinker’s paper was followed by a long discussion by representatives of Monsanto, the Halowax Corporation, General Electric and others of the chlorinated naphthalenes and diphenyls and their production and use. Dr. Albert Gray, Director of the Bureau of Occupational Diseases in the Connecticut Department of Health, announced that he too had found a number of these cases in his state [14].

Sandford Brown, the President of the Halowax Corporation, discussed the economics of occupational disease research and the calculus that manufacturers went through in deciding whether or not to test their products for possible toxicity. “The problem so far as the chemical manufacturer is concerned is a question of timing.... Should we take a product of which you have developed, say, 5 or 10 gm. and spend \$50,000 on research to determine whether or not it is toxic or should you wait until you have determined whether you have a market for it?” he asked. “If you are producing only one hundred substances a year you can see that that would run into box car numbers in the way of dollars and cents until you ever sold any.” This general problem of how to evaluate the relative costs and benefits of toxicological research was relevant to the issue of Halowax and chlorinated diphenyls more generally. Halowax “has been on the market for 25 years. Until within the past 4 or 5 years there has never been any intimation that it would cause any systemic effects.... Then we come to the higher stages, combined with chlorinated diphenyl and other products, and suddenly this problem is presented to us” [15].

General Electric’s representative, F.R. Kaimer, described in 1937 the human costs of exposure to chlorinated naphthalenes and diphenyls: It was “only 1½ years ago that we had in the neighborhood 50–60 men afflicted with various degrees of this acne about which you all know,” he reported. “Eight or ten of them were very severely afflicted—horrible specimens as far as their skin condition was concerned. One man died and the diagnosis may have attributed his death to exposure to Halowax vapors but we are not sure of that.” Kaimer told of the company’s initial human reaction to this tragedy in the plant: “The first reaction that several of our executives had was to throw it out—get it out of our plant. They didn’t want anything like that for treating wire.” The reality of running an electrical company overwhelmed the humanitarian instincts of the executives. “That was easily said but not so easily done,” he explained. “We might just as well have thrown our business to the four winds and said, ‘we’ll close up,’ because there was no substitute and there is none today in spite of all the efforts



we have made through our own research laboratories to find one.” They began working on remodeling the plant and instituting hygienic precautions in order to reduce exposure of the workforce to the chemicals.

With the adequate ventilation system we have installed, with the routine for change of clothing from street clothing to work clothing when they come to work and the reverse of that process, with the assurance that a shower will be taken before the street clothing is again put on, we have found no recurrence of this skin trouble [16].

Near the end of the conference, R. Emmet Kelly, who would later become the Medical Director of Monsanto, spoke on behalf of the company. As the sole producer of chlorinated diphenyls in the United States, the company did not have much to contribute vis a vis toxicological studies, “but there has been quite a little human experimentation in the last several years, especially at our plants where we have been manufacturing this chlorinated diphenyl.” He spoke of “a more or less extensive series of skin eruptions which we were never able to attribute to as cause, whether it was impurity in the benzene we were using or to the chlorinated diphenyl,” but “never had any systemic reactions at all in our men. We have examined them very closely both from what laboratory tests we thought might help us and from the clinical viewpoint. Also, from chlorinated diphenyl alone there have been no cases of systemic poisoning reported” [17].

Following the publication of Cecil Drinker’s article, other private internal company communications alerted Monsanto to the toxicity of the chlorinated biphenyls that the company was producing. In October 1937, L.A. Watt, a Monsanto official, wrote that “Experimental work in animals shows that prolonged exposure to Aroclor vapors evolved at high temperatures or by repeated oral ingestion will lead to systemic toxic effects.” He also worried that “Repeated bodily contact with the liquid Aroclors may lead to an acne-form skin eruption,” and called for “Suitable draft ventilation to control the vapors evolved at elevated temperatures, as well as protection by suitable garments from extensive bodily contact with liquid Aroclors, should prevent any untoward effect” [18].

The next year Cecil Drinker wrote a private “Report to the Monsanto Chemical Company” that pointed out that some chlorinated biphenyl compounds were “so definitely toxic” at “such low concentration[s]” that “It seems imperative that whenever this compound is used in industry, great care be taken to keep concentrations in the air at an extremely low level. No liberties can be taken with it,...” [19]. In 1939, Drinker published a new article in the *Journal of Industrial Hygiene and Toxicology* correcting an earlier statement that one of the substances that he had identified as a chlorinated diphenyl was, in fact, “a mixture of chlorinated diphenyl and chlorinated diphenyl benzene.” In Table 1 of the article, he listed fourteen chlorinated hydrocarbons and his suggested permissible exposure limits. The ninth substance was listed as chlorinated diphenyl and had the lowest “permissible limit” of 0.5 mg per cubic meter [20].

During World War II, New York State’s Division of Industrial Hygiene “conducted an investigation in two cable plants using chlorinated naphthalenes and diphenyls.” What they found were “many cases of dermatitis ... and several



deaths due to liver damage among workers in the industry.” Their study concluded that “Chlorinated naphthalenes and diphenyls are in general highly toxic compounds and must be used with extreme care.” And they suggested that “every effort” had to be taken to assure “that such exposures are controlled, insofar as humanly possible.” Specifically, they suggested that companies “depend on a maximum of maintenance and engineering control” because they did “not believe it safe to rely on limiting atmospheric concentrations” [5].

By 1944, Monsanto was warning its salesmen about the dangers of Aroclor. In its Salesmen’s Manual, the company warned that “All chlorinated hydrocarbons have measurable degrees of toxicity to the animal organism. Aroclors are no exception.” They listed both topical and systemic symptoms as well as acute and subacute effects of exposure to PCBs. Chloracne was “a result of insufficient cleansing of the skin” while “acute yellow atrophy of the liver” was “a result of extensive exposure over long periods of time.” Among the chlorinated hydrocarbons that could produce such symptoms were as follows: “Carbon tetrachloride, dichlor-ethylene, trichlor ethylene, chlorinated naphthalene (Halowax).” The Manual said that “The foremen of all departments where this material is handled should be apprised of the toxic nature of the material and instructed in safe handling procedures.” It also recommended pre-employment and periodic physical exams, skin examinations, reliable liver function tests, and immediate medical checkups when workers developed Gastro-intestinal complaints” [21].

By 1949, the dangers of Aroclor and Halowax were noted in a major industrial toxicology text:

Systemic poisoning from these chlorinated substances usually follows the inhalation of fume rather than from the handling of the dry hydrocarbon waxes. Damage is severe, and occasionally fatal. Acute yellow atrophy of the liver is generally associated with serious exposure to the chlorinated naphthalenes and diphenyl fumes. Three fatalities were reported in 1936–1937. In 1939, three additional cases were reported by Greenburg, Mayers, and Smith and a further case by Collier in 1943. While acne may be taken as a warning sign in workers handling this material it is not invariably present and systemic poisoning may occur in the absence of this sign [22].

Also during 1949 an employee at Monsanto’s British affiliate, Monsanto Chemicals Limited, reported that the company had only published one technical service bulletin on Aroclors that acknowledged the toxicity of the substance. That bulletin stated: “Prolonged exposure to Aroclor vapours will lead to systemic toxic effects. However, this is not significant except at high temperatures and then normal draught ventilation will remove any risk.” The bulletin also stated that “Acne-form skin eruptions may arise from continued bodily contact with liquid Aroclors, but normal precautions and, if necessary, suitable garments provide adequate protection.” The bulletin said that it was unlikely that workers would ingest enough Aroclor for serious harm [23].

Also, in 1938 Monsanto began paying serious attention to one of the attractive qualities of PCBs: their persistence. They set up a test site on the campus of the



University of Florida at Gainesville where they deposited Aroclors 1242, 1248, and 1254 [24].

Industry’s commitment to workers and the public: research and warnings in the 1940s

In an era before the establishment of federal health and safety agencies like the Occupational Safety and Health Administration in 1970, industry argued that they, not the government, had the responsibility for not only maintaining a safe workplace but also for identifying dangers their products posed for both the workforce and consumers. This section will outline the development of these industrial principles. Two trade associations of which Monsanto was a member, the Manufacturing Chemists Association (MCA) which represented all major chemical companies in the country, and the Industrial Hygiene Foundation (IHF), the leading health-focused industrial trade group in the United States, were leading proponents of these principles. In 1939, the MCA stated: “The manufacturer or one who holds himself out to be the manufacturer must know the qualities of his product,” and further, the “manufacturer cannot escape liability on the ground that he did not know it to be dangerous.” The MCA also wrote, “a manufacturer who puts out a dangerous article or substance without accompanying it with a warning as to its dangerous properties is ordinarily liable for any damage which results from such failure to warn” [25]. In 1945, the MCA incorporated these principles in its “L-1 Manual,” “A Guide for the Preparation of Warning Labels for Hazardous Chemicals” [26, 27].

The IHF made similar statements of principle in the 1940s. Francis Holden, the chief industrial hygienist for the foundation stated in 1942:

Every new chemical or product should be investigated as to its toxicity before it is prepared in large amounts and released to the public. This practical common-sense procedure is followed by several larger producers of synthetic chemicals. At least two of the companies are members of the Foundation and can furnish details of their experience to other interested members [28].

Henry F. Smyth, a toxicologist with Union Carbide and the Mellon Institute—the research arm of the IHF, summarized the consensus of major industrial leaders on companies’ responsibilities when confronted with potentially dangerous substances: “It is clearly the duty of a manufacturer to delay production of a chemical until the health hazards are well enough defined so that protection of his workmen is possible.” This was the “responsibility of industry”. He suggested that when a product was being developed initially, it was appropriate to first do a quick test, but if the material was going to be produced in large quantities, then the company needed to “perform more detailed studies” [29].

It is clear that Monsanto understood its responsibilities to consumers. In 1947, Monsanto’s Medical Director, Emmet Kelly, spoke to the American Public Health Association about the importance of industrial medicine and industrial hygiene. In a news release about that address that Monsanto prepared, it said, “Although many new products are being developed by manufacturers, the problem is to make certain



that no new chemical is used in a manner in which systemic toxicity or skin irritation might result either in workers making the product or in consumers” [30]. In fact, in 1957, Jack Garrett, Monsanto’s industrial hygienist (who would later become manager of Pollution Abatement and Industrial Hygiene at the company), published an article in *Industrial Wastes* in which he identified the responsibilities of companies to test their products for danger to humans and the environment:

When a new product is to be manufactured it behooves the manufacturing plant to determine the effect, if any, of the waste products on the receiving stream. The determinations should answer the following questions: 1. Will the effluent, as discharged, adversely affect human life? 2. Will the effluent, as discharged, adversely affect aquatic life? The effects referred to here are of a more insidious nature. What, for example, would be the long term effects on human life of drinking water containing X concentration of a certain compound over a period of many years?

He specifically addressed the importance of doing “chronic toxicity” studies to know what the long-term effects of materials may be [31].

In fact, by the 1940s there were hundreds of chemicals that had been tested for cancer and numerous studies were undertaken to evaluate the cancer risks in industry. Wilhelm Hueper, the former medical director of Dupont, published in 1942 *Occupational Tumors and Allied Diseases*, a massive 800-page text reviewing these studies [32]. In addition, the National Cancer Institute which Hueper would soon join, surveyed the literature of the potential carcinogenic properties of 696 chemicals, 169 of which were reported to be potential carcinogens. Their survey was summarized in the IHF’s *Industrial Hygiene Digest*, and sent to all its members [33].

New uses for PCBs in the post-war era: environmental contamination and systemic toxicity in the 1950s

While PCBs were already used in the emerging electrical industry, Monsanto found other potential markets for its product. This section explores the variety of industrial and consumer products that PCBs found their way into, most of which could and did become environmental pollutants. In addition, it explores the growing worry that PCBs were a potential cause of systemic disease in humans.

The end of World War II marked the end of a long period of austerity for most Americans. For 15 years (1930–1945), the consumer economy had been at a virtual standstill as economic Depression, combined with the focus on war production continued to stymie consumer demand. But that was about to end as the United States experienced a sustained period of economic growth (1945–1970). This demand was seized upon by chemical and electrical manufacturers, in particular, who claimed that Americans would experience “Better Living Through Chemistry” and that “Progress Is Our Most Important Product.” In 1946, Monsanto joined in running a full page color ad in the *Saturday Evening Post*, one of the nation’s leading mass circulation magazines, that detailed to readers the numerous materials and consumer



products that contained their PCBs. These included shower curtains, paints, varnishes, adhesives, rubber finishes, and others [34]. During the 1950s, Monsanto expanded its use of PCBs to carbonless carbon paper, and indirect heating systems for fried foods, uses that could and did get into the open environment.

Also, in the 1940s and 50s, Monsanto was a manufacturer of DDT, under the trade name “Santobane.” In 1951, in “A Guide for Formulating Santobane, Monsanto, DDT,” Monsanto suggested that PCBs be used as a solvent with Santobane [35]. Other Monsanto documents indicate that PCBs were recommended or used as either pesticide extenders or as pesticides themselves. In June 1955, P.G. Benignus, the director of development for Monsanto, wrote in his technical sales report that “field tests with Aroclor in the insecticidal field are under way in about 12 locations, including Florida, Oregon, Texas, Maine, Mississippi.” He pointed out the widespread use of Aroclors as pesticide extenders, arguing that “The people at Beltsville [at the Department of Agriculture] seemed to appreciate it when we mentioned that we have sold truckload amounts of Aroclor for use in combination with Lindane and other insecticides. Evidently they were not aware that their work has led to commercial value” [36].

As the use of PCBs in pesticides expanded in the mid-1950s, one Monsanto scientist (L. W. Sherwood) warned the Development Department of the company of the potential problems this could cause. In a memo to Benignus, he cautioned his colleague about this use of Aroclor.

It is most surprising to see that you are recommending without restriction a use for Aroclor which has not been approved by U.S.D.A.-F.D.A. [United States Department of Agriculture-Food and Drug Administration]... You may already know that since Aroclors are toxic and, according to your attached reference, may extend the residual life of the pesticide, the Federal government would require the following before selling for use on food and feed crops: 1) Proof of benefits for the application. 2) Data to show whether or not residual Aroclor is present and whether it modifies the residual amount of Lindane or other active ingredient at harvest. 3) If Aroclor is present or if the residual quantity of Lindane or other active ingredient has been significantly changed, tolerances for the pesticide in question must be developed. 4) If a toxic quantity of Aroclor is present at harvest in food or feed crops a tolerance cannot be established until after two year chronic toxicity feeding tests have been completed for Aroclor [37].

Sherwood acknowledged that much of this would be obviated if the pesticide was not used on food crops, but “Even then the label must show safe handling procedures, since Aroclor is toxic.” He continued, “Admittedly, your August 27 *Bulletin* does not specify using Aroclor in insecticides for use on food or feed crops but neither does it specify such a combination *should not be used on food or feed crops*. [emphasis in original] Perhaps this is an over-sight which you will wish to call to the attention of recipients of the bulletin.” In a postscript, Sherwood explained why such a warning was so important:



P.S. We repeatedly find that users of formulations prepared for a specific use will apply the material for other uses. In other words, even though Monsanto may encourage the use of Aroclor in pesticide formulations for non-agricultural use you can rest assured that some of it will be used on agricultural commodities. For these reasons alone it is strongly recommended that we state very specifically in any Monsanto literature, including correspondence, that Aroclors not be used on agricultural commodities. I believe our Legal Department will confirm that there is an important legal aspect involved [37].

In 1950 Monsanto's medical Director, Emmet Kelly, wrote to Indiana's director of industrial hygiene that the company "advised protection against all Aroclor fumes when an elevated temperature is used" [38]. Around the same time, Monsanto reissued its warnings about chlorinated hydrocarbons in general and Aroclors specifically. The company warned that Aroclors should not be heated in open vessels above 300° because of possible skin and eye irritation and because "prolonged and repeated exposure to such fumes may, in addition to causing irritation, interfere with the normal skin functions and result indirectly in physiological disturbances" [39].

For most of the 1950s Monsanto continued to warn about the potential skin problems with Aroclors, but downplayed the systemic effects of inhaling PCB vapors. By early 1952 the dangers from chlorinated diphenyls were so well established that Monsanto entered into an agreement with the United States Public Health Service to insert a warning in all bills of sales. The warning stated,

This product is sold under direct agreement with the U.S. Public Health Service and if re-sold as such or in mixture thereof for further fabrication within the United States, it is necessary that such products be labeled as follows: 'This package contains (Name of Product) AVOID REPEATED CONTACT WITH THE SKIN AND INHALATION OF THE FUMES AND DUSTS.'

But Monsanto officials acknowledged privately that their "bills of sale do not carry the notation as given in the second part of the agreement noted above," even though the dangers from inhalation of Aroclor were prevalent since "so many of the new Aroclor applications involve their use at elevated temperatures." Further, they pointed out that while "the toxicity hazard of Aroclor's fumes is well established," Monsanto had encountered "violations" of safety precautions quite frequently and that therefore "keeping in touch with these things [is] a major responsibility in the promotion of Aroclors." The company recognized that the subject of Aroclor's toxicology was "not the easiest one in the world to understand" but stated very clearly Monsanto's responsibility to live up to what had emerged as industry standards to test for potential dangers of their products and to warn workers and consumers how to protect themselves against those dangers. Because they had such a "large stake" in Aroclors and because of the "rather widespread commercial use" of Aroclors "we constantly strive to learn more about this subject of Aroclor toxicology and to safeguard against any possible hazards" [40]. Yet, at this point, Monsanto had not yet done any long-term chronic toxicity studies.



The acute and subacute toxicity of PCBs continued to worry Monsanto in the early- to mid-1950s. In June 1953, a confidential report from the Monsanto Phosphate Division's Research Department found that the “Aroclor vapor concentration in the air at the sample points is seldom below the 0.5 to 1.0 mg. per cu. meter level, which is the maximum tolerable concentrations (according to Elkins, See References), and often is as high as 3 to 5 mg. per cu. meter.” It noted that “these higher concentrations are extremely irritating to the eyes, nose and throat” [41].

Thus, one Monsanto official wrote to another that “As I am sure you know, Aroclors cannot be considered nontoxic.” He thought, however, that the hazards of PCBs were minimal “when using Aroclors in transformers” [42]. Similarly, in 1954 after several workers developed acne in an Aroclor plant, air tests showed “only negligible amounts of chlorinated hydrocarbons” and led to the conclusion that “fairly long continued mild exposure is not innocuous.” It was suspected that “the low concentration of the chlorinated diphenyl might account for development of lesions in only 50% of those involved” [43].

By 1954, Monsanto officials were searching for data on the toxicity of Aroclor. In a February 27th memo entitled, “Aroclor Toxicity” one of their European officials described searching through “our files” and finding one report “containing data on Aroclor toxicity.” The internal report was from 27 April 1948 and included a section copied from the *Journal of Industrial Hygiene and Toxicology* from February 1938. The report noted the “systemic toxicity effect which chlorinated hydrocarbons including chlorinated biphenyls can cause. Liver damage is of course the outstanding effect and of the various chlorinated hydrocarbons tested, chlorinated diphenyl gave evidence of being the most toxic” [44].

Also in 1954, the Medical Director at Monsanto acknowledged that there was no known “maximum allowable concentration of Aroclor,” even though a “one milligram per cubic meter has been set up.” The Company had been running animal experiments “for about 60 days at 7 times this [1 mg level] and found some liver damage.” At the time they were also experimenting at lower levels. Even though the company claimed that they had “never found any liver trouble in any of the workers in our plant,” they recommended that their customers use exhaust ventilation in their manufacturing processes. Kelly was concerned about the exposure of painters to Aroclors, which were an ingredient in some new latex paints, and worried about unwarranted liability suits from painters who might develop hepatitis and ascribe it to their work with paints containing Aroclors. Monsanto was, however, “concerned with the level of Aroclor during spray painting, but I think that level can only be determined by actual measurements.” There is no evidence that spray painters were told of Monsanto's concerns, but Kelly acknowledged a possible hazard internally, writing to Dr. Newman in London that “we certainly want you to have the entire picture about Aroclor toxicity.” It appears from the memo that Monsanto was awaiting a report from the Kettering laboratories at the University of Cincinnati [45].

Monsanto continued to do its own research into the possible dangers of the use of Aroclor as a plasticizer in Saran Wrap and latex paints [46], and within the company there were continued concerns about the toxicity of Aroclors and other compounds through “absorption from the inspired air,” and contact with the skin causing “a serious and disfiguring dermatitis” [47].



