

# Missouri's Costly Dioxin Lesson

*Up to 100 sites in the state were contaminated with dioxin 12 years ago; a wrong assumption that the chemical would break down delayed action*

*Times Beach, Missouri.* For Judy Piatt, the recent news that Times Beach is contaminated with dioxin—perhaps the most toxic chemical known—came as no surprise. That the contamination has been traced to a waste hauler came as no surprise to her either. Eleven years ago, Piatt sent state and federal officials a long list of sites where she had seen the company spray waste oil to control dust. Times Beach was on that list.

In 1971, Piatt was suspicious of the oil for good reason. Earlier that year, a waste hauler named Russell Bliss soaked her horse arena in Moscow Mills, a town near Times Beach, with 2000 gallons of waste oil to keep the dust down for an upcoming horse show. Almost immediately, hundreds of animals became sick and died. Piatt herself, her two daughters and the other co-owner of the arena became ill.

Piatt speculated that something in the waste oil was to blame. Although it would take until 1974 for state and federal scientists to nail dioxin down as the culprit, Piatt took matters into her own hands. She began trailing the waste hauler's trucks, photographing and keeping written records of their dumping. But the list which she mailed to government authorities apparently disappeared into a black hole in the bureaucracy.

It appears that state and federal environmental authorities failed to recognize the magnitude of the dioxin problem for at least 8 years. In particular, Missouri officials ignored warnings in 1975 from federal public health officials that tainted soil in one eastern Missouri neighborhood posed such a public health hazard that it should be excavated.

Now, thanks in part to the publicity given to the contamination of Times Beach, government officials have awakened to the problem. Missouri is facing a "dioxin crisis," Governor Christopher (Kit) Bond declared recently before that state legislature. His assessment is no exaggeration.

Officials have confirmed that 14 sites around the state are poisoned with dioxin. Another 100 sites are suspected. The problem came to a head in December when Times Beach, a blue collar community located 10 miles from subur-

ban St. Louis, was hit with a double disaster: federal officials announced that the soil was contaminated with alarmingly high levels of dioxin, and then, the muddy Meramac River inundated the town with a 14-foot wall of water, possibly spreading the dioxin. Tests taken before the flood showed that some parts of the community had more than 100 parts per billion (ppb) of dioxin. The Centers for Disease Control (CDC) advises that exposure be limited to less than 1 ppb.

Now Times Beach residents are anxiously awaiting word whether the flood

sores, and their hide broke out in rashes. Eleven cats and four dogs that had frequented the arena died. Over the course of the next few years, more than 65 horses died or were destroyed.

At first, Piatt thought the animals might be suffering from a deadly infectious disease, but her veterinarian ruled out the possibility. Three weeks after the spraying, Piatt called Bliss to ask if he had had any problem with the oil. A document states that Bliss indicated there was none.

Soon afterwards, Piatt's concern heightened even more when her 6-year-

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## The problem came to a head when Times Beach was hit with a double disaster.

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made the problem better or worse and whether their homes are safe from dioxin. Preliminary results from post-flood tests are due the first week in February.

Yet whatever the outcome of the soil testing, there is the lingering question whether the chemical has imperiled the health of Times Beach residents. Some have been exposed up to 10 years now, but there are no good clinical data from which to draw any conclusions about health effects. The chemical is, however, known to produce a variety of acute toxic effects, including a severe skin rash called chloracne, and nerve and liver damage. In animal tests, the compound is a potent carcinogen, and a teratogen.

The key incident that led to the current alert on dioxin dates back to the spraying of the horse arena at Piatt's Shenandoah Stables on 26 May 1971. Within the next four days, Piatt and her business partner raked up hundreds of dead sparrows which had been living in the arena's rafters. On the day of the horse show, spectators noticed that the arena was remarkably free of flies. That same day, two previously healthy horses, which were kept near the arena, became ill. In the next two weeks, the health of a dozen more horses deteriorated. They all developed anorexia, diarrhea, and abdominal bloating. They began to stagger and twitch, their mouths developed

old daughter, who played often in the arena, became ill. The child became listless, complained of headaches and developed diarrhea. According to her medical report, her urine was "grossly bloody and contained clots. . . ." At that point, the CDC was called in. But for the next 3 years, epidemiologists were stumped.

While CDC investigators were attempting to unravel the mysterious cause of the Piatt child's illness, Bliss was still spraying roads and three more horse arenas. The Missouri Department of Natural Resources estimates that Bliss sprayed at least 18,500 gallons of dioxin-laced oil around the state.

Bliss has maintained that he did not know the oil was contaminated. According to a 1972 CDC report, Bliss said that he only accepted used motor oil and transformer oil and that the transformer oil, laden with polychlorinated biphenyls, was never used for wetting roads. But two years later, CDC learned that Bliss in 1971 had picked up thousands of barrels of dark, tarry sludge from a chemical plant in southwestern Missouri. The plant, located in Verona, had previously manufactured the herbicide, 2,4,5-T for the Army and was now making hexachlorophene. One of the unwanted byproducts of the herbicide and the disinfectant production is 2,3,7,8-tet-

achlorodibenzodioxin, the most toxic of the dioxin isomers. It was this sludge, contaminated with dioxin, that Bliss mixed with waste oil and spread on roads and arenas, state documents say.

