FRIDAY, OCTOBER 22, 1976

PART III:

DEPARTMENT OF LABOR

Occupational Safety and Health Administration

EXPOSURE TO COKE OVEN EMISSIONS

Occupational Safety and Health Standards
Pursuant to sections 6(b) and 8(c) of the Occupational Safety and Health Act of 1970 (the Act) (29 Stat. 565, 656), the Secretary of Labor is hereby amended by adding a new § 1910.1059 in the manner set forth below.

The Act provides, among other things that the Secretary of Labor:

- In promulgating standards dealing with toxic materials or harmful physical agents under this subsection, shall set the standard which most adequately assures, to the extent feasible, on the basis of the best available data, the workplace exposure of the employee to such material or agent at a level which is known or anticipated to cause no adverse health or functional capacity even if such employee has regular exposure to the hazard dealt with by such standard for the period of his working life.

- In addition to the attainment of the highest degree of health and safety protection for the employee, other considerations shall be the latest available scientific data in the field, the feasibility of the standards, and the experience gained under this and other health and safety laws.

I. HISTORY OF THE REGULATIONS

As is described more fully below, emissions from coke ovens pose a significant risk of cancer to the exposed working population. The American Conference of Governmental Industrial Hygienists (ACGIH) adopted in 1967 a Threshold Limit Value (TLV) of 0.2 mg/m³ coal tar pitch volatiles (CTPV) described as the maximum concentration in the air which is likely to protect employees from cough material impairment of health or functional capacity even if such employee has regular exposure to the hazard dealt with by such standard for the period of his working life.

In addition to the attainment of the highest degree of health and safety protection for the employee, other considerations shall be the latest available scientific data in the field, the feasibility of the standards, and the experience gained under this and other health and safety laws.

II. OCCUPATIONAL SAFETY AND HEALTH STANDARDS

A. Petitions for a new standard. On June 8, 1971, the American Iron and Steel Institute (AISI) petitioned the Secretary of Labor to develop a standard specifically applicable to coke oven emissions and not covered by the existing standard of 0.2 mg/m³ CTPV on the grounds that the existing standard is an invalid measure for coke oven employee exposure. In addition to revocation of the existing standard, AISI requested, following the appointment of an advisory committee under sections 6 and 7 of the Act (29 U.S.C. 655, 656) and the establishment of certain health and safety procedures including the use of respirators (Ex. 2-49).

Following the submission of the AISI petition, the United Steelworkers of America (USWA) requested, on July 12, 1971, that the Department of Labor develop a new, more stringent standard for exposure to CTPV in coke ovens, refineries and smelters.

On September 9, 1971 (36 FR 18129), the Department denied both petitions insofar as they related to the commencement of a standard-setting proceeding, pending further research by the National Institute for Occupational Safety and Health (NIOSH). The notice affirmed the propriety of the promulgation of the CTPV standard under section 6(a) of the Act, (36 FR 18129) and stated that if based on the information available, coke oven operation could comply with that standard. To provide guidance as to the methods of compliance under the existing standard, the Secretary of Labor signed a proposed standard for coke oven emissions (formerly 29 CFR 1910.93 (40 FR 27073)), the notice set out certain protective measures that could be utilized pending the installation of feasible engineering controls. These included the use of respirators, protective skin creams and medical examinations. The development and implementation of engineering controls to reduce employee exposure to CTPV was expected to continue pending completion of the NIOSH research and any subsequent rulemaking proceedings.

In light of the promulgation of this final standard for exposure to coke oven emissions, the September 9, 1971 Federal Register notice including the compliance guidelines is hereby revoked.

B. Advisory committee. In February of 1973, NIOSH published the document "Criteria for a Recommended Standard • • • Occupational Exposure to Coke Oven Emissions." In this criteria document, developed pursuant to section 20 of the Act (29 U.S.C. 669), NIOSH recommended the use of specified engineering controls and operating procedures, to reduce employee exposure to CTPV. NIOSH did not recommend a change in the present CTPV standard but rather stated that it could be used " • • • both as an index of exposure to coke oven emissions and as a measure of the effectiveness of engineering controls and operating procedures." (Ex. 2-18)

In order to review the available information and assist in the development of the new standard, the Assistant Secretary of Labor for Occupational Safety and Health (Assistant Secretary) established a Standards Advisory Committee on Coke Oven Emissions on August 12, 1974, to make recommendations with the Federal Advisory Committee Act (48 Stat. 770, 5 U.S.C. App. 1), and section 7(b) of the Act (29 U.S.C. 656). The Committee was chartered to " • • • study the problem of coke oven emissions associated with the exposure of workers to such emissions in order to prepare recommendations for an effective standard in the assessed area." (Ex. 2-2) The Committee held its first organizational meeting on November 6, 1974, in Washington, D.C. During the course of its operation, the Committee scheduled twenty-eight days of meetings during which testimony was presented by numerous experts and interested parties and over 200 exhibits were received. As a result of its deliberations the Committee prepared a recommended standard for employee exposure to coke oven emissions and submitted its report to the Secretary of Labor in a timely manner on May 24, 1975, for consideration. The Secretary issued a proposed standard for exposure to coke oven emissions.

C. Proposed standard. On July 24, 1975, the Secretary of Labor signed a proposed standard to control occupational exposure to coke oven emissions. This proposal, which was published on July 31, 1975, a Federal Register notice was published containing a detailed preamble describing the necessity for the standard, the information relied upon in developing the standard and the terms of the proposal in its entirety. The notice requested the submission of written comments, data, views and arguments on all the issues raised by the proposal by September 15, 1975, and scheduled an informal hearing pursuant to section 6(b) (3) of the Act (29 U.S.C. 655(b) (3)) for November 4, 1975. On September 4, 1975, a Federal Register notice was published containing several corrections to the proposal and extending the comment period until September 30, 1975 (40 FR 40849).

In conjunction with the development of the proposed standard, the Occupational Safety and Health Administration (OSHA) also prepared a draft environmental impact statement and an economic and inflationary impact analysis. On September 9, 1975, notice of OSHA's intent to prepare an environmental impact statement (EIS) was published in the Federal Register (40 FR 41797) pursuant to 29 CFR 1999.8(d). Subsequently, the published notice, a draft environmental impact statement was prepared and on October 24, 1975, the Council on Environmental Quality published a notice of availability of the Council’s draft environmental impact statement (EIS) (40 FR 49816, 49818). In addition to the 45 day comment period specified in 29 CFR 1999.8(g), environmental impact, if any of the proposed standard, would also be subject to the informal hearing as provided by 29 CFR 1999.4(b) and the notice of proposed rulemaking (40 FR 32268).
In addition to the draft EIS, OSHA also prepared an economic and inflationary impact assessment pursuant to section 6(b)(5) of the Act (29 U.S.C. 655(b)(5) and Secretary's Order 15-76 (40 FR 54484)). While the economic issues were to be considered during the informal hearing scheduled for November 4, 1975, it was subsequently determined that the full economic and inflationary impact assessment by that date. Consequently, on October 15, 1975, a Federal Register notice was published (40 FR 48360) postponing the hearing insofar as it related to the economic issues until at least 30 days after the availability of the economic analysis. The hearing on the proposal commenced on November 3, 1975 and concluded on January 8, 1976.

On March 12, 1976, a notice was published in the Federal Register (41 FR 62625) of the availability of the inflationary impact statement. An informal hearing was scheduled for May 4, 1976, and interested persons were invited to submit written comments, views and comments on a series of issues including economic and technical feasibility as well as inflationary impact. The notice certified that the economic and inflationary impacts of the proposal had been carefully evaluated in accordance with Executive Order 11821 (39 FR 41501) as implemented by Office of Management and Budget Circular A-107 and Secretary's Order No. 15-75 (40 FR 54484). A notice of clarification as to the scope of the second hearing was published in the Federal Register on June 21, 1976 and the complete record, consisting of 145 exhibits and approximately 5000 transcript pages was certified by the presiding Administrative Law Judge on July 28, 1976, in accordance with 29 CFR 1911.17.

Prior to publication of the final standards, OSHA prepared a final environmental impact statement (EIS) in accordance with 29 CFR 1997.5. Notice of the availability of the final EIS was published by the Council on Environmental Quality on August 20, 1976 (41 FR 35211, 35212). A supplementary notice of availability was also published by OSHA on August 20, 1976 (41 FR 35220). Several comments were received and have been considered along with the final EIS in the decision to promulgate this standard.

II. BACKGROUND—COKE INDUSTRY

Coke is the porous cellular residue from the destructive distillation or carbonization of coal. It is used as a fuel and reducing agent in blast furnace operations, and in foundries as a cupola fuel. Of the approximately 32 million tons of coke produced annually in the United States, 92% is used in blast furnace operations and 3% in other types of industrial plants. (Ex. 2-146; Ex. 6A-14; Ex. 109; Ex. 121e). Of the total coke production, slightly over 90% is produced by steel industry plants, 8% by foundry plants and 1% by beehive ovens (Ex. 6A-14; Ex. 109; Ex. 121e). The value of domestic coke is generally rated at $60 - $80 per ton, although other figures presented by AISI and OSHA's JIS indicate there were 65 plants including both blast furnace and foundry operations. These plants contained 258 blast furnaces, 11,498 ovens (Ex. 2-146; Ex. 109). There are a limited number of coke oven designs i.e., Koppers, Wilputte, Semet-Solvay, Otto, Koppers-Beckers and Simon-Carves. The predominant designs are Koppers, and Wilputte, which together with Semet-Solvay and Koppers-Beckers, constitute 97% of the coke ovens in the country (Ex. 144, App. A).

A by-product coke battery consists of 10 to 100 ovens made up of heating chambers, coking chambers, and regenerative chambers. Heating and coking chambers alternate with each other so that there is a heating chamber on either side of a coking chamber containing a beehive coke oven. The beehive coke ovens are located underneath. Oven size varies considerably. Present day ovens measure from 3 to 6 meters (10 to 20 feet) in height, 11 to 15 meters (37 to 50 feet) in length, and 42.5 to 50 centimeters (17 to 20 inches) in width (Ex. 2-20; Ex. 149 Ref. 1). Ovens with the larger dimensions are generally of more recent construction (Ex. 144, App. A).

The coking cycle begins with the introduction of coal into the coke oven. This procedure, called "charging," is carried out in a "coke-side" or a "char-brick" which operates on rails on the top of the battery. The larry car receives a load of coal from the coal bunker at the end of the battery and a number of coke hoppers, which corresponds to the number of charging holes, usually either 3 or 4. The car moves down the battery to the oven to be charged. The lids on the oven are removed, the charge is deposited and coke is removed. The oven charge is then elevated to the top of the battery, and the coke is loaded by a coke-mover into the larry car. As the coke is transported along the rail tracks, the doors on the oven are closed. The coke is then removed from the oven by machine or by hand (Ex. 80).

B. By-product coke production.

The first by-product coke ovens in the United States began operation in the 1890's. Induced draft coke ovens continued in increased in number of by-product coke plants in the early 1900's. Additional coke and by-product capacity, necessary for coke oven gas by gas utilities, stimulation for further expansion of the industry during the 1920's. The depression of the 1930's halted construction of new plants and decreased the number of ovens in use. Construction resumed after the outbreak of World War II and continued into the 1950's, with the number of operating ovens peaking in 1958. Since then, the number of plants and ovens has declined slowly, dropping from 66 by-product coke plants in 1968 to 64 in 1968 (Ex. 2-27). There were 65 plants in 1966 and 1974 (Ex. 6A-14) although other figures presented by AISI and OSHA's JIS indicate there were 65 plants including both blast furnace and foundry operations. These plants contained 258 blast furnaces, 11,498 ovens (Ex. 2-146; Ex. 109). There are a limited number of coke oven designs i.e., Koppers, Wilputte, Semet-Solvay, Otto, Koppers-Beckers and Simon-Carves. The predominant designs are Koppers, and Wilputte, which together with Semet-Solvay and Koppers-Beckers, constitute 97% of the coke ovens in the country (Ex. 144, App. A).
through the “cote-gule” attached to the door machine and into a railroad car called the “hot car” or “quench car.” The quench car moves down the battery to a “quench tower” where the hot coke is cooled with water (Ex. 2-27). The quenched coke is then dumped onto the cote walk from which it is conveyed to the screening station for sizing, then to the blast furnace, or removed for other purposes when it is to be disposed. When the doors on the oven are replaced, the oven is ready to be charged again (Ex. 2-20).

C. Products of coke production. The coke production involves many complex reactions which can be analyzed in three basic steps. First, there is a breakdown of coal at temperatures below 700° C (1296° F) to primary products consisting of water, carbon monoxide, carbon dioxide, hydrogen sulfide, olefins, paraffins, hydroaromatics, and phenolic- and nitrogen-containing compounds. Second, thermal reactions of the primary products occur as they pass through the hot coke, along the heated oven walls, and through the hot free spaces in the oven above 700° C (1296° F), resulting in the formation of aromatic hydrocarbons and methane, the evolution of large amounts of hydrogen, and the decomposition of nitrogen-containing compounds, hydrogen sulfide, pyridine bases, ammonia, and nitrogen. Third, production of the hard coke occurs by the progressive removal of hydrogen. (The Making, Shaping, and Treating of Steel, 9th ed., U.S. Steel Corp., 1971, Ex. 149, p. 3)

Twenty to thirty-five percent by weight of the initial coal charge is evolved as vapors and gases and is collected in by-product coke production. One ton of coal yields the following amounts of coke and coal chemicals:

- Blast furnace coke, 545-635 kg (1,200-1,400 lb)
- Coke breeze (large coke particulates), 45-90 kg (100-200 lb)
- Coke oven gas tar, 285-346 m³ (8,500-11,500 cu ft)
- Ammonium sulfates, 7-8 kg (15-20 lb)
- Ammonia liquor, 55-195 l (15-45 gal)
- Light oil, 8-12 l (2-3 gal)
- Heavy oil, 2-5 l (0.5-1 gal)

The coke oven gas contains numerous fixed gases, i.e., those which are gases at 15°C (50°F) and 760 mm pressure. The fixed gases are hydrogen, methane, ethane, carbon monoxide, carbon dioxide, ethylene, propylene, acetylene, hydrogen sulfide, ammonia, oxygen, and nitrogen. The ammonia liquor is an aqueous solution of a number of ammonium salts, pyridine gas, and nitrogen. The tar is a black, viscous liquid which condenses from the gas in the collector main. It is the source of pyridine, tar acids, naphtalene, cresote oil, and coal-tar pitch. The light oil fraction is a yellow-brown liquid of varying composition. Principal products recovered from the light oil are benzene, xylene, toluene, and solvent naphtha.

Summary. It is apparent from the description of the coking industry that the majority of by-products operations rely on a uniform process that results in the production of coke and the recovery of by-products in coke ovens that have the same basic design.

The size of the industry has remained relatively stable although 67% of the present blast furnace and 70% of the foundry by-products have been in operation for 20 years or more (Ex. 2-146; 73). The blast furnace by-products constitute 45% of present capacity and are near­by used for fuel but are also used to control coke oven emissions which are used in coke production and other products.

This increased efficiency is important because the value of the industry lies not only in production of coke for blast furnaces but also in the energy available to the rest of the steel plant from the coke oven and in the sale of the by-products. As stated by AISI, many of these by-products serve as feedstocks for organic chemicals, are used in short supply. In addition, the coke oven gas, coke breeze, and tar are all used by other sections of the steel plant (Ex. 2-146).

Any decision to regulate the coke industry and the nature of that regulation depends on an understanding of the nature and extent of the hazards as well as the effective and practical mechanisms for taking such regulatory action. The hazards to coke oven employees as well as the economic analysis of the impact of the regulation are discussed below, followed by a detailed explanation of the provisions of the standard and where relevant, their technological feasibility.

III. COKE OVEN EMISSIONS—EXPOSURE HAZARDS

The overwhelming scientific evidence in the record supports the finding that coke oven emissions are carcinogenic. This finding rests on epidemiological surveys as well as animal studies and chemical analyses. As discussed more fully below, coke oven workers have an increased risk of developing cancer of the lung and urinary tract. In addition, observations of animal and of human populations have shown that skin tumors can be induced by the products of coal combustion and distillation. Finally, chemical analyses of coke oven emissions have shown the potential of a large number of scientifically recognized carcinogens as well as several agents known to enhance the effect of chemical carcinogens especially on the respiratory tract.

In addition, recent updates of the major epidemiological study of coke oven workers show an elevated risk of non–muscular diseases such as bronchitis or emphysema. Finally, there are other hazards in the coke oven environment that while not directly related to exposure to coke oven emissions must be considered in setting an appropriate standard for employers and employees. These include particularly exposure to high temperatures, fire and moving equipment during the coking operation.

The following sections summarize the major hazards outlined with regard to the hazards outlined above.

A. Historical data. It has long been recognized that the combustion or distillation of coal produces carcinogenic substances to humans. Over the past 200 years it has been demonstrated that a variety of industrial populations exposed either to emissions from these processes or to handling of the products have a special susceptibility to cancer of the lung, skin, and urinary organs (Ex. 8-11).

The first observation of cancer from coal products was made in 1775 by Percival Pott who noted that cancer of the scrotum in London chimney sweeps was peculiar to that occupation (Ex. 8-2). For almost 100 years, Pott’s observations were looked upon as a medical curiosity and no further attempt was made to relate cancer incidence to occupation.

In 1873, three cases of scrotal cancer were reported by Vidal and the handling of tar and paraffin recovered from the carbonization of lignite. These cases “agreed to the last detail with the so-called chimney-sweeps cancer of the British” (Ex. 8-3). Additional reports of unusual skin cancer experience among coal carbonization workers and handlers of various by-products soon appeared (Ex. 8-4, 5, 6).

Experimental studies on cancer induction further demonstrated the carcinogenicity of materials produced during the destructive distillation of coal, and eventually led to the isolation of the first known chemical carcinogen. In 1915, Yamagiwa and Ichikawa showed that coal tar was carcinogenic for the skin of the rabbit (Ex. 8-7) and, in 1922, Passer induced skin cancer with an ether extract of chimney soot (Ex. 8-8). Following many years of research on the constituents of coal tar, many discrete chemicals, which are potent carcinogens in animals, were isolated, including benzo(a)pyrene (Ex. 8-9).

As early as 1892, it was suggested that exposure to coal tar products might be responsible for cancer of the internal organs (Ex. 8-4), and many investigators during the early 20th century speculated that the increasing rate of lung cancer might be attributed to the increased use of tar and tar products (Ex. 8-10, 8-11). Prior to 1936, however, the evidence linking lung cancer to coal tar exposure was limited to single case reports and to the observation by Kenway that a high proportion of non–cutaneous cancers in chimney sweeps were situated in the respiratory tract and in the alimentary tract above the stomach (Ex. 8-12).

B. Chemical analysis of oven emissions. Coke oven emissions are a complex mixture of particulates, vapors and gases, and many have been shown to be carcinogenic. These are "a carcinogen-rich environment." (Ex. 3, p. 75). Indeed, multiple carcinogens and cocarcinogens have been identified...
tified in coke oven emissions. Because neither the manner in which such substances interact nor the specific causative agent has been identified with regard to the multiple types of cancer resulting from exposure to coke oven emissions, no one substance can confidently be selected at this time to serve as the substance to be regulated. Indeed, as discussed in the section on permissible exposure limit, the standard utilizes an indicator substance that is designed to represent the mixture of known carcinogens present in coke oven emissions.

The scientific references identifying a number of chemical carcinogens found in coke oven emissions were presented both to the Advisory Committee and at the informal hearing by Dr. Eula Bingham, Chairperson of the Advisory Committee. Dr. Bingham stated that the chemicals generally recognized as carcinogens include benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(b)anthracene, and chrysene. The presence of certain other carcinogens has been tentatively established (Ex. 14; 15; 34, p. 17). One of these carcinogens, benzo(a)pyrene has produced cancer in a number of organs of nine animal species by various routes of administration including oral, cutaneous and intratracheal routes (Ex. 13). The types of cancers included respiratory, kidney, skin, gallbladder, spleen, reproductive organs, and gastrointestinal among others.