Monsanto's Medical Director, Dr. Emmet Kelly, "summarized" the company's views regarding the toxicity of Aroclor in the mid-1950s. "We know Aroclors are toxic but the actual limit has not been precisely defined." He explained that the market for Aroclors was growing, particularly in consumer products, and that both workers and consumers who developed liver disease might have a history of Aroclor exposure. Legal liability therefore was a threat because, in his view, "juries would not pay a great deal of attention to MACs [Maximum Allowable Concentrations]." It was with consumer liability in mind that Monsanto "review[ed] every new Aroclor use.... If it is an industrial application where we can get air concentrations and have some reasonable expectation that the air concentrations will stay the same, we are much more liberal in the use of Aroclor." But in consumer products, the problem became much more complex:

If, however, it is distributed to householders where it can be used in almost any shape and form and we are never able to know how much of the concentration they are exposed to, we are much more strict. No amount of toxicity testing will obviate this last dilemma and therefore I do not believe any more testing would be justified [48].

Consumer exposures presented a major challenge for a company used to thinking in terms of industrial toxicology.

The dangers of PCBs and potential liability affected even the management of specific plants. In November 1955, the Medical Department at the Aroclors Department in the Krummrich plant in St. Louis, recommended that "the eating of lunches should not be allowed in this department" because "Aroclor vapors and other process vapors could contaminate the lunches unless they were properly protected." It therefore left the possibility that "where a workman claimed physical harm from any contaminated food, it would be extremely difficult on the basis of past literature to counter such claims" because such literature "claimed that chlorinated biphenyls were quite toxic materials by ingestion and inhalation" [49].

In 1955, Monsanto contracted with the Kettering Laboratories to conduct studies of short and medium term effects of Aroclors on rabbits, mice, rats, guinea pigs, and a cat. In the private report to Monsanto, the lead researcher, J.F. Treon, identified a mouse that developed a "malignant lymphoma that involved the liver, spleen, kidneys and heart, and therefore its death was attributed to natural causes" [50]. The next year (1956), Treon published his report in the *American Industrial Hygiene Association Journal* but omitted any mention of the cancerous mouse [51]. Further, neither Treon nor Monsanto conducted long-term chronic toxicity studies at that time.

In 1956, Monsanto tried to interest the Navy in using one of their products Pydraul 150, as a material for elevating the antennas in submarines. The Navy was worried about the use of PCBs in its atomic submarines which could "remain submerged for periods of up to 6 weeks" which meant that "any possible toxicological effects [could not] be tolerated." Monsanto worried that Pydraul 150 which contained 25% of Aroclor 1240 would face "demise ... in the antenna retracting mechanisms of submarines unless we can present a convincing story as to its safety of use" [52].



In June, Kelly “had quite a discussion with the navy people concerning the use of ‘Pydraul 150’.” He was informed by the Navy that their industrial hygiene group thought that because the submarine would be submerged for so long, that submariners would inevitably be exposed to higher levels of PCBs than what was acceptable. While Kelly told them that in his opinion this would not occur, there was continuing worry on the part of the Navy. Kelly suggested that Monsanto test Pydraul 150 for if “we don’t do this work, we haven’t a chance of getting 150 used on any submarine. If the work turns out favorably, there might be a very good chance that it might be used not only on the radio antenna but also on all the hydraulic systems on a submarine” [53]. By December 1956, the prospects for using Pydraul 150 in submarines seemed very dim. The Navy was receiving negative information about its toxicity. Despite doubts at Monsanto about the significance of the Navy’s findings with regard to humans on submarines, it was becoming apparent “among us [at Monsanto’s headquarter] here in St. Louis that this is about the last straw in our relationship with the [Navy’s] Bureau of Medicine.” Wheeler believed that “apparently we can do nothing about influencing [Commander Siegel’s] conclusions based on such tests.” Apparently, while they were abandoning the attempt to “develop toxicity data on hydraulic fluids for the Navy,” Monsanto continued to get “information to satisfy ourselves that the use of our fluids is safe under any normal foreseeable conditions. This is generally enough to satisfy non-military customers” [54].

In January 1957, Monsanto’s Dr. Kelly “spent an afternoon with the navy people” to discuss Pydraul 150. The Navy informed Monsanto that they had done their own toxicity testing of Pydraul 150 at the Naval Institute of Medical Research. The Navy researchers found that “Pydraul 150 caused death in all of the rabbits tested,” while an alternative fluid “did not cause any deaths.” Further, they learned that “10 mg of Pydraul 150 per cubic meter ... for 24 h a day for 50 days caused statistically, definite liver damage.” Kelly informed Monsanto that “no matter how we discussed the situation, it was impossible to change their thinking that ‘Pydraul 150’ is just too toxic for use in a submarine. It may be that such concentrations would never be reached in a submarine but the Navy does not appear willing to even put the material in a trial run to see if it will work.” Kelly concluded that Monsanto “should discontinue to sell ‘Pydraul 150’ for this particular application and try to develop a hydraulic fluid without Aroclor as one of its components” [55].

By September 1957, Monsanto was in negotiations with the Navy over the release of “commercially discreet information” regarding Pydraul 150 and its components. What was at issue was that the Navy wanted to publish its research on the toxic dangers of this material. Monsanto worried that Aroclor’s reputation would be tarnished. “In publishing such data” Monsanto’s S. Robert Sido reported, “they [the Navy] feel they would have to be rather specific chemically to be meaningful but could avoid all reference to trade names, hydraulic fluid or Monsanto.” Monsanto wanted to avoid informing consumers about their product’s possible dangers [56]. Also in September, Monsanto learned that not only would the Navy not accept Pydraul 150, it most likely would not accept any “other fluid containing chlorine or chlorinated diphenyls.” Monsanto concluded that it would not try to “dissuade BuMED [Navy Bureau of Medicine] since it appears to be hopeless” [57].



Despite the Navy's rejection of Pydraul 150 on health grounds, Monsanto continued to reassure their customers that the material was safe. For example, in a letter from Elmer Wheeler, Assistant Director of the Medical Department, to James Lofstrom at Standard Oil's corporate headquarters at 30 Rockefeller Center in New York, Wheeler did not mention the Navy studies. Instead, Wheeler wrote that "the toxicity report on Pydraul 150 indicates that it is practically innocuous when fed orally to rats In rabbit skin and eye irritation studies Pydraul 150 was no more irritating than a 10% soap solution tested similarly" [58]. Also, in a May 1957 Monsanto Technical Bulletin, Monsanto wrote "Animal toxicity studies and 20 years of manufacturing and use experience indicate that Aroclor compounds are not serious industrial hazards" [59].

In 1958, other major corporations shared the Navy's concerns about Pydraul. That year some states passed labeling laws which were "brought forcibly to [Monsanto's] attention" by the Socony Mobil Corporation that requested a caution stamp to "be affixed to all Pydraul which they purchase from Monsanto for resale." Monsanto worried about the wording which Socony Mobil was planning to use on their product for it was "not in the best interest of Pydraul sales, and is such that our competition could use to great advantage." They were specifically concerned that the label identified chlorinated hydrocarbons with danger from breathing and physical contact. Monsanto's label was simpler and much less specific, telling customers simply, "Avoid prolonged and repeated contact with skin. Avoid prolonged breathing of vapors and dust." Monsanto stated quite explicitly (but privately) that they wanted to

comply with the necessary regulations, but to comply with the minimum and not to give any unnecessary information which could very well damage our sales position in the synthetic hydraulic fluid field.... I am requesting that you and Mr. Carpari discuss what is necessary from the labeling viewpoint and the legal side, in order to comply, but yet maintain our excellent position in this field [60].

In June 1959, Emmet Kelly wrote to Monsanto's O.F. Heasel about the company's attempt to promote "the sale of Pydraul AC [another hydraulic fluid that contained PCBs] in Germany." He was concerned about German attitudes about toxic substances.

If these Germans are afraid of mineral oil, I feel they will be rather suspicious of Pydraul AC. After all, the constituents are considerably more toxic than mineral oil. The odor or taste would be considerably more marked than mineral oil, should any of the material get into the food.

Kelly believed that Monsanto had to "be factual and tell them that Pydraul AC has an LD₅₀ to rats of 40 gm./kg and in rats 31/2 gm. to 41/2gm/kg." Kelly suggested that "if, however, there is a possibility that vapors would enter the food or beverage, a filter should be incorporated in the line." He wrote that a charcoal filter would be able to absorb "organic vapors and any objectionable odors." He concluded that he thought "the Germans are being overcautious in this matter,



but,” Kelly admitted, “I certainly can’t give Pydraul an absolutely clean bill of health, assuming some might get into the food” [61].

Reassuring customers and government alike: new problems and challenges in the 1960s

The 1960s were a tumultuous decade in United States history. The Vietnam War, the civil rights movement, the women’s movement as well as a growing environmental consciousness all challenged the political and social complacency of the post-war world. This section details the growing concerns about the potential dangers of PCBs. It also details the efforts by Monsanto to reassure its customers and others that their product was safe.

In 1960, the issue of environmental stream pollution emerged in the internal memos of the Monsanto Company. Jack Garrett, an industrial hygienist in the medical department, wrote to an official in a tool company in Chicago about the potential dangers to aquatic life if Pydraul fluids were discharged into streams around factories. “As you know,” wrote Garrett, “the Pydraul fluids are insoluble in water as well as heavier than water.” This meant that they would “sink to the bottom of any receiving stream and as such will not give rise to the typical picture of oil pollution.” Despite the fact that one would not see the typical oil slick on top of the water, if Pydraul were “discharged in large concentrations it will adversely affect the organisms in the bottom of the receiving stream which will affect the aquatic life in the stream.” He acknowledged that some factories discharged “large concentrations of these materials” and if this were “contemplated,” Pydraul should “probably be removed by emulsion breaking and settling.” At that time, the industry had “no experience with any regulatory agency concerning the discharge of these materials,” but Garrett “imagine[d] that these agencies would frown on the discharge of large quantities of any type of hydraulic fluid.” Further, Garrett reassured the representative that “Based on the toxicity studies of these fluids with laboratory animals [he] would not expect them to be very toxic to aquatic life.” He acknowledged, however, that “this is a surmise on my part since we have no tests on aquatic animals.” While Garrett believed that “if small quantities of these materials are accidentally spilled into a receiving stream there would probably be no harmful effect,” he also recognized that “If, on the other hand, a great deal of the material was spilled some readily identifiable damage might ensue” [62]. Thus, in 1960, years before any articles appeared on PCBs in the environment, Monsanto understood that there were potentially deleterious consequences to their discharge into streams and rivers. The growing body of data on the dangers of PCBs in general appeared to lead the company into a particularly defensive position in the early 1960s. In February 1961, Emmet Kelly wrote a memo to Richard Davis, an official in Monsanto’s Organic Chemicals Division in the St. Louis office, about an incident at the Hexagon laboratories in the Bronx where two employees were “nauseated from exposure to a leak in a heat transfer unit that used Aroclor 1248” [63].

One of the employees was suspected of having liver damage. Less than 2 weeks later, the Chief Engineer at Hexagon learned in more detail about the two plant



personnel and their conditions. Both men, he reported, “developed symptoms of Hepatitis as you predicted and were confined to a hospital for approximately 2 weeks.” The experience had given him “considerable concern.” He was particularly upset with the lack of adequate information about the toxicity of PCBs:

Since we are dealing with a highly toxic material at high temperatures and since these failures cannot be prevented, it is felt that a more thorough and clearly written description of the hazards be described under Safety of Handling.... I trust that this matter will be given your serious consideration so that other or new users are fully aware of the problem [64].

Leaks were not only occurring in industrial processes but in the food industry as well. Monsanto learned between 1960 and 1967 that the indirect heating by PCBs of cooking oils in deep fat fryers were themselves polluting the oil in which food was being fried. In 1960, Monsanto received a report of concern from the Frito Lay Company about PCB-polluted cooking oil. Frito Lay “suspected a leak in their heat exchanger” [65, 66].

A year later, Marcus Key of the US Public Health Service (who would later become the head of National Institute for Occupational Safety and Health) received a letter from Kelly in which was enclosed a copy of Monsanto’s Technical Bulletin PL-306, “Aroclor Plasticizers.” Previously, Key and Kelly had had a telephone conversation about chloracne and other dermatological problems and any potential dangers from Aroclors. Kelly reviewed the data on these problems as outlined in the *Bulletin*, and reaffirmed that safe handling of Aroclors demanded “the necessity for avoiding exposures, particularly when the Aroclors may be used in applications where elevated temperatures are involved.” Despite growing knowledge within the company of problems with their product, Kelly reassured Key that “our experience and the experience of our customers over a period of nearly 25 years, has been singularly free of difficulties.” He went on assure Key that to Monsanto’s “knowledge, there have been only three instances where chloracne has occurred. In view of the millions of pounds which have been produced and used in many and varied applications, the low frequency of any difficulties has been gratifying.” Despite having heard directly from Hexagon laboratories and Socony Mobil that better warning labels were necessary, he told Key that Monsanto had “Certainly ... attempted to provide sufficient information to insure safe handling and usage. We have not in any case attempted to minimize potential hazards” [67]. (The assertion that there were “only three” cases of chloracne ever identified by 1963 was clearly not true, as Kelly himself had attended meetings as early as the mid-1930s about the chloracne problem when Swann was taken over by Monsanto.)

Monsanto received, at least by 1963, results from its test site at the University of Florida at Gainesville where, in 1938, it had deposited Aroclors 1242, 1248, and 1254 in test soil. Monsanto learned that as of June 1963, nearly a quarter century later, there was “still visual evidence of the presence of Aroclor” [24].

By 1964, the issue of warnings and what constituted ‘adequate information’ was being discussed in Washington as well as at Monsanto. The Federal Hazardous Substances Labeling Act, which became law in 1960, had led to discussion about what legal responsibility Monsanto had with regard to warnings. It was clear that “Under



the provisions of the subject act, Aroclor 1232 would be classified as a ‘toxic’ substance.” But new research indicated that PCBs might be even more toxic than previously suspected. “We have several indications that the Aroclors are more toxic when in an oil solution than when administered undiluted to animals.” Monsanto appears to have tried to shift responsibility to its customers. “The ultimate responsibility of the labeling of a formulation remains with the customer,” E. P. Wheeler, of Monsanto’s Medical Department, said “since we cannot be expected to get animal data on every possible formulation containing a Monsanto product.” He went on to suggest that “the very minimum precautionary statement that I think would be necessary would be: ‘CAUTION—Harmful if Swallowed. Keep out of the reach of children.’” [68]

In 1965, it became clear that customers were depending upon Monsanto to furnish them with adequate information about the potential dangers of their PCB compounds. Wheeler had written to one customer, the Reliance Electric and Engineering Company in Cleveland, Ohio, about some potential dangers of the use of Aroclor 1242. Subsequently, the owner of Reliance Electric had a telephone conversation with Wheeler during which he told him how “disturbed” he was by Wheeler’s letter.

He told me that the Monsanto literature furnished him has been more reassuring in terms of what problems might arise in their application. I guess what really shook him was when I mentioned that with temperatures greater than 150 [degrees] mechanical exhaust ventilation should be provided to remove vapors. For the record, Mr. Haredos’ application involves the use of Aroclor 1242 as a coolant in electric motors [used in mines].

For Mr. Haredos, the warnings and information in the literature were clearly inadequate. Mr. Haredos estimated that the motors in this mining equipment took approximately ten gallons of PCBs, of which “four quarts per day of this quantity would be lost in the mine—presumably all of it by volatilization.” Wheeler informed him that he “doubted that the ventilation [was] sufficient to keep this amount of Aroclor at the threshold limit value of 1.0 mg/cu. meter of air.” Wheeler was horrified at the conditions in the plant where “hot Aroclor spills on the floor were common and that [Haredos’s] own employees had complained of discomfort.” Despite Monsanto’s earlier reassurances to Marcus Key, Wheeler was very disturbed: “I was brutally frank and told him that this had to stop before he killed somebody with liver or kidney damage—not because of a single exposure necessarily but only to emphasize that 8 hour daily exposures of this type would be completely unsafe.” Monsanto recognized that PCBs should only be used in closed systems because of their toxicity: “I told Mr. Haredos further that the Medical Department was skeptical about the use of Aroclors in mining operations because we had not seen data to show absence of toxic levels. I emphasized and re-emphasized that the Aroclors are excellent products but must be used in closed systems if they are to be heated” [69].

Despite the fact that Monsanto had not yet conducted any long-term chronic toxicity studies, it reassured its customers that fear of its product causing cancers, the most fearsome of chronic conditions, was unfounded. “The question of possible carcinogenesis was brought up,” Emmett Kelly the Medical Director at Monsanto, wrote to I.M. Singer at Dupont.



This certainly can be dismissed completely, as we have no reason to believe the components of this compound would have this type of action. We have never had the slightest rumor of this from our customers and certainly no tumors have arisen in our workers manufacturing the material [70].

PCBs in everything: Monsanto's response to environmental science, 1966–1969

Despite the early information about the systemic dangers of PCBs, and their widespread use in products that could ultimately leak into the environment, it took independent researchers to document that they had become a widespread environmental pollutant. This section details the identification of PCBs in the environment in the mid-1960s and the reaction of Monsanto to these discoveries.

In 1966, a startling study appeared from researchers at the University of Stockholm, Sweden. Soren Jensen and Gunnar Widmark, of the University's Institute of Analytical Chemistry, used gas chromatography and mass spectrometry to study the impact of pesticides on a variety of fish and fauna. They were looking for DDT and other pesticides, but to their surprise, they found other "unknown compounds" in the biological samples which they identified as polychlorinated biphenyls. They found "a large number of samples" which revealed that "polychlorinated biphenyls are found especially in fish and in sea birds ...and in some samples of human depot fat." It was a troubling revelation that human beings were accumulating the minute amounts of PCBs [71].

The Swedish Study was disturbing to Monsanto. David Wood of Monsanto Europe, received a letter from a law firm in Sweden that talked about the "publicity in Sweden" generated by the study. In his letter, Oda Palm quoted extensively from an article in a Swedish daily newspaper that condemned PCBs. "It is found in Salmon and in Pike. It is found in Sea Eagle living on fish. It is found on the surface of the needles of the fir treesIt is found in the hair of a 5 month baby." Palm warned that the study had revealed that PCBs "accumulated in certain organs of animals. They are said to be related to DDT and equally poisonous." Palm reported that another daily paper remarked on the significance of Jensen and Widmark's study. It "disclosed facts which will have far-reaching importance because the findings have proved a new source of pollution of ... nature." Palm concluded his letter with a statement about the implications of this study for the future of the industry:

I suppose there is no doubt that what has been termed Polychlorinated Biphenyls is equal to Aroclor. There is also no doubt that the published facts will cause considerable unrest in several quarters. We probably will have to have Aroclor registered with the Swedish Board of Poisonous Substances and the industry will have to be particularly careful in handling the material [72].

The full impact of this study and the potential harm it could do to the company was not lost on Monsanto officials in Europe and the United States.



In consideration of the importance we are placing on development of the Swedish market for Aroclor over the next five years, we would be grateful if you could arrange for this information to be considered by the appropriate departments in St. Louis and their comments transmitted to us as soon as possible. Based on the recommendations made by our medical departments we shall have to decide whether to arrange for publication of data in Sweden or not [73].

There was an increasingly important problem of how to dispose of PCBs. Wood noted that this would be difficult: “in the U.K. many companies have been burying material in drums, material in the drums having been absorbed into vermiculite or some similar porous material. Has any entirely safe method been developed for the disposal of waste Aroclor?” [73]

Simultaneously, Monsanto had contracted with a professor at Mississippi State University to test the fish in streams polluted by the waste water of the Anniston, Alabama PCB plant [74]. In November 1966, the Mississippi zoologist reported to Monsanto on the results of his investigation.

The outflow to Snow Creek from the east side of the Monsanto plant (at Highway 202) contains some extremely toxic materials and kills fish in less than 24 hours when diluted 300 times. In a flowing system (as opposed to our static tests) and under conditions of constant exposure, this effluent would probably kill fish when diluted 1000 times or so. Since this is a surface stream that passes through residential areas, it may represent a potential source of danger to children, domestic animals, etc. [75].

