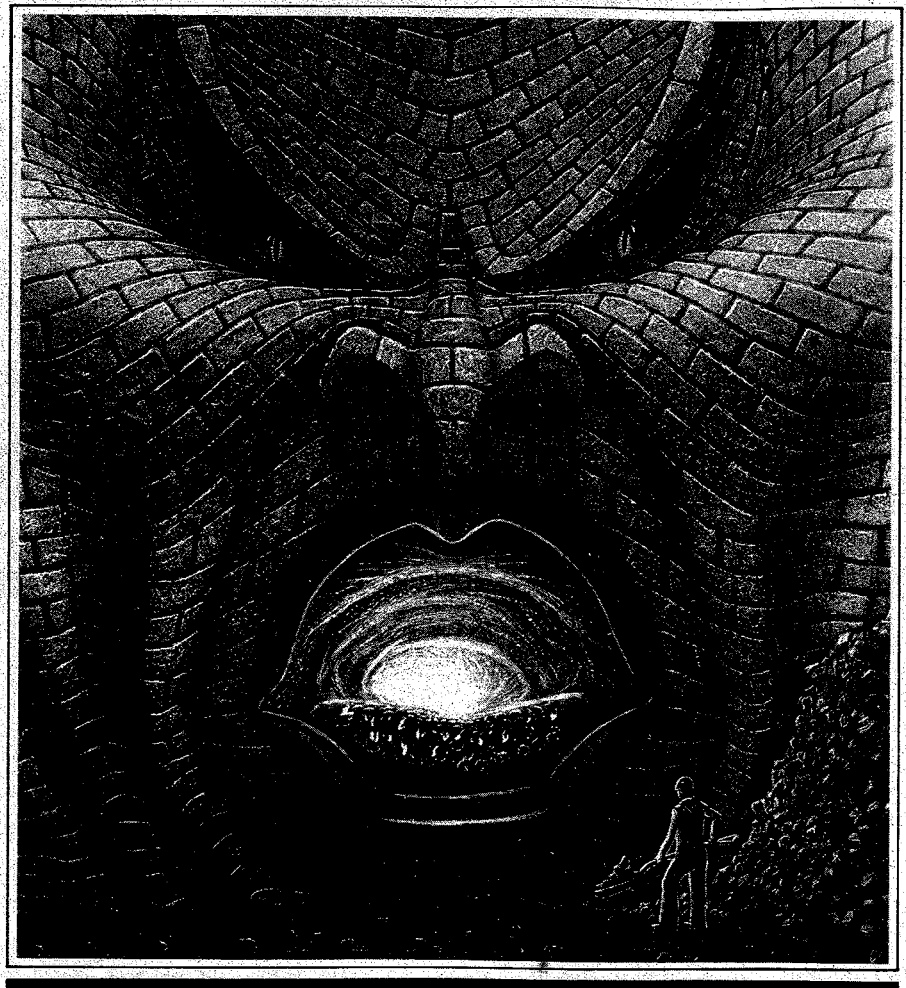
NEW ENGINEER

COKE OVENS

STEEL'S BIG DEMON WINS AGAIN



by Frank Goldsmith

In 1775 Percivall Pott showed that English chimney sweeps were being given cancer of the scrotum by their jobs. The specific carcinogen was later identified as benzo(a)pyrene (BaP). Chimney sweeps no longer get scrotal cancer, because they employ the simple expedient of washing regularly. However, the same carcinogen is today giving cancer to people who work in American coke ovens, and to people who live near coke ovens. Soap won't cure the problem this time.

COKE OVENS

Neither the steel companies nor the unions pushed for stronger coke oven standards, so who can blame OSHA's Morton Corn for ducking the responsibility?

The federal government has become interested in harmful emissions from coke ovens because of its responsibilities for occupational health and environmental protection. Steel companies, however, have been opposing clean-up moves on the grounds, variously, that ways to clean up the ovens do not exist, that they are too expensive to be practical, and that their emissions aren't really all that dangerous.