In addition to carcinogens, there are several agents in coke oven emissions known to enhance or potentiate chemical carcinogens, particularly in the respiratory tract. Testimony was presented at the hearing by Dr. David Kaufman concerning induction of lung cancer in hamsters by intratracheal installation of particulates (tirex oxide particles) coated with benzo(a)pyrene, one of the carcinogens found in coke oven emissions. The tumors produced by this method have many features in common with human lung cancers (Ex. 26). The results also indicated that the benzo(a)pyrene must be physically associated with, i.e., adsorbed on, the particulate to achieve an increased tumor incidence (Ex. 26D).

Laskin and co-workers successfully induced bronchogenic tumors in rats by inhalation of benzo(a)pyrene and sulfur dioxide. These tumors were also considered to closely simulate lung cancer in man (Ex. 8-41). When benzo(a)pyrene alone is administered to animals it has generally been unsuccessful in producing respiratory tract tumors or produces a smaller incidence of tumors after receipt of high dosages (Ex. 26; 26B). Yet, as discussed below, Scheel found that exposure of rats to coal tar aerosol containing benzo(a)pyrene, a number of compounds including benzo(a)pyrene, did produce a significant number of lung tumors. (TR 959; 732). Scheel concluded that "the presence of these compounds in the coal tar has little with the number of lesions found" (TR 997).

C. Lung cancer. 1. Epidemiologic studies. There are two primary groups of epidemiologic studies in this area, those that deal with gas producer or generator employees which generally predicate the second group concerned specifically with coke oven workers. While the latter are more directly relevant to the occupational hazards at issue here, both groups have not been negligible. This study of volatile organic matter and by-products produced by coal carbonization despite the possible variations in plant construction and methodology of treating coal (Ex. 8-1; 8-18). The first report of unusual lung cancer occurrence for men engaged in coal carbonization concerned gas producer workers in Japan (Ex. 8-13). In 1936, lung cancer was a relatively unknown disease in Japan, accounting for only 3.1% of all malignancies (Ex. 8-14). However, there was an extremely high lung cancer rate for gas generator workers which was even more striking in contrast with the experience of other employees at the same steel plant. At the time lung cancer was noted among the 46 male gas producer workers, it was observed in the other employees. In the same year that the Japanese reported the lung cancer excesses in gas generator workers, data on the number of death certificates for England and Wales, 1921 to 1931, showed that other coal carbonization and by-product workers had experienced higher than expected lung cancer mortality (Ex. 8-15). In this and a later report for 1931 to 1938, the Kennaways reported excess lung cancer mortality for gas producer-men, chimney-sweeps, and several categories of gas works employees (Ex. 8-16). The excess indicated for "gas stokers and coke oven chargers" was approximately 3-fold.

Doll, in a study of gas retort pensioners in 1982, observed an 81% excess of lung cancer deaths in comparison with the general population (Ex. 8-17). As of 1965, he confirmed a high risk for British gas workers by area of exposure i.e., those in the coal carbonizing process had the highest mortality rate compared to the general population (Ex. 8-18). More recently, an updated report on the 1931 to 1938, the Kennaways reported excess lung cancer mortality and presenting a preliminary indication that the amount of exposure as determined by job category was related to the number of lung cancer deaths (Ex. 8-118A).

Specific attention was focused on coke plant workers when, in 1966, Reid and Buck concluded that the risk of lung cancer "relative to the current risk in the population at large * * * is not as excessive as had been feared, and may in fact be negligible." This study of cancer mortality in British coke plant workers separated coke oven workers from by-product workers but did not further subdivide the coke oven worker population. In an earlier publication, the authors did not make a slight excess when the coke oven worker category was enlarged to include not just those presently employed but those in the study population who had ever been employed at the coke ovens. Finally, the authors stated that to the extent that the increase in lung cancer in the general population is due to a "universal habit like cigarette smoking the effect of occupational exposure to industrial air pollutants may be submerged." (Ex. 8-20)

Christina, in 1962, reported lung cancer in 12 of 102 workers employed in the coke processing industry, including coke carbonization and by-product workers. This represented approximately 12% of the employees in that department and 9.6% of the total number of cases. None of the other 25 departments surveyed had such high incidence. While the length of employment averaged 20 years, the range was not given nor was the population broken down to specific jobs within the department. Since the study primarily dealt with the diagnosis and treatment of lung cancer and not occupational incidence (Ex. 8-21).

As will be discussed below, both the duration of exposure and the job category are important factors in relating exposure to coke oven emissions to an excess risk of lung cancer.

Attention began to focus on the implications of these early studies for the American coal tar industry, including the coke industry. During this period, that decade the Kettering Laboratory of the University of Cincinnati College of Medicine initiated an investigation of the potential cancer hazards in the production and refining of coal tar (Ex. 2-55A).

While both animal and epidemiological studies were conducted, only the epidemiological results will be discussed in this section. The population consisted of a cohort with at least 5 years work history from several states including Illinois, Michigan, Pennsylvania, Alabama, New York, and Minnesota. From a total of 6203 individuals there was a total of 780 deaths (Ex. 2-55C). With regard to the coke production areas, the study found an excess number of deaths from lung cancer in non-white coke production employees and after separating the white lung cancer deaths into coke production versus the coke refining sectors of the industry, a small excess of lung cancer for white employees was also noted. While 14 of the 17 non-white deaths occurred in Allegheny County the 6 white deaths had no geographic localization (Ex. 2-55 E, p. 14).

As a result of a U.S. Public Health Service, University of Pittsburgh study begun in 1963, the serious nature of the occupational health hazard to coke oven workers both white and non-white and without geographical limitation was demonstrated. The population studied and the methodology used are set out in the published papers generally referred to as the "Long-Term Mortality Study of Steelworkers" (Ex. 2-14).

This steelworker study is an on-going project and the mortality data is regularly updated. The parts which are relevant to this project dealing with coke plant and coke oven workers.

There are two primary studies. The first, in 1971, by Lloyd, compares the mortality experience of coke oven workers with that of other industries, in a control population of steelworkers in 7 plants in Allegheny County (Ex. 2-13). The second study published in 1972, was designed
to compare the mortality experience from lung cancer of coke oven workers in 19 non-Allegheny County coke plants with that of comparable control groups without coke oven experience (Ex. 2-14).

The initial study of the Allegheny County plants compared the mortality experience from 1953 to 1961 of coke oven and non-oven workers with the expected deaths by age, race and nativity specific rates for the total steelworker population. The job classifications included in this study are listed in Ex. 20J. In addition those steelworkers who had experience in the coke plant prior to 1953, but as of 1953 were employed in other work areas, were included in order to account for any selection out of exposure on account of health-related problems (Ex. 2-33 IV). Depending on which group is used, the number of coke oven workers is 1,227 or 2,046. The findings were significant. Coke oven worker mortality from respiratory cancer was 2.1 times that expected. Further delineation of the study population into job location, e.g. topside, partial topside, and side oven showed a five-fold risk of lung cancer for topside workers. With 5 or more years of fulltime topside employment the risk was 10.7 times the expected rate experienced by other steelworkers and three times for those with less than 5 years topside. As for the racial difference noted in the early Kettering study (Ex. 2-33 IV), it is accounted for by differing work area distribution in that more non-whites were employed in the higher risk topside jobs. There was no statistically significant excess reported in this study for side oven or partial topside employees.

In order to determine the applicability of this finding to coke oven workers outside Allegheny County, Redmond et al studied the lung cancer mortality in 10 coke plants outside Allegheny County both in comparison to, and together with, two of the Allegheny County coke plants, with a total of 4,661 coke oven workers in both groups (Ex. 2-14). The cohort included all men at the 10 plants who had worked at coke ovens in 1953 or later, and a comparable non-oven control group both of which were followed through 1966, plus a cohort from the early Allegheny County study. Again, coke oven exposure was divided by the job location and length of exposure. Of the 90 job descriptions used in Lloyd's study only 5 were either not used or reclassified in the second study (Ex. 2-14). Lloyd's earlier results were corroborated. In the non-Allegheny County coke plants the excess risk was 3 times that of the comparison group for both side and topside workers. Coke oven side workers had a 7-fold excess risk of lung cancer and the non-white/white breakdown had relative risks of the same magnitude. In addition, the partial topside coke oven workers showed increased risks that were statistically significant after five or more years of exposure (Ex. 2-14 Table 6).

The mortality experience of the Allegheny County cohort through 1970 were presented at the informal hearing by Dr. Redmond of the Department of Biostatistics at the University of Pittsburgh (Ex. 20, TR 979-986). To date, only partial data has been updated. However, the results strongly support the finding of both early studies as to lung cancer mortality for coke oven workers regardless of geographic location. Mortality from lung cancer for full topside is 9 times the expected rate, for partial topside it is almost 2.3 times the expected rate and for side oven it is almost 2 times the expected mortality. All of these rates are based on 5 or more years exposure in the job category (Ex. 20, Table 3: 20L). All of these excesses are considered significant at the 1 percent confidence level.

As the length of employment increases so does the mortality experience. For example, for employees with 20 or more years employment topside the lung cancer rate is 20 times the expected, 5 times for partial topside and twice the expected rate for side oven. The first two figures are significant at the 1 percent confidence level.

The evidence of the carcinogenicity of coke oven emissions was not disputed by participants at the rulemaking proceeding including the U.S. Steel Corporation and the American Coke and Coal Chemicals Institute. As Dr. Halen testified on behalf of AHSI, there is "sufficient qualitative evidence to indicate action is required despite the substantial gaps in knowledge" (TR 1718). These gaps have to do generally with the specific etiology of lung cancer, the causative relationship of the excess from coke oven emissions, and the relationship if any between cigarette smoking and the excess lung cancer. On the first points, the specific cause of the disease is not known, nor is it known why only certain people, even those in high risk group, get lung cancer. However, this is not sufficient reason not to act where there is an excess related to exposure observed in a particular population over a reasonably long period of time. On the question of cigarette smoking and lung cancer causation, because of the work histories of the studied population did not contain adequate information on smoking histories (Ex. 82C; TR 905). Indirect tests were applied, however, by comparing the lung cancer rates for heavy cigarette smokers with that for coke oven employees. Even with this assumption, the excess lung cancer of coke oven workers could not be attributed solely to smoking (Ex. 82C).

One participant reported that after a survey of the employees at the coke oven and coke coker plants many employees were found (Ex. 52; 128A). The sample population is only 363 employees, however. This is too small a sample size to discern the increased risk of lung cancer due to coke oven emissions. The studies which defined the hazard (Ex. 8-1; 8-19) relied on vastly larger samples over a wide geographic area, and specifically coke oven workers do have excess risk of death from lung cancer. The emissions from coke ovens contain many known carcinogens (Ex. 14) and, as it is impossible to perform a study of every plant to establish excess mortality, OSHA believes that coke oven emissions should be treated as known human carcinogens wherever they are generated.

2. Animal studies. Since it has not been possible to generate actual coke oven emissions in an experimental setting, animals have been conducted utilizing aerosols of coal tar derived from coke operations. The methodology and results of several of these experiments were described by Dr. Lester Scheel of the National Institute for Occupational Safety and Health before both the Advisory Committee (Ex. 2-95) and at the informal hearing (TR 672). While the short term 90 day exposure studies were inconclusive as to the carcinogenicity of the coal tar aerosol at different exposure levels for the species used (TR 737, 748), the longer term 18 month study yielded positive results of lung tumors in exposed rats and none in the controls (TR 27P). The numbers as stated in the hearing differ from those reported in the NIOSH memo (TR 27P) the finding remains significant. As Dr. Maxwell Layard, a mathematical statistician with the National Cancer Institute stated "The occurrence of squamous cell carcinoma in rat lungs is an important result, since these tumors are rare in untreated animals." (Ex. 81).

D. Cancer of the genito-urinary system. Excess mortality from cancers of the urinary system has been reported for coke oven and gas retort workers. In a review of bladder cancer deaths from 1921 to 1928, Henry and coworkers reported greater than expected mortality for nine occupational groups exhibiting an excess of 50% or greater (Ex. 8-26). Five of the groups were among the "coal tar" occupations. The high rate of bladder cancer in gas workers was also reported by Dole, et al (Ex. 8-18). Bruns-gard (Ex. 8-26) and Battye (Ex. 8-27) also reported an excess of bladder cancers in gas retort house workers. Data on urinary cancer excess is not available specifically from coke oven workers. However, the more than expected cancer deaths reported in the Kettering study as to lung cancer any conclusion is limited because it is not known, nor is it known why only certain people, even those in high risk group, get lung cancer. However, this is not sufficient reason not to act where there is an excess related to exposure observed in a particular population over a reasonably long period of time. On the question of cigarette smoking and lung cancer causation, because of the work histories of the studied population did not contain adequate information on smoking histories (Ex. 82C; TR 905). Indirect tests were applied, however, by comparing the lung cancer rates for heavy cigarette smokers with that for coke oven employees. Even with this assumption, the excess lung cancer of coke oven workers could not be attributed solely to smoking (Ex. 82C).

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In their study of steelworker mortality (Ex. 2-14), Redmond, et al identified eight deaths from kidney disease among coke oven workers in twelve coke plants from 1951 to 1966. These eight deaths are not clustered in any plant or racial category. Four of the workers were in Allegheny County workers and four deaths were in the non-Allegheny County workers. Four deaths were among white coke oven workers and four were among non-white coke oven workers. The relative risk is 7.5 times the expected and it is statistically significant at the 1 percent confidence level. In the update of the
Allegeny County cohort, one additional kidney cancer death was reported (Ex. 20L). While nine cases is a comparatively small number, the kidney is a rare cancer site. As an illustration of this fact, bladder cancer deaths, which have not occurred in coke oven workers, are 2.5 times more common in the general population than kidney cancer deaths yet there were 9 kidney cancer deaths to one for bladder cancer in the coke oven population (Ex. 2-14).

The mechanism of development of kidney cancer is unknown. Exposure to industrial agents is implicated as incidence of kidney cancer is higher in industrialized and urban areas (Ex. 907). Also the type of kidney cancer found in coke oven workers is adenocarcinoma rather than the transitional cell carcinomas which are associated with chronic use of analgesics (Ex. 2-14).

Kidney cancer in coke oven workers was found in workers with side oven experience, although some had topside experience had been full-time topside workers, however. Five of the deaths occurred in workers with five or more years of coke oven employment-suggesting that the carcinogenic efficiency of exposure increased with duration of employment. The route by which carcinogens from coke oven emissions reach the kidney is open to question. Particulate carcinogens may be absorbed after ingestion or inhalation, or carcinogens may be absorbed through the skin (TR 469-70). The observation of kidney cancer is consistent with a 1961 British report of excess bladder and kidney tumors in men employed as laborers in coke ovens and gas works (Ex. 2-18).

In addition to cancer of the kidney, the 1970 Redmond update revealed a statistically significant excess of cancer of the prostate in coke oven workers for those employees who ever worked at the coke oven and those who had partial topside experience. The excess appears related to employees with 10 or more years exposure (Ex. 20L) and indicates that considerable work remains to be given to protecting this susceptible population.

In conclusion, there is an overall excess mortality rate for cancer of the genito-urinary system for coke oven workers that is statistically significant at the one percent level (Ex. 20L).

E. Skin cancer. Observations in human populations. The first reports of occupational cancer from coal tar products, as previously stated, deal with skin cancers. Observations of exposed human populations have shown that products of coal combustion and distillation can induce skin tumors. The first American cases of skin cancer associated with exposure to coal tar products were reported by Lueke in 1907 (Ex. 8-22). In the same year, the British included in the Workmen's Compensation Schedule "acral epithelomas occurring in chimney sweeps and epithelomatous cancer or ulceration of the skin occurring in the handling or use of pitch, tar, and tarry compounds" and later made these diseases reportable under the Factories Act. The extent of the skin cancer problem among coal tar workers and the variation in incidence within occupations are reported in a comprehensive review by Henry (Ex. 8-23). For the period 1960 to 1943, 84 cases of epithelomatous ulceration, or cancer of the skin, including 40 scrotal cancers, were reported for British coke oven workers. Of a mong workers in employment, eleven fatal scrotal cancers were reported.

Redmond et al reported one skin cancer death for study population of 4,661 coke oven workers from twelve American coke plants (Ex. 2-14). The death occurred in a worker who had at least five years of full-time work at a side oven job and had never worked topside. An update of this study, submitted by Dr. Redmond, limited to only Allegheny County, Pennsylvania, steelworkers reported by Lueke in 1907 (Ex. 20L) .

Since skin cancer is easily treated by minor surgery and is not likely to cause death it therefore is not likely to appear in a mortality study, detailed information on skin cancer morbidity in coke oven workers is available. Testimony presented at the public hearing by National Steel Corporation stated that only one suspected case of skin cancer in coke oven workers had been found in 43 years by the medical director of National's Weirton Steel Division (TR 2312).

The medical director of CF & I Steel Corporation, after reviewing a local hospital's records, which covered 75 percent of the employees, found that for the period 1966-1974, 10.32 percent of the hospital's skin cancer patients had been CF & I employees (Ex. 52). No skin cancer deaths were found. The number of coke plant employees included in the 10.32 percent of the hospital's skin cancer patients had been found in 43 years by the medical director of National's Weirton Steel Division (TR 2312).

The United Steelworkers of America submitted an affidavit from Donald Young, a grievance handler at the Geneva Coke Plant of U.S. Steel Corporation, after reviewing a local hospital's records, which covered 75 percent of the employees, found that the skin cancer rate for Utah as 250 per 100,000 (two references were given), thus the expected number of skin cancer cases among the 400 workers at the Geneva Coke Plant from 1951-1975 is one case per year or 24 cases. Dr. Bundy stated that only 8 cases actually occurred in that 24-year period and, as a result, no factual evidence for the reported skin cancer excess for the Geneva Works exists (Ex. 148).

How this number of cases compares with rates at other coke plants is unknown. Morbidity data on most diseases is difficult to obtain and the available studies deal with mortality.

Animal studies. Early animal experiments on the effects of carcinogens successfully induced skin tumors by painting the skin with coal tar (Ex. 8-7) or extracts of soot (Ex. 8-8). More recent studies conducted by the University of Utah have revealed the carcinogenic properties of coal tar and coal tar fractions derived from coal. Further studies suggested that repetitive contact of the skin of mice with coal tar or fractions thereof containing benz[a]pyrene (B[a]P) at a concentration of 0.01 percent or more resulted in the development of squamous cell carcinomas of the skin (Ex. 2-53).

In a later series of studies conducted at the Kettering Laboratory on mouse skin, both coal tar and B[a]P diluted with toluene produced skin tumors in a dose response relationship (Ex. 2-91; Ex. 14A).

Unlike lung and genito-urinary cancer, there is no clearly demonstrated excess mortality from skin cancer in U.S. coke oven workers. However, from epidemiological surveys of British coke workers and similar studies involving employees in related processes in the U.S. and other countries, the possibility
of a skin cancer hazard cannot be dismissed. In addition, animal experiments demonstrate that coal tar fractions from coking operations produce a significant carcinogenic response in mice. The variations in human response may be related to differences in operation, and these materials produced as well as to such factors as personal hygiene and medical surveillance (Ex. 2-18) and to the extent such controlled exposures are related to the development of skin cancer, they are appropriate subjects for inclusion in the standard.

F. Non-malignant respiratory disease.

There is some evidence that exposure to emissions from the coal carbonization process results in excess mortality from non-malignant respiratory diseases such as bronchitis (Ex. 2-18; 8-18) while the causal relationship is not as clearly established in this instance. It is important to note that the recent update of the Redmond coke plant mortality study shows a statistically significant excess for non-malignant respiratory diseases for total coke plant beginning with 5 or more years of exposure and for coke ovens after 10 years of exposure (Ex. 8-18).

When non-malignant respiratory disease is examined from another perspective, i.e., morbidity, its impact on the health of the coke oven worker increases. Using coke plant workers as the reference since the data is not broken down into Job area within the coke plant, there may be 3-4 times as much morbidity as mortality from non-malignant respiratory diseases (Ex. 109, Ex. 110M).

Additional information on morbidity was provided by the USWA, again, for coke plant operations. Out of 112 employees examined by a physician over 50 percent were diagnosed as having some lung impairment, i.e., pneumoconiosis, emphysema, fibrosis, and chronic bronchitis (TR 3325-30; Ex. 58).