By January 1967, Monsanto was acknowledging internally the importance of the Swedish study, and the company was convinced that the materials tested were “very similar if not identical to Aroclors.” They also discussed this work with other chemical companies in Europe and were “assured that his work and findings are sound” [76]. By late January, Dave Wood, who was based at Monsanto’s affiliate in Brussels, wrote to officials in the various Monsanto offices around the world that he “should like to emphasize that there is no doubt that the chemical which is the subject of the investigation and the news release, is chlorinated diphenyl i.e. Aroclor.” Wood was especially attentive to the widespread effect in Sweden of this new information:

This matter was raised with us by every capacitor manufacturer in Sweden that we visited. Fortunately, there has not been too much adverse comment as yet from plant workers since they have not associated the polychlorinated biphenyls mentioned in the article with Aroclor or Pyralene used in the Swedish factories [77].

While there had not been “too much adverse comment,” the Swedish scientist who had discovered the widespread contamination, Soren Jensen, “stated that he had been approached personally by several workers associated with chlorinated diphenyls for non-electrical uses and these workers were quite worried about possible effect on their health.” There was nothing in the documents to indicate



that Monsanto informed workers in the United States of the Swedish study. By this time Monsanto officials had been in contact with Jensen at the University of Stockholm, offering to provide him with materials to test. They had also spoken with Jensen about

the need for care in any further publication of his work.... He accepts that the toxicology of chlorinated diphenyls should only be discussed with detailed information about exposure concentrations and exposure times and that generalized statements out of context can only arouse undue public concern.

The problem of the safe disposal of PCBs continued to concern Wood [77].

In early February, a Monsanto official in Europe wrote to an English chemical company that had inquired about the “safe handling and toxicology of Monsanto Aroclors.” The official wrote that

like so many other chlorinated hydrocarbons the Aroclors can cause damage to the liver as a result of prolonged exposure to the vapour and to the liquid. To the best of our knowledge no fatality has ever been attributed to the chlorinated diphenyl, but in view of the chronic action on the liver we advise that contact with the vapour and liquid must be kept to a minimum [78].

By the mid- to later 1960s, issues of water and air pollution, DDT and other environmental insults were being linked to the chemical industry in particular. The industry had become, in the words of Monsanto’s Medical Director, “very worried about what is liable to happen in the states when the various technical and lay news media pick up the subject.” Monsanto had received “quite a few communications from our customers, but the most critical one is NCR,” who used huge quantities of PCBs as an ingredient in their carbonless carbon paper. Kelly reported that Monsanto wanted to “keep in the background” about the PCB environmental and occupational “problem,” but didn’t “see how we will be able to in the United States.” Monsanto, according to Kelly, needed to prepare for customers, “especially NCR, [who] may ask us for some sort of data concerning the safety of these residues in humans.” He worried that this “might be opening the door to an extensive and quite expensive toxicological/pharmacological investigation” [79].

By February 1967, more professional and scientific journals paid attention to PCBs in the environment, detailing the “Swedish success in detecting the polychlorinated biphenyl.” Monsanto internally noted that by the end of January, *Chemical Engineering* in the United States took note of the Swedish study, marking the “first published information in the U.S.” Monsanto was also aware in December 1966, the British journal, *New Scientist* had reported on the Stockholm study [80].

“Due to the importance of Aroclor products to the Organic division,” Monsanto decided to prepare a statement “for use by marketing with customers who inquire about this publicity.” Further it began preparation of a press release and to give some thought to the “toxicological and pharmacological problem.”



Monsanto comforted itself that information was still relatively inexact and incomplete: “two questions that kept coming back to our minds ... were that in all of the propaganda published, there has been nothing about the levels that have been found particularly in the air and no one has defined anything about what level would be considered harmful.” Gene Wilde of Monsanto’s general office offered to help to “get these motions started and getting our information together so that we can make sure our Aroclor business is not affected by this evil publicity” [81].

In May 1968, Stanford University proposed a research project on the environmental pollution caused by PCBs. Kelly rejected it as “another example of widespread interest in what appears to be a rather insignificant phenomenon: namely, the persistence of PCBs in some species.... I would be against our doing anything [about Stanford] at this time.” He proposed waiting until the US government acted: “I think it would be wiser for us to find out what the government is doing and see where we go from there” [82].

In the mid-1960s, Monsanto began to consider whether the danger from large doses of PCBs to industrial workers who were known to develop chloracne and liver disease were also true of “small quantities [of PCBs] existing in human fat” [83]. According to Kelly, “there is no question but that Aroclor does possess a certain amount of toxicity.” He noted that “all our literature says this.” But “whether nanogram quantities mean anything is an entirely different matter” [84]. Based on information that Kelly received from Dave Wood of Monsanto’s affiliate in Brussels, “The customers [in Europe] would like some reassurances on the toxicity of Aroclor.” Kelly acknowledged in February 1967, that “everybody over there is 100% convinced that what Jensen and Widmark found was Aroclor” [85]. But, based on concerns voiced by a Shell Oil Company scientist, fresh questions arose in early 1967 about whether the materials that Jensen and Widmark found were, in fact, PCBs. These concerns were put to rest by early November 1967 when A. Richardson of Shell informed Monsanto that it was, in fact, PCBs that were being identified in Europe. D.V.N. Hardy of Monsanto wrote, “Now that it is certain that the contamination by chlorinated biphenyls is taking place we are keen to follow up and determine just how and where the contamination is taking place” [86]. Despite their knowledge of the PCB pollution in Europe, the Monsanto Board of Directors approved spending almost \$3 million for “expanding Aroclor facilities at the Aniston, Alabama, and W.G. Krummrich plants” [87].

Aroclors were being introduced into more and more products that could lead to PCB pollution of the environment. One Monsanto publication in September 1967 reviewed the brief but dramatic history of Aroclors: “We began operations 31 years ago, but in all probability you have never heard of Aroclor or its uses,” it began. “Mainly this is because it is sold in bulk to manufacturers who blend it with other chemicals to make many items used by you in your home or in your car.” The material was ubiquitous, being used in “...plastics, lacquers, paints, waxes, insecticides, adhesives, pigments, ballast on fluorescent lights, carbonless carbon paper” [88]. An internal Monsanto publication a few months later reviewed the use of PCBs in these products and articulated the goal of expanding these uses in the following year: “What we hope to accomplish during ‘68 centers on the following items (1)



meet '68 sales requirements; (2) Start-up new manufacturing facilities to enable us to meet future sales requirements" [89].

Monsanto was faced by two competing needs: the first was to expand the market for Aroclors; the second was to figure out a way of protecting itself from the increasing evidence that PCBs were a widespread environmental pollutant. The environmental issue began to loom larger and larger in the thinking of Monsanto officials. In November 1968, an "Outline PCB Environmental Pollution Abatement Plan," noted that PCBs were "already present in nature having done their 'alleged damage'." Monsanto worried about the "Legal Liability" and the possibility of lawsuits because "All customers using the products have not been officially notified about known effects nor [do] our labels carry this information. These are only a few of the possible legal implications which would best be covered by the legal department" [90].

Increasingly, Monsanto worried about its public image, an issue that would become increasingly prominent over the next few years. "The corporate image of Monsanto as a responsible member of the business world genuinely concerned with the welfare of our environment will be adversely affected with increased publicity," a report on the PCB Environmental Abatement Plan warned. "The evidence proving the persistence of these compounds and their universal presence as residues in the environment is beyond questioning. This combined with certain scare publications is certain to give an adverse image." Monsanto was worried that PCBs would be linked in the public mind with the controversy then whirling around DDT and thus PCBs would be "guilty by association." "Some customers who presently use these materials will be 'scared' [off] to other competitive products. Products associated with the same name or 'trademark' will be adversely affected." The plan warned that Monsanto's products, Therminol, Pydraul, and Aroclor would lose market share to competitors who "will use the information as a competitive advantage" [91].

Monsanto had reason to be concerned. DDT was under attack and, in the words of one author in 1969,

the tide has been running against DDT ever since Rachel Carson's *Silent Spring* appeared in 1962. In fact, Carson specifically identified DDT as a possible human carcinogen. DDT production was at its peak then – 183 million pounds – and by 1967 it shrank to 103 million, 70% of which was exported.

Some of DDT's defenders had "raised the possibility that DDT may be taking the rap for PCB..., a plasticizing agent widely used by industry" [91].

By the end of 1968, the growing attention to environmental pollution led Monsanto to focus more and more on the "legal-political problems facing Aroclor." In a memo from W. R. Richard of Monsanto's Research Center in the Organic Division to W. A. Kuhn, Richard noted "the accusations in the literature that chlorinated biphenyls are poisoning and killing wildlife." This was not a trivial issue, he remarked, because "these wildlife people have to be taken seriously. They have taken the DDT industry to court in Wisconsin to prevent the use and sale of DDT ...and



if they win in that state DDT will be banned in many others The wildlife people are dedicated to the demise of DDT.” He noted that Monsanto had a real problem:

Our problem is that Aroclor has been ‘identified’ along with DDT residues and hence we are almost certain of being drawn into the court records and may also be one of the scapegoats of the DDT defense. The wildlife people have accused Aroclor of doing all the bad things of DDT [92].

There were three steps that Monsanto was taking to “protect ourselves.” First, studies with chickens fed with Aroclor were being done in the hope that Aroclor would not remain in their tissues. Second,

E. Wheeler is having feeding tests done on animals to establish a ‘safe’ level for Aroclor feeding. If we can find a ‘safe’ level Calandra’s Lab will do 2 year experiments on animals including effects on succeeding generations. This will help a bit but the wildlife people won’t be stopped by this kind of evidence [92].

Finally, they hoped “to minimize exposure to Aroclor, to reduce air and water pollution, to restrict Aroclor to uses which can be controlled. This is the only way I see to survive.” Richard believed that the Anniston plant was vulnerable to criticism as a possible polluter and that “Aroclor should be 100% controlled.” He also hoped to “demonstrate that Aroclor can be incinerated to harmless products for disposal” and wanted Monsanto to “help our customers dispose of off-grade or non-reworkable Aroclor, either by incinerating or by toxic dump.” Richard believed that it was the responsibility of the plasticizer group to “know where their product is going and be able to minimize exposure risk if Aroclor has truly been identified as a pollutant. We probably have 6 months to 1 year while they fight out the DDT case. I want to use this time to minimize our exposure” [92].

In early 1969, Monsanto and the world learned about a major industrial tragedy in Japan attributed to PCBs pollution: “...bran oil poisoning of quite a number of Japanese citizens ... was attributed to Kareclor 400 (chlorinated biphenyl comparable to FR-2)” [93]. In 1968 in southern Japan, a thousand people “had eaten rice oil contaminated with PCBs that leaked from a heat exchanger during manufacture.” These citizens had “developed darkened skins, eye discharge, severe acne, and other symptoms of what came to be called Yusho oil disease...” Allan L. Hammond, an independent scientist, in an article published in *Science*, described the tragedy, pointing out the disturbing information that was gathered from this incident: “The PCBs can readily cross the placental barrier, and several infants were born with Yusho symptoms, some to apparently unaffected mothers.” Hammond, citing scientists in Japan, wrote that “recovery appears to be difficult... with symptoms still present in many cases 3 years later; no methods of treatment are known” [94].

Monsanto understood the implications of this tragedy. Don Roush of the Functional Fluids Division, wrote that while the company believed they had “a good track record here in the States using Therminol FR ... it only seems a matter of time until the regulatory agencies will be looking down our throats regarding the



use of this material.” They were hopeful that their feeding studies would show results that would ease people’s minds. “Possibly, by the time this comes about, we will have completed feeding studies [with chickens] with chlorinated biphenyls that will allow us more exact data than has been available in the past.” Ultimately Roush believed that engineering could control the most serious aspects of the environmental problem. He wrote, “I can only suggest that you attempt to put [a colleague’s] mind at ease regarding the ‘toxic’ aspects of these chlorinated biphenyls by playing down the medical reports and playing up proper system design.” He concluded by asking Monsanto’s representative to show “some discretion” in distributing this data [93].

Back in the United States, Monsanto had hoped that incineration would break down PCBs, thus neutralizing their toxic effects, and providing a means of disposing of PCBs in carbonless carbon paper and other products. But in March 1969 they learned that the Aroclor present in the National Cash Register Company’s (N.C.R.) carbonless copy paper was not destroyed by incineration. A study they sponsored revealed to Monsanto that “Aroclor is easily volatilized when N.C.R. paper is burned,” and “undergoes little, if any, decomposition.” This was bad news for the company: “Unfortunately, it appears that significant air pollution can occur via burning of N.C.R. paper or other Aroclor containing materials even under more strenuous conditions” [95].

The company soon received even more bad news with the publication of an article that they had read in draft form several months earlier. At the end of October 1968, Elmer Wheeler of Monsanto’s Medical Department wrote that a technical paper provided to him by Donald Spencer of the National Agricultural Chemical Association, reported that a researcher “has found PCBs along with chlorinated pesticides in a number of species of fish and birds along the California coast as well as in waters off Baja California and Central America” [96]. The paper by R.W. Risebrough of the Institute of Marine Resources, Department of Nutritional Sciences, University of California, Berkeley, was published by the prestigious journal *Nature* in December 1968 and, according to Monsanto’s W. R. Richard, “has attacked chlorinated biphenyls in three ways” [96].

First, the article made clear that PCBs were a “pollutant” that was “widely spread by air–water” and was “therefore an uncontrollable pollutant.” Second, it was clearly “a toxic substance—with no permissible allowable levels” and was “causing extinction of [the] peregrine falcon by induced hepatic enzymes which degrade steroids upsetting Ca [calcium] metabolism leading to reproductive weakness, presumably through thinner egg shells.” Finally, PCB was “a toxic substance endangering man himself.” The implications were dire: “the peregrine falcon is a leading indicator of things to come.” Even worse in some ways, was a report in another prestigious journal, *Science*, that the Environmental Defense Fund was seeking to “write new legal precedents in conservation law by hearings and court action.” Monsanto was in a bind. They believed that they could

take steps to minimize pollution from our own chlorinated biphenyl plants, we can work with our larger customers in minimize pollution, we can continue to set up disposal and reclaim operators. We can work for minimum



exposure in manufacture and disposal of capacitors, transformers and heat transfer systems, and minimize losses for large hydraulic users [96].

But once the material was sold to other manufacturers and even consumers the company's ability to control environmental pollution was lessened.

We can't easily control hydraulic fluid losses in small plants. It will be still more difficult to control other end uses such as cutting oils, adhesives, plastics, and N.C.R. paper. In these applications, exposure to consumers is greater and the disposal problem becomes complex. If chlorinated biphenyl is shown to have some long term enzyme or hormone activity in the ppm range, the applications with consumer exposure would cause difficulty [96].

Risebrough's work presented Monsanto with real problems and Richard laid out the stark choice the company faced:

Either his position is attacked and discounted or we will eventually have to withdraw product from end uses which have exposure problems. Since Risebrough's paper in '*Nature*' Dec. 1968 has just been published, it is timely, perhaps imperative, that this paper and its implications be discussed with certain customers. This is a rough one because it could mean loss of business on empty and false claims by Risebrough.

He urged the company to engage in “well prepared discussion with Ind. Bio-Test [Industrial Bio-Test, a toxicological laboratory], Monsanto biochemists, the medical and legal departments, and that such discussion must take place now.” Richard concluded his memo to Wheeler and others by asking them to examine the experience of DDT manufacturers: “We are being accused of the same things attributed to DDT” [97].

The threat was serious and Monsanto responded with a press release in March 1969 that sought to raise doubts about both Risebrough's and Jensen's research. “The conclusions of these scientists are puzzling from several aspects,” the press release asserted. PCBs “are stable chemical compounds which are essentially insoluble in water. Their use does not make them easily released into the natural environment.” Monsanto claimed that they were primarily used in sealed systems such as transformers and capacitors, and also “in several plastic-type applications. Here the chemical is incorporated into the polymer as an integral part of the solid material. This applies whether the polymer is used as an adhesive, an elastomer or a surface coating....” The company claimed ignorance. “To our knowledge, [PCBs] are not sprayed or dusted on crops, woodlands or any other areas, as are pesticides.” They feigned surprise that it could be found widely dispersed in the environment. “It is, therefore, not only puzzling, but extremely difficult to conceive how commercially produced PCB can show up in wildlife in the quantities reported.” Despite their private acknowledgment that what Risebrough and Jensen had found were PCBs, publicly, they raised “the question whether the substances identified in the Swedish work, and now in California, are actually PCBs—or whether they are compounds which, due to the metabolism or other materials in the marine environment, appear to be PCBs.” Monsanto took the position that what was needed was more research.



Monsanto will continue to exercise the highest degree of control in its manufacturing, shipping, and storing of PCB – as we do with all products. The source of the marine life residue identified as PCB is not yet known. It will take extensive research, on a worldwide basis, to confirm or deny these initial scientific conclusions [98].

About the same time, Richard and other Monsanto personnel met with Industrial Bio-Test Laboratories (IBT) and created a list of possible academic consultants “who might be of help on this problem” [99]. Robert Metcalf, an entomologist at the University of Illinois, had been suggested as a consultant at the meeting with IBT and, evidently, accepted the offer because he issued a Report to Monsanto about a “Meeting on Chlorinated Biphenyls in the Environment at Industrial Biotest Laboratories” in Chicago on March 21, 1969. In his Report he noted that “the background data presented” at the meeting suggested that “something of the order of 80 million pounds” of PCBs were being produced annually. He wrote that “at first thought it seems unlikely because of the major uses of PCBs in capacitors, transformer oils, [and] heat transfer fluids in closed systems, that these materials could be the source of the substantial degree of environmental contamination reported.” But, Metcalf noted, “about 40 million pounds annually is stated to be used in plasticizers, hydraulic fluid, adhesives, and in carbon paper.” He concluded therefore, that “a very substantial percentage must escape into the environment as waste” [100].

Further, making the situation worse was the “apparent high stability of PCB,” which meant that the PCBs “entering the environment would be degraded very slowly and it seems possible that at least 10 million pounds annually may become environmental contaminants.” He noted that PCBs had been in production for 40 years and “if this has averaged 50 million pounds per year, then about 2×10^9 [two billion] pounds have been made and perhaps 2×10^8 [two hundred million pounds] have entered the environment.” He further concluded that because of the “apparent stability” of PCBs “most of the PCBs that entered the environment may still be circulating in the global ecosystem.” He concluded his report to Monsanto with the following warning:

It seems to the writer that the evidence regarding PCB effects on environmental quality is sufficiently substantial, widespread, and alarming to require immediate corrective action on the part of Monsanto. The defensive measures presently underway will do little if anything to refute the evidence already presented [100].

He suggested that Monsanto undertake a major effort to begin “a substantial analytical program to monitor air and water effluents from Monsanto plants producing PCB and also those of major customers.” He also suggested “prompt correction of effluent conditions where PCB can be demonstrated.” Further, Metcalf suggested to Monsanto that “serious consideration of curtailing sales of PCB for uses such as plasticizers, adhesives, and carbon paper where waste is certain to enter [the] environment.” In addition to suggesting that Monsanto review its own disposal and recovery methods for PCBs in “capacitors, transformers, heat transfer fluids, and hydraulic fluids,” he told Monsanto that the company should “emphasize



to customers [the] importance of preventing environmental contamination.” (It took almost a year for Monsanto to issue such a warning to its customers.) He suggested that Monsanto conduct a “thorough investigation of environmental fates of various PCBs, including petrochemical oxidations, chlorination in water systems, etc.” Further, he proposed that Monsanto conduct a “biochemical and electron microscopic study of levels of PCB ingestion which cause proliferation of endoplasmic reticulum and induction of multifunction oxidases in chickens and rats.” Finally, Metcalf suggested to Monsanto that the company “begin investigations of possible biodegradable substitutes for PCBs as plasticizers, adhesives, fire resistant hydraulic fluids, etc., anticipating loss of these markets as a necessary corollary of environmental problems” [100].

Monsanto’s own experiments revealed that one of the major uses of their PCBs, carbonless carbon paper, was contributing to environmental pollution through a primary disposal method: burning. In March 1969, they learned that PCBs were “Easily volatilized when burned,” and underwent “little decomposition.” Their conclusion was that “Unfortunately it appears that significant air pollution can occur... burning of N.C.R. paper [or] other Aroclor containing materials” [95].