At one point even Bliss's own property was contaminated. In 1971, one of his trucks was issued a citation for being overweight. The driver went to the 90-acre Bliss farm in eastern Missouri and unloaded 500 gallons of the sludge, undiluted with waste oil, onto the road bordering the farm. Shortly thereafter, the neighboring farm lost 70 chickens and one dog.

from another stable was dumped in a sanitary landfill.

But most worrisome was the fact that the soil from the third stable was used—incredibly enough—as landfill for two homes located in Imperial, a small town near St. Louis. Soil samples from the property of Vern Stout showed concentrations of 440 ppb. The yard of Valerie Minker was contaminated in some spots at 740 ppb.

Despite such high contamination, federal and state officials seemed to move at glacial speed. Seven months after the soil testing was complete, CDC issued in

EPA has provided six families with money for temporary relocation.

Looking back to the mid-1970's, state officials now say that they had focused attention on what they regarded as more serious problems. For example, the Verona NEPACCO plant still had 4600 gallons of waste in a storage tank with a dioxin concentration of 300,000 ppb. State and EPA officials deliberated long and hard how to get rid of the stuff. Dioxin is an extremely stable compound that defies usual methods of destruction. Six years after the waste tank was discovered, the material was destroyed on site by photolysis in 1980.

Around the same time, state legislators became concerned about hazardous waste in general as more reports of spills and dump sites emerged. EPA, for example, after receiving an anonymous phone call, discovered several farms in southwest Missouri which were contaminated with dioxin. Sampling of fish in a nearby river showed hazardous amounts of the chemical. In addition, a state government survey reported that one million tons of hazardous waste were produced in Missouri every year. The legislature passed hazardous waste legislation in 1980, but it was too late to control the dioxin problem.

Fred Lafser, director of the department of natural resources, tried to convey the gravity of the hazardous waste problem to then-governor Joseph Teasdale. He said that during 1980, his agency had received daily reports of hazardous waste sites and spills. He cited an EPA list of 85 sites in Missouri that warranted investigation. (Times Beach was still not on the list.) Lafser said, "The present staff and funds are inadequate to provide emergency response and investigation in these incidents." He recommended that the state establish its own Superfund to aid in cleanup. Last month, Governor Bond reiterated the same proposal to state legislators.

It is still unclear why EPA decided to sample the soil at Times Beach this fall. Arthur Spratlin, a regional EPA official, says that the agency is investigating a list of sites, one-by-one, that was generated from leads given by citizens, drivers of waste companies, and other sources. Some news accounts credit a former driver from Bliss Waste Oil Service for tipping off officials. Piatt ventures that someone finally listened to her after all these years. She said that an EPA list leaked in October was remarkably similar to the one she sent to agencies 12 years ago.

The dioxin problem in Missouri has



Marjorie Sun

#### **Times Beach**

*Its 800 families ponder their future finances and health.*

In 1974, CDC determined that dioxin was the cause of Piatt's problems at Shenandoah Stables. Soil samples revealed astonishingly high levels of contamination that, at first glance, almost make the Times Beach problem look insignificant. According to CDC testing, the original soil sample from the horse arena contained 33,000 ppb of dioxin. (Times Beach before the flood was measured at 100 ppb.)

State and CDC officials then asked Bliss where he had oiled in 1971. Bliss gave them the names of some sites, but he apparently did not mention the Verona plant where the herbicide and hexachlorophene were manufactured. A CDC investigator would learn a week later, by tracing a list of companies under contract to make 2,4,5-T, that Bliss had hauled the sludge from the Verona plant named NEPACCO. Even then, there was apparently no legal pressure put on Bliss to disclose his records of dumping.

By the time dioxin was pinpointed in 1974 as the poison at Shenandoah Stables, three of four other stables had already excavated the top several inches of soil and disposed of it in various places. Piatt dumped the soil along the highway in front of the stables, where human exposure would be minimal. Soil

March, 1975 a "final report" on its dioxin investigation in Missouri. Although it stated that the half-life of the chemical is one year, based on an Air Force study, it advised the state to excavate the Minker-Stout sites and place the soil in a "remote, deep landfill."

Four months later, state officials in the solid waste program and a veterinarian in public health advised their superiors that CDC's advice to remove the soil was "overly cautious." Accepting the same scientific information—that dioxin's half-life was 1 year—the state officials estimated that the concentration must have dropped considerably.

Unfortunately, new scientific data have proven them wrong. The half-life is now estimated to be as long as 10 years. In fact, last May and June, sampling by the Environmental Protection Agency (EPA) revealed even higher concentrations at the Minker site of 900 ppb. In any case, the state in 1975 chose to disregard CDC's recommendation to clear out the soil in the Imperial neighborhood.