G. Other hazards.

In evaluating the hazards to which coke oven workers are exposed, it is important to consider possible interactions with other factors in the work environment. These include not only coke oven emissions but also dust, heat, flame, coal and coke dust, and noise and heavy equipment (TR 1983-1986).

One aspect of such interaction is the need to limit exposure to coke oven emissions by ingestion (TR 439, 470) and a concomitant need for some form of water supply on the batteries due to the heat exposure (TR 1983). Other situations of this nature involve minimizing skin contact with coke oven emissions and yet not prescribing protective equipment which affects exposure to heat (TR 1983). These items as well as additional protective equipment and hygiene facility requirements are discussed in greater detail under the specific sections of the standard.

H. Conclusion.

The evidence in the record conclusively supports the finding that coke oven emissions play a causal role in the induction of cancer of the lung and genito-urinary tract in the exposed population. Constituents of coke oven emissions and coal tar, a by-product of the coking process, are known animal skin carcinogens and have been related to increased skin cancer mortality in human populations exposed to coke oven workers. This information is sufficient to warrant protective measures designed to reduce employee exposure to coke oven emissions.

IV. Economic Considerations

In setting standards for toxic substances, the Secretary is required by section 6(b)(5) of the Act to consider whether the proposed standard is feasible for the steel industry (Ex. 147). Both of these issues are discussed in the following section.

Based upon the proposed standard, DBA completed a second, more detailed study of coke oven emissions. This study, which was eligible for public record March 12, 1976, in which two alternative cost-of-compliance scenarios were developed (Ex. 109). Scenario I considered the economic feasibility of the proposed standard as established in Appendix B of the proposal, except for automatic lid lifters, remote control dampering, oven door gaskets, and automatic door cleaning equipment. Total capital costs associated with this scenario were estimated to be $451 million, or $68 per year, using an annualization factor of 0.15 to reflect both depreciation and an 8 percent interest rate (Ex. 109, p. 2). Required changes in engineering controls and work practices in this scenario, it was determined, would increase the demand for labor and intensify efforts in the maintenance function. In this scenario, DBA estimated that employment in coke oven departments would rise by an average of 17 percent and that labor costs per year attributed to the proposed standard would be $103 million. Increased annual maintenance costs were estimated to be $70 million and the sum of the annual maintenance and labor costs attributed to the proposed standard were estimated to be $173 million (Ex. 109, p. 4, Table 1-8). Based on the 0.15 annualization factor, total annual costs were estimated to be $241 million. Using a 0.10 factor, based upon an assumption of 10-year, straight-line depreciation exclusive of interest or the financial cost of capital, annual costs were estimated to be $218 million (Ex. 109, p. 86).

Scenario II was based upon the strictest possible interpretation of the proposed standard. Inclusion of the capital items omitted from DBA's first estimate raised total capital costs to $860,000,000, or $130,000,000 a year. Other annual costs rose to $1,500,000,000 reflecting estimates of capital requirements, which could be lost as a result of controls and work practices required under this interpretation. The result was an annual total cost of $1.28 billion (Ex. 109, p. 3).

The American Iron and Steel Institute (AISI) accepted the estimates of $860,000,000 for capital and $1,280,000,000 for total annual costs as the basis for their estimates of the effects upon the steel industry attributed to the proposed regulation. The Council on Wage and Price Stability (CWPS) accepted this estimate as representing the upper limit of the range of possible cost effects of the proposed standard. The United Steelworkers of America rejected the Scenario II estimate, and further modified the estimate of Scenario I. ACCUC used both figures in submitting its summary estimates. AISI rejected the Scenario I capital cost estimate on the basis of OSHA interpretation and enforcement of the proposed standard would require use of all the Appendix B items deleted from the analysis. Though not entirely in agreement with all the Scenario II
capital cost estimates, AISI believed that those estimates with which it disagrees with OSHA, on balance, tend to cancel out, leaving the overall total estimate to be a reasonably accurate indicator (perhaps understated) of the level of capital costs that must be expended in order to comply with the proposed standard (TR 4265).

With respect to annual costs, AISI suggested that the Scenario I estimate discounted the value of the lost coke production, which, it believes, is possibly the greatest single cost effect of the proposed standard (TR 4265). In addition, AISI said that other OIS costs were miscalculated, but that the sum of their effects offset one another. AISI emphasized, however, that the appropriate way to value coke loss was to subtract the value of coal not used from the sum of the purchase price of coke and the values of energy and by-products lost (TR 4650).

Coke loss proved to be an issue which aroused considerable controversy. National Steel Corporation was the only participant to argue that coke loss was an inequitable cost. AISI recognized that portions of the coke loss had already been accounted for, but it argued that coke loss was not an inequitable cost. AISI concluded that coke loss was an inequitable cost because coke loss would be minimized, especially through the use of additional manpower to reduce coking time, AISI reported that imported coke is used when needed, but that it is expensive ($140/ton) and of poor quality. In response to inquiries made by the participants, DBA indicated that the study estimates of coke loss were based upon the assumption of capacity production at the time of the study and did not reflect occurrences of idle capacity, downtime or use of stockpiles (TR 4142, 4143, 4063, 4088).

CWPS noted that Scenario II estimates were based upon reports from the several coke producers that would not allow a highly detailed company data estimates and that had an incentive to overstate costs (TR 4250). Utilizing Inland Steel Corporation's estimates of capital and annual costs which were representative of the industry, CWPS concluded that the upper bound of $13.29/tons was given by the DBA estimates, CWPS deflated the cost estimates of other companies to develop its own lower bound Scenario I cost estimate to complement the upper bound DBA estimate. Utilizing the costs of DBA Scenario I, CWPS then estimated the total capital costs to be $410,000,000; annual capital costs to be $61,500,000 (an increase of 16%) and other annual costs to be $23,300,000. Using a capital recovery factor reflecting only a depreciation assumption, the lower bound estimate is about $139,000,000 (TR 4699). Thus, CWPS estimated the range of annual costs (based on a 0 .15 capital recovery factor) to be between $180 million and $28 billion. Though CWPS indicated that further study would be required in order to develop an estimate within this range, CWPS said its "best guess" of total annual costs would be in the neighborhood of $300 million (TR 4750).

The United Steelworkers of America (USWA) also developed an alternate estimate, by revising the DBA Scenario I estimate of $450,000,000 in capital costs, $61,500,000 in annual capital costs, and $250,511,000 for four items. These included overestimates of costs of $46,725,000 for hygiene facilities, $57,910,000 for double drafting and oven doors, and $50,000 for oven doors. In addition, the USWA noted that the DBA document and other estimates ignored the effect of the 10 percent investment tax credit. It also noted that the value of that credit to be $22,576,000, after deduction of the overestimates. As a result of these deductions, the USWA's estimate of total capital costs was $199.5 million.

The USWA accepted the annualization factor of .15. Based upon this figure, they estimated annual capital costs would be $30 million. If DBA Scenario I estimates of other annual costs were added, the USWA's estimate of all annual costs would be $203 million. Thus, DBA scenario II appears too high because (1) the annual investment tax credit to be $22,576,000, after deduction of the overestimates; (2) separate "contaminated" and non-contaminated control dampering and oven door gaskets are not presently contemplated for any batteries; and (3) although OSHA recognizes that at least some of the specifically mandated controls may have some impact on production, it appears that increased familiarity with the work practices and operating procedures, greater use of labor and improved technology will minimize any loss in production. In addition, the lower range estimates of 139,000,000 and 160,000,000 (.15 recovery factor) were based upon the assumption that Inland Steel date were representative of the steel industry do not appear to be accurate since Inland's situation is atypical of the steel industry because it already has more new equipment than many other employers (TR 4750, 4751).

A wide range of cost estimates was presented by concerned parties at the hearings. OSHA concluded that it was inappropriate to accept any one of these estimates as its own or to make a definitive estimate of the actual costs necessary to comply with the proposed standard; however, OSHA has concluded it appropriate to narrow the estimated cost range. Based upon an analysis of the record, including potential loss of production, cost of controls and cost related to other portions of this final standard OSHA believes that total annual costs are likely to fall in the $200 million range rather than the $1,000,000,000 range. In reaching such a conclusion, it should be noted that the time required for implementing the required engineering controls will spread the costs. OSHA recognizes that any estimate of future costs of controls, especially costs relating to lost production resulting from controls which have not been installed, a particular battery are necessarily speculative because of the variation among batteries. In addition, we recognize that some employers who implement all of the required engineering controls and work practices may have to expend additional funds to develop new technology in order to meet the permissible exposure limit. Cost figures for these elements are also speculative to estimate (C39).

B. Inflationary Impact. As previously noted, the performance of economic feasibility studies is based upon OSHA's desire to obtain the data necessary to assess the capacity of covered employers to comply with its proposed standards and upon the statutory mandate that the standards is feasible. OSHA believes that such economic-feasibility information is essential to informed and responsible rulemaking.

Additionally, Executive Order 11821 (39 CFR 41501) and related implementing instructions, particularly Secretary's Order 15-75 (40 FR 54(841), require that OSHA certify that the inflationary impact of the proposed standard on the general economy was evaluated. The evaluation of such impacts was made a part of the economic analysis presented in the second DBA study. The results were extensively discussed and are summarized below.

Price elasticity of steel represents a principal determinant of the industry's ability to pass on any rise in costs in the form of a price increase. Though the DBA study did not attempt to estimate the price elasticity of demand for steel, it noted that it is relatively small in the short run, essentially permitting cost pass-through. This means demand for steel is not likely to significantly diminish as a result of increased costs related to the standard. For Scenario I the price of steel is expected to rise by approximately $1.50/ton.

Industry representatives contended that, since the industry is in an expansionary mode, capital requirements for compliance with proposed OSHA regulations would directly compete with capital requirements for expansion. If, therefore, a capital shortage develops, it is possible that steel prices may be necessary to generate the necessary funds for compliance. An upper bound of $1.29/ton was given by the industry for such a price increase. However, OSHA estimated that capital requirements for the overly pessimistic Scenario II represent only 2 to 3 percent of planned capital expenditures by the industry over the next eight years and, therefore, a capital shortage is not likely to occur as a result of the proposed coke oven standard.

Based upon the assumption that the steel industry would be able to pass through in the form of higher prices the full compliance costs in Scenario I, OSHA calculated an upper bound for steel price changes of 0.5 percent and a rise in the price index of 0.01 percent, a relatively small increase. DBA concluded that there would be a minimal effect on wage rates and coke production costs due to the relatively small increase in the price of coke. DBA also concluded that some small steel pro-
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ducers would have to expend more to institute the mandated controls than large ones because they had lagged behind the larger producers in implementing such controls.

Many industries are facing compliance costs in connection with coke oven emissions from requirements of other regulatory agencies as well (e.g., EPA). It is not possible to determine what costs for benefits should be attributed to which regulations and, therefore, OSHA believes that estimates of compliance costs should be considered as ranging which may include the joint costs of other regulations.

There was some disagreement with upper bound estimate effect on the CPI. The principal source of contention was the not the method (CWPS accepted the validity of the model). It was that the inflationary impact was calculated only for the lower point of the study's range of cost estimates (TR 4027). OSHA noted that by extrapolating from these estimates of inflationary impact it was possible to estimate a range of effects. Thus the bound estimates of change in the Consumer Price Index could range from 0.01 to 0.07 percent (TR 3935). In any event, we find that the impact is small and, therefore, will not disrupt substantially the income and consumption patterns of the economy. We, therefore, conclude that little or no change in the pattern of steel use would be expected.

CWPS said that another view of inflationary impact would involve calculation of the dollar values of anticipated costs and benefits. They said that if estimates of costs exceeded those for benefits, they would term the results inflationary, and the converse would be termed anti-inflationary. Attempts to take this view, and the attendant problems in developing such estimates are discussed below.

5. Benefits. It is clear that the over-riding purpose of the Act is to protect employees' health and safety even if such protection results in the expenditure of large sums of money, increased production costs and decreased profit margins. On the other hand, the Act is not intended to impose unnecessary or inappropriate financial or other burdens upon affected employers.

In an effort to assist OSHA in its decision-making process, CWPS suggested that OSHA utilize cost-benefit analysis. That is, benefits of the coke oven standard would be quantified in dollars and measured against the dollar costs of implementing the standard. Cost-benefit analysis is a common method for making economic decisions. In recent years, some economists have sought to apply this analysis to the value of human life and the cost of health care (TR 4580–1). However, there is no consensus on the appropriate methodology to arrive at dollar values for benefits (Ex. 109, p. 56).

There are inescapable obstacles to any attempt to accurately and to reduce to dollar terms the value of any health regulation. To begin with, since life and health are neither bought nor sold in our society, any estimate as to dollar values must necessarily be speculative. Yet, such an estimate requires recognition of the predominant probabilities of preventable mortality and morbidity and accepted standards of dollar values of life, illness, pain, and grief of those directly and indirectly affected. Indeed as CWPS suggested, there is no data from public health data. They indicated that their approach was based upon sound economics, but that they would defer to the methodology utilized by epidemiologists. They also indicated that their estimates of cost/benefit relationships were sensitive to any errors in the process of estimating the standard.

In the course of CWPS testimony, it was noted that a rate .0016 was used in the calculation of their high (.53) estimate of excess mortality. The record indicates that the .0016 rate related to coke plant workers, but that, under similar assumptions, a rate of .0041 would apply to coke oven workers as the population at risk. Using the .0041 rate for the 22,100 workers resulting in the estimate of about 90 as an alternative high estimate of excess mortality under the CWPS assumptions (TR 4739, 4741) it is assumed that there is a 20% turnover and that the rate is .0041, then the excess mortality would be approximately 109 deaths per year under the methodology used by CWPS.

As can readily be seen, estimates of the mortality benefits of the reduced exposure will vary significantly, depending on the assumptions used. However, OSHA does not believe it is appropriate to quantify even a range of the benefits of the final rule.

To begin with, we believe that the mortality benefits of the standard include more than the reduced exposures which will result. Based upon the data in the record, it is impossible to quantify the decrease in mortality, which will, we believe, occur as a result of medical surveillance, hygiene facilities, protective clothing and other methods of the final rule.

Moreover, were were to focus only upon the benefits derived from reduced exposures, the most costly requirement of the standard meaningful quantification is not possible. In this regard, it should be noted that we are aware of no "safe" level of exposure to coke oven emissions. Therefore, although we believe that mortality rates will be significantly reduced, we do not know whether compliance with the permissible exposure limit will remove all mortality results from coke oven exposures. We assume that significant reductions in mortality will not result from the standard as soon as exposures are reduced. Rather, because of the inherent nature of mortality resulting from occupational health hazards, including carcinogenesis and its long latent period, the yearly mortality will, we believe, be gradually reduced over a period of years. We believe that compliance would result in a significant decline, and coke oven workers will continue to suffer
the excess mortality of the past. In our view, the final rule provides immediate benefits relating to mortality by protecting employees today so that their mortality will be significantly reduced in the future. Under these circumstances, we believe that it would be inappropriate to attempt to speculate on the reduced yearly mortality which will result from the final rule.

In addition, it is likely that at least some of the engineering controls required by the final rule will reduce exposures to the general population in the surrounding communities. To the extent that mortality and morbidity are reduced, an obvious benefit would thereby be derived. We do not have adequate data to quantify these benefits.

Even if a meaningful estimate of reduced mortality could be established, we do not believe that there is an adequate methodology to quantify the value of a life. Various methodologies were suggested in the IIS, but none was viewed as satisfactory.

One method commonly used in analyses of programs involving health care or disease control is often referred to as the “human capital” approach. The “human capital” method derives a minimum monetary value of human life based on the value of an individual’s future earnings which would be lost as a result of premature death. Such calculations are occasionally supplemented by the “suggestion that auxiliary calculations be made in order to take account of the suffering of the victim, his loss of utility from ceasing to be alive, and/or of the bereavement of his family” (Ex. 110-D). Others, such as Dorothy Rice, extend this concept by “totaling the amount that is spent on medical care and the value of earnings foregone as a result of disability or death” to obtain a minimum value of human life (Ex. 110 D; 110N).

Use of the human capital approach is qualified by its reliance on the arguable assumption that the sum of foregone wages (or foregone wages plus medical care costs) is the best estimate of the value placed on human life by society. Use of this method is further handicapped because it implies, for example, that retired persons (who are not longer “earning”) are worthless, and that men are worth more than women (because the average earnings of men are higher than the average earnings of women) (Ex. 109, p. 57).

Another method, somewhat similar to the first, is sometimes called the “net output” approach. The value of an individual’s life under this method is found by "calculating the present discounted value of the losses over time accruing to others as a result of the death of a particular individual" (Ex. 110-Q). Use of this method requires acceptance of the attitude that what is most important to consider is the harm done to others as well as the grief following the death of one or more of its members. If accepted, the approach implies that the death of any person whose earning power or productivity is negative to others will result in a net gain (regardless of his or her ownership of property), represents a net benefit to society.

The method has no regard for the feelings of the potential victim or his family, restricting itself only to the interests of the surviving members of society as a whole (Ex. 110-Q).

A third method advocated by many for use in benefit assessment approaches the problem from a "social" aspect and bases the value of life on the amounts invested by government to provide improved health status and life expectancy at reducing the number of deaths. Renal dialysis for persons with kidney failure (the costs of which range from $15,000 to $25,000 per patient per year) is just one example of the free medical care available under a government-sponsored program (Social Security). Under this benefits analysis approach, the costs involved in the program imply that society places a value on life substantially higher than the sum of the wages these persons would earn over their working lifetimes (Ex. 110-D).

While some have also suggested that an implicit value of human life could be derived from decisions on amounts spent in other programs to prevent mortality, Mishan notes that such values may probably differ among programs. He also notes that no democratic voting process is involved directly in such program decisions and that there is an independent economic criterion for the value of life would be required for rational decisions (Ex. 110 Q). Some have felt that such an independent value could be derived from an examination of wage rates paid in hazardous occupations. However, this would assume that workers have perfect knowledge of the nature of the hazards, and this would be more likely in obvious exposures than in the case of exposure to occupational carcinogens which have a long latency period so that the time of death is remote from the initial exposure. The time difference also introduces questions on whether the future benefits of reduced mortality should be discounted to arrive at some present value, but there Is substantial disagreement among economists on the use of discounting in estimating the value of a life to be saved in future years (Ex. 110, p. 59). Finally, even if the value of life could somehow be assessed, there appears no way to value a difference between the slow and painful process of dying from cancer as compared to other dying processes with different levels of pain and suffering (TR 4581).

OSHA believes that these methodologies do not adequately quantify the value of life. Accordingly, we decline to do so.

In the case of expected benefits from exposure to coke oven emissions of 150 µg/m³ benzene soluble fraction of total particulate matter present during the destructive distillation or carbonization of coal. In addition, the standard specifies minimum engineering controls and work practice controls designed to reduce exposures to coke oven emissions. Additional controls to reduce annual costs are not necessary where the benefits of the standard are exeeding the costs of compliance, and the rule is likely to be satisfied.

Based upon the record as a whole, OSHA finds that compliance with the standard (even if the higher cost estimate was used) is well within the capability of the coal industry. Moreover, although we cannot rationally quantify in dollars the benefits of the standard, it is concluded that these costs are necessary in order to adequately protect employees from the hazards associated with coke oven emissions.

V. SUMMARY AND EXPLANATION OF THE STANDARD

The following sections discuss the individual requirements of the standard. Each section includes an analysis of the record evidence, the recommendations of the Advisory Committee and NTOSH, and the policy considerations underpinning the decisions on the particular provisions of the standard. After consideration of all the evidence in the record, the final standard sets a permissible exposure limit to coke oven emissions of 150 µg/m³ benzene soluble fraction of total particulate matter present during the destructive distillation or carbonization of coal. In addition, the standard specifies minimum engineering controls and work practice controls designed to reduce exposures to coke oven emissions. Additional controls to reduce annual costs are not necessary where the benefits of the standard are exceeding the costs of compliance, and the rule is likely to be satisfied.