No one outside the steel industry (the biggest coke-producing group) seriously disputes that coke oven emissions are harmful, however. Aside from BaP, the generally recognized carcinogenic substances in coke emissions include benzo(b)-fluoranthene, benzo(j)fluoranthene, benzo-(b)anthracene, and chrysene. Several other substances in coke oven emissions are known to increase the potency of chemical carcinogens. All this was suspected by 1892, and confirmed in the medical literature by 1936.

Last October, after five years of legal and administrative wrangling, the federal Occupational Safety and Health Administration of the Department of Labor finally got around to issuing a new standard limiting emissions from coke ovens. The steel industry's trade association, the American Iron and Steel Institute, immediately sued in the federal Court of Appeals for the Third Circuit, in Philadelphia, asking that the Labor Department review the standard once again. The AISI was joined by six steel companies: U.S. Steel, National, Jones & Laughlin, Wheeling-Pittsburgh, Sharon, and Shenango.

But it turns out that the new standard, which is scheduled to be phased in during a three year period beginning this month, is not much different from the one it replaced —200 micrograms per cubic meter of "coal pitch tar volatiles," versus the new standard of 150 micrograms per cubic meter of benzene-soluble particulate emissions (roughly the same thing), both averaged over eight hours. And unfortunately, in developing the standard, the Occupational Safety and Health Administration ignored several significant technological advances that are available in this country, some of which are already in widespread use in other countries. The standard is thus, from an engineering point of view, both inadequate and outdated even before it takes effect.

The model for the new standard was the U.S. Steel plant in Fairfield, Alabama. The Department of Labor says that this plant uses the best technology achieved by the steel industry to date in this country. Yet, there is other technology available that would protect both the workers and the general population from coke oven emissions to a far greater degree. There is no question that such methods need more development work, but such work seems well within the financial capabilities of the industry—especially since the federal government is now willing to give the industry until 1980 merely to catch up with the better plants now operating in this country.

Why did the federal government ignore the most modern technology? The Occupational Safety and Health Administration decided to accept only the testimony of the steel industry and of the United Steelworkers union. Neither group brought the subject up.

Contrast the steelworkers' inaction to the activism of the United Rubber Workers Union in forcing a tough worker protection standard for vinyl chloride in 1975. Under the leadership of Peter Bommerito, the rubberworkers used testimony from such experts as Dr. Cesare Maltoni of Bologna, Italy, to show that workers exposed to VC risk cancer of the blood vessels in the liver (see "Grim Lessons of the Vinyl Chloride Coverup," November 1975).

The Occupational Safety and Health Administration even backed away from the recommendation of the Labor Department's Special Advisory Committee on Coke Oven Emissions in setting the new standards. The committee had recommended that workers be given the right to transfer out of the ovens before feeling the medical effects of exposure to coke fumes, at no loss in pay.

Dr. Morton Corn, chief of OSHA, refused to consider this as part of the standard, on the grounds that issues of worker transfer should be handled in collective bargaining. The Occupational Safety and Health Act was supposedly designed to remove worker safety and health questions from the bargaining table. Why should a worker have to sign away his health to keep a job?

Instead, the steelworkers and the industry agreed to discuss transfers only for personnel already judged to be in medical trouble. By then, of course, it is too late. And, under the standard, medical examinations are to be voluntary on the part of the workers, rather than mandatory. How many will refuse to be tested for fear of losing their jobs?

I have been following these developments with more than ordinary interest since February 1976, when I was rudely awakened to my personal stake in the issue of coke oven emissions. At that time I received newspaper clippings from my parents, who live in Johnstown, Pennsylvania. The Pennsylvania Department of Environmental Resources had found that the air in Johnstown contained 20 to 30 times the amount of BaP that is considered normal for an urban area. The Department of Environmental Resources attributed this concentration primarily to the emissions from the Bethlehem Steel Corporation, the nation's second largest steel producer.