While Metcalf was providing Monsanto with his assessment of the “alarming” environmental contamination caused by PCBs, Monsanto itself was discussing ways to measure the environmental impact of PCBs through a study of a test site at the University of Florida. In 1938, Monsanto had mixed Aroclors 1242, 1248, and 1254 in test soil on the University grounds at the Gainesville campus. Elmer Wheeler suggested that the company might “look into the possibility of obtaining samples of these plots for measurement of loss or ‘degradation’.” [24]

Monsanto, recognizing that environmental pollution presented a major threat to their business, began, in the spring of 1969, to consider working with major companies to control pollution. W.R. Richard wrote that in order “to defend the Aroclor position, it seems that we should provide for disposal of and incineration of off-grade fluid and work with Westinghouse and Findett on the disposal of the off-grade capacitors as well.” He believed that the “control of the total material balance for Aroclor will be important for future operation. We should therefore help control the entire cycle of a capacitor.” Already, the company was reclaiming used Aroclor to put into new Pydraul hydraulic fluid. But this presented a problem for the company. It would not, in Richard’s words, “satisfy pollution people” and would “just bring the focal point to hydraulic fluids that much sooner” [101].

Even as they were learning about the threats that Aroclors presented to the environment, Monsanto’s Corporate Development Committee learned that the president of the company “advised that he would recommend to the Board of Directors for approval \$1,100,000 for solid Aroclor expansion [at] Anniston” [102]. Despite knowing that Aroclors were endangering the environment and that they were in the effluents of their plants, Paul Hodges of Monsanto’s General Offices, wrote that the company had “generally taken the position that, before any expensive projects are undertaken to halt sewerage of Aroclors, we should know what levels exist in the receiving waters” [103].

The information about the various ways that PCBs were entering the environment built up rapidly at the end of the 1960s. Monsanto faced the problem of how



to provide information to both the public and the government about the dangers of Aroclors specifically and PCBs in general. It was at this time that Elmer Wheeler learned of a conversation between Dave Nelson of Monsanto's Research Center and Bob Day in the Cincinnati Laboratories of the National Air Pollution Control Administration. Day had called Nelson asking "for any information Monsanto might have relating to what might happen to chlorinated biphenyls in products that might be incinerated." Nelson was immediately taken with Day for he felt that this public employee "was not a 'Knight on a White Horse' but was reasonable and objective." Soon, Nelson found out an aspect of Day's past that explained part of the reason he was "reasonable and objective." Nelson told Wheeler that "Day finally told me that he is a Monsanto employee from Pensacola fulfilling his military commitment as a member of the Commission Corps. in the Public Health Service." Nelson was pleased with the conversation and told Wheeler that Day would "send word back to Washington which will then be related to the members of Congress that the PCBs are not used in some of the applications which have been indicated in the public press and in general try to present Monsanto's views to wit: 'We cannot conceive how the PCBs can be getting into the environment in a widespread fashion and that the company is actively involved in research programs to try to shed some light on the situation.'" [104] This spin on the information provided to the government was in spite of years of information about the environmental effects of PCBs during which the mechanisms by which PCBs entered the environment were being described in detail to Monsanto itself [105].

"Sell the hell out of them as long as we can": 1969

While they publically questioned Jensen, Widmark, and Risebrough's identification of widespread contamination by PCBs, in private company officials acknowledged the huge problem they faced. By August 1969, the concerns about PCBs had become so severe that Monsanto set up a Task Force that became the "Aroclor 'Ad Hoc' Committee." At its first meeting, the PCB Task Force reviewed the growing evidence that PCBs were in a wide range of products in different states and in previously unidentified locales. The Georgia and West Virginia health departments had found it in milk; Japan had found Aroclor 1248 in bran; Therminol was being used for heat transfer fluids; it was in detergent; a government lab found PCBs in soap; it was in Electrosol dishwasher liquids; over 10% of samples identified PCBs in Lake Michigan; it was in mud samples in Pensacola, Florida; and, of course, in San Francisco Bay. The notes from the meeting indicated that the "subject is snowballing." In hand-written notes, a Task Force member summarized the sense of the meeting: "where do we go from here" and listed the "alternatives" as "(1) Go out of business. (2) sell the hell out of them as long as we can and do nothing else" and "(3) try to stay in business in controlled applications—control contamination levels" [106].

The Aroclor Ad Hoc Committee's meeting on September 5, 1969 was chaired by E. P. Wheeler, at the time Monsanto's Manager of Environmental Health. The other members of the committee were W.R. Richard, manager of Research and Development of the Organics Division, E. V. John, Director of Public Relations, P.



V. Hodges, manager of Environmental Engineering, and M.W. Farrar, of Organics Research. The Committee agreed on three objectives: “(1) Permit continued sales and profits of Aroclors and Terphenyls. (2) Permit continued development of uses and sales. (3) Protect image of Organic division and of the Corporation [Monsanto].” In their background discussion, they noted that environmental damage had been quite extensive to that point: “PCB has been found in: a. Fish, oysters, shrimp, birds. b. Along coastlines of industrialized areas such as Great Britain, Sweden, Rhine River, low countries, Lake Michigan, Pensacola Bay, in Western wild life (eagles). It may be a global contaminant,” they remarked. They also noted, “PCB has been tied to DDT in effects on disappearance of wild birds that have fish diets.” The Committee also argued that Aroclors “have been shown to be safe in man in reasonable exposure concentrations” and Monsanto was “testing 100 ppm [of PCBs] in diet of rats and dogs on a rule-of-thumb basis that 1/100 of the toxicity level is safe and 1 ppm is probably the upper limit in total diet.” The company officials acknowledged privately that there had been a

test at Pensacola where 5 ppb was found to be toxic to shrimp in 18 days exposure. One problem we are facing is to keep the ‘safe level’ (?) for shrimp from being applied to e.g. Lake Michigan where more tolerant fish species probably exist. We need to show the safe level in shrimp, clams, oysters and several species of fish [107].

The Committee then discussed what they should do about reducing the toxic waste from the Anniston and Krummrich plants where PCBs were being discharged into nearby streams.

The question of exactly how far to reduce (how much money to spend) is not yet clear and expenditures to date have been comparatively small. It was agreed that, until the problems of gross environmental contamination by our customers have been alleviated, there is little object in going to expensive extremes in limiting discharges from the plants.

Their position was that Monsanto’s own pollution was minimal in comparison to the contamination caused by their customers. “In one application alone (highway paints) one million lbs/year are used. Through abrasion and leaching we can assume that nearly all of this Aroclor winds up in the environment.” Although the minutes do not give any details, the Committee had a discussion about the “philosophy of controlling sales or working with customers to prevent pollution by PCBs” [107].

That same week W.R. Richard wrote a memo to Elmer Wheeler entitled “Defense of Aroclor—F. [Functional] Fluids.” For Monsanto, the PCB issue was fast approaching a crisis point. On the one hand, Richard suggested that they should, as a “general policy... Make the Govt., States and Universities prove their case, but avoid as much confrontation as possible.” The company should “let government prove its case, on case by case basis.” Monsanto should “question evidence against us; Question shrimp toxicology especially other toxic chemicals” as well as raise doubts about the implications for regulation of a broad range of materials of



condemning Aroclors: "If Aroclor [is] bad, others must be worse," he argued. On the other hand, the company should "Comply and work with public officials to meet or exceed requirements ahead of time." The Company should "keep track of how much contamination—which sources." They believed that the "probable outcome" was that they could "prove some things are OK at low concentration," and that this would "give Monsanto some defense." It was clear to Richard that the company could not "defend vs. everything," because, "Some animals or fish or insects will be harmed." The company also had to acknowledge that "Aroclor degradation rate will be slow," and that this information would be "tough to defend against." Richard was beginning to conceptualize a defense against the complete ban of PCBs: He suggested that "Higher chlorination compounds will be worse [than] lower chlorine compounds. Therefore we will have to restrict uses and clean-up as much as we can, starting immediately" [108].

By 2 October 1969, the Ad Hoc Committee had drafted a confidential report that outlined the profound depths of the emerging crisis over PCBs. The committee reaffirmed goals enunciated at the first meeting, but added the additional objective to "Protect the image of the Organic Division and the Corporation as members of the business community recognizing their responsibilities to prevent and/or control contamination of the global ecosystem." By this date the committee believed that

there is little probability that any action that can be taken will prevent the growing incrimination of specific polychlorinated biphenyls (the higher chlorinated – i.e. Aroclors 1254 and 1260) as nearly global environmental contaminants leading to contamination of human food (particularly fish), the killing of some marine species (shrimp) and the possible extinction of several species of fish eating birds [109].

And it also acknowledged that "there is no practical course of action that can so effectively police the uses of these products as to prevent completely some environmental contamination." But despite these acknowledgments, the draft report suggested that there were "a number of actions which must be undertaken in order to prolong the manufacture, sale and use of these particular Aroclors as well as to protect the continued use of other members of the Aroclor series." In particular, they believed that while the continued use of highly chlorinated biphenyls could not be defended, "The continued use of the lower chlorinated biphenyls (less than 5 chlorines) and the chlorinated terphenyls in applications [were] amenable to such control that there is practically zero losses to the environment." Further, they asserted the old toxicological principle that there was a level of exposure below which any product, no matter how toxic, could be made safe: "In the interim we would hope to establish by appropriate research efforts 'tolerance' or safe levels for particular Aroclors in the environment." In light of this belief, they first recommended notifying customers who were using the more highly chlorinated biphenyls Aroclor 1254 and 1260 "of the environmental contamination problem." "Legal and moral" considerations led them to this policy: "As the alarm concerning the contamination of the environment grows it is almost certain that a number of our customers or their



products will be incriminated. The company could be considered derelict, morally if not legally, if it fails to notify *all* customers of the potential implication” [109].

About 2 weeks later in a document marked “Company Confidential—Attorney- Client Privilege” a second draft of the above report was sent by the committee to Rodney Harris, Jr., Director of Monsanto’s Law Department. This report reviewed the growing knowledge of chlorinated pesticides as well as PCBs over the previous fifteen years. The experience with DDT provided a model for the environmental damage that PCBs were causing:

For the last fifteen years there has been growing world-wide concern regarding the persistence of chlorinated pesticides (particularly DDT) and their universal presence in man, food, animals, fish, birds, air, water, and soil. DDT and its metabolites have been found in virtually every living organism and matter around the globe – including penguins in the Antarctic and the polar ice cap.

Similarly, during just the last few months,

PCBs have been reported in: a. Milk in Georgia, b. Waters of Lake Michigan, c. Fish in Connecticut, d. Sea food along the gulf Coast (toxic – fatal to shrimp at Pensacola), e. Electric dishwashing compounds, f. Milk in Maryland, g. Bald Eagles from the mid-west and h. Mother’s milk (rumor – not confirmed) in Denver [110].

The first and a major conclusion of the committee was “*That the identification of the PCBs as a contaminant of the environment is certain.*” [Emphasis in original] In addition the committee acknowledged, “There is no question as to the non- or low-biodegradability of the PCBs—particularly the higher chlorinated Aroclors 1254 and 1260 and probably 1248.” It asserted that this was clearly an industry created problem as “the possibility of [other] origins of the PCBs ... is so remote that it is not a satisfactory explanation for their presence.” The report also acknowledged that the highly chlorinated compounds, particularly 1254 and 1260, were widely identified in the literature as contaminants [110].

While the environmental issue was clearly identified in this document, the committee also acknowledged that “possible toxic effects” could result if workers were exposed to this material.

There have been a limited number of cases of occupational disease where workmen have been exposed to excessive vapor inhalation or repeated and prolonged skin contact with subsequent development of skin manifestations (‘chloracne’) or more serious involvement of the liver and kidneys.

In their evaluation the committee asserted that “PCBs may be ‘moderately toxic’ to man.” They believed that their own toxicological studies on rats and dogs, along with a new study of three generations of rats, to be conducted by their consultant, Industrial BioTest Laboratories, will be made “available to the U.S. Food and Drug Administration and other federal and state agencies” and would “confirm that the levels of PCBs being found in nature—and particularly in human



food—do not constitute a serious threat to public health.” Studies with fish, however, presented problems for the company. Fish “can concentrate/accumulate persistent chlorinated hydrocarbons in their tissue. For example, trout raised in water containing 1 part per billion will contain 1 part per million in their tissues in 6 weeks.” This buildup presented potential problems where fish consumption was high. “In Sweden and other Scandinavian countries, where fish make up a large portion of the daily diet, the use of DDT has been temporarily or permanently banned,” the committee noted. Similarly, several states have taken action to ban the sale of fish and “bills have been presented in Congress to outlaw the sale and use of DDT.” The committee noted that just in the previous summer, “the U.S. Food and Drug Administration seized and destroyed Coho Salmon caught in Lake Michigan” [110].

The committee also worried about a second consequence, the “alleged effect on species of coastal and other fish-eating birds.” These data were “interpreted by a number of scientists (and seized upon by the conservationists-pseudo-scientists)” as evidence that certain “birds face elimination or absolute *extinction* because of persistent chlorinated hydrocarbons in fish which make up the major portion if not all of their diet.” One troubling aspect of this problem was that bald eagles were identified as a bird at risk by the US Department of the Interior. “Now the emblem of the heritage of the United States is threatened!” The growing body of evidence that indicated that birds, fish and even shrimp were accumulating or being threatened by PCBs presented serious problems for the industry and particularly tended to undermine their hope that a threshold level could be found below which PCBs were not harmful [110]. (Emphasis [on *extinction*] is in the original.)

The committee acknowledged the difficulty of preventing environmental pollution even at Monsanto’s own plants. They noted that in one plant “up to three gallons per day was being lost to the river from the use of Pydraul AC in air compressors.” Despite all the ambiguity in the data that indicated that there might not be a well-defined threshold limit, the committee suggested that “PCBs are ‘moderately’ toxic to man” but that “a probably safe level for Aroclor 1254 and 1260 in the diet will be something less than one part per million.” The committee also argued that while adult birds or fish were not grossly affected, “the ‘safe long term’ or ‘chronic dose’ is less than 100 ppm insofar as reproduction is concerned.” It also argued that shrimp were “safe” when exposed to Aroclor 1254 at levels “less than five parts per billion.” They took solace from the conclusion that “we may be able to show some kind of reasonable numbers for ‘safe levels’ of Aroclor 1254 and 1260 (and other chlorinated biphenyls) in some species” but worried that “there are other species of life in the ecosystem where a *zero to 5 parts per billion* limit for Aroclor 1254 and 1260 ... will be the tolerance level” [111]. [Emphasis is in the original.]

The committee remarked on the changing political context and specifically the influence of the growing environmental movement on their image and ultimately, the market for their products. As of that moment, in late 1969, “there are no restrictions which control the current uses of our Aroclors or PCBs.” They were



faced, instead with pressure being applied relatively to persistent chlorinated hydrocarbon pesticides in general and specifically DDT. The evidence proving the persistence of these compounds and their universal presence as residues in the environment is beyond question.

While the Committee believed that the importance of this fact was unclear, “the development of ‘lunatic fringe’ post-Rachael Carson has led to a domination of the media by scare publications in the public and scientific press.” They warned that the business community in general had to pay attention to this: “Only the most myopic individual in the business world could be unaware of the overwhelming interest and influences being directed at preventing contamination of the environment. The principal groups with an apparent avowed mission of providing a world of pristine pure food, water and air include many in academic and political fields who recognize the headline value of statements supporting these ideals.” This was particularly important for those concerned about PCBs:

as environmental contaminants, the committee believes that Monsanto is faced with a barrage of adverse publicity in all elements of the news media – including those with national coverage. Factual basis will be sparse or non-existent but guilt by association (with DDT) will provide background and prevail.

The committee was pessimistic: “The public and legal pressure then to eliminate or prevent global contamination are inevitable and probably cannot be contained successfully” [110].

But the threats would not come from the environmentalists or regulators alone, for the producers of DDT and other chlorinated pesticides “will not be loathe to incriminate the PCBs as being culprits in the development of misleading data relative to their concentrations as residues.” Also “the manufacturers of competitive products will seize any opportunity to point out to our customers their potential problems if they continue to use products containing Aroclors. This has already occurred in the case of our Pydrauls.” Monsanto officials were increasingly concerned about possible laws and regulations governing dangerous products, particularly food additives [110].

The committee concluded that “the identification of PCBs as an environmental contaminant is certain” and that the “toxicity to some biological species at extremely low levels (a few parts per billion) is significant.” The committee also concluded that PCBs “are persistent once they become a part of the environment and the rate of degradation is extremely low.” The committee also ruled out the “likelihood that the PCBs appear in the environment as a result of ‘natural’ origin on the metabolism or degradation of other chlorinated hydrocarbons.” The dismal conclusions of the committee led one participant to state in his handwritten notes that Monsanto should “contact all customers” to “assure them that there is no way to contaminate without detection” [110].

At the end of October 1969 Monsanto “confirmed the adequacy of work by Widmark and Jensen and others” that pointed to PCBs as a “*world-wide ecological problem*.” [Emphasis in the original] They also noted that while Aroclors 1254 and 1260 were clearly a problem, “other Aroclors may contribute, but have not been identified



yet.” The company recognized that this problem had multiple effects on Monsanto, including that its “business potential [was] at stake on a world-wide basis,” that it faced “legal responsibility,” that its “public image” was at stake, and that it could have an “effect on other product areas.” The company was also concerned about the effect of this problem “on Customers and Ultimate Consumers.” This would include the “entire electrical industry—capacitors and transformers,” food processing, dye casters, and other ‘hot metal’ working industries, a “wide range of plastics and adhesive applications,” as well as a “wide range of paints and coatings.” It acknowledged that the “main sources of pollution” were

difficult to define, but Aroclor 1254 and 1260 are used in electrical devices, heat transfer, plastics, adhesives, coatings, and industrial fluids.... Manufacturing plants also a *vulnerable* contributing factor, but less significant in *quantity* than customer or end user losses.

Although Monsanto thought that it was “possible to control” the PCB pollution in electrical and heat transfer units “with effort and reclamation,” “industrial fluids, plastics, coatings and adhesives are very difficult, if not impossible to control. Substitute products needed” [111].

In early December 1969, R.H. Munch of Monsanto’s Organics Research Division wrote to W.R. Richard about the dilemma that Monsanto faced with regard to the future of PCBs. Don Olsen had raised a fundamental question: “How we should go about reaching our objective of being the world leader in the Aroclor business.” Munch suggested reformulating the question: “Under present conditions this question should probably be changed to: How should we go about achieving maximum profit from dielectric fluids or dielectrics in general?” He argued that “there are two reasons for changing the question. One is the environmental pollution problem. The other is that technological needs in the dielectrics area are changing with ever increasing rapidity. Both are compelling reasons” [112].

Publicly acknowledging environmental danger: 1970

By the early 1970s it was impossible to publicly maintain that PCBs were not an environmental pollutant as researchers, newspapers, environmental groups, government agencies and congressmen detailed the wide variety of ways PCBs were contaminating the Great Lakes, rivers and streams in Alabama, fisheries, milk supplies in Ohio, shrimp in the Gulf of Mexico, birds on the west coast, New York’s Hudson River and other regions of the country. This section outlines Monsanto’s acknowledgment of this environmental pollution, its efforts to limit the use of PCBs and ultimately its phase out of what they termed “open uses” in the American market.

By the beginning of the new decade, Monsanto was receiving more and more bad news. In January 1970, Monsanto representatives met with General Electric Corporation, perhaps Monsanto’s biggest customer of dielectric fluids, to discuss “the PCB-Pollution Problem.” General Electric had “requested and we were pleased to give Dr. Murphy their Environmental Control man, a list of all GE and other locations receiving Pyranol shipments in 1969.” Monsanto estimated that these locations



accounted for “about 16 million pounds of askarel fluids with economic worth of near 2.5 million dollars.” Of special concern was that they had shipped this material to “244 different locations of which 115 were GE plants and service shops scattered throughout the country...” and that “Environmental Sources of PCBs from Dielectric Applications” polluted the environment from “1. Spills; 2. Disposal of waste; 3. Ultimate disposal of product—for failed apparatus; 4. Ventilation of operation for employee protection; 5. Waste from containers; 6. Field on service failures; 7. Repair and return apparatus ‘service shops’.” [113]

Now, their largest customers were pushing back against the argument that Monsanto had used only a year before—that Aroclors were used almost exclusively in “closed” systems that the company couldn’t imagine would enter the environment. This was not sustainable. Benignus told Monsanto’s corporate leadership of the enormous contamination produced in the electric industry itself:

Estimated Annual Amounts of Contaminated and Scrap PCBs from the electrical Industry; 1. From the Transformer Industry:....Near 2 million pounds a year of transformer askarels are sold to service and repair shops....As these service shops are devoted primarily to repairing faulty transformers, we can assume that as much as 1.0 million pounds annually of ‘scrap’ is generated. Most of this has been dumped or disposed of in streams.” “2. From the Capacitor Industry: a) Collectable waste from normal capacitor impregnation operations amounts to about 850,000 lb annually [113].