Based upon the record as a whole, OSHA finds that compliance with the standard (even if the higher cost estimate was used) is well within the capability of the coal industry. Moreover, although we cannot rationally quantify in dollars the benefits of the standard, it is concluded that these costs are necessary in order to adequately protect employees from the hazards associated with coke oven emissions.

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A. Scope and application. This standard applies whenever the presence of destructive distillation or carbonization of coal for the production of coke. It covers the control of employee exposure to coke oven emissions and includes considerations which are necessary to achieve that control. "Coke oven emissions" is defined in the standard to mean the benzene soluble fraction of total particulate matter (TPPM) present during the destructive distillation or carbonization of coal for the production of coke. Both the concept of "present" and the choice of the particular substance to be regulated are important in defining the scope of the standard. OSHA has chosen to define the standard in terms of the benzene soluble material "present" during the production of coke, rather than the material "generated" by the process as recommended by the Advisory Committee. The reasons are twofold. First, the record establishes that no analytical method exists by which all the potential sources of benzene soluble material can be determined. Second, since coke ovens are located in an environment other sources of pollutants a precise sampling technique to eliminate all external interference is impossible and, secondly, the benzene soluble method is one that is least likely to measure such extraneous sources.

Finally, while the scope may appear expansive, the choice of the substance to be regulated narrows that coverage with sufficient precision to provide an accurate measure of employee exposure as well as of the effectiveness of the controls and work practices. (See Permissible Exposure Limit).

Industry participants were also concerned that employers might be cited for exceeding the permissible exposure limit in workplace areas which have not been associated with an excess health risk. By limiting the application of the permissible exposure limit to a defined regulated area, OSHA has insured that this will not occur. The regulated area which has been defined is the coke oven battery, including top-side, pushside, coke-side and their machinery, the wharf and the screening station. All of these areas were associated with the excess health risk (Ex. 20; 8-1; 8-19; 8-29; 2-105, p. 106). It should be noted that the beehive ovens have also been established as a regulated area even though no epidemiological studies of this type of coke production have been done. However, since beehive ovens utilize the carbonization of coal for the production of coke, and such processes have been related to excess lung cancer and other respiratory diseases, the decision was made to include them in the coverage of the standard.

In accordance with section 4(b)(1) of the Act, this standard will not apply to working conditions with regard to which other Federal agencies have exercised statutory authority to prescribe or enforce regulations relative to occupational safety and health. This standard is not intended to limit the rights under applicable statutes and regulations of local, state, and federal air pollution and occupational safety and health officials to enter the regulated areas.

Another aspect of the applicability of this standard is its relationship to the existing standard for coke oven pitch volatiles in 29 CFR 1910.1000 Table Z-1. The existing standard will continue to apply to employee exposures to coke tar pitch volatiles outside of coke oven employees, such as the asphalt industry, including those parts of the steel plant other than the regulated area. However, other OSHA standards, of course still apply in the regulated area. (Subpart I—Personal Protective Equipment of Part 1910—Occupational Safety and Health Standards (29 CFR 1910.132-140) contains requirements for eye and face protection (§1910.139), respiratory protection (§1910.134), occupational health protection (§1910.135), and occupational foot protection (§1910.136). Subpart I—Personal Protective Equipment of Part 1910—Occupational Safety and Health Standards (29 CFR 1910.132-140) contains requirements pertaining to toilet facilities (§1910.141(re)), washing facilities (§1910.141(d)), change rooms (§1910.141(e)), and consumption of food and beverages (§1910.141(f))). In the event that any of these standards conflict with requirements established in the new standard, the new requirements shall apply.

B. Definitions. The standard contains fourteen definitions in order to establish a working vocabulary.

C. Permissible exposure limit. The standard provides that no employee in the regulated area may be exposed to coke oven emissions in excess of 150 mg/m3 as determined for an eight-hour period. Coke oven emissions is defined as the benzene-soluble fraction of total particulate matter (BSFRPM) present during the destructive distillation or carbonization of coal for the production of coke. The permissible exposure limit established in this standard applies to employees in the regulated area, to BSFRPM which is present during the destructive distillation or carbonization of coal for the production of coke, and to exposure measurements have in the past been determined in terms of BSFRPM, allows for comparison for scientific purposes between present and previous exposure levels (Ex. 14; TR 1753). BSFRPM is less likely than coke oven workers used BSFRPM as the measure of employee exposure levels (Ex. 14, p. 30).

Finally, the fact that coke oven emission exposure measurements have in the past been determined in terms of BSFRPM, and not the respirable or total particulate matter (29 CFR 1910.1000 Table Z-1), is a distinct possibility that other, as yet unidentified, carcinogens will be found and measured in coke oven emissions. This type of investigation is highly desirable. However, there is a need to have a quantitative measure of coke oven emissions.

The ideal situation would be to routinely analyze several substances in coke oven emissions. This was suggested by Dr. Eugene S. Bingham (from EPA) to the coke oven advisory committee. The analytical burden and economic considerations make monitoring for multiple substances on a routine and frequent basis appear impractical.

Therefore, the selection of indicator substances appears to be the most practical.

There is substantial support in the record for the concept of using an indicator substance in the establishment of a permissible exposure limit (Ex. 149, p. 68). In light of this support and for the reasons stated above, OSHA has decided to use an indicator substance in establishing a permissible exposure limit.

According to Dr. Bingham (TR 156), these four major factors in the selection of an indicator substance: (1) It should have a reasonably good association with the disease, (2) it should be as specific as possible, (3) the analysis should be reliable and not prohibitively expensive. In addition, a data base from which to choose a permissible level of exposure for the indicator substance is extremely important. OSHA's choice of BSFRPM as the indicator substance for coke oven emissions is based upon these considerations.

BSFRPM has a reasonably good association with the health hazards which confront coke oven workers. The extract contains all of the organic materials in coke oven emissions that have in any way been implicated in the observed coke oven employee health problem, including all of the polycyclic aromatic compounds in coke oven emissions known to be physiologically active (TR 1753). It contains a large quantity of lower molecular weight polycyclic organic matter which has been related to the increased incidence of cancer among coke oven workers (TR 1753). Furthermore, the major epidemiological study relating exposure to coke tar pitch volatiles (CTPV) to excess mortality and morbidity among coke oven workers used BSFRPM as the measure of employee exposure levels (Ex. 149, p. 30).

Finally, the fact that coke oven emission exposure measurements have in the past been determined in terms of BSFRPM, allows for comparison for scientific purposes between present and previous exposure levels (Ex. 14; TR 1753). BSFRPM is less likely than coke oven workers used BSFRPM as the measure of employee exposure levels (Ex. 149, p. 108). It is a more specific measure of exposure to the carcinogenic components of coke oven emissions than either respirable or total particulate matter (Ex. 14; 149, p. 109). In fact, there is evidence that it more specifically estimates the mixture of potential carcinogenic compounds in coke oven emissions than any other indicator substances (TR 1752).

BSFRPM sampling is less likely than sampling of other indicator substances.
to be affected by interference from emissions present, but not generated from the destructive distillation of coal (TR 1928; TR 2493–4). This is because almost all of the BSFTPM on the coke oven battery is removed from the coke oven operation with the other benzene-soluble materials comprising only a very small fraction of the total present (TR 1928).

It should be noted that in the preamble to the proposed standard (Ex. 1a, p. 32271), OSHA referred to this as a non-specific measurement. There has also been testimony during the public hearing relating to this effect. However, in consideration of the record as a whole, OSHA now believes that BSFTPM is specific when compared to other indicator substances considered, particularly when the sample is obtained within the specific confines of a coke oven battery.

As stated in the preamble to the proposed standard (Ex. 1a, p. 32271), there are problems associated with this (and any other) sampling method. However, subsequent evidence suggests that, if a well defined and controlled procedure is used, the results of BSFTPM exposure measurements are "reasonably" accurate and reproducible (TR 1753). The test is "relatively rapid" (TR 1952; Ex. 149, p. 108) and can be carried out by all employers large or small (TR 1753). Most employers already have considerable experience with this test (TR 1753), and some have been using this procedure since 1967 (Ex. 2–95, p. 9, TR 1932) including use in connection with the present standard for CTV (Ex. 149, p. 110).

A source of sampling error which may be encountered with other indicator substances such as respirable particulate matter is avoided by the selection of BSFTPM. Hydrogen sulfide gas which is present on the coke oven battery can react with the silver membranefilter used in sampling to form silver sulfide. The silver sulfide produced would result in a weighing error. However, since sulfide is insoluble in benzene, this problem would not occur if a benzene-soluble determination is utilized (TR 1775).

BSFTPM also fulfills the fourth criterion of an indicator substance. The test is reasonably rapid (TR 1752), and it involves only a modest equipment and personnel cost (TR 1753). The use of benzene in the analytical procedure may create occupational health hazards for benzene itself is toxic. However, it is OSHA's belief that if appropriate laboratory practices and procedures are employed, the potential hazards can be adequately reduced. While some have suggested alternative solvents such as cyclohexane, there is insufficient data at present to determine what level of a cyclohexane soluble fraction of total particulate matter would be equivalent to the level of BSFTPM established by this standard. As discussed elsewhere in this section the level of BSFTPM has been chosen in part based on reference to much previous data obtained by an analytical method utilizing benzene as a solvent. Such a reference would be lost by the selection of an alternate solvent. At the same time, OSHA has requested NIOSH to investigate the possibility of substitutes for benzene or alternative analytical procedures that would achieve the same analytical purpose, but not present the hazards to lab personal.

As mentioned above, there has been a major epidemiological study (Ex. 8–29) which relates exposure to different levels of BSFTPM to excess death among coke oven workers. The exposure levels were obtained by averaging exposures for each coke oven job category from data collected by the State of Pennsylvania in 1967. It was the product of the length of time in a particular job category and the average exposure for that category.

At the request of OSHA, Dr. Charles Land of the National Cancer Institute analyzed the data upon which this earlier study had been based in order to estimate what the excess risk of mortality from lung cancer would be at various levels of exposure (Ex. 82). The analysis incorporated two models of cancer initiation: (1) The linear model, also known as the "one-hit" model, where a single event, whose probability is proportional to dose, is required to initiate a cancer, and (2) the quadratic model, also known as the "two-hit" model, in which two or more events, whose proportions of contribution to the total dose, are needed to initiate a cancer. It also incorporated lag or latent periods of zero, five, ten and fifteen years. The analysis provided estimates of lifetime (to age 85) excess risk of lung cancer mortality due to occupational exposure to coke-oven emissions for a hypothetical individual exposed to a constant (average BSFTPM) concentration from age 20 to age 65 or death for the variables discussed above.

There is also evidence in the record of the levels of BSFTPM which have been achieved on coke-oven batteries where a significant number of the required engineering controls and work practices have been instituted (Ex. 2–223). While this information does not place a lower bound on what a permissible exposure limit should be, it is certainly helpful in determining a feasible level.

Respirable particulate matter (RPM), which was the indicator substance selected in the proposed standard, has a good association with the disease. RPM is itself probably a cocarcinogen (Ex. 149, p. 103). It is less expensive than BSFTPM analysis (Ex. 14). Also, it is less expensive than BSFTPM analysis (Ex. 14). The advantages and disadvantages of total particulate matter as an indicator substance are similar to those discussed for RPM. Additional disadvantages are that RPM has a low correlation with the disease, RPM may contain a large portion of extraneous material that has nothing to do with carcinogenic effects; and that RPM is less specific than BSFTPM (Ex. 14).

Benzo(a)pyrene (BaP), which was the indicator substance recommended by the Advisory Committee, is itself a known carcinogen (Ex. 14). In the case of RPM, there is no epidemiological evidence establishing a relationship between BaP and observed excess of disease among coke oven workers (Ex. 149, p. 101). There is, however, a study in the roofing industry relating inhalation of BaP and elevated death rates from lung cancer (Ex. 17; Ex. 17a).

BaP is highly specific (Ex. 14). It might not, however, have carcinogenic activity of coke-oven emissions (Ex. 14). It has been characterized as both a good (Ex. 14) and bad (Ex. 149, p. 102; Ex. 17a) indicator of carcinogenicity in coke-oven emissions.

The methods of analysis for BaP have been characterized as medium to difficult, and requiring training (Ex. 14), and requiring extreme care and attention to detail (Ex. 21, p. 4). The analytical methods have been referred to as being reproducible (Ex. 149, p. 102) and varying (Ex. 2–16) results. The analysis is generally viewed to be time-consuming (Ex. 21, p. 4; 149, p. 102). It is also viewed to be more expensive than the methods involving BSFTPM, RPM, and TPM (Ex. 21, p. 7).

As stated earlier, there is no comparable epidemiological study relating exposures to RPM, TPM, or BaP to the excess mortality of coke oven workers. Nor is there a study from which excess mortality risk is known, under different latency periods and different cancer models at different exposure levels may be determined. There is, however, a study (Ex. 17; 17a) relating inhalation of BaP to...
and elevated mortality rates from lung cancer in a different occupational setting (roofing). There are also experiments which demonstrate the effect of exposure to various indicator substances on animals, although this information is less compelling in light of the existence of human epidemiological data for BSFTPM.

There is evidence in the record of exposure levels of RPM (Ex. 78M; 49F; 51A; 73A), TPM (Ex. 28A; 73A), and B(a)P (Ex. 68; 74; 55) found on coke oven batteries. Unlike the BSFTPM data (Ex. 2-223) these levels cannot be readily compared with vast amounts of existing data and they do not represent exposures at the coke-oven batteries which are generally conceded to be the most effective in emissions control, and, therefore, are not as useful in determining a lowest feasible level.

While each of the possible choices of an indicator substance has both advantages and disadvantages, OSHA believes that BSFTPM is the appropriate indicator substance for coke oven emissions. This decision is based upon the following:

BSFTPM has a reasonably good association with the disease; is relatively specific; has a reliable analytical method which is sufficiently rapid, not overly expensive, and is subject to minimal interference; and BSFTPM has a large database for exposure and risk assessment.

One approach for establishing a permissible exposure level indicator substance is to determine what the background or ambient level is and to set the permissible exposure limit at this level. This has the effect of creating a zero exposure above background limit. This was essentially the approach followed by the Advisory Committee in arriving at their recommended level for exposure to B(a)P (Ex. 3). This level (0.2 µg/m³) was selected as representative of high average background or ambient levels of B(a)P as determined by the National Air Sampling Network of the EPA (Ex. 14, p. 20). Data on background levels for TPM and BSFTPM are also available (Ex. 2-220). The proposed standard correlated RPM levels to the known B(a)P background level (Ex. 1A, 32227) based on data presented to the Advisory Committee and included in its report (Ex. 2-174, Vol. 3, p. 3).

The zero-exposure above background approach has been heavily criticized (Ex. 149, p. 99). Participants have challenged the determination of the background level (Ex. 149, p. 98), the applicability of such a standard to employers who would exceed the determined background level without even operating their coke ovens (Ex. 51), and the technological feasibility of meeting such a standard (Ex. 149, p. 97).

There has also been a vigorous challenge to the correlation used to determine a background level for RPM (Ex. 2-220; 1968). The determination of the correlation levels of B(a)P was based on seven B(a)P samples and fifty RPM samples from one coke plant (TR 143). There is no data to show that the conclusions drawn from that one plant could be extrapolated to other plants (TR 240). The relative efficiencies of the high-volume and personal samplers in collecting RPM is also a small factor in the correlation. It was reported that personal samplers were approximately 10 times more efficient than high-volume samplers. Only values who were 11.7 times for samples at one plant and 20.5 at another (TR 214). The greater efficiency of 20.5 times may be due in part to the fact that these samples were collected in the summer and volatilization of B(a)P due to the higher temperature in combination with the high flow rate, resulted in decreased collection efficiency (TR 214). The collection efficiency of personal samplers in relation to high-volume samplers is not constant.

Only three personal samples and seven high-volume samples were used to calculate the 11.7 to 1 ratio. Only the data from the coke plant sampled during the winter were used as the data collected during the summer were discounted because of cause of volatilization losses. Inclusion of this data would have changed the collection efficiency ratio to 15 to 1 (TR 1759).

It is important to note that OSHA do not think that the Instantaneous Exposure Process (Ex. 149, p. 109) considers BSFTPM to be the same substance as the benzene-soluble fraction of coal tar pitch volatiles, at least in relation to the production of coke. Measurements involving the existing standard for coal tar pitch volatiles (29 CFR 1910.100, Table 2-1) have actually been measurements of the coke itself. OSHA considers that the permissible exposure limit of this standard and the permissible exposure limit of the existing standard are defined in terms of the same substance.

One alternative approach to the use of an indicator substance as a permissible exposure limit indicator substance is to use data from visible emissions from the coke ovens to be permitted. This approach was considered by OSHA and was rejected. As a matter of policy, OSHA has chosen to establish a permissible exposure limit for coke oven emissions rather than to establish a "no visible emissions" requirement. In this regard it should be noted that a permissible exposure limit is an objective requirement (whereas questions as to what constitutes a visible emission are subjective). Moreover, there are risk data available regarding various levels of exposure for BSFTPM, whereas no such data exist for visible emissions. It is not to say that visible emissions are to be ignored. To the contrary, where emissions are visible, the source of the emissions should be identified, the emissions cleaned, repaired, or replaced as necessary.

A series of permissible exposure limits to BSFTPM have been considered in the course of the rulemaking. These range from B(a)P of 0.66 mg/m³ (560 µg/m³) to a level of 0.05 mg/m³ (50 µg/m³).

The 0.56 mg/m³ level has been recommended at different times by various industry participants as representing a safe level of exposure (Ex. 149, p. 86; 151). The level is taken from the major epidemiological study relating exposure to BSFTPM to excess mortality among coke oven workers (Ex. 8-29). According to the study, the data therein provide certain criteria which could constitute a safe level of exposure. The study gave an example of a worker exposed to less than 0.58 mg/m³ for a period of 8 hours with no increase in cumulative 200 mg/m³-months of exposure at a level which the data indicate would not increase the risk of lung cancer. The study concluded that a level of 0.2 mg/m³ is probably adequate protection since it would allow for increased exposure of those workers with over 30 years of work experience at the coke ovens.

At the rulemaking hearings, Dr. Redmond, one of the authors of the study, explained why 0.56 mg/m³ should not be used as a safe level of exposure. First, the model of carcinogenesis used in the study, the instantaneous cancer model, does not incorporate the concept of a latent period, which is inherent in current theories of carcinogenesis (TR 421). Second, even accepting the instantaneous cancer model as used in the study, there was an insufficient number of white workers in the population to permit independent verification of the lung cancer excess that had been observed for blacks (TR 422).

Third, the excess cancer risk reported from coke oven workers was relative to the rates for the steelworker population. The lung cancer rate of the steelworker population tends to be the same as other Allegheny County (site of the study) populations, yet steelworkers tend to have higher lung cancer rates than the United States population as a whole (TR 1014). Hence, even if a level of 0.56 mg/m³ were considered for coke oven workers to that experienced by the steelworkers, coke oven workers would still be at a greater risk than the United States population as a whole.

Fourth, the 0.56 mg/m³ level was based on a study of workers who had been exposed for 30 years upon which 0.56 mg/m³ was based was used only by way of example (TR 1013), and in no way represents the maximum level that many workers spend in the coke oven environment (TR 1014). As mentioned in the study itself, a lower level would be required to protect workers who were employed longer than 30 years (Ex. 8-29).

Fifth, the 0.66 mg/m³ level is based upon the fact that the cumulative exposure interval of less than 200 mg/m³—months exhibits no increased risk (Ex. 8-29). However, the value for the lung cancer rate for each interval is the average weight for the entire interval, and it is customary to use the mid-point of each interval as representative of what cumulative exposure (TR 1015). By taking the mid-points of the sub-intervals listed (Ex. 8-29, Table V), and weighting for the number of employees within each of these intervals, it can be determined that the

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average exposure for the interval is 77 mg/m²-months (TR 1015). Following the procedure of making a judgment of the midpoint determined average exposure (77 mg/m²-months) would reduce the "safe" exposure for a 30-year period of 0.56 mg/m³ by a factor of 0.77/200 µg/m³ (TR 1012-3).