I then figured out my own personal cancer equation. I was born in Johnstown in 1941 and spent the first 18 years of my life

in that coal mining and steel producing town, which until now has been known more for its disastrous floods than for its bad air. (A flood in 1889 left more than 2,200 dead. Another flood occurred in 1936.) Eighteen years of exposure to high levels of BaP puts a person in the high-risk group. The long-term effects of such exposure usually take 25 to 40 years to manifest themselves, so I am also in the right age group to start showing symptoms. Did the air I was breathing contain BaP levels high enough to harm me? The evidence is conflicting, but ominous.

Let's take a look at our culprit, the coke oven. George Clack, writing in the U.S. Labor Department publication *Job Safety and Health* magazine, provided the following description:

"Coke itself is the solid residue, mainly carbon, left after coal has been heated and the volatile materials distilled away. It is primarily used as a fuel for making steel in blast furnaces. Modern coke ovens also allow recovery of such calculable by-products from the coking process as benzene, creosote, toluene, road and roofing tars, and ammonia for fertilizer.

"Coke ovens vary in size between 10 and 20 feet in height, 40 and 48 feet in length, and 17 and 19 inches in width, and the ovens are arranged in batteries of 10 to 100.... In a typical coke plant, during the 'charging' process, a 'larry car' loaded with coal moves along a track on top of a battery of coke ovens, pausing to pour coal down three or four chutes into each oven. The coal is then heated at temperatures between 22,000°F and 28,000°F. After 16 to 20 hours of coking, a 'pushing' machine shoves the whole mass of materials from the oven into a 'quench car' alongside. Finally the hot material is carried to the quenching plant and doused with water to cool it. This 'quenching process' produces enormous clouds of billowing steam—the sure sign of an American coke plant. Though the steam may obstruct vision, most experts view it as a relatively innocuous emission if the quenching water is unpolluted—a big if.

"The three major sources of harmful emissions are charging, pushing, and leakage from coke oven doors during coking.

"To draw off the hot gases produced when coal pours into the red-hot oven during the three to five minute charging process, each oven has one [or] two ducts hooked up to a [steam powered] vacuum system. The problem in traditional coke plants is that these ducts and the charging holes themselves tend to become jammed with settled coal or clogged with carbon buildup, or the steam pressure may simply not be enough to draw off all vapors. When any of these things occur, flames,

Bad Faith, Bad Air

On February 20, 1976, the Pennsylvania Department of Environmental Resources filed suit—against Bethlehem Steel; Lewis W. Foy, its chairman; Thomas N. Crowley, its general manager; and Stewart S. Cort and F.A. Daggett, former chairman and general manager respectively—alleging violations of the state Air Pollution Control Act, and asking for civil penalties.

The complaint held that Bethlehem and the department had agreed, on February 25, 1972, on a program for controlling air contaminants emitted from the coke batteries at Bethlehem's Johnstown plant, including 228 ovens in three batteries (numbers 17, 18, and 19) at the Franklin works and two batteries (numbers 15 and 16) containing 88 ovens at the Rosedale works. The result of the agreement was a consent order covering the charging, coking, and pushing operations of the batteries. The order called for establishment of an abatement plan, which, according to the department, Bethlehem submitted to it on June 29, 1973. The department approved the plan on July 23, 1973.

According to the complaint, Bethlehem was supposed to submit to the department detailed plans for controlling pushing emissions at Battery 16 by October 1, 1973, complete construction by July 1, 1975, and be in compliance with the final emission standard by October 1, 1975. The department alleged that, at the time of the complaint in February 1976, Bethlehem had yet to take any of the planned steps toward rectification of Battery 16's pushing emissions.

Also according to the June 1973 plan, Bethlehem was supposed to take Battery 17 out of operation by May 31, 1975. The complaint alleged that Bethlehem was still operating the battery in February 1976.

The February 1972 order also established emission standards for pushing with which Batteries 18 and 19 were supposed to comply. The department alleges that these standards have been violated at both batteries.