Mr. Wheeler reported “on chronic animal toxicity tests and animal reproducibility studies underway” which had turned out to be “not as favorable as we had hoped or anticipated.” Wheeler wrote that it was “particularly alarming” that the chicken studies (referred to earlier) of Aroclor 1242, 1254, 1260 found “evidence of effect on hatchability and production of thin egg shells regards white leghorn chickens.” Wheeler concluded that “some of the studies will be repeated to arrive at better conclusions” [113].

At the same time Monsanto officials learned of new, even more troubling information. Elmer Wheeler of the Medical Department reported that the company’s animal toxicity studies showed that PCBs were “exhibiting a greater degree of toxicity ... than we had anticipated.” In addition, the problems with PCBs were “about the same as DDT in mammals.” Even more worrisome was “additional interim data which will perhaps be more discouraging. We are repeating some of the experiments to confirm or deny the earlier finding and are not distributing the early results at this time” [114].

By mid-February 1970, officials at Monsanto’s headquarters in St. Louis were paying close attention to Aroclor’s environmental problems. In a “Pollution Letter” addressed to about twenty representatives in a variety of offices in the United States and throughout the world, N.T. Johnson suggested ways by which Monsanto representatives could talk to their customers about the PCB problem. Johnson suggested “a list of questions and answers which may be asked of you by customers receiving our Aroclor-PCB letter.” He told his representatives that when asked questions, that representatives “give verbal answers; no answers should be given in writing.” He suggested that if a question were asked that the representative could not answer, “or



if he wants an answer in writing, then send his question to me and we will answer it from here” [115].

Foremost, Johnson wrote, “We want to avoid any situation where a customer wants to return fluid.” New “reformulated products will be available within a month,” he wrote, and “we would prefer that the customer use up his current inventory and purchase [alternate Pydraul products] when available.” He argued that over a period of time the customer will “top off with the new fluid and eventually all Aroclor 1254 and 1260 will be out of his system.” Of paramount importance, he emphasized in his letter, was “*We don’t want to take fluid back.* [emphasis in the original] Sell him the replacement” [115].

Johnson saw this as a positive, even progressive move on Monsanto’s part. “We must be very positive in our approach with each customer We (your customer and Monsanto) are not interested in using a product that may present a problem to our environment. We certainly have no reason to be defensive or apologetic about making this change. ... No one has forced us to make this change.” He told the representatives to “be positive. Take the offense. Don’t let a customer or competitor intimidate you.” He argued that the company had to act responsibly: “We should also recognize (point this out to your customer) we must clean up. The Chemical Week article gives him an idea of laws in effect in his state. Read this yourself. Be familiar with the data of each state in which your customers are located. Use this in your discussions.” Monsanto still had a major problem: “We have no replacement products for Aroclor 1254 and Aroclor 1260. We will continue to make these products; however,” he pointed out, “customers will have to use their own judgment on continued use.” His final comments were most telling: “We can’t afford to lose one dollar of business. Our attitude in discussing this subject with our customers will be the deciding factor in our success or failure in retaining all our present business. Good luck” [115].

The January decision to focus attention on the highly chlorinated Aroclors—namely 1254 and 1260—was reflected in a letter sent out to customers concerning newspaper and magazine articles that highlighted the dangers of PCBs. On February 18, 1970, Donald Olsen, the Director of Sales of Monsanto’s Functional Fluids Group, wrote to customers about “newspaper and magazine articles” that reported that PCBs had “been discovered at some points in some marine, aquatic and wild-life environments. The quantities detected are said to be in the parts per million and parts per billion categories.” Olsen pointed out that “PCBs found [in the environment] strongly resemble chlorinated biphenyls containing 54 and 60% chlorine by weight. He went on to point out the various products that Monsanto produced that contained these Aroclors and that Monsanto was one of “several other companies around the world” that produced these chlorinated biphenyls. Olsen was somewhat reassuring to his customers, writing that there are many products that Monsanto produced that “are not formulated with Aroclor 1254 or 1260.” He also advised his customers that “PCBs with a chlorine content of less than 54% have not been found in the environment and appear to present no potential problem to the environment” [116].

Even so, Olsen said, “all possible care should be taken in the application, processing and effluent disposal of these products to prevent them becoming environmental



contaminants.” In public, Monsanto maintained that PCBs that were in closed systems did not represent a threat to the environment. But Olsen painted a very different picture in this private communication to Monsanto’s customers. He suggested that the buyers of “transformers and other electrical equipment containing dielectric fluids which include Aroclor 1254 and 1260” be aware that “although these fluids are sealed into such equipment it is recognized that occasionally the fluid may be lost through leaks resulting from equipment misuse or equipment repair necessitating replacement of the fluid.” He concluded his letter by saying that while Monsanto was not contacting each individual purchaser of electrical equipment, manufacturers of these end products should do so [117].

The information that Monsanto received about its toxicological studies continued to be bad for the company. In early March 1970, Elmer Wheeler, Manager for Environmental Health at Monsanto, wrote to Joseph Calandra of Industrial BioTest about Calandra’s view of the toxicity data of “three Aroclors in the rats, dogs and chickens. I think we are surprised (and disappointed?) at the apparent toxicity at the levels studied” [117].

William Papageorge, who had been “given the full-time assignment of coordinating all of the efforts on the PCB problem,” [117] wrote to a company representative in Tokyo about Monsanto’s plans for handling the Aroclor problem. He told J. R. Durland of the company’s decision to “reduce the amount of Aroclors in the plant effluents to essentially zero. Lacking any positive guidelines, we have tentatively selected a target of 10 ppb.” He reiterated the company’s “original plans to move toward discontinuance of 1254 and 1260.” But Monsanto re-evaluated even this limited response after “meeting with representatives of General Electric, [where] this decision to discontinue 1254 and 1260 was challenged. The G.E. representatives,” Papageorge reported, “believe that the benefits of these Aroclors in transformers far outweighs the yet considerable threat to the environment.” The new position of Monsanto that they planned to present to the Corporate Management Committee was that “in those situations where control is practical, such as transformer usage, we could continue to supply Aroclor 1254 and 1260” [118].

Papageorge noted the continuing problem of the PCBs used in N.C.R.’s carbonless copy paper where “the ultimate destination of this product is difficult to control. Normal incineration vaporizes the Aroclor which eventually is found somewhere in the environment.” In contrast to the concern that Wheeler expressed about the IBT studies, Papageorge wrote that the studies of the “effects of Aroclor 1221, 1242 and 1260 on rats, dogs and chickens ... so far, have been inconclusive” [118].

But published studies were not inconclusive: *Science News* reported in late March 1970 that David B. Peakall, a researcher at the Langmuir Laboratory at Cornell University, found that PCBs “act in much the same way as DDT in causing a decrease of birdlife through action on eggshells.” He also found that PCBs behaved similarly to DDT in other ways: “They are very stable and nondegradable, they are concentrated by passing from the fatty tissues of one organism to another as they move up the food chain, and levels of them are nearly as high as DDT levels in some areas” [119].

Papageorge got even more bad news at the end of March 1970 when Emmet Kelly wrote him about a communication Kelly had received from “a Dr. Hill of



the Ohio State Board of Health.” Hill reported to Kelly that he had found “Aroclor 1254 in samples of milk from at least three herds in Ohio,” which he had traced back to the silos where the feed grain had been stored. “The silos are concrete silos whose interior surfaces were painted in 1967 using a formulation that contained 1254.” For Kelly this raised “a very serious point” that had legal and public relations implications.

When are we going to tell our customers not to use any Aroclor in any paint formulation that contacts food, feed, or water for animals or humans? I think it is very important that this be done. It may be that some of the customers will assure themselves on the basis of non-extractability that a particular formulation might be safe but I think we should make a blanket recommendation against these uses [120].

Despite the growing concern about the environmental and human health implications of PCBs as related in their internal documents, Monsanto downplayed the dangers in public. The stakes were raised for Monsanto in April when Congressman William F. Ryan, (D-N.Y.) “called for a ban on polychlorinated biphenyls.... [He] asked the Department of Agriculture to ban the use of PCBs in insecticides. He also asked the Food and Drug Administration to set food tolerance levels for PCBs and to conduct a study to determine if a ban is necessary” [121, 122].

In a press release issued in response to Ryan’s attack, the Company began by acknowledging the public concern over PCBs: “Monsanto Company said today it was well aware of the concern over possible environmental contamination by polychlorinated biphenyl (PCB), an industrial chemical made by the company.” But Monsanto argued that it was on top of the problem, having begun “a six-point program in 1968 to properly identify and measure PCB in the environment.” In addition they argued that “Steps have been taken to strictly control use of the chemical and replace those grades of PCB which linger in nature.” The press release argued that Monsanto was a responsible company that was doing all that it could to address the problem of PCB environmental pollution [123].

The press release quoted Howard L. Minckler, Monsanto’s Vice President and General Manager of its Organic Chemicals Division who assured the public that “PCBs is not a household product, as some have suggested.” This was not true, as it ignored the fact that PCBs were a critical constituent, for example, of N.C.R.’s carbonless copy paper, a widely distributed consumer product. Minckler said “to our knowledge it is not used in plastic food wraps, house paints, cellophane, asphalt or tires.” Minckler maintained that “the principal market is electrical applications where the chemical performs a vital function as an insulating fluid.” Despite the private concerns about the “occasional leakage” the press release argued that in these electrical applications “PCB is completely sealed in a metal container,” and “other major markets employ similar closed systems.” The press release tried to limit public concern about PCBs. Their research, it said, showed that the only real problem was with “the higher chlorinated materials” and that their “animal feeding studies [showed] PCB is not a highly toxic material” [123]. In April 1970, Monsanto acknowledged that it was not only in the air, water, fish, milk, mud sediment and in Lake Michigan but also in nine U.S. rivers and finally, in human fat [124].



In April 1970, the growing body of concern about PCBs reached the top of Monsanto's leadership group, the Corporate Development Committee. Until this point the Organic Division and the Medical Department were the most actively engaged in developing “facts and knowledge about PCBs through gathering information, visits to universities, and work with industrial test laboratories.” They had kept in contact with “other worldwide producers, and other industrial collaborators” and had followed closely the scientific and other popular literature that addressed the problems of PCBs and environmental pollution. They had also funded “a toxicological and analytical test program in excess of \$100 M.” Now the leaders of the Functional Fluids and Plasticizer Business Groups, and the Medical and Law Departments made a presentation to the Corporate Development Committee to discuss their findings, and to provide the US Centers for Disease Control (CDC) with the information it would need to develop a long-term and short-term strategy for dealing with the PCB crisis. The group began with a brief review of PCBs and their relationship to Monsanto's bottom line. Monsanto's “worldwide Aroclor business” amounted to over 104 million pounds of which 70 million were functional fluids and 34 million were plasticizers. This resulted in \$22 million in sales per year for a gross profit of \$10 million per year. They then explained the Aroclor product line ranging from Aroclor 1221 which was a thin liquid to Aroclor 5460 which was a solid. The complete list included:

- Monochlorobiphenyl—Aroclor 1221—Thin Liquid
- Dichlorobiphenyl—Aroclor 1232—Thin Liquid
- Trichlorobiphenyl—Aroclor 1242—Oily Liquid
- Tetrachlorobiphenyl—Aroclor 1248—Oily Liquid
- Pentachlorobiphenyl—Aroclor 1254—Heavy Molasses
- Hexachlorobiphenyl—Aroclor 1260—Thick Tar
- Heptachlorobiphenyl—Aroclor 1262—Thick Tar
- Octachlorobiphenyl—Aroclor—1268—Thick Tar
- Decachlorobiphenyl—Aroclor 1270—Solid
- Terphenyls—Santowax—Solid
- Chlorinated Terphenyl—Aroclor 5460—Solid

They informed the CDC that a significant part of Monsanto's business was now “being threatened not by competition but by recently found pollution problems,” and that “possible adverse legal and public relations problems [could be] leveled against Monsanto” [125, 126].

The leadership of the Functional Fluids and Plasticizer Business Groups, and the Medical and Law Departments presented four “Alternative Courses of Action” for the company executives to consider. The first alternative was “Do Nothing” but this “was considered unacceptable from a legal, moral, customer & public relations & company policy viewpoint.” It was considered “also the quickest route to being forced out of business.” The second alternative was to “Go out of Total Aroclor business,” and while this was considered unacceptable from a Divisional viewpoint it was presented as a possibility from a corporate viewpoint. Here the committee was asked to consider a partial solution to the company's problem: “All Aroclor products



are not serious pollutants.” The committee was told that “many degrade,” but also “there is too much customer/market need and selfishly too much Monsanto profit to go out” of the business completely. “To go out would require a write-off of Aroclor net investment of \$7 M [billion] (10 cents/share) or if biphenyls [was] included \$8.8 M [billion] (12 cents/share).” In addition, the company would have to face the problem of what to do with their inventory, “the continuing cost of utilities and back up capital and serious manpower & resources reallocation at Anniston” [125].

“Markets—1969 Sales [in millions of pounds]—Major Aroclor used”

- Carbonless carbon paper—8.8—Aroclor 1242
- Hot melt adhesives—5.7—Aroclor 5460
- Swimming pool paints—1.7—Aroclor 1254; 5460
- Protective Coatings—5.3—Aroclor 1254; 5460
- Emulsion Adhesives—1.5—Aroclor 1254; 1260
- Sealants—3.0—Aroclor 1254; 1262
- Wax Modification—2.0—Aroclor 1254; 5460
- Miscellaneous—5.0—Aroclor 1248; 1254 [125].

The third alternative was even more limited. The company could get out of the more highly chlorinated PCB business specifically Aroclor 1254 and 1260. “[T]his was seriously considered and may eventually occur by our actions and customer actions,” but they still felt “that segments of this business are defensible or are so ‘confined’ in use that specific plans of action are called for this portion [of the market].” This alternative was also rejected. The fourth alternative was to “Develop specific action plans ‘tailored’ to each business group and each customer/market situation to ‘clean up’ the mess.” This “was the alternative selected at this point of time and based on our knowledge from a Divisional viewpoint as making Monsanto act in the most positive, responsible way to society and our customers as well as our interests.” However, “because of the magnitude and seriousness of this problem and its total implications for corporate Monsanto your guidance and approval is needed” [125].

The Functional Fluids and Plasticizer Business Groups and the Medical and Law Departments proposed what they called a “Joint Action Plan” to the CDC that included the following: Appointment of a Project Manager (the Project Manager position would be held by William Papageorge), who would be “responsible for the overall management of the Aroclor pollution problem. He [the Project Manager] would be assisted by a Task Force from members of each Business Group plus Medical, Law, Engineering and Manufacturing.” Further “all Aroclor customers of PCBs” would be notified about possible pollution problems and all containers would be re-labeled “within 60 days,” and Monsanto would “educate customers on need for clean-up at their plants—within 4 months.” Within a year the action plan called for a “Clean up” of the effluents from Monsanto plants. Aroclor 1254 and 1260 would be repackaged within six months and Monsanto would develop replacement products for Aroclor 1254/1260. Monsanto would “continue and expand [its] biodegradation test program ... [its] toxicological test program ... [its] analytical test program,” its search for alternatives for Aroclors 1242 and 1248, its study of incineration as a



means of disposal and its methods for developing Fluid Reclamation and Recovery.” The company was hopeful that

through this Action Program, Monsanto would expect to: 1. retain or convert a good portion of our business and profits 2. Gain further valuable knowledge 3. Clean up the major contributing PCB pollution factors. 4. Minimize customer complaints and hardships [12].

The CDC accepted the proposed action plan. To implement it Monsanto initiated a series of actions aimed at reducing the amount of PCBs it would produce in the future. It committed itself to “Reduce and effectively control the PCB content of all effluent from Monsanto plants” with the aim of achieving “50 ppb in effluent by January, 1971” and “10 ppb by September, 1971.” It reported that the “Newport, Anniston and Saugnet plants [had] reduced losses considerably” but that “losses [were] still above the 50 ppb target.” Another of its objectives was to “Inform customers of the PCB problem and the importance of preventing environmental pollution both at their plants or by their customers.” Specifically, it aimed to “Inform customers in U.K., Canada and Japan by May 1, 1970; Europe and South America as indicated.” The company believed that it had met this goal with regard to Canada and the U.K. as “Customers in Canada and the U.K. were informed by July 1, 1970.” They lagged a bit with regard to “Customers in Japan, Europe and South America” who “have not been informed pending coproducer actions.” Also, the company had aimed to end distribution of Aroclors as plasticizers by September 1970, replace 1242 in N.C.R. paper coating “for U.S. applications by May, 1970...and for U.K. applications by July, 1970” and was pleased it was on target to achieve this goal. It had also found “acceptable substitutes” for Aroclor 1254 and Aroclor 1260 sealants and coatings and found other acceptable substitutes, allowing for the eventual phasing out of “persistent Aroclor-containing industrial fluids” which it planned to complete by April 1971. Pydraul 312 and Pydraul 150 still “pose major problems.” It sought to discontinue sales of polychlorinated biphenyls for cutting oils, pesticides, medicinals, and dental and cosmetic use by June 1970 and believed it was close to accomplishing it [127].

In mid-July 1970, Monsanto announced that it had “decided to restrict sales of the chemical because of mounting evidence that it can induce birth defects in animals.” In a letter to Representative Ryan, Monsanto said that it “would no longer sell PCB for use as a water-resistant plasticizer or as a hydraulic fluid.” The company wrote that it would continue to sell PCBs “for use as a coolant in electrical transformers because of its ‘unique properties’ and because its emission into the environment could be controlled in a ‘closed system’ such as a transformer.” *New York Times* reported that “the primary use of PCB has always been as a lubricant in transformers, the purpose for which Monsanto would continue to make it. The chemical also appears in a number of paints and adhesives that require a high degree of corrosive resistance” [128].

Berkeley’s Robert Risebrough, one of the first researchers to identify the environmental impact of PCBs, responded to Monsanto’s assurances that the product could be used safely since it would henceforth be used “only as insulating fluids in electrical and heat transfer systems where the PCBs are completely enclosed



and thus not likely to get into the environment.” Risebrough said “‘I’m not very optimistic. This electrical equipment is going to be thrown away eventually. With an expanding technology, I am afraid we will continue to have large amounts of these chemicals entering in the environment’.” According to an article in *Science News* Monsanto was still refusing Representative Ryan’s request to provide a list of all of PCBs uses. Monsanto was also refusing to provide “statistics on amounts of PCBs manufactured. A Monsanto spokesman admitted both charges this week, saying secrecy was necessary because Monsanto is the sole producer of PCBs” [129]. News reports did not mention that carbonless copy paper contained PCBs.

Whatever words were used to assuage public fear about PCB pollution, just a week later, Monsanto’s R.E. Keller of the Organic Research Division, acknowledged internally that the problem might be quite widespread. In a study of 167 samples of various environmental materials, Monsanto researchers detected “PCBs typical of our Aroclor products ... in water and sediment from nine US rivers, one UK river and Lake Michigan, air ... at the Anniston plant, fish from Lake Michigan and three midwest rivers, ... milk from Maryland and Ohio dairy farms,” and perhaps most distressingly, “human fat from a midwest biopsy specimen.” Further, Keller wrote that “The water, sediment and air samples contain PCBs typical of Aroclor 1242, 1248, 1254, and/or 1260. The milk, human fat and fish samples contain PCBs most typical of Aroclor 1254.” The problem was not just the Aroclor 1254 and 1260 [130].

In the same month, William Hunt from Monsanto’s Medical Division wrote to Kelly and Wheeler about developments in the rat reproduction and fish toxicity studies that Industrial BioTest was conducting. He reported that the fish toxicity studies conducted on catfish and bluegills were about 2–3 weeks behind schedule because of some unexpected results. He said that “doses [of Aroclor] which were believed to be OK produced 100% kill. At levels of 1–10 ppm for both 1242 and 1254, for 50 fish per level, all died. For 1260 at levels of 10 and 100 ppm, there were a few survivors at 10 but all were dead at 100 ppm” [131].