Finally, two sets of exposure data were available for use in this study, one from the State of Pennsylvania, which was used in the Redmond study (TR 1013). The exposure levels of the AISI data were consistently lower than the levels used in the study (Ex. 8-18, Table 7-1, T 1013). Had these lower exposure levels been used in the study, then the average exposures of the intervals would have been correspondingly lower (TR 1013). Hence, the 0.56 mg/m³ level which was derived by dividing 200 mg/m³-months by 360 months (30 years) would also have been correspondingly lower.

Dr. Land's analysis of the excess risk associated with exposure at the 0.56 mg/m³ level (the highest exposure level used in the study) showed that the risk was even less than a safe level (Ex. 82, Table 3). At an exposure level of 0.5 mg/m³, (the closest lower level examined to the suggested 0.56 mg/m³ from age 20 to age 65 or death, assuming a linear dose-response, with a dose model incorporating zero, five, ten and fifteen year lag periods the estimated excess risks are 0.0002, 0.0005, 0.0009, and 0.0012 respectively with relative risks of 99% to 151% greater than the normal lifetime risk of lung cancer mortality (Ex. 83, Table 3).

Assuming a quadratic dose-response, at the same exposure level, for the same lag periods the estimated excess risks are 0.0019, 0.0029, 0.0029, and 0.0029 respectively (Ex. 82, Table 3). The relative risks for this model run from 38% to 79% greater than normal risk (Ex. 82, Table 3).

On the basis of Dr. Redmond's explanation of the reasons for not using 0.56 mg/m³ as a safe exposure level, the calculation by Dr. Land of the excess risks of lung cancer associated with exposure at this level, and the evidence in the record of the probability of reducing exposures to significantly lower levels, OSHA rejects the suggestion that setting the permissible exposure limit at 0.56 mg/m³ BSPTPM would provide an adequate measure of employee protection.

The existing standard (29 CFR 1910.1000, Table Z-1 for the benzoic-soluble fraction of coal tar pitch volatiles, which is viewed as BSPTPM, sets a maximum permissible exposure at 0.2 mg/m³ (200 µg/m³). The criteria Document (Ex. 2-18, p. II-2) included a recommendation that the existing standard for coal tar pitch volatiles be retained as an index of workers' exposure and as a measure of the effectiveness of engineering controls and operating procedures. As noted earlier, Dr. Redmond found that her study indicated that this was probably an adequate level of protection (Ex. 8-29, p. 389). In fact, the recalculated 0.56 mg/m³ level used in the customary point analysis resulted in a level of approximately 2.23 mg/m³ (220 µg/m³) (TR 1014-5). However, Dr. Redmond did not research the possibility that a latent period model led to the conclusion that there was no exposure level that could be considered safe (TR 423).

The analysis performed by Dr. Land still responds roughly to the proposed standard, the criteria Document (Ex. 82, Table 3).

At all of the investigated exposure levels (0.05-1.00 mg/m³ BSPTPM), dose models (Ex. 82, 10, and 15 year lag) and corresponding relative risks of lung cancer (Ex. 82, Table 3) were found. For example, according to Dr. Land's calculation (Ex. 82, Table 3), assuming a quadratic dose-response model and latency periods of zero, five, ten, and fifteen years, the excess risks of lung cancer associated with OSHA's current standard of 0.2 mg/m³ are 0.0029, 0.0045, and 0.0061 respectively.

The corresponding relative risks are 6.2%, 7.7%, 9.5%, and 13.1% greater than the normal risk. Assuming a linear dose-response model and latency periods of the same exposure level, for the same lag periods the estimated excess risks are 0.0011, 0.0029, 0.0024, and 0.0029 respectively with corresponding relative risks of 41.6%, 48.1%, and 63% greater than the normal risk.

Putting the above calculations into more general terms, Dr. Land said (TR 3588).

As a final statement, I would just point out that it has not been my task to weigh the costs of reducing coke oven emissions against excess risks associated with not doing so; but it is possible to note from these analyses that the estimated excess risks corresponding to average coal tar pitch volatile levels of 0.0036, 0.0045, and 0.0061 respectively.

Then from the point of view of choosing a safe level of exposure, the permissible exposure level was set at zero. However, based on the evidence in the record, OSHA does not believe that a zero standard for exposure to coke oven emissions is feasible. In fact, it is clear that for any of the indicator substances considered, certain quantities of each substance are present in the ambient environment as a result of natural phenomena and as artifacts of human activity.

The Advisory Committee recognized this issue and proposed that the standard be set at a level equivalent to "background" for (a) as the next best approach to a zero standard. The Chairperson of the Committee explained this approach as follows (Ex. 14):

Since coke oven emissions are carcinogenic, the best data to demonstrate that there is a safe level of exposure to carcinogen is the basis of this standard must be "no exposure." It is true, however, that in the ambient environment, there are certain compounds arising from various combustion processes which are the same as those arising from coke operations.

The basis of this standard is no permissible exposure levels; excess risks are measured in representative urban environ-
ments removed from the influence of coke oven emissions **.

This limit is based on an evaluation of the best available scientific evidence, and on a determination that the health and safety of employees must be protected to the fullest possible extent.

The proposal, while based on a different indicator substance from (a) in an effort to establish a reasonable particulate standard roughly equal to background consistent with the Advisory Committee recommendations.

While a permissible exposure limit equal to zero plus background would represent the lowest level theoretically possible, OSHA believes that the record shows such an approach is not feasible. Even if such a number could be determined, achieving a standard of zero plus background would require that the emissions from a coke oven be effectively zero so as not to increase employee exposure above background levels. There has been no evidence presented that would convince OSHA that such a complete elimination of coke oven emissions can be achieved by existing technologies.

OSHA finds that the determination of an appropriate permissible level of employee exposure to coke oven emissions relies in part on the record of this proceeding and in particular on the determinations which lead the Agency to conclude that in dealing with a carcinogen or other toxic substance for which no safe level of exposure has been demonstrated, the permissible exposure limit must be set at the lowest level feasible. Such a determination involves a measure of subjective judgment which OSHA believes is justified by the nature of the hazard being dealt with and the intent of the Act. Section 6(b) provides that the standards for toxic substances shall be feasible. That section further provides that:

In addition to the attainment of the highest degree of health and safety protection for the employee, other considerations shall be taken into account in the field, the feasibility of the standards, and experience gained under this and other health and safety laws.

OSHA has determined that 150 µg/m³ is the level which most adequately assures, to the extent feasible, the protection of coke oven workers. Several factors have been considered in making this determination and are discussed below.

The estimated excess risks of lung cancer mortality due to occupational exposure to BSPTPM at the 150 µg/m³ level are less than the peaks from exposure at the level of the existing standard, 0.2 mg/m³ (200 µg/m³) according to interpolations performed by OSHA from Dr. Land's calculations (Ex. 82, table 3).

Thus, for the same hypothetical individual that has been used in the preceding examples, assuming a linear dose-response model and latency periods of zero, five, ten and fifteen years, the relative risks at the 150 µg/m³ level of exposure are 0.0145, 0.0159, 0.0184, and 0.0223 respectively. The corresponding relative risks of 1.034, 1.043, 1.053, and 1.066 are not negligible, even for those dose response models and latency assumptions that give the smallest estimates of risk.

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cess risks are 0.0016, 0.0020, 0.0025, and 0.0034 respectively, with corresponding standard deviations of 1.038, 1.061, 1.056, and 1.072 times the normal. The lowering of the permissible exposure limit closely represents a lowering of the risks associated with exposure to coke oven emissions.

The level of 150 µg/m³ is a feasible one. Although the industry generally has found it difficult to utilize emission control technology which has been available for some time (e.g., stage charging has been in existence since 1961 (Ex. 2-37c; 2-19)) and have exceeded the existing permissible exposure limit of 0.2 mg/m³ (Ex. 68), exposure levels below 150 µg/m³ have been reached at various times on various batteries for various job classifications (Ex. 49E; 51A; 2-146; 2-223). The strongest evidence of this performance is the NIOSH study of U.S. Steel's Fairfield, Alabama plant (Ex. 2-223, table 1). For all of the seven job categories tested, on at least one of the three days during which samples were taken, exposure levels were below the 150 µg/m³ level. Three job categories (tarry- molder, pusher, and quencher operators) registered below this level on two days. Furthermore, for three of the job categories (pushside door machine operator, pushside helper, and quench car operator) no detectable level of ex- posure was measured. OSHA is mindful that many of the measurements taken by NIOSH at Fairfield show levels above 150 µg/m³, however, the Agency believes that the lower measurements are a strong indication that these levels are attainable.

OSHA recognizes that Fairfield is generally considered to be the best coke plant in terms of controlling emissions. In fact, EPA uses Fairfield as a data base for their new source performance standards for coke plants (TR 1971). However, even Fairfield does not utilize all of the specific engineering controls that OSHA believes are effective in reducing exposures and have been required in this standard. For example, Fairfield uses filtered-air cans or standby puppets (TR 2066). Nor does Fairfield have all of the additional controls that are not specifically required in the standard, such as canopies to capture and remove door emissions (TR 3078). OSHA believes, therefore, that by utilizing all of the required controls and additional existing controls, Fairfield could be doing even better.

OSHA also believes that other coke plants can follow Fairfield's lead. Fairfield is a rehabilitated battery (Ex. 41A), which suggests that existing batteries can likewise be rehabilitated to perform with similar success. New batteries should be able to do even better, since they are not faced with the space, design, and other constraints sometimes imposed by rehabilitation of a battery.

Furthermore, as the Courts of Appeals have emphasized, OSHA is not bound by the status quo. Standards may be set which require improvements in existing technologies or which require the development of new technology, and OSHA is not limited to setting standards based solely on devices already fully developed (see, e.g., Society of Plastics Industry v. U.S. Steel, 509 F.2d 301 (c.A.2, 1975) cert. denied).

OSHA agrees with the statement of David J. Burton, the contractor who performed the feasibility studies, that "... implementation of the standard and of efforts to control employee exposure will undoubtedly raise new and innovative control technology will be developed." (Ex. 116, p. 4).

In fact, there is new and innovative control technology looming on the horizon. For example, there was extensive testimony at the rulemaking hearings on the effectiveness and feasibility of new door sealing techniques which may lead to the almost total elimination of door leaks (Ex. 30; 66P; Ex. 144, App. A, p. 77). As another example, there was testimony regarding new techniques for the quenching of coke which could greatly reduce the emissions resulting from the pushing process (Ex. 30; 33; 33D). Further, there was testimony concerning alternative methods of coke production (Ex. 2-223). OSHA has carefully considered the issue of economic feasibility in the course of this rulemaking and is convinced that the control measures which are necessary for the reduction of employee exposure to the permissible exposure limit are well within the economic capabilities of the industry (see Economics). Therefore, OSHA believes that the level of 150 µg/m³ is economically, as well as technologically, feasible.

Therefore, pursuant to OSHA's authority to force technology and in consideration of the evidence of new technology looming on the horizon, OSHA has determined that it is appropriate to allow for the factor of technology forcing in ascertaining that the 150 µg/m³ level is feasible. OSHA believes that this level is not infeasible by virtue of being at or below background levels, which would effectively require the emission-free operation of coke ovens for several years. This is three-fold. First, the National Air Sampling Network estimate of benzene-soluble organic matter back- ground levels (10 µg/m³) is significantly lower than the permissible exposure limit (Ex. 14). These measurements are, however, taken with different samplers, (high volume) and over a longer (24 hour) time period, and may not be directly translatable to sampling methods which are required by the standard. Second, the measurement of "no detectable levels" at Fairfield suggests that the background falls below the limit of detectability (approximately 20 µg/m³) of the sampling method (Ex. 2-223). Third, as stated earlier, there is general agreement that BRFPM is the indicator substance whose measurement is least affected by interference from background (TR 1928; TR 2493-4). It should be noted that the 150 µg/m³ level is not absolutely safe and that the risks associated with lower levels of exposure which were considered (e.g., 50 µg/m³ and 100 µg/m³) are correspondingly lower. However, as an exercise of rational Agency discretion, OSHA has determined that based upon the evidence available at this time exposure limit lower than 150 µg/m³ may not be feasible. This, of course, does not preclude the possibility that the level will be lowered in the future in the event that evidence becomes available at that time establishes that it would be feasible to do so.

D. Regulated Areas. The final standard requires that regulated areas (RA) be established and access thereto be limited to authorized persons. One purpose of this section is to serve as a mechanism for instituting other requirements, such as, exposure monitoring, medical surveillance, employee training, their corresponding recordkeeping requirements, the posting of precautionary signs, washing and showering, and the prohibition of certain activities.

The medical surveillance requirements apply to employees who are employed in the RA for 30 days in a year. The employee information and training provided applies to employees working in the RA. The precautionary signs mandated in this standard are required to be posted inside the RA. Employees in the RA are required to wash their hands and face prior to eating, and to shower before leaving at the end of the work shift. The presence or consumption of food or beverages, except water, and the application of cosmetics are prohibited in the RA except in certain designated areas.

Another purpose of this section of the standard is to aid in limiting exposure to coke oven emissions. By limiting access to the RA to authorized persons, the standard requires the employer to prevent those persons who are not authorized to enter the RA from doing so and thereby being exposed to coke oven emissions. This affirms the practice that some industry members report is already in effect (TR 2433 and Ex. 5A-3, p. 4). The standard (paragraph (k)) also requires the employer to train all authorized persons who are employed in the RA in the steps necessary to protect themselves against exposure to coke oven emissions.

In requiring the establishment of the RA's and limiting access thereto, the standard follows the approach of the ACGIH (Ex. 1a, p. 32273) and various participants (Ex. 5A-21, p. 5). It is also consistent with various sections of the NIOSH Criteria Document recommendations (Ex. 2-18, pp I-5, B, 8, 9, 11) which are related to specific work areas.

For by-product ovens, standard establishes the whole coke oven battery including topside, pushside, coke side, and their machinery, the battery ends, the screening station, and the wharf as the RA. This is based upon the epidemiological evidence which has established a link between exposure to coke oven emissions at various specific work areas of the coke plant and an increase incidence of morbidity and mortality (Ex. 20, 8-1, 8-29). It should be noted that the employees working at the screening station and wharf were categorized as side oven workers (an increased risk group) in the coke oven worker mortality studies (Ex. 2-105, p. 106; 20-J). Addition-
ally there is evidence that coke oven emissions, are present in these areas (TR 3374, 3375). Therefore, they have been specifically delineated as part of the RA. OSHA recognizes that at some coke plants, the screening station is not located adjacent to the rest of the coke oven battery. However, OSHA has decided that as a matter of policy, the RA shall include the screening station. This is to ensure that employees receive the full benefit of the various protective provisions of the standard, such as medical surveillance and employee training. Defining the beehive oven(s) and its machinery as an RA is the mechanism by which these requirements are instituted.

The proposed standard established the same specific regulated areas including beehive oven(s) and its machinery as the standard does, except that the screening station was not specifically included in the proposal (Ex. 1a p 32278). The Advisory Committee also recommended that the specific areas detailed in the final standard be established as the RA. Neither the beehive oven(s) and its machinery nor the screening station were specifically mentioned, but the RA requirement which included "all areas integral to the coke oven operations" is sufficiently broad to be interpreted to include them. (Ex. 3 p 18).

Both the proposed standard and the Advisory Committee report also established "any coke plant work area where the permissible exposure limit is exceeded by an RA (Ex. 1a, p 32278; 3, p 16). The final standard does not follow that approach. The permissible exposure limit of this standard only applies in the RA. Neither the beehive oven(s) and its machinery nor the screening station were specifically mentioned, but the RA requirement which included "all areas integral to the coke oven operations" is sufficiently broad to be interpreted to include them. (Ex. 3 p 18).

Fourth, section 8(c) (3) of the Act (29 U.S.C. 667) requires employers to promptly notify any employee who has been or is being exposed to toxic materials or harmful physical agents at levels which exceed those prescribed by an applicable occupational safety and health standard and to inform such employee of the corrective action being taken. Exposure monitoring is necessary in order to determine whether respiratory protection is required at all, and if so, which respirator is to be selected.

Fifth, the results of exposure monitoring are part of the information which is supplied to the physician. Finally, the use of respiratory protection is not required by the Act.
It is OSHA policy to monitor exposures by taking personal samples whenever possible. Area samples are generally not as direct a measure of employee exposure as are personal breathing zone samples. The Advisory Committee recommended periodic monitoring at least every three months. The proposed standard also followed that approach (Ex. 1a, p. 32278).

Exposure conditions on a coke oven battery vary from month to month (TR 2143). At least one sample is to be taken during each shift in order to ensure that exposure measurements represent exposures of employees on all shifts. The samples are to be full-shift samples in order to ensure that the measurements do not include parts of more than one shift in representing the exposure of an employee who works only one shift and to give a more accurate indication of an employee's average exposure during a work shift than would sampling for less than a full shift. Short term samples would not reflect either the ability of coke oven emissions associated with different parts of the coking cycle. Full-shift samples tend to average out these variations since the sampling period would cover many, or all, parts of the coking cycle. The Advisory Committee recommended essentially followed this approach (Ex. 3, p. 25). The proposed standard did not address these issues. The standard has added requirements for the reasons stated above.

OSHA recognizes that it takes time to issue and retrieve the samplers and that a full eight hour sample may not be possible. Therefore, full-shift sampling is defined to mean sampling for at least seven continuous hours. This does not, however, alter the requirement that the monitoring be representative of each employee's exposure over an eight-hour period. If the employer samples for less than eight (but at least seven) hours, then the average exposure determined for the sampling period must be used as the employee's exposure for an eight-hour period. If the sampling period is less than a full eight-hour period, then the exposure determined for that period would be multiplied by a factor of the sampler time to shift to shift in representing the exposure of an employee who works only one shift and to give a more accurate indication of an employee's average exposure during a work shift than would sampling for less than a full shift. Short term samples would not reflect either the ability of coke oven emissions associated with different parts of the coking cycle. Full-shift samples tend to average out these variations since the sampling period would cover many, or all, parts of the coking cycle. The Advisory Committee recommended essentially followed this approach (Ex. 3, p. 25). The proposed standard did not address these issues. The standard has added requirements for the reasons stated above.

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and incorporates this statutory obligation.

The employer is required to use a method of monitoring and measurement with an accuracy (at a confidence level of plus or minus 35%) of concentrations of coke oven emissions greater than or equal to 150 mg/m³. Problems with the accuracy of the benzene-soluble method of analysis led to the selection of a Sorensen apparatus; therefore the substitution of ultra-sonic extraction would improve the present accuracy of plus or minus 50% by approximately a factor of two (TR 427-428). Other improvements in the accuracy would result from such changes as: (1) The use of a combination of filter; (2) the use of routine operational checks to ensure proper operation of the semi-microbalance; (3) the use of ultraviolet light to check on the completeness of extraction; (4) the use of an extraction thimble to prevent loss of particulate material from the filter during extraction; (5) the use of a standard procedure to ensure removal of moisture from filters prior to weighing; (6) the use of polystyrene filter cassettes in place of the tenite cassettes now generally used (TR 1803). Since the improvement in accuracy of these changes, which are only one factor of three or four cannot be quantified, and since the improvement resulting from the use of ultrasonic extraction is only an estimate, an accuracy of plus or minus 35% has been required. It should be noted that this refers to a single sample.

Both the proposed standard (Ex. 1a, p. 32278) and the Advisory Committee report (Ex. 3, p. 28) required an accuracy of plus or minus 25%. This level was challenged as being unreasonable (TR 1802). OSHA believes that a requirement of plus or minus 35% is more reasonable and has changed the requirement in the standard accordingly.

The requirement for semi-annual analysis of polystyrene filter cassettes in the proposed standard (Ex. 1a, p. 32278) has been deleted from the standard. This analysis had been criticized as being time consuming and costly and yielding meaningless information (TR 1800; 32278). OSHA agrees that the time and expense are not justified by the information that would be obtained and has accordingly deleted this requirement.

OSHA has rejected the concept, for this standard, of the use of two substances for monitoring purposes. The proposal contained dual requirements for monitoring, RPM and B(a)P, as did the Advisory Committee report. For the reasons stated above, the use of BSFPTM is considered the most advantageous method and will provide the information necessary for the evaluation of the coke oven environment and OSHA has therefore rejected the use of RPM and B(a)P either individually or in combination.