There were several other counts in the complaint, concerning such things as stack emissions and pollution from steel furnaces. In conclusion, the department made the following statement:

"By its failure to comply with the various applicable rules, regulations and orders and its continued unlawful operation of the sources identified in [the complaint], Bethlehem has caused carcinogenic, oncogenic and other harmful air contaminants to be emitted into the outdoor atmosphere in the Johnstown Air Basin in such manner and concentration as to be inimical to the public health, safety, and welfare, or which are injurious to human, plant and animal life, and to property, and which unreasonably interfere with the comfortable enjoyment of life or property, thereby causing air pollution as defined in the Air Pollution Control Act."

As of this writing, the case is still pending.

Among Bethlehem's responses to the suit was a public statement, which read in part:

"State officials focused attention on levels of a substance called benzo(a)-pyrene (BaP) and singled it out as a health hazard.

"While it is true that coke ovens emit benzo(a)pyrene, they are neither the largest nor the only source of that substance in the U.S.A. Benzo(a)pyrene is a product of combustion, and occurs wherever there is burning. BaP is found in cigarette smoke, the smoke from fireplace logs, in smoke from incinerators, from motor-vehicle exhausts, in fumes from hot roofing tar and in such grilled foods as toast, bacon and charcoaled steaks.

"Bethlehem's Johnstown plant, where the DER has taken its samples, is only one of the many sources of BaP in the community. Data from a National Academy of Science study shows that the major single source of BaP emissions in the United States is coal-burning furnaces in homes. The next major source is refuse burning.

"With respect to coke-oven emissions, BaP constitutes a very tiny portion of the total—no more than a few tenths of one percent. BaP levels in a large, crowded, air-conditioned sports arena where smoking was not permitted were found to reach 220 nanograms per cubic meter of air, as compared with the highest reading claimed by the DER in Johnstown of 60 nanograms per cubic meter....

"There is no evidence from toxicologic studies that inhalation of BaP by itself causes cancer. Studies also show that a Johnstown resident would take in more BaP by eating two charcoal-broiled steaks than he would from breathing air for a year at the BaP concentration claimed by DER to exist at some location in Johnstown."

Of course, the issue is not whether BaP is a problem nationally, but only whether or not it reaches harmful levels in Johns-

black smoke, and gases may shoot 10 feet into the air of the charging holes at the top of the oven. These charging emissions account for as much as 70 percent of total emissions."

Hardware exists that can prevent these charging emissions. A 1974 article in the *Journal of the Air Pollution Control Association* discussed a total of eight possibilities. The article was written by Larry Kertcher, of the Maryland Bureau of Air Quality Control, and Benjamin Linsky, a civil engineering professor at West Virginia University.

One of the systems they discussed, the pipeline charging system, was in successful operation at the Allied Chemical Corporation's Semet-Solvay Division in Ironton, Ohio. This system, instead of using larry cars, uses a pipeline to carry preheated coal into the ovens. The pipeline-oven connection is a closed one, unlike the larry car

town—where coke ovens are indeed the biggest source of the substance. And BaP ingested is metabolized in a different way than BaP inhaled. Generally, a substance that gets into the body through the lungs is more harmful than when it must traverse the digestive system first.

In an interview with the Associated Press, Maurice K. Goddard, head of the Pennsylvania Department of Environmental Resources, said, "One of the discouraging facts about trying to get these big steel companies to do something is that the ownership and key officers are remote from the plants.

"Lukens steel in Coatesville is in compliance. Both air and water. Most of the smaller firms in this state are in compliance or at least they're trying. I think that's because they live in the community, they know the workers."

"U.S. Steel keeps saying it can't afford to do anything. I'll bet Bethlehem Steel says the same thing. Last year was supposed to be a bad year for U.S. Steel. But they had a net income of $559 million and if you had one share you would have made a dividend of 10 dollars on a share worth almost 80 dollars. That's 12 percent return on your investment. You don't get that on your savings account at the bank. I think U.S. Steel could siphon off 50 cents of that and take care of the people's health.