As for the Minker and Stout residents, they were provided no relief from their plight until last fall. Their neighborhood is currently on the proposed list of sites to receive Superfund money for cleanup.

disrupted many lives. In Times Beach 800 families ponder their future finances and health. Judy Piatt sold her horse arena and now rents a few mobile homes, generating income that barely keeps up the medical bills that she says stem from her family's exposure to

dioxin. Six families from the Minker-Stout site are waiting to return to their homes. Russell Bliss is the target of several lawsuits for his involvement with the oil spraying.

Lafser wrote in a recent lengthy report to Governor Bond, detailing the history

of dioxin in the state. "Overall," he said, "the history shows the clear need for statutes which were developed in the later part of the 1970's and early 1980's. . . . Unfortunately, these statutes were not enacted in time to prevent these problems."—MARJORIE SUN

## Flaws Found in Popular Code

*The Data Encryption Standard has "weak" keys which may make the code easier to crack*

A coding system that government agencies are required to use to protect documents classified "confidential" may be relatively easy to break, according to several cryptography experts. The system, known as the Data Encryption Standard (DES), is the only coding system certified secure by the National Security Agency (NSA) and it is widely used in the U.S. banking industry.

The system, which was designed in the early 1970's by IBM, has always been controversial. Critics charged several years ago that it could be broken with the aid of sophisticated computer technology, but the new findings suggest that it may be even more vulnerable than previously realized.

The original objection to the DES—and one that still stands—is that the key size simply is not big enough. A key is a string of 0's and 1's used to inform a computer how to encode data with the DES and how to decode it as well. The DES key is 56 bits long and each user has a unique key, chosen from the  $2^{56}$  possibilities. A number of computer scientists, notably Martin Hellman of Stanford University and Whitfield Diffie of BNR in Palo Alto, argued in 1976 that a machine could be built that could determine any user's key in half a day by the brute force method of trying all possibilities (*Science*, 29 July 1977, p. 438).

This would require an expensive code-breaking machine, however, and only the NSA—or its counterpart in other technologically advanced countries—would be likely to spend the money.

Recently a number of investigators have found "weak" keys for the DES—keys that, if used, may make the code substantially easier and cheaper to break. The catch is, most users have no way of knowing whether the key they select is one of the weak ones. Cipher Deavours of Kean College in New Jer-

sey, who is a former NSA employee and is editor of *Cryptologia*, says, "These weak keys are surfacing right and left. The question is, How many weak keys are there?"

Another question is, Why are there weak keys at all? Robert Morris of Bell Laboratories in Whippany, New Jersey, remarks, "You would normally expect that good systems won't have weak keys." One possible reason is that the NSA wanted weak keys to make the code easier to break. But some experts think they arose accidentally, perhaps because the IBM people who designed the code did not have enough experience to avoid them.

The first group of four weak keys are nothing new and are so blatantly insecure that IBM cautions users to avoid them. With these keys, the function for enciphering and deciphering is the same. Donald Davies of England's National Physical Laboratory says these keys are "not a serious problem" because they are so well known.

Davies discovered 12 other keys that he calls semi-weak. These keys come in pairs—one will decipher the messages that the other enciphers. IBM also cautions against using these keys.

In addition, Davies found 240 "semi-semi weak" keys. "The semi-semi weak keys look good but some of the operations [during the encoding procedure] take on special values." Any such special values may make the code easier to break.

The DES takes a computer message, which is a string of 0's and 1's, and scrambles it 16 times. With the semi-semi weak DES keys, however, some of the 16 scrambling functions, which are supposed to be different from each other, are the same or are inverses of each other.

It would be "awkward," Davies says,

to reject all semi-semi weak keys. "But none of these properties need to have been present. When I looked inside the DES, I began to wonder if it was not as secure as it is thought to be."

Richard Polis of the Geneva Management Group in Switzerland has been collecting data on weak keys for some time. (Polis classifies as "weak" what Davies calls weak, semi-weak, and semi-semi weak.) So far, Polis knows of 25 categories of weak keys which, he says, result in "a substantially less complex transformation of plain text [unencoded message] to cipher text." No one is sure how many keys are in each category. "Every few months there seems to be another category or two added to the list. The list keeps getting bigger," Polis says.

Polis, like earlier critics, notes that it would be easy to break the DES anyway if anyone were willing to develop the necessary computer programs. In the worst case, using keys not known to be weak, he estimates the code could be broken in 8 hours. Weak keys would speed up this process substantially. With the strongest of the weak keys, it might take 4 hours to break the DES.

Deavours agrees that the DES can easily be broken. He himself worked out "lots of ways of attacking it." When he began carefully analyzing the code, he began to notice peculiarities. For example, there is a permutation in the code that lines up all the 0's and 1's—"just the sort of thing you'd want for cryptanalysis," Deavours says. He found "dozens of little things like that. At first I thought I was just seeing patterns where there aren't any but eventually I realized there's something wrong here."

Carl M. Meyer of IBM in Kingston, New York, takes issue with these charges that the DES is easily broken. He knows of weak keys, he says, and he