F. Methods of compliance.

The standard contains the general requirements that the employer control employee exposure to coke oven emissions, including the use of engineering controls, work practices, and respiratory protection. With respect to existing coke oven batteries, the standard requires that specific minimum engineering controls be implemented at the earliest possible time but not later than January 20, 1980, except to the extent that it can be established that such controls are not feasible. If these specific engineering and work practice controls do not reduce employee exposures to or below the permissible exposure limit, the employer is required to use them to reduce exposure to the lowest level achievable and to research, develop, and implement any other engineering and work practice controls necessary to reduce exposure to the permissible exposure limit. In any event, whenever the permissible exposure limit is exceeded, the employer must supplement the controls through the use of respiratory protection in accordance with the requirements of the standard. While no specific controls are required for bee-hive ovens, a general obligation is imposed to reduce exposures in accordance with (1) (i).

OSHA believes that the most effective means of reducing occupational exposures is to contain the emissions at their source. We do not believe the use of respirators is an acceptable long term solution to the hazards associated with exposure to coke oven emissions. Many of the drawbacks relating to their use. (See discussion under Respiratory Protection below).

A necessary element of this approach is to require the use of engineering and work practice controls which can be implemented to reduce employee exposures to the lowest level achievable by these controls, even when these controls may not reduce exposures to or below the permissible exposure limit. In reaching this conclusion, we have carefully considered the possibility of requiring such controls only where there is a reasonable expectation that exposures would be reduced to or below the permissible exposure limit. In this regard, it should be noted that there is no known safe level of exposure to coke oven emissions and that there are presently no respirators available which have been tested and approved by NIOSH for coke oven emissions.

We fully expect respirators to be approved by NIOSH for coke oven emissions in the near future. However, we would not know each employee's actual intake of coke oven emissions because of variability in quality control, fit, the extent to which supervisors enforce the requirement that employees wear respirators, even if achieved, ambient air levels necessarily reduce actual employee intake, there is a greater likelihood that actual employee intake will be at or below the permissible exposure limit as a result of the installation of such controls.

In addition, it is difficult, if not impossible, to predict in advance the levels of respirators which would render unprotected controls infeasible. Through all of this reasoning it was suggested that certain controls should not be required for all ovens. However, these arguments generally consisted of hypothetical design elements of hypothetical control devices. During the rulemaking proceeding it was suggested that certain controls should not be required for all ovens. However, these arguments generally consisted of hypothetical design elements of hypothetical control devices. During the rulemaking proceeding it was suggested that certain controls should not be required for all ovens. However, these arguments generally consisted of hypothetical design elements of hypothetical control devices. During the rulemaking proceeding it was suggested that certain controls should not be required for all ovens. However, these arguments generally consisted of hypothetical design elements of hypothetical control devices.
cause other controls could compensate for them. These are discussed more fully under the individual controls.

Although specific controls have been mandated, OSHA realizes that it is sometimes difficult to anticipate design problems and that a solution may be needed. Some of the controls may not be technologically feasible on a particular battery. Therefore, the standard explicitly recognizes that if employer measures raise the defense of infeasibility as to one or more of the control items for the particular battery.

The question of whether an employer has met the burden of establishing that a particular control or set of controls is infeasible on a particular battery involves the consideration of many complex factors, and a rational balancing process. Factors such as levels of exposure, useful remaining life of the battery, and the efforts made by the employer to implement the control or set of controls are relevant. For example, if a battery is nearing the end of its useful life, exposures are well in excess of the permissibility limits and feasible controls are infeasible because of design, weight or technological factors, OSHA believes that the requirement to install feasible engineering controls would include rehabilitation of the battery or building a new battery which would accommodate the controls. This approach applies to both mandated controls and all other controls which will reduce employee exposures.

The second aspect of technological feasibility is that which deals with the requirements for any other controls that may be necessary to reduce employee exposure. It should be noted that it appears from the record that all of the specified controls plus additional technological developments may be necessary to reach the permissible exposure limit through engineering and work practice controls alone. The evidence in the record indicates that there are available additional technological developments which are being developed and tested (Ex. 30: 33; 33D: 144, Apx. A: 2-61, p. 128-160). Therefore, OSHA concludes that it is appropriate to include such a technology forcing provision in the standard.

The basic coking operation is described in the background section. Coke ovens are large structures operated at high temperatures under positive pressure. As a result, the gases inside the oven tend to be forced out of the oven through openings in the oven, thus exposing employees to coke oven emissions. Openings are necessary to supply coal to the oven and to remove the coke product. An aspiration system is used to collect and remove from the oven the materials that volatilize from coal during the coking process. These systems can be identified as (1) the aspiration systems cause deterioration of equipment, and (2) the associated equipment and releases of the battery itself and the associated equipment.

As noted above, the basic rule, unlike the proposal, requires specific minimum engineering and work practice controls for byproduct coke ovens, which constitute about 99% of the coking industry. OSHA believes this approach is appropriate because: (1) While there are some differences among the 65 coke oven plants with 256 coke oven batteries, their design and operations are similar; and (2) much of the technology which is required by the final rule has been available for some time. Yet, large segments of the industry have failed to implement this technology to comply with the present standard which requires the use of this technology. In reaching this conclusion, we note that in all instances that we do not know the precise reduction in exposures which will be achieved by each engineering and work practice control which is mandated by the final rule. However, we are confident that as described more fully below the specified controls will significantly reduce exposures and that these controls represent minimum controls which are necessary to protect employee health.

Based on the record developed in the informal rulemaking proceeding, including the Advisory Committee, the agency has determined that the engineering controls and work practices specified are the essential minimum constituents of an effective emission control program and that they are technologically feasible on nearly all of the existing coke oven batteries.

Paragraph (f)(1)(i)(2) of the standard requires employers to institute engineering and work practice controls at the earliest possible time but not later than January, 1975. The Advisory Committee recommended that all engineering controls be installed and in good working order no later than 180 days from the effective date of the standard (Ex. 3, p. 38). OSHA believes that 6 months is not a reasonable period for such operations. OSHA recognizes that the design, procurement, and installation of all engineering controls cannot be accomplished immediately. However, the thrust of the final rule is to fully implement the required engineering and work practice controls at the earliest possible time. Employers should not be lulled into believing that the only real obligation is to implement the required controls by January 20, 1980. Rather, the intent of the standard is to require employers to begin immediately to develop a compliance strategy; to design, install, and test the required equipment; and to implement this plan at the earliest possible time. The January 20, 1980 date is OSHA's best estimate of the latest date for full compliance. OSHA has based this determination on compliance actions by OSHA and EPA and other data on installation of controls.

The agreement between Bethlehem Steel Corporation at Buffalo, N.Y. and OSHA (Ex. 68A) signed in December, 1973 allows for the installation of filtered air systems on the plant's five larry cars. The agreement between Allied Chemical's Semet-Solvay Division and OSHA (Ex. 68C), dated May, 1974, required installation of air on the larry car and in the rest area by February, 1976. The OSHA agreement with Koppers Co. (Ex. 66J) dated November, 1976, requires installation of a filtered air system for the furnace room. Two years appears, therefore, to be a reasonable expectation for the time for the installation of filtered air systems, some can be installed sooner.

The implementation of procedures for stage charging requires an initial survey of the battery to determine what is necessary in terms of maintenance, repairs, and hardware (TR 1972). Refinement of other controls may also be required (TR 1972). Such a battery improvement program was undertaken at U.S. Steel's Fairfield Works in July, 1972 on Batteries 5 and 6 which were put into service in 1967 (Ex. 68A). These are single collector main batteries with four charging holes, served by one larry car per battery. A complete description of what was done to improve these batteries was presented by the plant superintendent in testimony at the hearing (TR 1971-7). Stage charging was operational in Batteries 5 and 6 since March, 1973 (Ex. 41A) or nine months after the program of improvement was begun.

The EPA-Jones and Laughlin (Pittsburgh Works) consent order (Ex. 68B) required the installation of air systems from charging equal to or greater than 20% opacity for any period of more than one minute in any sixty minutes period not later than June 1, 1977. This order was signed in October, 1975. OSHA's agreement with B.F. Goodrich (TR 1974) requires the installation of sequential charging on four larry cars by January, 1975.

The OSHA agreement with Alcoa's Lackawanna plant of December, 1973 (Ex. 68A) required installation of sequential charging on four larry cars by January, 1975.

The OSHA agreement with Alcoa's East Sandwich plant of October, 1975 (Ex. 68B) required stage charging by August, 1976. The agreement was <finalized in November, 1975. The OSHA-Armco agreement (Ex. 68D), signed June, 1974, required installation of sequential charging by October, 1975.

The OSHA-Koppers settlement (Ex. 68D) of November, 1975 required the installation of stage charging, including larry car hopper volumetrics, to be completed by December, 1975. Additional equipment such as coal vibrators and water sprays were required by December, 1976. Based on the foregoing OSHA believes that stage charging can be implemented in a twelve to eighteen month period.
Doors are a major emissions source and extensive rebuilding and maintenance of doors may be required. The EPA-Jones and Laughlin order (Ex. 682) required control of door emissions from the plant's five batteries over a five-year period (November, 1975–March, 1980).

Lackawanna (Ex. 68A), control of door emissions was required over two years (December, 1973–December, 1975) and over 16 months (June, 1974–October, 1975) at Armstrong (Ex. 68B).

The Overcoming door repair program at Fairfield involved the removal of all the two batteries 308 doors, stripping them to their shells, and rebuilding them to new tolerances with new sealing diahram, refractory insulating plugs, and latchmates (TR 1973). The sealing diaphragm design was altered to facilitate repairs and sealing. The door jams and buckstays were reset (TR 1973).

Albert Calderon, in his testimony at the hearing, stated that, under a service contract with his company, a battery of 78 doors at Lackawanna could be flipped over in his "luted-seal" doors in two years to avoid having to remove more than three doors at any one time (Ex. 30, p. 25). This testimony on the door repair effort has not yet been implemented.

The problem of door leakage is recognized to be the most resistant to technological innovation of the major coke oven emissions sources (Ex. 2-19). Substantial effort will be required to control door emissions including the rebuilding of doors and jams and the education of employees and supervisors in proper methods of cleaning and of the need to adhere to the established cleaning and maintenance schedules. In view of the extent of the problem, three year time limit appears reasonable.

A major portion of the effort in the control of coke oven emissions involves work practices. These include regular inspection, maintenance, cleaning and repair of the all equipment and strict adherence to prescribed schedules. Employees must be properly trained in such work and must understand it and their importance. The proper training of all employees will require time. OSHA does not expect that three years will be necessary for all such training but some aspects, such as operation and maintenance of mechanical gooseneck cleaners and the proper techniques for stage or sequential charging are dependent on the installation of the necessary hardware.

OSHA's compliance activities to date (Ex. 6) indicate that most battery improvements can be accomplished within two years. However, OSHA recognizes that some necessary materials, such as refractory brick and equipment such as DC motors may be in short supply and that the production in order to accommodate the increased demand.

Accordingly, the standard requires engineering and work practice controls to be implemented as soon as possible, but not later than January 26, 1980 (three years from the effective date) to permit employers to design, procure and install all necessary equipment.

In the proposal, OSHA expressed its concern that the "luted-seal" doors would "limit the development of new technology or necessitate frequent revision of the standard" (Ex. 1a, p. 32273). Since operators specified door jams and those who are not able to reach the permissible exposure limit through these engineering and work practice controls alone are required to research, develop, and implement new technology, OSHA's concern has been resolved.

The four areas of concern in controlling emissions are charging operations, coking, pushing operations and maintenance and repair programs.

1. Charging controls. The charging of coal into the oven is a major source of emissions. In a recent study conducted by the Battelle Memorial Institute's Columbus Laboratories for the National Air Pollution Control Administration (now EPA), charging was estimated to account for 60 percent of all coke oven emissions (Ex. 2-20, p. V-4). Emissions from charging result from three primary factors:

   (a) The coal entering the oven displaces about 90 percent of the free space in the oven and the displaced air may leave through four to six ports, only one (or rarely two) of which is not open to the atmosphere.

   (b) The moisture in the coal is immediately put into contact with the incandescent oven walls and floor and much of it flash-vaporized.

   (c) The coke itself is susceptible to thermochemical breakdown. As soon as it has become heated to over 260° C (500° F), smoke, tar vapors, and gases are formed by these pyrolysis reactions.

   (Ex. 2-20, p. III-11)

   Coal consists primarily of high molecular weight aromatic hydrocarbons of the benzene family. Under the conditions of these pyrolysis reactions, these hydrocarbons are directly vaporized (anthracene, chrysene, phenanthrene, naphthalene). Some break down to yield methane and lighter aromatics such as benzene. Some give off their hydrogen and are rapidly coked to graphite. One form of emission attributed to charging has been called the "coke ball" which is a small, porous globule of coke carbon apparently formed upon the rapid decomposition of tar droplet (or coal particle fused to tar) in the charging gases. Some of these gases will contain some nitrogen, carbon monoxide, carbon dioxide, hydrogen, methane, and steam. Polynuclear aromatic hydrocarbons, some of which are carcinogenic, are also present (Ex. 2-20, p. III-11-17, Ex. 4-83).

   High levels of charging emissions at U.S. plants result from use of high volatile coal, high coking temperatures, low coal moisture (more easily flashed), and rapid charging rates (Ex. 2-20, p. III-17) although these factors are variable. Some highly coking, refractory brick and equipment such as gooseneck cleaners and the proper techniques for stage charging are primarily an operating technique. Ordinarily, the outer hoppers are discharged first (either separately or simultaneously) and the third hopper charged after the outer hoppers have been completely discharged. This procedure occurs while the oven is maintained under slightly negative pressure by use of the aspiration system. This differs considerably from the old practice of isolating the gas collection system from the oven and then charging the coal into the oven, dropping the coal from the all the larry car hoppers simultaneously. The gases and smoke produced had only one escape route, which was to the atmosphere. Stage charging controls the flow of coal from each hopper to the oven and to each of the gases to the collector main from being blocked. The order in which the hoppers are charged, and the volume of coal in each hopper is carefully controlled so that coal piles in the oven do not block the free space at the top of the oven. Maintenance of this free space allows the gases to flow into the collector main rather than be emitted into the air. The effectiveness of stage charging in reducing exposure of coke oven workers has been shown conclusively on Batteries 5 and 6 at the Fairfield Works of the U.S. Steel Corporation. Data submitted to the Advisory Committee by U.S. Steel indicates substantial reduction in the exposure of topside employees (Ex. 2-127).

   A rehabilitation program for Batteries 5 and 6 was initiated (TR 1973) including the adaptation of the batteries for stage charging and major overhauling of all battery equipment (TR 1972-4). Prior to the rehabilitation and use of stage charging, CTPV exposure of the larry car operator was 2.50 mg/m³ (average of four samples) and lidman, 4.22 mg/m³ (average of four samples).
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After rehabilitation and stage charging, the lorry car operator's CTPV exposure was reduced to 0.57 mg/m² (average of 8 samples) and the lorryman's to 0.69 mg/m² (average of 18 samples) (Ex. 2-127). Samples collected at NIOSH at Batteries 5 and 6 at Fairfield indicated average CTPV exposure of the lorry car operator's to 0.38 mg/m² (average for 6 samples). Average exposure of the lorry man was 0.39 mg/m² (average of 12 samples) (2-223). While employees in the battery area are exposed to emissions from other sources in addition to charging, it is apparent that charging emissions can thus be substantially reduced by the use of stage charging.

There has been some uncertainty about the ability to carry out stage charging on the new six meter (20 foot) batteries. These batteries are considerably taller than conventional ovens and hold about twice the volume per oven. This larger coal capacity means that about twice the volume of gas will be displaced from the oven during charging and longer charging times are required. Tall ovens have a higher thermal head, i.e., gases rise in the oven with a higher velocity. These factors may overload the aspiration system and make stage charging less effective than on shorter ovens. The SWA reports that four of the ten tall batteries presently in operation in the U.S. can be stage charged (Ex. 144). The EPA, however, reports that tall ovens exist that are able to perform the stage charging on tall ovens (Ex. 149, p. 118, footnote 2). It has been suggested that it may not be possible to have the same performance as with shorter ovens (TR. 1396). However, OSHA believes that stage charging can be scaled up to tall ovens by designing the carry cars to accommodate the necessary procedures such as sizing of the hoppers to allow for proper proportioning of coal. Aspiration systems can be designed to maintain sufficient suction.

b. Sequential charging. Another system of charging which has been successful is sequential charging. Four batteries in the U.S. are using sequential charging. Stage charging and sequential charging are often confused. Sequential charging refers to a procedure where the first two hoppers are still discharging while subsequent hoppers begin discharging. Sequential charging uses a automatically timed sequence to control the discharge of coal from the hopper. The term "stage charging" is the term used in the United States for a procedure developed in Great Britain about 1961 (Ex. 2-19; 2-199) and referred to as "sequential charging." The use of the term "sequential charging" in the U.S., and in the standard refers to the automatically timed charging systems described above. Sequential charging relies heavily on automation to reduce operator error. An automated lorry car for sequential charging is shown under the equipment of the EPA and AISI. The car was placed in operation on the P4 battery of Jones and Laughlin Steel Corporation's Pittsburgh Works in December, 1971. The battery contains a single collector main design with three charging holes. The lorry car had three primary components in the charging of operations, (2) a single area conditioned cab to protect the operator from the emissions, and (3) a single single coke-charging machine. The system was originally designed for fully automatic operation, but many operations were not automatically operated in actual use due to the need for more flexibility in the charging sequence.

Based upon its similarity to stage charging, its apparent success to date and its future potential, the standard permits sequential charging. Provided the aspiration system is adequate to effectively remove all of the gases from the oven into the collector main.

c. Scrubber lorry cars. Five of the presently operating tall batteries are equipped with scrubber lorry cars. A shroud covers each charging hole and emissions rise in the shroud and are ignited and burned from this point. The burning passed through a gas scrubbing system. All of this equipment is mounted on the lorry car. There are two emissions sources in this system. One is around the shroud and the other is where poor capture will allow emissions to escape and the other is from the scrubber. The primary variables that affect the performance of lorry car scrubber systems in controlling charging emissions are the type of scrubber and energy input (higher energy venturi scrubbers may be more effective), the consistency with which ignition of the gases is maintained, and the amount of suction used to capture emissions in the drop sleeve. Performance of these scrubbers has not been as effective as charging controls which contain, rather than capture the gases (Ex. 2-19, p. 26-7; TR. 1491-5, 1663-4, 2568).