"I think the key people at the big steel companies sat down and figured out the dollars and decided it would be cheaper to fight in court than comply.

"When Bethlehem Steel signed a consent decree with the state of Pennsylvania in 1972, I believed they meant it. When nothing happened, I gave them the benefit of the doubt. In 1974, I began to wonder. Nothing happened in 1975 and we decided to sue."

Chronology

1775: Percivall Pott documents job-related cancer of the scrotum in English chimney sweeps.

1873: German scientist R. Volkman confirms Pott's empirical findings.

1892: It is suggested that coal-tar exposure can cause cancer of internal organs.

1907: Exposure to "pitch, tar, tarry compounds" listed as compensable in workers' compensation schedule in England.

1920: Listed as "notifiable" in U.S. Factories Act.

1936: Lung cancer firmly linked to coal-tar exposure.

1948: Thousands disabled, 21 die in Donora, Pennsylvania, because of a pollution-trapping atmospheric inversion.

1967: American Conference of Governmental Industrial Hygienists (a non-official group) adopts as a standard an eight-hour time-weighted average of 200 micrograms per cubic meter coal tar pitch volatiles, defined as the benzene soluble fraction of total particulates.

1969: Secretary of Labor adopts ACGIH standard.

January, 1971: Allied Chemical and Salem Corp. form Coaltex Associates, to license technology for pipeline charging of coke ovens with pre-heated coal.

February, 1971: A study in the *Journal of Occupational Medicine* concludes that coke plant workers have two to three times the cancer risk of the general population, with those who work on top of the ovens having seven to ten times the risk of the general population.

June 8, 1971: American Iron and Steel Institute formally challenges the coke oven standard. In response, the United Steelworkers of America request development of stringent new standards. The Department of Labor reaffirms the existing standard, pending further research by the National Institute for Occupational Safety and Health.

1973: NIOSH issues a report entitled "Criteria for a Recommended Standard . . . Occupational Exposure to Coke Oven Emissions."

November 6, 1974: Standards Advisory Committee on Coke Oven Emissions begins hearings.

November 29, 1974: President Ford issues executive order 11821, which requires inflationary impact statements on proposed safety and health standards.

May 24, 1975: Standards Advisory Committee submits its report.

July 31, 1975: OSHA issues proposed coke oven emissions standard.

October 17, 1975: OSHA issues draft environmental impact statement on proposed coke oven emissions standard.

November 4, 1975: OSHA begins public hearings on proposed standard.

March 12, 1976: OSHA releases inflationary impact statement.

May 14, 1976: OSHA concludes public hearings.

August 20, 1976: Final environmental impact statement becomes available.

October 20, 1976: OSHA announces new coke oven emissions standard.

October 22, 1976: Standard appears in *Federal Register*. Industry goes to court, petitioning for delay.

January 20, 1977: Coke oven emissions standard scheduled to begin being phased in; final controls due by early 1980.

system, and therefore there is no opportunity for gases to escape into the air, when the system works right.

Kertcher and Linsky found indications "that use of the pipeline system will increase the coke production of a battery by approximately one-third," and that "pipeline charging also allows the use of lower cost, poorer quality coking coals." They also found that, for installation on existing systems, the pipeline system was quite expensive, compared to the other systems under review, and they suggested that, for retrofit purposes, a jumper pipe installation with a new larry car design would prove the most economical.

In the jumper system, the gases from the oven being charged are moved by suction through a jumper pipe to another oven, rather than into the atmosphere.

Another system, in operation at the Jones and Laughlin steel plant in Pittsburgh, was sponsored jointly by the American Iron and Steel Institute and the U.S. Environmental Protection Agency. It essentially is an improved design of the vacuum duct system that is now used to draw off gases during charging. Greater steam pressure is used, and gas escape routes are blocked. Most important among these escape routes are the larry car hoppers themselves. When empty, each of the hoppers currently becomes an easy route to the outdoors. Provision of butterfly doors to seal the hoppers remedies this situation.