By the summer of 1970, Monsanto executives visited at least some of their customers “to discuss the PCB problem” and ways of avoiding at least some of the environmental pollution. After one such visit, Papageorge sought to reassure an uneasy executive at the Espey Manufacturing Company that his visit

did not intend to cause undue alarm or create any panic concerning the use and handling of polychlorinated biphenyls. We were primarily interested in sharing our current knowledge of the situation with you and offered to help wherever we could.

Up to this point, Papageorge explained, the PCBs “which are present in Monsanto’s Aroclors,” did “affect some species of birds and marine life,” but were “not acute poisons to humans and other mammals.” He suggested a variety of means that could be employed so that workers could be protected from exposure to Aroclors, and he pointed to methods that should be used to protect the environment. He also offered to “help our customers with their liquid disposal problems” by accepting “for future incineration scrap liquid Aroclors” for \$.03/lb plus the cost



of shipping. He closed his letter with an admonition that voluntary action was preferable to government regulation. He was

certain that you will do all that you can to reduce the escape of PCBs from your operation. When all of us succeed in this objective, I am certain that no regulatory agency will be compelled to take precipitous action regarding the use of PCBs in vital operations [132].

In 1970 articles started to appear in the popular press about PCBs. One such article in the July 9th issue of the *Miami Herald* described PCB as a “DDT-like poison.” In response, Monsanto’s Assistant Director of Public Relations, shot off a letter to the editor objecting to several “inaccuracies” in the article, including its assertion “that the manufacturer, Monsanto Company, is organizing ‘at federal request’ a campaign to reduce leaks of the chemical.” Monsanto objected that its actions were “not at government request. It was started in 1968 when we first discovered PCB might be a problem to the environment and long before many scientists or politicians knew of the issue.” Monsanto also objected to a “reference to a major PCB fish kill in Alabama last year,” stating that “there have been no major fish kills in the area of our Alabama plant since 1966, when heavy rains caused damage to our plant.” Seeking to defend their product, the company argued that “investigations showed that kill was not caused by PCB.” Most particularly, Monsanto objected to the characterization of PCBs as a poison but implicitly acknowledged the dangerous properties of PCBs by saying, “we are withdrawing it from sale where it is not used within a closed system....” [133]

Monsanto concluded their July 14, 1970 Letter to the Editor by arguing that the company had only recently become aware of the concern about PCBs because of technological advancements. “Scientific instruments capable of detecting small amounts of chemicals have not been available too long. But more to the point, no one bothered to use them to examine organisms in the food chain until a couple of years ago.” When it became aware of the problem, Monsanto argued that it had taken action: “Since that time, Monsanto, as a responsible company, has taken the initiative in solving the problem without pressure from government or organized groups.” Monsanto maintained that the company was providing a vital public service by producing PCBs that were critical materials “in nearly all electrical transformers.” To remove PCBs from production “would result in major power failures throughout the world” [133].

Two days after sending the letter, Monsanto issued a “news release on PCBs that dealt with Monsanto’s recent actions to curb the use of PCB” and to rebut “recent stories that PCB caused birth defects.” It also “included a complete background of voluntary actions taken to solve the PCB problem. Copies went to all news media who have carried PCB stories in the past 2 years” [134].

They also sent a letter to Congressman Ryan that the company “would no longer sell PCBs for use as a water resistant plasticizer or hydraulic fluid,” but that it would “continue to sell PCBs for use as a lubricant in transformers and for paints and adhesives.” Monsanto also said that it would refuse “to make public a list of all the products in which the PCBs were used” [135]. In August, Monsanto increased the use of its July 16th Press Release. They were pleased that “our practice of following up



each PCB story with our news release—to those media who did not receive the initial mailing—seems to be paying dividends. The Booth Newspaper chain in Michigan was the first to run our release. Other major dailies include the *Austin Statesman*, *Milwaukee Journal*, *San Francisco Examiner*, *Akron Beacon Journal*, *St. Louis Post-Dispatch* and the *St. Louis Globe-Democrat*. Trade publications using the release were the *Oil Daily*, *Chemical Week*, *OP&D* and *C&E News*.” At the same time, the company said it ceased shipping Aroclors for use as plasticizers in a variety of products [136].

While publicly the company sought to assuage growing concerns about Aroclors, privately officials were absorbing more and more bad news. One internal report on the Anniston plant in Alabama which had been the focus of the *Herald* article, told of massive losses of Aroclor to the environment. “Aroclor losses from the Anniston plant for the period April 15 through June 30, 1970, averaged 16 lbs./day,” noted E.C. Wright in a report on “Aroclor Losses at the Anniston Plant” in mid-July 1970. “This is a considerable improvement over the losses of >250 lbs./day for a comparable period during 1969,” he wrote. But even this good news was tempered by the fact that this information excluded the majority of the period April 21 to June 20, 1970 when “the losses ran very high” because the “acid neutralization pit was being cleaned out” and no specific measurements were being taken. Also, a number of samples “were collected from Snow and Choccolocco Creeks at various times” indicating other problems. “They show that Aroclors are present in the Choccolocco Creek even above where the Monsanto effluent enters the creek. They also indicate significant amounts of Aroclor in the mud and water of Choccolocco and Snow Creeks a considerable distance (15–20 miles) downstream from the Anniston plant. In fact, Aroclor concentrations can probably be found in the Coosa River system” [137].

Two weeks later the Company learned that the US Food and Drug Administration (FDA) was finding “high levels of PCB in fish taken from Choccolocco Creek downstream from its confluence with Snow Creek.” They were assured by Joe Crockett, Secretary of the Alabama Water Improvement Commission, that he would “try to handle the problem quietly without release of the information to the public at this time.” Monsanto was told that Crockett believed “that FDA will not act precipitately [sic] in this matter,” but that he was not sure “how FWQA [Federal Water Quality Association] might react. Dr. Myers, Director of Public Health of Alabama, wants toxicity information on PCBs and this will be conveyed personally to him by Jack Garrett next week” [138].

By September 1970, the company was losing faith that new data “might show an improvement over the 1st week in September and thus demonstrate a favorable trend to Crockett. Instead, the emissions are considerably increased with 9/13/70 at 6.25 ppm, (or about 80 lbs. of PCB for the day).” Potential legal liability for the pollution led the company to consider restricting access to the information they were gathering:

From the Legal standpoint, there is extreme reluctance to report even the relatively low emission figures because the information could be subpoenaed and used against us in legal actions. Obviously, having to report these



gross losses multiplies, enormously, our problems because the figures would appear to indicate lack of control [139].

While Monsanto was learning of the widening environmental problems it faced in Anniston, a PCB conference was being held in Stockholm. One of the papers detailed the long history of knowledge of dangers to the workforce of chlorinated biphenyls:

Already in 1899 Hersheimer described a condition that he called chloracne, which was caused by chlorinated biphenyls or chlorinated naphthalenes. Chloracne is a type of follicular pyodermitis, e.g. pyogenic inflammation in the sebaceous glands of the skin.... Around 10 cases of fatal intoxication with chlorinated biphenyls or naphthalenes have since been described. They all showed liver atrophy and necroses. Histological examination revealed fatty degeneration, necroses and cirrhosis. All cases involved persons who handled or were exposed to these compounds in their occupations.

Subsequent toxicological experiments “confirmed that chlorinated biphenyls and naphthalenes can produce liver damage of this kind....” The author reported that in comparisons between chlorinated naphthalenes and the biphenyls, “the biphenyls are more toxic.” The paper detailed the environmental impact on birds and fish, and described the growing body of evidence that showed that PCBs had a “tendency to accumulate in body fat and in the lipid-containing tissues of the brain. That is about all we know. Our knowledge about the metabolism of these compounds is minute.” Mathe Berlin, the author, concluded that

There is strong suspicion that chlorinated biphenyls can be retained and accumulated in the body with chronic exposure. Present data do not permit evaluation of the risk of organ damage in the body at different doses of defined chlorinated biphenyls. There is a strong need for studies of the metabolism of chlorinated biphenyls in the body, as well as the mechanism of the toxic effect due to those substances [11, 140].

As the evidence of environmental and possible human damage continued to grow, Monsanto learned that the PCBs that were placed in the ground in 1938 on the Gainesville campus of the University of Florida were still there. Over the thirty year period the PCBs had hardly degraded at all. Monsanto’s “Manager of Environmental Control,” W. B. Papageorge, wrote about the discovery of PCBs persistence and the reasonableness of disposing of PCBs in public landfills:

The laboratory information I was waiting for relates to a study made by Monsanto in the Gainesville, Florida area in 1938. Aroclor 1242 was one of several materials applied to soil in holes 15” in diameter and 16” deep. The walls were sprayed with a solution of Aroclor 1242 and the soil was replaced with each layer sprayed with additional Aroclor 1242. When the hole was completely filled, the remaining solution was poured on top. A total of 4 oz of Aroclor was applied. We have estimated that the Aroclor content was about 2200 ppm.” The previous year, he reported, the company



returned to the site to measure the remaining Aroclor and discovered that at 6 inches below the surface there were 2820 ppm, and at 6" to 16" inches 510 ppm and at 16" to 26" there were 26 ppm still present.

To Monsanto the conclusion was clear: "This data would indicate that after 30 years the Aroclor has not migrated to any significant degree." Although not commented on, the data also indicated that the Aroclor 1242 did not degrade [141].

In his monthly report on environmental problems, W. B. Papageorge began by emphasizing the fear of law suits as a motivation for the company's actions in removing PCBs from some of their markets: he emphasized "to all remaining users of PCBs the importance of preventing escape to the environment." He pointed out to Monsanto officials that "we must ensure that these warnings are fully documented so that they will support the action we have taken in this area should we become involved in legal actions." The company continued its efforts to find substitutes for PCBs in certain products but ran into difficulties with N.C.R. copy paper and industrial/hydraulic fluids. He also reported that "the withdrawal of Aroclor plasticizers from the market appears to have been completed with very few loose ends" and, remarkably, "our distributors are well on their way to zero inventories of the Aroclors, having pretty well matched their purchases from Monsanto with firm orders with their customers." He was pleased that "it does not appear that there will be any extensive returning of unsold materials." He also reported that the public relations efforts appeared to be bearing fruit as their July news release "stating our position to withdraw from certain PCB markets, was used in whole or in part by 13 more major newspapers..." [142]. Papageorge was referring to their August 1970 decision to stop selling PCBs as plasticizers [143].

In regard to Monsanto's efforts to inform their customers of the environmental problems associated with PCBs and their plans to build an incinerator to dispose of the material, Randall Graham, Monsanto's Senior Fluids Specialist wrote customers, "No longer can we dump scrap Aroclor or spent transformer [?] down the sewer. Indiscriminate dumping of such material can lead to serious repercussions for the electrical industry. For this reason Monsanto is building an incinerator which will be ready some time during the first part of 1971" [144].

Meanwhile, Monsanto continued to produce PCBs and to try to find new markets for its product. In October 1970, Monsanto, faced by the prospect of losing some of the US market, considered approaching the Indian government about "the desirability of the manufacture of [PCBs] in India." The company considered the "great potential of India" where it "identified ...areas where it [could] bring its technology to participate in and foster the economic growth of the country." Specifically Monsanto identified "India's fourth 5-year plan" as providing "for significant growth of electric power generation and use which in turn presages a growing demand for products with the dielectric properties of PCBs" [145]. Monsanto also sought to maintain its reputation by counteracting occasional news stories that appeared in the local and national press. In one such incident, reported E.V. John of Monsanto's world headquarters, "The *Anniston Star*, Anniston Ala., somehow obtained figures from the FDA which showed unusually high levels of PCB in fish samples taken from Choccoloco Creek. A *Star* reporter," he noted, "contacted the Anniston plant



for comments on the data and information about our PCB production operations there.” John was pleased by the way that the Anniston plant management was able to convince “the reporter to visit the plant for a firsthand view of what the plant was doing to eliminate PCB escape to the environment.” He especially pleased by the result:

A factual front-page feature appeared in the *Star’s* Sunday, November 22, edition reflecting the value of cooperation with news media planning PCB stories. Quoting both plant management and the Alabama Water Improvement Commission, the feature emphasized the PCB problem was relatively new, was being solved by Monsanto and, at this point, was no cause for public alarm [146].

But such stories indicated the minefield that Monsanto was navigating, especially as the company learned of the continuing pollution problems at the Anniston plant. In a memo from Papageorge to J. R. Savage at Monsanto’s General Office, Papageorge reported on the continuing environmental pollution problems plaguing the Anniston plant: “One very important objective of our PCB environmental control program was to control the losses of PCB in our plants to achieve a maximum of 50 ppb in the waste water effluent by 1-1-71 and 10 ppb by 9-1-71,” he noted. But, “during the month of September, Newport [Monsanto’s facility in the United Kingdom] reported an average of 246 ppb. During November Anniston reported 1410 ppb and the Krummrich Plant reported 495 ppb.” He emphasized that “because of the seriousness of the PCB problem this level of performance cannot be allowed to continue. I do not recall that any of the plants have been denied a resource they requested to achieve the stated objectives.” “We do not have the luxury of unlimited time to combat this problem,” he remarked. “What do we need to reduce losses quickly?” [147]

Limiting damage to the environment and to the company: 1971–1975

This section explores the growing crisis that Monsanto faced as the dimensions of environmental pollution expanded and as questions arose about the impact of this pollution on human health.

Despite all the efforts to limit environmental damage, Monsanto continued to produce PCBs and even to consider developing highly chlorinated Aroclors. In an internal memo from January 1971, one official expressed his concern about this prospect, given the haunting history he recalled of the early chloracne outbreaks in the 1930s:

When I learned at our meeting today that we might begin to produce Aroclor 1272, I thought that I should pass on to you some of the things I heard years ago about production of highly chlorinated Aroclor, either 1270 or 1272. I have been told that about 1930 (Swann) Aroclor 1270 or 1272 was produced in our Aroclor department in Anniston. The people who were directly involved in the production of this product began to break out in a rash after some period of



time. Later sores began to show up on the face, neck, arms and body of these people. Medication did not seem to have much effect on these sores.

He related that “This operation apparently did not last too long and these people were transferred to other jobs, however their condition did not seem to show much improvement even with the medical treatment prescribed.” He went on,

After possibly three or four years, several of these people sued the company and they were awarded several thousand dollars each. I believe \$5000 was the most any one received. I remember four of the people filing suit. Their names were Craig Slaughter, Ollie Slaughter, James Hartsfield and a man named Henderson [148].

Also in January 1971, Monsanto began to understand how difficult it would be to reach their “target of 10 ppb of PCBs in our plant waste streams which we expected to achieve by the third quarter 1971.” Papageorge explained that “during the year as the plants gained tighter control of known sources of PCB pollution it became increasingly obvious that high levels would continue because of the PCBs trapped in the oil and the sewer systems.” He pointed out how expensive achieving such a goal would be, arguing that “Clean-up of these sources can be economically impractical.” The reason for his gloomy outlook was that the company’s hopes for cleaning up the streams in Anniston would provide a method for “removing PCBs from isolated small waste streams.” But the problem was much bigger than this, for “it appears that the PCB contamination is so widespread that all of the plant’s effluent must be treated. This would result in a system more complex and costly than anyone had anticipated and approaches tertiary treatment which at W.G. Krummrich plant is scheduled for completion by 1973.” Papageorge proposed new goals: “For 1971 I am proposing that 1 lb per day of PCB in the water effluent be achieved in our plants by Sept. 1972 and 1 lb per day to the atmosphere by year end. These are levels which I believe the regulatory agencies might tolerate” [149].

In mid-1971, Monsanto reviewed the toxicological studies “being carried out at Industrial Biotest Laboratories under sponsorship of the Monsanto Company.” In a private memorandum, the Deputy Head of the Division of Toxicology concluded that “the summary of data to date indicates several areas of concern.” He pointed to the studies of dogs, rats, and chickens exposed to Aroclors 1242, 1254 and 1260 and the “primary” area of worry was “the apparent effects on reproductive processes of the PCBs.” He noted that “while results vary for the three Aroclors studies, for the 1242 effects on hatchability were noted at levels as low as 4 ppm in the diets of parents. For the rat decreases of litter size or increases in stillborns are seen at levels of 100 ppm in parents fed 1254 and 1260.” He fretted that “It is possible that successive generations may show an increased severity in effect.” The results gave him reason to be troubled, for they undermined any serious effort to develop adequate standards for controlling contamination.

Our conclusions at this time are that pending completion of studies in progress we are in a poor position to recommend guideline levels for contami-



nation. This lack of complete toxicological data when coupled with our essential lack of information about background levels of contamination in foodstuffs in general, make it all the more imperative that we resist setting guidelines on anything more than a case by case basis at this time [150].

This might have been especially disheartening to Monsanto officials as they believed that the company possessed “probably the world’s best reference file on the PCB situation. This includes reprints from the literature beginning in 1935 to reports issued last week” [151].

In late July 1971, there was a spate of bad publicity that began when the *Washington Post* reported that “a ‘significant proportion’ of the chickens raised in 12 states have been contaminated with a DDT-like compound.” The U.S. Department of Agriculture reassured consumers that it had “‘no evidence’ that any of the birds have reached consumers” but the article went on to identify the contaminant as PCBs. The chickens had been found to have high levels of PCBs in their tissue as a result of contamination of fish meal that was “caused by leakage of PCB being used as the heat exchange mechanism in a sterilizing machine” [152, 153]. Several days later the *Washington Post* reported that “millions of chickens fed on fish meal contaminated with a DDT-like chemical had been sold in stores in the Washington area and much of the rest of the country” [154, 155].

In early August 1971, the Senate Commerce subcommittee on Energy, Natural Resources, and the Environment made public a report from the Alabama Department of Conservation that “showed that polychlorinated biphenyls, known as PCB, in amounts as high as 360 parts per million, or 72 times the guideline set by the Food and Drug Administration, had been found in various species of fish.” Dr. Robert Risebrough testified before the subcommittee that “such chemicals had ‘become widespread pollutants in the global environment’.” He advised against “eating those fish.” An article in the *New York Times* noted that Monsanto had withdrawn PCBs “from the market except for use in closed systems, such as electrical equipment systems and heat transfer units in which the chemical is used as a coolant.” Despite Monsanto’s assurances that such “closed systems” were safe, it is apparent that it was such a “closed system” that polluted the feed that ultimately ended up in the meal for the contaminated poultry. “Holly Farms of Wilkesborough, North Carolina found that its hatching of eggs had been impaired. It traced the trouble to the fishmeal, and notified the federal agencies. Holly Farms then destroyed about 88,000 chickens” [156]. In an earlier article reporting on the contamination the number of chickens destroyed was estimated at 77,000 [157]. Also, in 1971, Campbells Soup found that it had 180,000 lb of contaminated chicken that it had to destroy [158].

A subsequent article in *Science* revealed that the contamination of the fish meal had been “detected only after the hatchability of eggs from chickens fed the meal began to diminish alarmingly.... Although the leak began in late April 1971, PCBs were allowed to drip into the fish meal until the defect was discovered in mid-July. In the intervening period of two and a half months, approximately 16,000 tons of fish meal had been distributed to more than 60 companies in ten states.” In mid



August 1971, after consumer activist Ralph Nader pressed the FDA to investigate, and the Agency

revealed that it had seized over 75,000 eggs because tests had detected excessive amounts of PCBs in eggs from chickens that had consumed the contaminated fish meal. On 16 August – a month after the leak was detected—USDA took its turn and ‘detained’ more than 50,000 lb of frozen-egg products in which the level of PCBs was high.

Nader and Representative Ryan were not satisfied with the government’s actions and “conducted their own ad-hoc investigation and to their dismay, discovered that contaminated eggs had reached the consumer. The FDA, on 18 August, confirmed that a shipment of 60,000 contaminated eggs had reached the retail market and apparently been consumed in the Washington D.C. area...” *Science* magazine pointed out that

PCBs intrusion into the environment is difficult to regulate because of a lack of federal laws and because no one is quite sure how much PCBs had been produced. EPA [US Environmental Protection Agency] and FDA officials point out that at present, they have no legal authority to halt Monsanto’s present uses of PCBs. Last year PCBs in pesticides were banned by USDA Pesticide Regulation Division, now a part of EPA. According to a spokesman, FDA has, in the past, indicated to Monsanto that it would not allow PCBs to be used in food as an additive [159].