Based upon the foregoing, including the underlying concept of capture, rather than containment of emissions, and the relative ineffectiveness, to date, of the scrubber lorry car, we are unable to conclude that the lorry car provides or is likely to provide adequate protection to employees. This is not to say that scrubber lorry may not, at some point in the future, prove effective. Therefore, while we have not expressly permitted scrubber lorry cars, employ who can establish that the use of the scrubber lorry will provide a place of employment safe and healthful as those which would prevail if the employee utilized the possible forms of charging may utilize the variance procedure.

d. Enclosed charging. Five batteries in the U.S. are charged by means of an enclosed pipeline system. Pipeline systems were developed to boost coke production. Coke is charged with preheated coal. The shorter time required to carbonize preheated coal results in increases in production (2-19). Preheating allows use of high volatile coals without loss of coke quality. Preheated coal flows like a fluid which makes the coal charge self level. One emissions source, leveling through the shucht hole is thereby eliminated. Potential sources of emissions are the side holes and standpipe Als. Although coal is introduced into the oven by the pipeline and there is no larry car, there are holes on the battery top which may be opened for decarbonization. The charging holes and standpipe lids are in place and sealed during charging. With the lids sealed properly in emissions should result. On February 19, 1976, OSHA staff members visited the pipeline charged battery at Inland Steel's Indiana Harbor plant (Ex. 66H). The battery has been in operation for two years at the time of the visit. One of the side holes must be partially opened during charging to relieve the intense pressure build-up in the oven. Dense smoke and some flame is emitted from this lid during charging for 5-8 minutes. The pressure also contributes to the door emissions problem. Inland has made numerous alterations in order to solve some of the operating problems. The charging lines have been moved from the side of the battery to the top. This seems to reduce some emissions. The battery allows more coal to be placed in each oven. Adherence to proper operating procedures such as control of oven pressures and sealing of lids and doors should make smokeless operation possible. Based upon the foregoing, OSHA believes that the underlying concept of enclosing the charging system and containing the emissions is sound. We believe that this new technology has the potential to eliminate at least two sources of emissions—charging and leveling. In addition, the system seems to be improving in reliability in reducing or eliminating emissions. In sum, OSHA believes that pipeline charging or other enclosed systems can be operated so as not to release emissions into the workplace atmosphere. Accordingly, enclosed charging systems are permitted by the final rule. No specific charging requirements are set forth in the standard because the record was insufficient to do so. However, a general requirement has been imposed to design and operate pipeline or enclosures charged batteries to eliminate emissions during charging.

e. Drafting. There is general agreement that effective control of charging emissions requires drafting from two or more points in each oven (Ex. 2-163; Ex. 3; TR. 1380, 1472, 1561, 2055, 2181, 2465). To date, only double collector mains or a jumper pipe have been successful in removing gases from the oven. For this reason, the standard requires double drafting of either double collector mains or a fixed or movable jumper pipe on single collector main batteries. The jumper pipe is used to connect the oven being charged with a nearby oven in order to permit drafting from both ovens. The successful use of a jumper pipe system has been demonstrated by its use at the Fairfield Works. In U.S. Steel Corporation, it has been estimated that a jumper pipe reduces smoke emissions by two-thirds during charging (Ex. 2-27, p. 55; 2-93). Emissions from the ovens are collected with jumper pipes. Retrofitting with a second collector main is more difficult, (TR.
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3513a), although a second collector main has been retrofitted at C.P. and I's plant at Pueblo, Colorado (TR 2594).

In view of the evidence, as set forth above, on the necessity for double drafting and the retrofittablity of systems for this purpose, this equipment is required as part of the required stage charging or sequential charging process.

In order to ensure that gases evolved during charging can be effectively moved into the collector main the aspiration system, including the steam pressure and steam jet diameter must be adequate for this purpose. Coke oven operators and EPA representatives testified to the need for an adequate aspiration system for control of charging emissions (TR 1474-7, 1972, 2165, 2469). A report by the Battelle Memorial Institute to AIJS stated that adequate aspiration is essential in reducing smoke emissions during charging (Ex. 2-19). This may require an increase in the capacity of the steam plant as well as an increase in the size of the piping and nozzles. Some plants have already made such modifications (Ex. 2-19, 2-37, 2-40; TR 2470, 2594). The Advisory Committee Report contained a requirement for increased steam ejector capacity including sufficient cleaning capacity of the steam and vacuum system and steam jets of sufficient diameter and pressure (Ex. 3). It is not possible to establish even minimum specifications for aspiration systems generally because of the variation in systems. Therefore, the final rule requires that each aspiration system provide sufficient negative pressure and volume to effectively move the gases evolved during charging into the collector main or mains.

Absolute control of coal volume in each larry car hopper is mandatory for smokeless charging (Ex. 2-37c). Witnesses for EPA and coke plant operators testified that mechanical volumetric controls are necessary and have been or are being installed as part of plans to implement stage charging at several plants (TR 765, 1342-3, 1474, 2060, 2164, 2469-72). Although installing mechanical volumetric controls for modernizing the larry car (TR 1567) such controls are important in order to prevent blockage of the gas passage (TR 1627). Mechanized volumetric controls, such as mechanical rings, could be retrofitted on most batteries (TR 1628). Mechanical volumetric controls are necessary to regulate the coal charge by, for example, compensating for changes in coal flow properties due to bulk density, oil addition, moisture content and grind (Ex. 2-37c). It was suggested that a plant that has uniform coal may not need such controls (TR 2060). However, no evidence was presented that coal blends are, indeed uniform, and in view of the general recognition of the need for mechanical volumetric controls, the standard requires their use as an essential part of stage charging.

Effective stage or sequential charging requires a rapid and continuous flow of coke and the necessary devices for double drafting and the retrofittablity of systems for this purpose, this equipment is required as part of the required stage charging or sequential charging process.

No information on this type of equipment was presented to the Advisory Committee and, therefore, no recommendation was made in the final rule or the report. For the same reasons, this item is not in Appendix B to the proposed standard. The NIOSH criteria document makes no mention of this equipment. However, such devices have been utilized by employers as part of an effective charging program (Ex. 683). Compressed air equipment has been installed and is in use at U.S. Steel's Fairfield Coke Plant. Compressed air at 10,000 pounds per square inch (PSI) air pressure is used to dislodge coal from the coal bunker at Pueblo, Colorado (TR 1973-4). This equipment was described as being highly successful (TR 1974). Representatives of Republic Steel and National Steel both stated that compressed air or steam flow is a quite valuable tool for reducing emissions (TR 2280-1, 2387). Indeed, National Steel indicated that stage charging could not be successful without some means of dislodging coal from the collection system. Employees of both U.S. Steel's Fairfield and Clairton Works consider this equipment an effective charging system (TR 2076-7, 3141). The evidence presented indicates that pneumatic equipment is an effective means of facilitating the flow of coal both from the bunker into the hoppers for proper filling and from the hoppers to the oven for successful charging. Therefore, these are required among the alternative controls for facilitating the flow of coal.

For charging to be carried out properly it is important that the oven not be open to the atmosphere any more than absolutely necessary in order for the aspiration system to perform effectively (Ex. 2-37c). To do this, the charging hole lids must be replaced after the corresponding hopper has been emptied, as no aspiration system could maintain a negative pressure across an oven with all charging holes open. Therefore, the standard requires all larry cars to be equipped with individually operated drop sleeves and slide gates. These sleeves can be raised as each hopper is emptied so that the lid can be replaced. This is an important procedural step in stage or sequential charging (Ex. 2-37c). Witnesses for several steel companies and the EPA acknowledged the importance of this equipment (TR 1477-8, 1565, 2057-8, 2164-5). This control was included in the Advisory Committee Report having been a viable device (Ex. 2-139) and industry representatives (Ex. 2-163). The NIOSH criteria document, while not specifying individually operated devices, does recommend that charging hole lids be replaced as soon as possible after the hopper charge and thereby ensure the proper performance of a critical step in stage or sequential charging.

The removal of tar and carbon buildup can be accomplished in three ways: (1) manually, i.e. an employee stands over the oven to remove the gaseous emissions with a metal rod. This method effectively cleans the gooseneck, but is slower than other methods and exposes the employee to coke oven emissions (TR 1675); (2) flail-type or mechanical cleaners, i.e. motor driven cutting discs which are manually guided into the gooseneck (Ex. 2-37c); and (3) cookie-cutter or automatic gooseneck cleaner, i.e. a disc cut from a mechanical arm which moves into the gooseneck. Since it is an automatic device, proper alignment is necessary to effectively clean the gooseneck. There is no evidence, however, that such cleaners require major modification of standard equipment. Therefore, adequate aspiration is essential for stage charging. This can only be carried out if goosenecks and standpipes remain free of tar and carbon buildup which would reduce the size of the gas passage. A relatively small reduction in the effective gooseneck opening due to buildup of carbon can reduce the volume of gas moving through the offtake system and result in emissions. For example, an accumulation of 1/2 inches within a gooseneck with a diameter of 13 inches reduces the area by 41% and aspiration by 25% (Ex. 2-37c).

Design of larry cars and goosenecks is an important factor in the successful retrofitting of mechanized gooseneck cleaners (Ex. 145, App. A).

Carbon build-up can be cleaned mechanically from standpipes by the use of a heavy ball on a hoist which is lowered into the standpipe (TR 1565). Standpipe design may preclude the use of such equipment (TR 1625, 2328). On some batteries there is only a minor problem with the plugging of standpipes and such equipment may not be necessary (TR 1624; Ex. 144 App. A).

The Report of the Advisory Committee (Ex. 3) recommended that goosenecks and standpipes be cleaned prior to each charge by mechanical means on all batteries. The NIOSH criteria document does not mention mechanical cleaning devices although it does state that goosenecks and standpipes be cleaned of any carbon for tar build-up prior to each charge (Ex. 2-18). Mechanized gooseneck and standpipe cleaners were included in Appendix B to the proposed standard.

The record supports a requirement for non-manual cleaning of goosenecks and standpipes. Accordingly, use of mechanical devices such as the flail or cookie-cutter type cleaners that have been described above will comply with (1) (2) (g).

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This equipment, especially the mechanical cleaners, can be retrofitted on many existing batteries and is effective in cleaning goosenecks while keeping the employee a safe distance from the emission source (TR 1674, 3531–2). Automatic cleaners have been retrofitted on at least one battery (Ex. 66G). Machine assisted cleaning may not necessarily be more effective than manual cleaning but they can be as effective, without unnecessarily exposing employees (TR 2216–7). Standpipe caps must still be cleaned manually at the present time. As with all coke oven equipment, there is a continuing need to improve the design of mechanical offtake cleaning devices (TR 2471; Ex. 145, App. A). The success of emission control by use of advanced charging methodologies depends greatly on adequate aspiration which can be achieved only if the goosenecks and standpipes are kept free of deposits. This necessitates constant inspection and regular cleaning in order to remove any build-up (Ex. 2–37C, 40A, 146; TR 1479, 1572–6).

There is agreement on the necessity to maintain standpipes and goosenecks free of carbon and tar deposits and the need for adherence to a written procedure to ensure the inspection and cleaning are done on a regular basis (Ex. 2–165, 144, 145). This cleaning should be done each time the oven is charged (Ex. 2–120, 132, 220).

The standard requires cleaning of goosenecks and standpipes prior to each charge. The employer must determine a minimum gooseneck diameter which ensures effective aspiration. Regular cleaning will maintain the prescribed diameter. It is not possible for OSHA to specify a diameter which would be applicable to all batteries, so each employer must make that determination for each battery. As has been stated earlier, area reduction of 41% will reduce aspiration by 25% in a 13" diameter gooseneck (Ex. 2–37C). Both the Advisory Committee report (Ex. 3, p. 39) and Appendix B to the proposal included cleaning of goosenecks and standpipes to a specified minimum. U.S. Steel’s Fairfield Works has specified the minimum necessary diameter and the larry car operator has been instructed as to what this diameter is so it can be maintained (TR 2076–7). The proposed settlement agreement between OSHA and Republic Steel Corporation specifies a 10” minimum diameter for goosenecks and standpipes (Ex. 465). The settlement agreement between OSHA and Koppers Co. signed on November 18, 1975, requires the maintenance of an 11” minimum opening in standpipes and goosenecks (Ex. 68J, p. 9). The specification of a minimum diameter for goosenecks and standpipes was included in the USWA’s proposed agreement with U.S. Steel for the Clairton Works (E).

The specification in the standard that a minimum diameter for goosenecks and standpipes be established for each battery appears to be the most practical method of ensuring that the goosenecks and standpipes are kept open to permit optimal function of the aspiration system. Once established, the minimum diameter can easily be checked using a gauge, such as a metal disc of the proper diameter for a gooseneck or a standpipe (Ex. 68J, p. 9) and the amount of cleaning needed can be quickly determined.

The Advisory Committee recommended that steam nozzles, liquor sprays, and standpipe caps be inspected prior to each use of the aspiration system operating properly and cleaned as necessary (Ex. 3, p. 40). In view of the importance of keeping and standpipe caps seated correctly and sealed, the standard includes a provision similar to the Advisory Committee’s recommendation.

As has been previously stated, it is essential to smokeless charging to keep the gas passage open from the oven to the offtake system. To maintain this open passage the coal charge must be properly leveled (except for pipeline charging) to smooth out the peaks which form under each charging hole. To accomplish this, the leveler bar of the pusher machine is inserted in the oven through the chuck door located near the top of the oven. It is critical that the chuck door remain closed until leveling is begun and that the door be reseated properly to affect aspiration (Ex. 2–19, 2–37C). The leveling operation increases the volume of gas which must be handled by the aspiration system (Ex. 2–37C, 2–120). To maintain the integrity of the aspiration system during leveling, an air seal, or smoke boot, (Ex. 2–37C, Photo II) can be placed over the open chuck door and the leveler bar inserted through the seal (Ex. 2–146, 2–163). If well designed, the air seal provides a minimum amount of space between it and the leveler bar (Ex. 2–120).

There is some disagreement as to the need for air seals on all batteries. If all other devices are working properly and neutral or slightly negative pressure is maintained, air seals may not be necessary (Ex. 2–19; TR 1563). The location of the chuck door relative to the collector main may affect the need for an air seal. If the chuck door is directly below the collector main, suction will be lost when the chuck door is opened (TR 3519) and emissions may occur. The aspiration system may still be able to maintain adequate suction without an air seal if the collector main and chuck door are on opposite sides of the oven, as is the case at Fairfield (Ex. 144, App. A). Since the levels at Fairfield preceded the permissible exposure limit, air seals may well be necessary. The structural arrangement of the chuck door may preclude the retrofitting of an air seal, sufficient clearance may not be present and installation of an air seal may not, therefore, be necessary.

Several companies have installed air seals, including Ford Motor Co. (TR 766, 813), U.S. Steel, Clairton (2–37C), and Bethlehem Steel (TR 2469–72). Republic Steel stated that such air seals would be effective in reducing coke oven emissions sufficiently such seals are placed in the coke oven. Koppers and has agreed to install an air seal at its merchant coke plant (Ex. 68J). National Steel concurred that aspiration would be aided by air seals (TR 2328). National was the only participant to state that maintenance of the air seals causes additional employee exposure (TR 2328). OSHA believes, however, that if maintenance is done when the air seal is not actually in use, no increase in emissions occurs.

Air seals have been demonstrated to be effective in helping to maintain adequate aspiration during the leveling operation, thus reducing emissions (Ex. 2–37C, 2–120, TR 766, 813). Although some retrofit problems may exist, most plants can install and make use of leveler bar-air seals (Ex. 2–60, 2–21). The use of these air seals was included in the Report of the Advisory Committee after having been recommended by both industry (Ex. 2–165) and USWA (Ex. 2–159) representatives. The NIOSH criteria document does not mention this device although the document does recommend that leveling be carried out in a manner which minimizes the evolution of smoke (Ex. 2–18, Pg. 1–4).

In order to function properly, the seals must be structurally sound and must be regularly inspected and, if needed, replaced (Ex. 2–220). National strongly recommended by the Advisory Committee was to inspect prior to every charge. No information is present in the record for determining an exact frequency for inspection of air seals, however, air seals should be inspected regularly. Inspection prior to each charge would be prudent, although the necessity for this frequency for each charge cannot be determined from the record. Therefore, the standard requires that air seals be inspected regularly and repairs be implemented as soon as possible as part of the maintenance and repair program under paragraph (f) (3) (iv) (a) of the standard.

The accumulation of hard carbon deposits on the roof of the coking chamber can seriously impede aspiration and can cause tunnel head blockage to the offtakes. This results in increased pressure as the evolved gases seek another pathway. A constantly open tunnel head is necessary for the gases to be contained in the oven and exhausted through the collector main (Ex. 2–37C). If the amount of coal charged is less than the proper amount there will be an increase in the free space at the top of the oven. Top temperatures may then increase in the free space causing cracking of hydrocarbons which results in the formation of roof carbon (TR 1342, 2081). Roof carbon can cause tunnel head blockage and lead to charging emissions (TR 1486). Devices which mount on the pusher ram are available to remove roof carbon. These include aspiration systems which blow off loose carbon deposits and a carbon cutter which is a steel blade with teeth which cuts through hard carbon accumulation. These two devices are most effective in controlling roof carbon (TR 2173, 2328) and can be successfully retrofitted (2–220). These devices are in use or are being installed at plants of U.S. Steel and Bethlehem Steel (TR 2469–72). Roof
carbon can also be removed by leaving the oven open to the air after pushing is completed to burn off the carbon (TR 2081). This method however necessitates taking the oven temporarily out of use, which would operate as a production deterrent to do it. Accordingly, the standard requires carbon cutter or compressed air, or both.

Some cutters may not have roof carbon problems (TR 765, 1566, 2172), but carbon accumulations must be removed in instances where they occur (TR 1566). Decarbonizing compressed air and carbon cutters were recommended by the Advisory Committee as well as the recommendation that the oven not be charged if an adequate gas channel does not exist (Ex. 3, p. 39). This was considered by the Committee to be an important work practice. The standard requires that ovens be inspected prior to charging and that roof carbon build-up be removed in order to provide an adequate gas channel to effectively move the gas from the oven to the collector main(s).

The standard requires that a detailed work procedure for charging be developed and placed in operation. The procedure shall consist of all the necessary actions to be performed and their prescribed sequence. The standard enumerates several elements to be included, as a minimum, in the procedure (except for pipeline charging which will be discussed below). As previously discussed, stage and sequential charging are processes which are designed to keep the gas passage at the top of the oven so that gases evolved during charging are drawn off into the collector main(s) rather than escaping to the atmosphere. The elements in the standard, in combination with the required control equipment, are designed to ensure that end. The standard requires the following procedure: The larry car hoppers are to be filled with coal to the proper level determined by the mechanical volumetric controls required under paragraph (f) (2) (1) (d) of the standard. The exact distribution of the coal charge among the hoppers will vary although the outer hoppers usually make up the largest bulk of the charge. The hoppers are released and emptied. Instead, each slide gate between the drop sleeve and the hopper is closed and the lids are replaced after the charge is completed. The lids are replaced one at a time. The use of the slide gate instead of re-lidding in this manner may be effective if the drop sleeves fit closely enough over the open charging hole to prevent infiltration of air. The procedure at Clairton emphasizes the prompt and complete replacement of lids of all but the last charging hole prior to leveling (Ex. 2-37C). Many of the details of the procedure must be worked out for each individual bakery (Ex. 2-19). The stage charging process requires a well-trained operating crew (2-19; TR 1975). The success of the use of stage charging in part is due to radio communications in the plant (TR 1976). This is necessary as close coordination is required, especially between the larry car operator and the pusher operator. Such communications may be by two-way radio or by other means, such as horns or bells.

The same minimum procedures required for stage charging are required for sequential charging, except that for sequential charging a sequence may be used which results in more than two sequential hoppers being charged at one time. A typical sequence might have hopper No. 1 completing discharge while hopper 3 or 4 is beginning to discharge. Permitting sequential charging is not intended to provide a production rate which overloads or blocks the aspiration system. Rather it is a recognition that some systems may be able to effectively move the gases from the hoppers into the collector main by this means.

Obviously, some of the engineering control requirements would not be applicable to pipeline charging. For example, many of the stage or sequential charging requirements and the leveler bar requirements are wholly irrelevant to pipeline charging. Therefore, the final rule sets forth the requirements which do not apply to pipeline charging.

Coking emissions. The standard requires a series of minimum engineering controls and work practices to reduce coking emissions. Emissions during the coking cycle result from the positive pressure in the oven compared to the pressure in the collecting system. Under this circumstance, the oven gases will leak from all available openings in an attempt to obtain uniform pressure. The main sources of emissions during this time are topside emissions which are discussed under charging emissions, and door emissions. Other emission sources are considered under pushing emissions and maintenance and repair. In this section the major emphasis is placed on the control of door emissions through the requirements for door repair facilities for prompt and, as soon as possible, an adequate number of spare doors, chuck door gaskets, and the establishment of a routine program for inspection repair, adjustment and cleaning of doors. In addition, a main control system for maintaining and checking collector main pressure and oven pressure is required.

Of the three main emission categories i.e., charging, pushing and door, the door emissions problem has been most resistant to technological innovation (Ex. 2-19: 2-37C). A study prepared for the Environmental Protection Agency by Battelle Columbus Laboratories in July, 1975 (Ex. 75) contains a detailed discussion of the door emission problem, present control procedures, and possible technological solutions requiring further research. The basic cause of the emissions is the thermal warpage and distortion of the door seal. The main control systems work i.e. seals, jamb doors and refractory brickwork as well as damage in routine removal and replacement of the doors during the pushing operation (Ex. 75). There are two types of coke oven doors—luted and self-sealing. The former are generally in use on older batteries and are sealed by the application of a sealing material or clay mix around the door after it is replaced on the oven. Most coke oven batteries use self-sealing doors of a variety of designs that in general depend on "pressing a door-mounted edge strip against the mating face on the oven-mounted jamb (door frame)" (Ex. 2-19 p. 69; Ex. 75 p. IV-9). The doors seal, thus causing leaks to stop at some point in the coking cycle. This occurs because of the normal drop in the internal pressure as coking progresses and because of the formulation of a seal by the condensation of tars on the metal edge against the metal jamb.