There are two other sources of emissions, leakage from coke oven doors and emissions during pushing. Leakage from doors is related to the age of the ovens and the quality of maintenance. As for pushing emissions, one method of controlling them is to place a hood, or shed, over the side of the oven from which the coke is pushed, and over the quencher car and track. The hood extends the entire length of the battery and is equipped with fans and gas cleaning equipment to deal with the exhausted gases.

The Health Problems: Societal Implications

Industry generally does not contest the studies showing that coke oven workers are far more likely to die of cancer—especially lung cancer—than the general population. But the steel companies do contest the assertion that benzo(a)pyrene is the culprit. They want monitoring done for all respirable agents (fumes, dust, and gases) in coke oven emissions, and not merely BaP.

The United Steelworkers and the Occupational Safety and Health Administration say that while this would be nice in an ideal situation, it is difficult enough to monitor for BaP, and that emission controls for BaP will tend to reduce exposure to the other cancer-causing agents as well, without more cost and delay.

Another problem is that while studies have adequately documented the excess death rates among coke oven workers, the rate of disabling sicknesses is not known. The University of Pittsburgh's School of Public Health, under contract from NIOSH, has been conducting a retrospective mortality study on more than 50,000 people who worked in steel mills from 1953 to 1960. The fifth report of the nine generated by this study so far covers coke oven workers. No systematic health studies on the subject have been issued by the steel industry, except for a few reports covering small numbers of employees. If the industry really cared about worker health, it would have done such studies years ago.

One interesting finding of the University of Pittsburgh's studies is that black steelworkers tend to have a higher incidence of cancer than whites. One reason: coke oven work is the least desirable in a steel mill; new employees, including a disproportionate number of blacks, start on the ovens. And the Advisory Committee report noted that "more and more women, many of childbearing age, are being employed at the coke ovens. On some batteries, as much as 20 percent of the workforce already is women operating in such capacities as larry persons and lid persons. . . benzo(a)pyrene is a demonstrated transplacental carcinogen that could infest the unborn fetus of these women coke workers."

A common reply by management and company foremen in the steel industry, to workers complaining about their assignments, is to say "don't gripe about your job assignment, at least you aren't working in the coke ovens." But these studies have shown that workers elsewhere in the plant are affected—to a lesser degree—by coke oven emissions.

The Cancer Atlas, a county-by-county determination of cancer rates nationwide (published by the National Cancer Institute in 1975) shows that residents living around coke plants also show increased incidence of cancer. But it is difficult to show a firm relationship between the plants and the cancer, because other substances in the environment—as well as genetic variations in the population and such other variables as diet—also enter into the equations. Nonetheless, the statistical inferences are ominous.

Improvements are also available in the quenching process. Writing again in the *Journal of the Air Pollution Control Association*, Benjamin Linsky advocated a changeover from wet quenching to the dry quenching method. He reported that a dry quenching process was developed shortly after World War I by Sulzer brothers, and that dry quenching is now used in the Soviet Union, Czechoslovakia, Japan, Switzerland, Finland, France, Great Britain, South Africa, and East and West Germany, but not in the United States. (The Soviets commissioned their first commercial dry quenching plant in 1960.)

The dry quenching process uses inert gas instead of water to draw the heat from the coke. After pushing, the incandescent coke is placed in a quench tower, and the gas (basically nitrogen and carbon dioxide) is passed through it to absorb the heat. The gas then transfers the heat to a waste-heat boiler to make steam, which can then be used for such tasks as electricity production and preheating of coal. (The energy recovery involved can cut plant fuel bills drastically.)

Although quenching with unpolluted water does not cause air pollution, Linsky notes that "specialists familiar with air and water pollution control of coke ovens and steel mills recognize that wet quenching towers have been used to dispose of polluted mill and by-product coke plant waters. . . . By removing wet quench towers, the temptation for an operator to function at less cost, by not treating some of this polluted water, is removed."