In the midst of the chicken and egg controversy, Representative Ryan announced a broader bill than his previous one that would “ban all use of a DDT-like compound that has contaminated human and wildlife food chains in the U.S. and around the world.” Ryan’s congressional aide said, “this latest case convinces us there is no safe way for the stuff to be used.” Monsanto responded that “the use of PCBs is ‘absolutely essential’ for heavy electrical equipment and that the company had taken ‘very stringent measures’ to control use of the compound.” Further, the company announced that the previous year (1970) in August, Monsanto had

withdrawn PCBs from sale for any purpose other than as the insulating fluid in electrical capacitors, as a coolant in transformers or as a fire-resistant ingredient in industrial heating and cooling systems. The embargo also applies to the United Kingdom in which Monsanto also has a monopoly in PCBs.

The *Washington Post* cited the April 1971 *New Scientist* and *Science Journal* for its statement that “Monsanto’s recognition of PCBs as an ecological hazard and its voluntary ban on their use except in ‘closed-system’ equipment is very nearly unique in industry” [160].

At the same time that the drama was unfolding in Washington, Monsanto’s pollution control engineer received a report from two consultants who were studying “the PCB residue data” of Choccolocco Creek, the Coosa River, and tributaries.



The consultants did not have good news for the company: “considering the favorable publicity Monsanto Company recently received as a result of the congressional sub-committee report, we felt it imperative that we submit an interim report to Monsanto Company.” They reported that “We must conclude that for Analysis I that no improvement in fish residue levels, all species combined, is indicated.” For the second analysis, “the results are not good since both analyses show us that Aroclor 1254 residues have not decreased as we had hoped they would. Considering the residual nature of PCBs we were certainly optimistic to say the least.” The third analysis showed that with regard to “each of five fish species ... [in] each instance the residue levels were higher in the experimental area than in the control area. ... At this point we would have to say that the data are detrimental to Monsanto.” Their fourth and final analysis warned that “In the future we must be able to demonstrate considerable decreases in residue levels here if we are to show environmental improvement” [161].

The researchers had been following the effects of PCBs on fish in the area for a number of years and had found “that the greatest number of deformed fishes have been found at Marth Williams (Station 7) and stations immediately below 7. We also see the greatest number of fishes that are either sick or listless in these areas.” While it was difficult to ‘prove’ the causes of the deformities and problems faced by the local fish, the researchers knew that something was very wrong: “Of course visual observations won’t tell us what caused these fishes to become deformed or sick but we must consider the total observations as a crude indication that something is indeed wrong in these areas.” The data were damning: “In summary, there is nothing we can do with the residue data at this point that would allow Monsanto to counteract the unfavorable public opinion that may result from the congressional sub-committee report (which we have not seen).” They held out the hope that “perhaps the June 1971 data will show a decrease that is not apparent at this point—we can only hope that this will be the case” [161].

They also suggested

one additional aspect of the problem that might allow Monsanto Company to derive some favorable publicity. It is our impression that your plant data will show that the plant effluent has been cleaned up tremendously and that on a pound for pound basis you are putting very little residue into Choccolocco Creek at the present time in comparison with past years.

They concluded that they “are very sorry that we can’t paint a brighter picture at the present time. However, we all know that we have to study these situations carefully and that we must be able to document any claims of environmental improvement before they are released for public consumption” [161].

The unfavorable publicity and the bad news they were receiving about the impact of residual PCBs on fish and other animals led Monsanto to consider changing its “strategy on Aroclor 1221 in view of the increasing number of PCB episodes and the potential involvement of this product.” They had previously believed that Aroclor 1221, because it was less chlorinated than 1254 and other Aroclors, “was not a key offender on the PCBs found in the environment and, as



such, we elected to continue to sell direct and in plasticizer blends. This is still the policy in force today.” As part of their plan to clean up the Anniston plant, H.S. Bergen, Director of the Special Products Group at Monsanto, noted that the company was “planning to move production of Aroclor 1221 from Anniston [Alabama] to Krummrich [St. Louis plant] so there will be no more liquid PCBs of any variety made in Anniston.... This will cost us a considerable amount of extra freight money for plasticizer blends but we feel it is the best political and practical solution to this problem.” They acknowledged that they had a substitute—MCS 1109—which was “considerably more ecologically safe than Aroclor 1221 and more biodegradable.” Bergen asked “is it now time to decide to convert Aroclor 1221 to MCS1109? Or, should we wait until after the FDA/Dr. Berger meeting?” [162]

In September 1971, The *New York Times* (NYT) reported that the President’s Office of Science and Technology and the President’s Council on Environmental Quality had formed a study group “to investigate the presence of PCB in food and other compounds.” The EPA and representatives of Departments of Commerce, Agriculture, Interior and the Food and Drug Administration were described by the NYT as “expressing increasing concern over the possible health hazards of a colorless, odorless liquid named PCB.” In describing why the Interagency Taskforce had been set up, William D. Ruckelshaus, the Administrator of the EPA, told the NYT that “it is the sudden accumulation of information about PCB that gives us concern because it is used so widely in the environment’.” Monsanto was cited by the NYT as being in the process of “conducting a two-year study of the effects of the chemical on rats and dogs. A company spokesman said that no ill-effects had yet been detected” [163]. This was in spite of an internal memorandum from H. Blumenthal, Monsanto’s Acting Deputy Director, Division of Toxicology to Leo Friedman, Director, Division of Toxicology which spoke of the company’s observations that the Industrial Biotest studies sponsored by Monsanto of dogs, rats, and chickens indicated numerous reproductive problems including reduced litter sizes, reduced “hatchability,” and increased numbers of stillborn pups [150].

At about the same time the National Academy of Sciences appointed a special panel headed by Dr. Edward D. Goldberg, a chemistry professor at Scripps Institution of Oceanography at La Jolla, to examine the PCB problem as well. While acknowledging that there was some reason why companies would want to protect trade secrets, Goldberg pointed out that the National Academy of Sciences panel “also feel that there are times when it is not in the public interest for government to maintain as privileged data that are necessary for research into the state of our environment and for an assessment of its condition” [164]. By the end of September, all this publicity led Monsanto to agree to “stop selling” PCBs “to food and feed processing plants” [165].

In October 1971, Monsanto learned from an EPA scientist, Renate D. Kimbrough, about disturbing new studies that indicated rats fed Aroclor 1260 had developed “malignant anaplastic carcinoma of the bladder” [166]. Other studies continued to document environmental effects [167].



The end of 1971 was a busy time for the Monsanto PCB group. And Papa-george, the coordinator of the response to the PCB crisis, acknowledged that

It is the Company's position with respect to possible PCB contamination of the Environment that our responsibilities should and do include not only consideration of our employees, [sic] shareholders and customers but also consideration of all other persons who may eventually be affected by such contamination [168].

In addition, Monsanto noted its on-going problem with leaks from the storage drums used to transport PCBs to their customers. Benignus was aware that even the transportation of PCBs was a source of continuing pollution. Benignus quoted a letter from their representative in Brazil: “All Monsanto customers are complaining that too many drums arrive leaking. They state that our drums are much lighter than the German drums. This means that we use a too-thin walled drum more easily punctured.” Benignus complained that this had been a problem for “many years”:

I don't know for how many years now I have reported that our drums are inferior to our competitors' packages both from the standpoint of strength and quality.... More recently we have emphasized that the PCB pollution problem does not allow us to take liberties with leaking drums domestic or international. This drum thing has been in the mill a long time. For reasons given above we must now act [169].

In early 1972, there was growing attention to the environmental pollution caused by PCBs. In an article published in *Science* in January 1972, Allan Hammond, the research news editor at the magazine, noted that unlike DDT, PCBs “were seldom deliberately released into the environment.” This raised a new and problematic situation for scientists, policymakers, and industry alike. PCBs

presence and persistence [in the environment] reemphasize the likelihood that any widely used industrial chemical may become an environmental pollutant, and increase the responsibility for public disclosure of production quantities and use patterns when similar situations occur in the future [170].

The seriousness of the problem can be gauged by the fact when the National Institute of Environmental Health Sciences (NIEHS) at Research Triangle Park, North Carolina launched its journal, *Environmental Health Perspectives*, it devoted the entire first issue to, in its words, “the extent of the PCB story.” In devoting its first issue to PCBs, the journal editors said that “our hope is that this volume will contribute a new perspective to the study of PCBs and will help as well to engender a renewed vigilance about other ‘inert’ chemicals which are so pervasive a part of the environment of man.” The articles included in the issue were “originally prepared for a conference on PCBs, sponsored by NIEHS at the request of an interdepartmental taskforce on the subject.” The conference was held in North Carolina on December 20–21, 1971 [171–179].

By early 1972 Monsanto was informing all of its affiliates that the Monsanto Board of Directors had approved the “discontinuance of sales of polychlorinated



biphenyls and terphenyls for certain end uses in the domestic market.” In a note to executives of Monsanto affiliates throughout the world, Edmund Greene, from Monsanto Industrial Chemical Corporation headquarters in St. Louis, explained how company representatives should address the concerns of its customers. He pointed out that some might be upset that they were “being put to a lot of expense and trouble by our decision.” But, “in our personal contacts, you must convince him that we sold him material in good faith, and that only the most compelling reasons have forced us to this decision. But ultimately conversion and disposal are *his* problem. You should be helpful but avoid accepting any direct responsibility for successful conversion and safe disposal. The stakes are simply too high for us to accept any such risks” [180].

He also warned of the risks involved in promising too much to customers concerned about proper disposal of the PCBs they had purchased, especially for overseas buyers. “We also cannot offer overseas the disposal service offered in the US, and it is doubtful that the kind of high temperature incineration (2000F) facilities necessary are available in your areas.” Monsanto would not accept responsibility for the disposal of their customers’ PCBs:

The business group has agreed to prepare a description of suitable disposal techniques for the guidance of your customers as far as this may be possible. We certainly cannot accept responsibility for supervising each customer’s disposal, but we will try to tell him methods to avoid, at least. Obviously, he should avoid sewerage, any possibility of contamination of water supplies, feeding areas for wildlife, open dumps where scavengers might have access to the fluids or materials or containers which have had contact with the fluids.

Finally, he suggested that “your customer would find himself in the most secure legal position if he seeks out and follows the advice of local authorities.” He cautioned the representatives that they needed to make sure that customers understood the seriousness of their efforts by avoiding any appearance that this was a “sales gimmick” for new alternative Monsanto products: “recommending another Monsanto fluid simultaneously with the withdrawal of the FR series might make the whole exercise look like a sales gimmick,” he noted, “and dilute the sense of urgency we wish to convey to our customers” [180].

Monsanto decided to continue to sell PCBs for specialized uses in closed systems, including to General Electric which depended on PCBs “because of certain desirable flame resistant and insulator properties.” Monsanto, however, sought to insulate itself from any legal liability for damage done to humans, animals, or the environment and asked General Electric to sign a contract holding Monsanto harmless in case of future problems. The contract stated that General Electric “acknowledges that it is aware and has been advised by Monsanto that PCBs tend to persist in the environment, that care is required in their handling, possession, use and disposition; that tolerance limits have been or are being established for PCBs in various food products.” It continued,



Accordingly Buyer hereby covenants and agrees that with respect to any and all PCBs sold or delivered by or on behalf of Monsanto to Buyer on or after the date hereof and in consideration of any such sale or delivery, Buyer shall defend, indemnify and hold harmless Monsanto, its present, past and future directors, officers, employees and agents, from and against any and all liabilities, claims, damages, penalties, actions, suits, losses, cost and expenses arising out of or in connection with the receipt, purchase, possession, handling, use, sale or disposition of such PCBs by, through or under Buyer, whether alone or in combination with other substances including without implied limitation, any contamination of or adverse effect on humans, marine and wildlife, food, animal feed or the environment by reason of such PCBs [181].

All these agreements and decisions were taking place in a rapidly evolving US political environment. As indicated above, in 1971 the federal government, under pressure from environmental groups, Representative William Ryan of New York and others, established the Interdepartmental Task Force (ITF) consisting of representatives from the Departments of Agriculture, Commerce, Health Education and Welfare, Interior, as well as the EPA. In May 1972, it issued a 181 page report that recommended that PCBs be “restricted to essential or nonreplaceable uses which involve minimal direct human exposure.” The EPA reported that “it would curb industrial discharges of PCB” [182].

The Report described the “ubiquitous” contamination of the environment that was caused by the open burning or incomplete incineration of solid wastes, municipal, and industrial wastes, the vaporization from paints, coatings, plastics, etc., the discharge into municipal and some industrial sewers, accidental spills or improper waste disposal practices, the direct application to the environment as ingredients of pesticides or as carriers for pesticides, the dumping of sludge, solid waste on land and at sea and the migration from surface coatings and packaging materials to foods and feeds [183]. Newspaper reports continued throughout that spring, summer, and fall on the continuing environmental and consumer impacts of PCBs. PCBs were being found in food, rivers, fish and feeds [184–189].

Meanwhile, Monsanto continued to get bad news about the contamination of fish in the creeks surrounding the Anniston plant. In June 1972, Royal Suttkus and Gerald Gunning, biological consultants, told Monsanto that “it [was] obvious that the fishes below the source of PCBs in Choccolocco Creek have concentrated the residue to a greater degree than those fishes resident upstream from the source.” They concluded that “the data for the first year of the survey indicate clearly that the fishes below the Monsanto outfall have concentrated the PCB residues to a very high level.” They continued “to find deformed, sick, and lethargic fishes in our collections particularly at Stations 7, 8 and 10. Since the residue levels are highest at these stations, it is apparent to us that there is a cause and effect relationship,” and “the residual nature of PCBs complicates the environmental problem, as well as the very large quantity of PCBs that have been added to Choccolocco Creek in past years” [190].

Monsanto closed the Anniston plant on May 1, 1972 [191] and less than a year later found significant improvements in the ecology of the Choccolocco creek: “The September 1972 data reflect a very significant decrease in PCB residue levels, more



than I had ever hoped for quite frankly—I was indeed surprised to see such a tremendous drop in such a very short time,” reported Gerald Gunning. In his report to Monsanto, Gunning noted,

As stated many times previously Consultants have found a rather large number of deformed fishes below the point of effluent discharge, as well as many fishes that were hemorrhaging or exhibiting various degrees of nervous system damage. These instances are on record at the Monsanto plant, Anniston. Since these fishes are found in parts of the stream that were characterized by high PCB levels, one must admit the possibility that debilitation is due directly to PCBs or to other products manufactured to Monsanto Company [192].

As Monsanto became more concerned about the environmental impact of PCBs, it faced the problem of disposal. Incineration was their first choice but the limited number of appropriately equipped incinerators and the difficulty of transporting and paying for the incineration itself, meant other methods of the disposal were also considered. At the International Dielectrics Symposium in September 1974, W. B. Papageorge talked about the disposal of PCB materials in both liquid and solid form. He spoke of the fact that liquids “can be handled by (1) Chem-Trol Pollution Services, located in and headquartered in Model City, N.Y., (2) Rollins Environmental Services ... in Wilmington, Delaware.” Papageorge acknowledged that for solid PCBs “landfills are a reluctant second choice for disposal.” One major problem with both incineration and landfill disposal was transportation. E.M. Potter acknowledged “Problems occurred with the bottom of drums collapsing on long hauls about three years ago. Spillage could cause food contamination” [193].

Meanwhile, Monsanto continued to document the damage to fish pulled from the Choccolocco Creek in Alabama. At one location, their biological consultants found a goldfish with “a deformed stub” where a fin should have been and a skull with “the eyes... popping out of the sockets.” “In general,” the consultants explained, “the goldfish, when we lifted them from the net in the field, hemorrhaged from the gills. We have observed this in the field on many other occasions, in the past years of course.” The consultants concluded that “The goldfish feeds off the bottom and hence is particularly subject to picking up larger amounts of PCB residues.” Despite the fact that the Anniston plant had stopped producing PCBs for over two years at this point, the consultants found that “In summary, we would have to say that we did not find any more or any less abnormalities than in previous years of the survey” [194].

In October 1974, the National Institute for Occupational Safety and Health (NIOSH) was concerned that studies to “evaluate long term health effects in humans from either acute or chronic exposure to PCBs are not available” but that research showed that PCBs caused “serious impairment of the functions of the liver” and “a recent article by Mobuyuki, Nagoski, et al....suggests PCBs are carcinogenic in animals.” NIOSH wrote to Emmet Kelly at Monsanto suggesting a meeting “to discuss the inclusion of PCB-exposed active and inactive workers at Monsanto in a planned retrospective cohort study” [195].

Less than six months later, in March 1975, Monsanto responded to a list of questions from Westinghouse about the coolant Inerteen, a product containing PCBs that



Monsanto had sold them. Papageorge told the staff supervisor at Westinghouse Electric Corporation he could not “overemphasize the need to properly control the use and handling of Inerteens to prevent their escape into the environment.” Although Papageorge “emphasized” that “over 40 years of experience” had shown “no human harm,” and that “the proper handling of Inerteens should pose no environmental or human health problems, permitting society’s continued use of a very valuable material,” he laid out the very real dangers that PCBs represented for people and the environment. He warned that “the polychlorinated biphenyls in Inerteen can have permanent effects on the human body,” and that there was a dose response relationship. “In general,” he argued, “a single exposure for a few minutes to atmospheric concentrations that cause irritation to the eyes and/or respiratory tract would not be expected to cause either the skin eruptions or demonstrable liver injury. The problem arises from repeated and prolonged exposure to atmospheric concentrations in excess of the accepted Threshold Limit Levels or repeated and prolonged skin contact” [196].

And yet, the information Monsanto had about possible exposure routes was troubling and led to real problems: “Animal data and human experience indicate that the toxic effects are similar whether exposure results from ingestion, inhalation of vapors, or absorption of the liquid through the unbroken skin.” These exposures, in turn, could have “potential toxic effects in humans from excessive exposure to polychlorinated biphenyls includ[ing] injury to the liver and chloracne.” Westinghouse posed a difficult question. “Since Inerteen affects birds and other animals, if there is no real effect to human beings, how do you explain it to employees in such a way that they will understand why it can kill a bird and not a human?” to which Papageorge responded, “There is potential real effect to humans.” But, he argued that it was possible to explain that birds might have a more serious reaction to the PCBs:

Due to differences in metabolism of food (and food contaminants) in birds and humans (and particularly the difference in the reproduction process in birds and mammals – including humans), birds are particularly sensitive to many chlorinated hydrocarbons including polychlorinated biphenyls [197].

Death Knell for PCBs: the controversy over cancer, 1976-1980

Underlying the efforts to control environmental pollution was the implication that PCBs, once in the environment, would affect human health. This section describes the fear that PCBs were carcinogenic and Monsanto’s efforts to allay or even deny academic studies that raised this possibility. The passage of the Environmental Protection Act that established the EPA, and the increasing attention to industrial pollution as a cause of cancer in humans, raised the prospect that Congress would pass, and the EPA would enforce, laws that would limit if not ban PCBs. Along with the enormous negative publicity that was attaching to Monsanto’s name, these federal initiatives led Monsanto to terminate production of PCBs in 1977 in the United States.



While Monsanto had acknowledged that PCBs were an environmental threat to birds, shrimp, and other wildlife and that they also were a liver toxin and an acute threat for skin disorders, its management still hoped that PCBs would not prove to be a human carcinogen. Industrial BioTest, the organization with which Monsanto had contracted to conduct animal studies of Aroclor 1260, reported in March that while Aroclor 1260 “appears to be slightly tumorigenic at levels of 100 ppm when fed continuously in the diet for 2 years,” [197] IBT also concluded that “Aroclor 1260 does not appear to be carcinogenic in rats fed for two years at levels up and including 100” [198].

This distinction between “tumerigenic” and “carcinogenic” was controversial because other studies identified PCBs as carcinogens. IBT laid out the scientific debate over what constituted a carcinogen that was then evolving, and told the company that “we are prepared to assist Monsanto in any adversary situation in and out of government.” IBT was concerned because an investigator, Dr. Renate Kimbrough, a physician with the Centers for Disease Control in Atlanta, had conducted a toxicological study that concluded PCBs were carcinogens. Other investigators who conducted toxicological studies of PCBs identified pre-cancerous “nodules” that may or may not develop into cancers. The problem for Monsanto was that the field of toxicology was itself undergoing a rapid change in its view of what constituted carcinogenesis. “Workers in the field have published extensively on the pathogenesis of hepatocellular carcinoma in recent years and the concepts have undergone considerable changes since the preparation of the final BIO-TEST report on chronic oral toxicity studies,” J. C. Calandra, the President of BioTest, reported to Monsanto. As recently as the early 1960s, for example, “studies on Aramite... postulated that hyperplastic nodules were transformed into hepatocellular cancer; however, this concept was not generally accepted by the scientific community.” But, this was changing. Calandra cited “an excellent paper” in the *Archives of Pathology* in 1974 that “‘highlights some newer developments of our understanding of liver carcinogenesis’.” But Calandra warned that

If the concepts presented in this paper as well as those of Squires, Saffioti [the head of the National Cancer Institute] and others are accepted, a number of substances would have to be reclassified as liver carcinogens. Carried to extreme, we could argue that any substance that results in stimulation of liver microsomal enzymes or possesses a hepatocytotoxic properties to any degree is a potential liver carcinogen [199].