"Because adjustments can be made on the coke transporting vehicles," Linsky goes on to note, "dry quenching could reduce air pollution during the push and transportation phases of the coke process" as well.

Dry quenching of incandescent coke after it has been pushed from the coking ovens is a proved, reliable process that is presently being used in several industrialized countries," writes Linsky. "Foremost among dry quenching's advantages are: (1) virtual elimination of air pollutants emitted during quenching; (2) elimination of potential water pollution associated with wet quenching; (3) improvements in the working environment; (4) saving substantial amounts of energy in usable forms; (5) producing more usable coke that is superior to wet-quenched coke."

Kertcher and Linsky have clearly shown that the technology needed for a clean-up is available. The steel industry, however, has not shown itself to be very interested in cleaning up its coke ovens, and even under government prodding it has performed prodigies of foot-dragging (see box). The problem has not been made any easier by the federal government's virtual surrender to the industry in the matter of the new coke oven standard.

The history of the new standard goes

back nearly ten years. In 1967, the American Conference of Governmental Industrial Hygienists (a non-official group) adopted as a standard an eight-hour time-weighted average of 200 micrograms per cubic meter coal tar pitch volatiles, defined as the benzene-soluble fraction of total particulates. The Secretary of Labor adopted this limit in 1969, and OSHA took it over as an established federal standard after it began operations in 1971. But that same year, the American Iron and Steel Institute, an industry group, challenged the applicability of the standard in a petition filed with the Department of Labor. The steel industry's reaction was a common one that year, as many previously voluntary standards became mandatory under OSHA. In the petition, AISI requested the revocation of the standard. In response, the United Steelworkers requested stringent new standards.

The Department of Labor reaffirmed the existing standard, pending further research by the National Institute for Occupational Safety and Health. In 1973, NIOSH published a report entitled "Criteria for a Recommended Standard...Occupational Exposure to Coke Oven Emissions." The next step in the bureaucratic process was the holding of hearings by a Standards Advisory Committee on Coke Oven Emissions, appointed by the assistant secretary of labor for OSHA. The hearing process began in November 1974, and the report was submitted in May 1975.

On July 31, 1975, OSHA published its proposed standards for exposure to coke oven emissions in the *Federal Register*, and in October it released its draft environmental impact statement. In February 1976, OSHA released its inflationary impact statement on the proposed standard.

Needless to say, the industry was opposed to the standard. In testimony about the cost of complying with the proposed standard, Bethlehem Steel argued that it could not afford to clean up. OSHA's inflationary impact statement had held that cleaning up would have a negligible effect on the price of steel, but the Council on Wage and Price Stability supported the industry position, suggesting that the money might be better spent on cancer research.

Will the new standards, as weak as they are, cause substantial harm to the industry, with a loss in jobs? It seems hardly likely. During the next eight years, industry spokesmen testified, the steel industry expects to invest nearly $40 billion in new facilities. Estimates of the total annual cost of the new standard range from $130 million (the study done for OSHA) to $1.28 billion (the one done for industry). The American Iron and Steel Institute said much of the higher cost would be in lost coke production during installation of new controls, and so forth. But the study done for OSHA noted that scheduling of conversions during slack times over the next three years offered enough flexibility to keep such losses to a minimum. No one really expects the industry to run at peak capacity continuously for several years.

In the end, the Council on Wage and Price Stability said its "best guess" of costs would be $200 million per year—a figure that would cause steel prices to rise by considerably less than 1 percent.

OSHA declined to place a dollar value on the benefits to be derived from this expense, noting that the controls will help protect both workers and people living near coke ovens. It seems clear, however, that the expense is reasonable—if the new standard is strict enough actually to protect worker health. We won't know that for another 20 years, at the earliest. Let's hope we don't have to say then that we made a mistake, and try once again to install controls that were technically feasible as early as 1977, to protect against a hazard that was clearly defined in the 1930s. □

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