IBT sought to hold the line to maintain a narrow conception of carcinogenesis. While BioTest’s “position was and remains that the PCBs were not shown to be liver carcinogens in its studies,” it “has no means at its disposal to dispute the findings of Kimbrough that Aroclor 1260 in female Sherman rats is a liver carcinogen except on the basis of experimental design” [199].

In the 1970s and 1980s, Industrial BioTest was exposed as being incompetent and possibly criminal. The trade association for the chemical industry, the Manufacturing Chemists Association, of which Monsanto was a member, did its own internal investigation on IBT’s research on vinyl chloride’s effect on rats, mice, and hamsters and concluded that “the study by IBT is scientifically unacceptable”



[200]. An MCA internal audit raised further suspicions about the integrity of IBT as a scientific research group, suggesting that their vinyl chloride study was “conducted in an extremely sloppy fashion” and that “foul play by IBT” was a possibility [201]. In 1983, these concerns became public when *Chemical Week* reported that over the years IBT had “systematically falsified test data collected on scores of drugs and chemicals.” The journal quoted one observer that IBT’s practices were the “‘most massive scientific fraud’ in American history” [202]. Monsanto’s dependence on IBT was certainly not helpful in future years.

Even the defense of PCBs as “slightly tumorigenic” was inadequate from Monsanto’s point of view. Monsanto wrote IBT, “In 2 instances [the reports on Aroclor 1260 and 1242] the previous conclusion of ‘slightly tumorigenic’ was changed to ‘does not appear to be carcinogenic’.” The latter phrase is preferable. May we request that the AROCHLOR 1254 report be amended to say ‘does not appear to be carcinogenic’” [203]. IBT complied with Monsanto’s request [204].

A year later, in 1976, Monsanto received even more troubling news, as investigators at the University of Wisconsin reported on studies of monkeys exposed to PCBs. Paul L. Wright of Monsanto’s Department of Medicine and Environmental Health wrote to George Roush, Jr. now Monsanto’s Medical Director, about “Studies conducted under the direction of Dr. J. R. Allen, University of Wisconsin.” These found “specific toxicity manifestations following prolonged PCB administration to Rhesus monkeys. These reports have been used to support the conclusion that the subhuman primate is much more sensitive to PCB than is the rat. The greater sensitivity of man is implied,” Wright explained. “One toxic manifestation reported was impaired reproduction performance in the treated females....” Not only was reproduction impaired but “a no-effect level was not determined in the subhuman primate,” a fact that “may have future critical implications for Monsanto,” Wright worried in this internal assessment [205].

In the fall of 1975, concerns about PCBs in the environment made headlines in the leading US newspapers. The *Wall Street Journal*’s front page story, for example, captured the nation’s mood about the threat of PCBs: “Persistent PCBs; Industrial Pollutants May be Worse Threat than DDT to Ecology; They Linger Longer and are Toxic at Lower Levels Than Had been Thought; Sick Monkeys, Minks and Men.” The article detailed the nature of these “ubiquitous pollutants” which were “far more resistant than even DDT to degradation by natural forces.” PCB pollution was discovered “far from industrial plants” and one EPA official was quoted as saying “our overall concern about PCBs is greater than ever before.” That concern was based upon “the fact that a three-year-old voluntary restriction on PCB application has failed to reduce pollution.” The stakes were being raised said the *Journal* because, “as a result of the apparent failure of voluntary controls, environmentalists are urging a ban on PCBs.” Barry Commoner, the author of *Science and Survival* and other environmental science critiques, and Director of Washington University’s Center for the Biology of Natural Systems called “the lack of environmental caution in introducing PCBs ... ‘an absolutely shocking and staggering case history’.” The *Journal* also cited the “soon to be published study by Renate D. Kimbrough,” a toxicologist with the Centers for Disease Control, as providing “the strongest indication to date that PCBs can cause liver cancer in rats” [206]. The *Washington Post* noted the



EPA's concern that "PCBs are widely contaminating the environment ... three years after the government thought it had them 'well in hand'." [207]

Even though Monsanto was questioning Kimbrough's study, their own people at IBT agreed with her findings. At a meeting at the US National Cancer Institute (NCI) on January 31, 1975, attended by Kimbrough, two representatives of the NCI, two from IBT, and George Levinkas of Monsanto, they reviewed Dr. Kimbrough's study. The representatives of Industrial BioTest "reviewed sections of liver from all animals in the study." They concluded, "to a large extent, substantially the same type of lesions were observed in both [IBT's and NCI's] studies except that the lesions seemed to be more advanced in Kimbrough's study. Although there was some variation in terminology, the findings were reasonably close." Unambiguously, Levinkas wrote, "there were definite liver adenocarcinomas in Kimbrough's study. Dr. Richter [IBT] expressed the view later that two animals in our study approached the type of lesion Kimbrough had observed...." [208]. Levinkas saw this as a defeat: "as an observer, I wanted to get the reaction of BIO-TEST's pathologist before deciding what to do. There was no opportunity to caucus while at NCI. After we left, and they conceded the occurrence of hepatic carcinomas, there was little else to do" [208].

In November 1975, the EPA sponsored a three-day conference of over 400 federal, state, local officials, public interest and environmental organizations [209] in Chicago on PCBs where it was disclosed by Thomas E. Kopp, a chemist with the EPA's Office of Toxic Substances, that plants were discharging PCBs directly into rivers and streams in New Bedford, Massachusetts; Bloomington, Indiana; Sharon, Pennsylvania; Pickens, South Carolina; Pittsfield, Massachusetts; Fort Edward, New York; Hudson Falls, New York; and Totowa, New Jersey. In addition, Monsanto and another company were discharging PCBs into the sewage treatment systems of Sauget, Illinois, and Bridgeport, Connecticut [210]. The conference also heard that "perhaps 41–45% of all Americans had ... PCBs in their tissues" and that PCBs "had also been found in human milk" [211].

Two scientists from the EPA's ecological monitoring branch reported that that percentage had risen from 35.1% in 1973 [209]. On the final day of the conference in November 1975, Nathaniel Reed, the Assistant Secretary of the Interior, raised the stakes even further when he stated that "the Federal Government must impose a ban on the use ... [of PCBs] except in certain electrical equipment." He said that PCBs "should be confined to electrical transformers and capacitors" because "the nation's rivers and lakes were 'in mortal danger'" from PCBs. Even this limited use should be considered temporary and "all substitutes must be evaluated so that PCBs can be completely eliminated from industrial use." The Assistant Secretary continued, that he was "'deeply shocked by the pervasiveness by PCBs; they are literally everywhere'. He said he was 'very troubled by the exceedingly high levels found in fish from all our drainage systems'." [212]

Monsanto's internal memo regarding an EPA press conference the following month (December 1975) included "EPA's comment: PCBs are 20 times more persistent than DDT. They cause tumors in animals. They are laying in the environment, in the sediment in the bottom of lakes and rivers where they are like a delayed action time bomb waiting to go off. We may have to live with them for the rest of our lives" [213]. Around this time Canada reduced its allowable limit of PCBs in fish to two



parts per million forcing the FDA to consider lowering its allowable limits which stood at five parts per million [214].

Also in early December 1975, Dow Chemical “disclosed plans to market a new insulating fluid that it said could replace the controversial chemicals known as ... [PCBs], in high-voltage-power capacitors.” Dow estimated that this new fluid could “replace perhaps six to eight million of the estimated forty million pounds of the PCBs produced in the U.S. annually” [215]. The EPA-sponsored conference, according to the *Los Angeles Times*, helped to stimulate “a growing body of opinion that PCBs represent an increasing health hazard and should be banned entirely.” The *Los Angeles Times* noted that although the conference “took no formal stand on the ban of the chemical,” some organizations such as the National Fisheries Institute, Inc., the “lobbying organization for 550 companies that package and market seafoods” also endorsed “a total ban” [209].

By the end of 1975, Russell Train, the EPA Administrator, was calling for a voluntary ban on PCBs noting that although the EPA didn’t have “any authority to order that PCB use be discontinued,” it could “control their discharge into the nation’s waterways.” He was quoted by the *Wall Street Journal* as saying that “the public has to understand that we have a hell of a problem and nothing this agency can do will solve it for a long time” [216]. The *Chicago Tribune* quoted Train as describing PCBs as “a significant hazard to human health and the environment.” According to the paper, he “urged moving ‘toward totally eliminating the use of polychlorinated biphenyls (PCBs) as rapidly as possible’” [217]. Train called for dramatic actions in order to stem the problem of environmental pollution from PCBs. He noted that since the beginning of its production in 1929, there had been approximately, 700 million pounds of PCBs produced of which 300 million pounds still “remain in the air, water and soil.” PCBs, he noted, “caused tumors, skin lesions, gastric disorders and miscarriages in mammals.” He announced an “‘action plan’ to reduce levels of production and discharge and to seek an eventual halt of all production and use in the United States.” Train “directed EPA Regional Offices to crack down on PCB discharge by manufacturers and large scale users of the chemicals, and has called for voluntary self regulation by both groups” [218].

The tremendous public attention to PCBs and their impact on the environment in late 1975—and the calls for banning PCBs—led Monsanto to consider getting out of the PCB business entirely. The pressure was building. The Vice President and Managing Director of Monsanto’s Industrial Chemicals Company, Francis J. Fitzgerald, told the Chairman, President and Chief Executive Officer of Monsanto, John W. Hanley, of these mounting pressures. For one thing, “the EPA has called Chicago hearings with the idea of making Monsanto an example.” For another, Fitzgerald explained that “the issue is coming to a head because of a series of recent tests *tentatively* show PCB’s [sic] when building in animals apparently create a carcinogenic effect.” [Emphasis in the original] In response, Hanley asked Fitzgerald “to consider using the Corporate PR Department to make a judgment as to PCB’s [sic] adverse impact on Monsanto. The study should address the point as to whether we should get out of the PCB business as a deliberate move” [219, 220].

Six weeks later, the Monsanto “PCB Study Group” presented its report “concerning the past, current and future impact upon Monsanto’s image of PCB



manufacture.” Up to that time, the “negative impact... has been minimal measured against the highly visible environmental and political controversies which had occupied so much national attention in recent years.” But the news was not all good. “Negative environmental effects and/or potential health hazards always leave a residue of ill will with most audiences and publics and this negative reaction must be fully recognized.” The Study Group then asked the question “is the adverse impact now, or in the future, likely to be greater than the benefits derived from staying in the business?” [221]

In answer to this question, the Study Group noted that “the Toxic Substances [Control] Act will become law in 1976 and by year-end mechanisms will be in place to ban or restrict PCB use to closed systems.” Also, “additional lawsuits may well occur... [and] the fact of the litigation will help keep the controversy alive.” Continuing research will lead to “serious questions ... be[ing] raised in regard to the potential human health hazard and such medical and research data will build.” Earle Harbison, the General Manager of the Special Chemicals Division, learned that “media attention, which has fluctuated in the past 5 years, will remain high and constant. Monsanto’s customers will bear the brunt of the criticism; media pressure will build for strict control if not a total ban. Monsanto will receive an increasing share of the criticism in the absence of a publicly stated intention to withdraw from PCB manufacture. The Study Group concluded: “These conditions suggest, in answer to the question at hand, the negative impact on Monsanto’s image will, indeed, exceed the benefits derived from staying in the business.” They considered how, “during the period ahead to minimize the negative impact on Monsanto’s image.” The principal one was that “Monsanto must not be viewed as being forced into a decision to withdraw from PCB manufacture by either government action or public pressure. Rather, key audiences must perceive Monsanto as having initiated responsible action in a manner consistent with its past reputation and practices” [221].

In January 1976, Monsanto “announced today that it plans to phase out the manufacture” of PCBs. “F.J. Fitzgerald, a corporate Vice President, said he could not give an exact timetable for the phase-out but ‘it could be in a planned and orderly manner’” [222, 223]. Shortly after, in March 1976, the much anticipated Toxic Substances Control Act was passed by the Senate. It went to the House and passed in August and was signed into law by President Gerald Ford in October. Significantly, the Act empowered the EPA to regulate PCBs and other chemicals introduced into the environment, specifically saying “no person may manufacture any poly chlorinated biphenyl after 2 years after the effective date of this act and no person may process or distribute in commerce any polychlorinated biphenyl after two and one-half years after such date” [224]. A week before the Act was signed into law, Monsanto announced that they were ceasing production of PCBs on August 31, 1977 [225].

Despite Monsanto’s decision to phase out of the PCB market, and to allay the possible negative public relations and regulatory impact on the company, the Company continued its efforts to control the narrative about PCBs. In 1978, the National Cancer Institute reported the findings of a study of rats to assess the “possible carcinogenicity of Aroclor 1254.” The study animals were fed PCBs for about 2 years. The NCI reported “the combined incidences of lymphomas and leukemias showed a significant dose-related trend in males.... However, the direct comparisons with



each dosed group with those of the matched controls were not statistically significant, and the tumors cannot clearly be related to administration of with [sic] Aroclor 1254” [226].

The Report went on,

hepatocellular adenomas and carcinomas were found in the dosed groups, but not in the controls.... Additionally, a high incidence of non-neoplastic hyperplastic nodules were noted in the dosed animals.... Although the incidences of tumors were not significant, the occurrence of the hyperplastic nodules appeared to be related to administration of the chemical.

Further,

in the stomach, jejunum or cecum, adenocarcinomas were observed in two dosed females as well as a carcinoma in one dosed male. None of these lesions were found in controlled animals in this study. Historical incidences of these tumors at this laboratory ... suggest that the lesions – although not statistically significant – may be related to the administration of Aroclor 1254.

The NCI concluded,

that under the conditions of this bioassay, Aroclor 1254 was not carcinogenic in Fischer 344 rats; however, a high incidence of hepatocellular proliferative lesions in both male and female rats was related to administration of the chemical. In addition, the carcinomas of the gastrointestinal tract may be associated with administration of Aroclor 1254 in both males and females [226].

The NCI study was carefully worded to meet scientists’ criteria for asserting causation. Hence, their conclusions indicated that statistical causation “under the conditions of this bioassay” could not show absolute certainty. While there was evidence of a relationship between Aroclor 1254 and the development of tumors and even cancers, more research would have to be done to establish a statistically valid conclusion. Monsanto, however, wanted to use the study to say that the NCI had given Aroclor a clean bill of health insofar as cancer was concerned [227].

They prepared a press release that stated “NCI has determined that Monsanto’s PCB is not carcinogenic in a two-year animal feeding study.” Their own scientists, however, told Monsanto that it was inappropriate to make such a statement, given what the NCI itself had actually said. Peter E. Berteau of Monsanto’s Department of Medicine and Environmental Health, suggested that Monsanto’s statement about the NCI’s conclusion “should be avoided” and was “requesting advice from a statistician concerning some of the statements” in the NCI report. “You want to say what NCI said,” he pointed out, “not merely express Monsanto’s opinion.” If the statements were “released to the public,” he noted, it might generate objections from the NCI.” Monsanto’s interpretation of the study was “too strong” [227].



Berteau did consult a statistician, A.W. Dickenson from Monsanto's General Offices, who provided his assessment of both the NCI Bioassay and Monsanto's proposed statements about it. Dickinson wrote, "it is definitely not legitimate to state that 'NCI has determined that Monsanto's PCB is not carcinogenic'. All they have done," Dickenson explained, "is fail to demonstrate conclusively that it is carcinogenic. If we must make some statement, I would prefer your [Berteau] 'there is no conclusive evidence that PCBs cause cancer'." Dickenson was even more circumspect. "I would have some qualms about releasing this statement without the qualifying (p. 62) 'it is suggested that Aroclor 1254 may be a tumor promoter'." He concluded "perhaps the best position is to make no public statement." Dickenson explained the bar that statisticians set for claiming causation was high and that the fact that the NCI study did not meet the criteria, may have simply been because of the small sample size. "In view of the fact that the power of the individual comparisons is limited by the small group sizes, I would view the presence of the positive dose-related trend as a strong warning that the substance may be carcinogenic." In the handwritten note at the top of Dickinson's memo, one of the Monsanto people who received these reports wrote: "You sure these guys work for us?" [228]

Despite having solicited the opinions of their own in-house experts and having received very explicit warnings about what they could and could not say about the NCI study's conclusions, Monsanto's Director of Communications, Dan Bishop, saw fit to ignore their advice. In a letter to H.L. Stevenson, the Editor-in-Chief and Vice President of United Press International, the news service that distributed information and articles to hundreds of news outlets throughout the country and the world, Bishop complained about "stories treating the subject of PCBs [that] repeatedly referred to them as 'cancer-causing agents'." Bishop wrote that "according to no less an authority than HEW's National Cancer Institute, PCB is not a cancer-causing agent." He claimed that while environmental pollution was a real concern, his correction was "an honest attempt to set the record straight and avoid creating needless, unwarranted further alarm. You could aid us greatly in the endeavor by communicating this information to your bureaus" [229].

Bishop continued to try to allay concerns about PCBs relationship to cancer. In a memo to a group of Monsanto's public relations directors in October 1980, Bishop enclosed a memo, "PCB Hazards-Facts and Fallacies," that said "we circulated... widely, last week to local news media contacts in an all-out attempt to get them off the 'cancer-causing'/'deadly toxin' kick. And, I'm happy to report, with guarded optimism, that we're making some headway." The enclosure, a "Note to Editors from Monsanto Company," argued "the 'cancer-causing' label resulted from a single animal study conducted by a Public Health Service researcher in 1975—and later discredited by peer review. The cancer stigma has persisted, however, despite this and the results of a later animal study performed by the National Cancer Institute [226]. The conclusion of the NCI study was that PCBs *were not* cancer-causing compounds" [emphasis in the original] [230].

In an internal newsletter for workers at Monsanto's Krummrich plant that produced PCBs from the 1930s through the mid-1970s, Monsanto sought to calm workers' concerns about the material they worked with every day. One worker



had written to the editors that he “worked in aroclors department... for almost ten years. I am concerned about my health, because the newspapers describe PCBs as ‘human cancer-causing agents and deadly toxins’.” The newsletter addressed his concerns by reviewing a number of studies including the NCI study: “In April of 1978, the National Cancer Institute published a report of an animal feeding study in which laboratory rats were fed PCBs for 105 weeks.” The management once again misrepresented the data: “NCI concluded that PCBs were not cancer-causing compounds as a result of these studies” they calmly misinformed their workforce [231].

Looking backwards: 2018

The story of PCBs is the story of missed opportunities and Monsanto’s unwillingness to live up to its and US industries’ own stated principles. From early in the twentieth century, as the country became a major industrial power, industrial leaders promulgated certain rules of the road through their own trade associations. If this new industrial model was to function with minimal government regulation in a ‘free market’ economy, industry had responsibilities to the public that they could not forsake. Chief among them were industry’s obligation to maintain safe workplaces, test their products for safety, and to educate workers and the public how to use their products safely if there were intrinsic dangers [232]. The fact that virtually every human being in the United States, if not the world, now has PCBs in their bodies and the International Agency for Research in Cancer (IARC) now states unequivocally, “PCBs are *carcinogenic to humans (Group 1)*” [emphasis in the original] tells of the price we have paid for Monsanto’s decisions [233].

There are lessons for public health practitioners that can be gleaned from this history. First, we should be aware that when we introduce new chemicals into our environment, we have an obligation to make sure that we apply the fundamental principles of public health: that we need to test products before they are introduced into our environment and into our bodies. If we wait for final epidemiological or statistical ‘proof’ that a substance will be dangerous, it very well may be too late. As Bradford Hill famously said in lecture to the Royal Society of London in 1965, “All scientific work is liable to be upset or modified by advancing knowledge. That does not confer upon us a freedom to ignore the knowledge we already have, or to postpone the action that it appears to demand at a given time” [234]. Second, as a society we cannot entrust those with self-interests to be the judge and jury of what is and what is not a danger. As we learned here, that can only lead to compromised science, a questionable decision-making process, and a potentially polluted world.

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