The extent of door emissions in relation to employee exposure varies from battery to battery depending on, among
other things, the condition of the battery and the need to door repair and maintenance. While emissions from all sources are present during battery operation, it is possible to isolate somewhat the amount of door emissions in terms of the repair period. In sampling taken on the push side of the battery, Examples of these exposures for pusher side door machine operators ranged from 0.1 mg/m² CTPV to 1.0 mg/m² CTPV according to data submitted by Republic Steel Corporation (Ex. 74). Because these exposure levels are not insignificant it is appropriate that the standard prescribe adequate minimum requirements for control of coking emissions and particularly door emissions.

To assure that the aspiration system functions properly, the final rule requires pressure control systems for control/oven and collector main pressures during coking cycles. Excess pressures constitute an explosion hazard and also increase the incidence of emissions (TR 1567, 1575). Both the Advisory Committee recommendations (Ex. 3) and the Report of Industry Members of the Advisory Committee (Ex. 4) included similar requirements as did the recommendation of the United Steelworkers of America (TR 3538, Ex. 144; Ex. 145). The door emission control program includes appropriate maintenance and repair of the metal components on the ovens, the doors and their components, door handling machinery and inspection and cleaning methods. Door repair facilities are an essential component of a door emissions control program in order to make repairs to parts such as door edges, or refractory brickwork (TR 1918-2020). The need for such facilities was cited by the Advisory Committee (Ex. 4) in the Report of Industry Members of the Advisory Committee (Ex. 3) and representatives of employers and employees (TR 1568, 2018, 3536-37). While door repair facilities are often located at the coke plants (TR 1918, Ex. 9B) smaller facilities were also in operation. Similar reports and surveys conducted on the coke side were submitted by Battelle (TR 1568, Ex. 12A-19) as well as reports from other facilities (TR 2173, 2335). While door repair facilities are often located at the coke plants (TR 1918, Ex. 9B) smaller facilities were also in operation. Similar reports and surveys conducted on the coke side were submitted by Battelle (TR 1568, Ex. 12A-19) as well as reports from other facilities (TR 2173, 2335).

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An adequate number of spare doors for replacement purposes is required because the coking operation is a continuous process and the only way to effect repairs on operating doors is to be able to replace them during the repair period. In sampling taken on the push side of the battery, Examples of these exposures for pusher side door machine operators ranged from 0.1 mg/m² CTPV to 1.0 mg/m² CTPV according to data submitted by Republic Steel Corporation (Ex. 74). Because these exposure levels are not insignificant it is appropriate that the standard prescribe adequate minimum requirements for control of coking emissions and particularly door emissions.

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May 24, 1976, James Smith of USWA reported that the Armco Steel Corporation was going to install canopies on all the pushside doors at its Houston plant (TR 4897-8). Armco informed OSHA, in a letter dated May 20, 1976 (Ex. 137) that canopies were to be installed on only five ovens. Armco stated that the letter indicated that the canopy system proved capable of improving the topside environment, the system would be extended to the balance of the oven when possible.

At Bethlehem Steel's Burns Harbor plant, four experimental door canopies were installed on Battery No. 1. These canopies were no longer in use when Department of Labor representatives visited the plant on February 8, 1976 (Ex. 68FP-3). No test results from either Bethlehem or Armco have been received by OSHA.

Although such canopies may hold promise, insufficient information is available for OSHA to mandate their use. Canopies, at present, are technology under development, and a requirement for their installation would be premature.

The second component of the coking emissions control provisions is in the area of work practices. These sections generally indicate that the emission control program must reflect an intent to comply with the standard. The basic area of dispute on this point is the requirement for cleaning the sealing surfaces of the door. The proposed cleaning requirements for the sealing edges of the door fit the jamb (TR 2038-9). It is recognized that, particularly with regard to jamb replacement, such a program is an extensive undertaking that would be necessary for periodic jamb and door replacement are currently part of a number of coke oven emission control programs (Ex. 68B; Ex. 6-6C; Ex. 65-K; Ex. 68N; TR 1973 3068).

A similar provision was contained in the Advisory Committee's recommendations and in Appendix B to the proposal.

The second component of the door emission control program concerns routine cleaning each coking cycle, i.e., when the door is removed from the oven to be pushed. The basic area of dispute on this issue is the requirement for cleaning every cycle rather than inspection every cycle with cleaning as necessary (Ex. 4). While there was no dispute as to the need for periodic cleaning, the parties disagreed on the necessity for cleaning every cycle, along with other aspects of the emission control program, impact on the production schedule, and the size of the operation (TR 1351, 1484-5). As employee representatives testified, door cleaning, even where necessary, may be ignored in order to maintain the production schedule (TR 3118).

The complete record discussion of an effective operating door emission control program is contained in the testimony of U.S. Steel Corporation (TR 2014-2052). The final rule set forth minimum requirements for effective emissions control.

The container is required to the extent necessary to provide an effective seal. It was generally recognized that while metal-to-metal fit is required, the seal itself is effected by the formation of a thin layer of tar on the sealing surfaces (Ex. 75; TR 5347-8). Therefore, cleaning is required to the extent necessary to provide this seal. Cleaning of the doors and jams is to be done each time the door is removed for the oven to be pushed. On batteries with accumulated amounts of carbon deposits, extensive cleaning will be initially required whereas, on batteries with less deposits, instituted good cleaning practices, little cleaning may be necessary (TR 2040-3).

The third portion of the door emission control program ties the other elements together to form an inspection, analysis and corrective action program. Details, and a discussion of the effectiveness of one such program, were provided by Armco (Ex. 199, TR 2026-7). Similar emission evaluation programs are incorporated in the emission control programs of other coke plants (TR 1462: Ex. 68B).

The final work practice procedure under coking emissions deals with luted doors and defines the applicable criteria to prevent emissions from these doors. Consequently, such doors are to be luted each coking cycle and related to other emissions. As with other doors, luted doors on oven jams can also warp or be damaged and require adjustments, repair, or replacement. (Ex. 75; Ex. 68D), and such a program is required for the standard.

The Advisory Committee report contained a recommendation that the coal mixture, moisture and grind be selected to minimize reduction. Coal characteristics consistent with efficient operation of the plant and the availability of coal. (Ex. 3, p. 41). The standard does not include this requirement as the variability in the availability of coal makes this impractical.

Low volatile coals, which would generate less emissions, are becoming increasingly scarce. For coke, operators to use lower quality coals for coking. Although the Advisory Committee recommendation does represent sound operating practice, it constitutes too vague a requirement from the standpoint of employer compliance. OSHA enforcement is, and therefore, not included.

The specifics of the previously discussed work practices are to be written and included in the operation and maintenance plans. The required operations and maintenance programs are stated in the proposal, for a metal-to-metal seal. Coke oven builders, as reported in the Battelle Report, recommend such cleaning before each coking cycle (Ex. 2-201). This procedure is contained in the Memorandum of Understanding between U.S. Steel and USWA at Clairton (Ex. 2-69C) and in other abatement programs (Ex. 68B).

The standard requires the repair, replacement and adjusted of the various oven sealing components. These parts, i.e., oven doors, chuck doors and door jams, are to be repaired, adjusted or replaced as necessary to provide a continuous metal-to-metal fit of the sealing edge to the jamb. Once the doors are properly installed, the battery is removed from the oven to be pushed. On batteries with accumulated amounts of carbon deposits, extensive cleaning will be initially required whereas, on batteries with less deposits, instituted good cleaning practices, little cleaning may be necessary (TR 2040-3).
ear operators, who work at a greater distance from the ovens and are generally in closer proximity to pushing emissions than other emission sources, have generally lower exposures i.e. from no detection at CTPP at (Ex. 2-233; Ex. 71) and <0.1 mg/m³ to 1.6 mg/m³ at Republic (Ex. 74, Item 2) and 0.6 mg/m³ at a foundry plant (Ex. 73A).

While reliable measurements of the amount of volatile material in pushing emissions is not available in the literature (Ex. 10) and has not been submitted for the record, it is generally agreed that due to the volatilization of material during the coking process, the pushing emissions contain less volatile matter than other emission sources, have general lower exposure so that employee exposure to these emissions will be less than exposure from other parts of the coking process. Therefore, the primary emphasis of the standard is on control during coking, e.g. proper heating and maintenance of the heating system to ensure proper coking and the prevention of green pushes to the maximum extent possible. As discussed in prior proceedings, it is not sufficient to control employee exposure in many coke oven operations. However, there may be some batteries where control of pushing emissions may be required by the standard to control a particularly difficult pushing emission problem. In addition, pushing emission controls may be required on existing batteries under state and local air pollution regulations and may be required for new batteries by EPA (42 U.S.C. 1857 et seq.).

During the course of this rulemaking proceeding attention was directed to a type of pushing emission control that might conflict with the reduction of employee exposure. This control, the coke sideshed, is built so as to capture emissions within the shed and then draw off the emissions through a cleaning device (Ex. 2-216). It is constructed over the cokemaking area and is used to store employees in that area to work under the shed to perform door cleaning, repair and related pushing operations. The benefits of this control were discussed by the Advisory Committee and surveys of employee exposure were conducted by NIOSH, EPA, and several companies with operating sheds (Ex. 2-67, Ex. 2-92; Ex. 2-124; Ex. 2-187-188). The Advisory Committee passed a resolution requesting the Secretary to effect a moratorium on the construction of sheds until it could be determined that their use does not adversely affect employee exposure. While no such moratorium was initiated, it was apparent that EPA was concerned with the occupational impact of the shed and would consider an adverse impact from sheds to be cause to revise a particular abatement program (Ex. 2-21; Ex. 68-B).

Based on the evidence available in the record, the shed will not reduce employee exposure. However, based on the sampling data from 2 sheds presented to the Advisory Committee, there is no statistically significant increase in employee exposure (Ex. 2-187-188).

Some concern, however, has been expressed that use of the shed will result in lax maintenance practices, thereby exposing employees to higher emissions that than would occur at an unsheded battery. (Ex. 2-233; Ex. 71) and <0.1 mg/m³ do not appear to be adequate control of the emissions from the shed, which is a 1.6 mg/m³ at Republic (Ex. 74, Item 2) and 0.6 mg/m³ at a foundry plant (Ex. 73A).

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The Advisory Committee passed a resolution requesting the Secretary to modify the standard to control emissions from the shed. The standard sets out four constituents of the detailed program on pushing emission control that are related to the three variables stated above. These are proper heating of the coal for a sufficient time period to insure proper coking; prevention of pushing of green coke to the maximum extent possible; inspection, adjustment, and correction of heating flue temperatures and defective flues; and cleaning of heating flues and related equipment at least weekly and after any green push. All of these items were discussed by many of the participants and are also described in the material submitted for the record (Ex. 2-187-188).

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need to push an oven with some green coke which will never be coked out.

The second criteria is intended as a complement to the first criteria for taking time to ensure the development of a system for preventing green pushes to the maximum extent possible as recommend

The final criteria relate to the inspection, repair, adjustment, and cleaning of the heating system to prevent green pushes by maintaining the necessary heat distribution within the oven. This is particularly a problem with the fluxes at the end of the oven which are in part subject to temperature fluctuation when the doors are removed and replaced and may become clogged (Ex. 2-19). Proper alignment of the heating system is necessary on a routine basis (TR 1575). The standard requires a detailed written program to cover those areas and as such, any repair and adjustments are done as soon as possible and that cleaning is performed on a weekly basis. Both the Advisory Committee report and the proposal had similar recommendations although the Committee recommended that any repairs be done before the oven is charged again. Since the oven is usually charged following completion of the push, there would be considerable difficulty not only in completing some repairs but also in determining the exact cause of the problem without the oven being pushed again under close observa

The final provision in this section specifies the timing for the institution of the necessary repairs. It requires that repairs shall be instituted as soon as possible. This is based on evidence in the record which indicated that there is no set timeframe applicable to these repairs but rather, because some repairs may require replacement or rebuilding of some equipment, but also to prevent exposure to emissions caused by coal spillage that may create exposure to coke oven emissions (TR 2900-1, 3524-5: Ex. 66F).

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The importance of this point is apparent in the sharing of the minutes of attention paid to work practice control at U.S. Steel, Fairford with that at other plants. The emission control program required additional workforce, bench level, and maintenance personnel to perform the operating and cleaning procedures. They were used either on a temporary or permanent basis depending on the nature and extent of the problem (TR 2905-2908). The efficacy of these programs is described in Mr. Burton’s testimony (Ex. TR 1971-2) as well as in the testimony of the USWA representatives from that plant (TR 3046, 3060: Ex. 69A). Similar efforts at other plants have also led to improvement (TR 3378 80). In order to implement this, the necessary requirements of the additional personnel may be needed, for example, during inspection and cleaning of the gooseneck and stoppages every cycle (TR 3687), cleaning of the doors (Ex. 68J), or cleaning of doors and jambes (TR 3113-4, 3193).

A requirement for adequate manpower does not appear in the standard. However, OSHA believes that the need for an adequate number of personnel is implicit in the engineering and work practice control requirements. For all the required work practices to be performed, the employer must have enough personnel, or the work practices cannot be performed and a citation can result. It would seem to be impossible to demonstrate what size workforce will be “adequate” for each coke battery and specify this in a standard. OSHA agrees with the philosophy of those who support this requirement and as has been demonstrated at U.S. Steel’s Fairfield Works, increases in crew size may, indeed, be necessary. An employer may be cited by OSHA for failure to carry out the necessary work.
practices, this may or may not be the result of inadequate crew size.

An issue that has been raised during this rulemaking proceeding is that the number of personnel that may be required to maintain coke battery equipment and perform necessary work practices would result in a larger population at risk from exposure. While this may be true, control measures with the decrease in emission levels that will result from the additional engineering controls and work practices will substantially decrease the risk from exposure. Although the population at risk will increase, the amount of risk will decrease. In light of the experience to date, such as Fair­field, in reducing emission levels at coke ovens, the number of personnel seems likely. However, failure to mandate the required work practices would inevitably perpetuate the high risk to employees because the existing controls alone would be ineffective. Accordingly, OSHA believes the benefits which will ultimately be derived from a vigorous control program exceed the risk from exposure to the high emission levels especially in light of the present risk from exposure to the high emission levels on many batteries.

6. Filtered air equipment. The standard requires that the cabs of the larry car, pusher machine, door machine and quench car, and stand-by pulpits on the topside, screening station, and at the wharf, be equipped with a positive-pressure filtered air system. These installations are intended to reduce employee exposure to coke oven emissions by isolating the employee rather than by eliminating the emissions themselves. This type of control is acceptable under current work practices when it is not possible to eliminate emissions at their source. Air filtration systems have been tested and installed at several plants. Tests conducted under NIOSH contract on a larry car serving a 79-oven coke battery demonstrated a reduction of 87% in the concentration of respirable dust with controlled temperature filtered air at the time the samples were taken. In addition to the filtered air supply, the battery was equipped with sequential charging, a jumper pipe, steam aspiration, improved drop sleeves and door sealing. These installations work well, with apparently minimal maintenance problems. NIOSH criteria document recommends positive pressure filtered air supply for pusher cars, larry cars, door machine cars, quench car cars, and topside stand-by pulpits on the wharf. NIOSH endorses the use of such equipment for the wharf or screening station. As discussed in the section on regulated areas, the wharf and screening station were included in the "side-oven" job classification in the steelworkers mortality studies (2-105, p. 106) and excess morbidity and mortality has been demonstrated in that category (2-14). Coke oven emissions are present in these work areas (TR 3374-5).

7. New and rehabilitated batteries. One of the most significant issues before OSHA is how to treat new or rehabilitated batteries. In this regard, it should be noted that AISI indicated that 67% of the blast furnace coke batteries in the U.S. were constructed prior to 1955, which represents 43% of the coke-making capacity (Ex. 2-146). Similar percentages apply to foundry coke plants (Ex. 73). The USWA indicated that 43% of the coke ovens currently operating in the U.S. are 25 years old or older (TR 3502, Ex. 83-A, List 3). The average useful life of a battery is in the 25-35 year range (Ex. 6A-14). Based upon these data, it is clear that a considerable portion of present coke-making capacity...
will need to be replaced in the relatively near future. This new construction presents an excellent opportunity to incorporate engineering controls that are feasible on new or rehabilitated batteries but may not be feasible on existing batteries.

Since the feasibility problems related to implementing the latest control technology, such as automatic lid lifters, automatic door and jamb cleaners and double collector mains (except for pipeline charging), can be designed out in the planning and construction of a new or rehabilitated battery, the Agency fully expects new or rehabilitated batteries to more easily reach the permissible exposure limit, through engineering and work practice controls alone, than existing batteries.

Accordingly, the standard requires that new or rehabilitated batteries use the best available engineering and work practice controls to comply with paragraph (f). The standard does not specify the controls which must be used. However, OSHA believes that the controls required for existing batteries constitute the best available technology and should be incorporated in the standard. As control technology improves, the standard contemplates that new and rehabilitated batteries should be at least as good as the best available technology. Rather, it is intended to include any effective technology which is available to the employer. By utilizing this approach, OSHA believes that technology will not be frozen and employees' health will be benefited.

The Advisory Committee recommended that automatic door and jamb cleaners, automatic lid lifters, filtered air equipment, and automatic gooseneck cleaners that can accommodate automatic cleaning equipment, remote-controlled dampering-off systems, and double collector mains (except for pipeline charging), be designed out in the planning and construction of a new or rehabilitated battery, the Agency fully expects new or rehabilitated batteries to more easily reach the permissible exposure limit, through engineering and work practice controls alone, than existing batteries.

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system which has not been perfected (TR 3540).

The record is mixed on the subject of HPW. It has been termed experimental, yet it is currently permitted only for employers who are required to use pipes regularly performing HPW cleaning.

It is clear that such equipment cannot generally be retrofitted on existing batteries (TR 147). It would appear feasible, however, to install HPW for cleaning coke oven doors on new batteries, and is considered effective. HPW has not been developed for cleaning doors; however, the battery does not permit OSHA to specifically require HPW on new batteries although it can be a useful part of a program of maintenance and cleaning to prevent door emissions.

OSHA does not view jumper pipes as being the best technology for new batteries or for most rehabilitated batteries. The need for double drafting during charging has been discussed. The two principal methods for accomplishing this are either double collector mains or a single collector mains greatly reduce the possibility of emissions caused by tunnel jambs. The uncertainty in the recording of emissions or for most rehabilitated batteries. In batteries, jumper pipes have a principal methods for accomplishing this ability of emissions caused by tunnel jambs. The uncertainty in the recording of emissions or for most rehabilitated batteries.

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3540. Although effective on single main batteries, jumper pipes have a variety of maintenance and malfunction problems that are eliminated by use of double mains (Ex. 2-220). Double collector mains are a more effective means of aspiration than jumper pipes (Ex. 261, p. 13; Ex. 2-220). Double collector mains greatly reduce the possibility of emissions caused by head blockage during charging (Ex. 2-120, p. 22). Although effective on single main batteries, jumper pipes have a variety of maintenance and malfunction problems that are eliminated by use of double mains (Ex. 2-220). Double collector mains are a more effective means of aspiration than jumper pipes (Ex. 261, p. 13; Ex. 2-220). Double collector mains greatly reduce the possibility of emissions caused by head blockage during charging (Ex. 2-120, p. 22). Although effective on single main batteries, jumper pipes have a variety of maintenance and malfunction problems that are eliminated by use of double mains (Ex. 2-220).

46772. Alternatives to battery car charging are presently five pipeline charged batteries. This system has been described under "Charging." It is a method for controlling charging emissions which is applicable to new and rehabilitated batteries using conventional charging systems (Ex. 3, p. 38).

9. Written plans for compliance. In order to insure compliance with this standard, employers are required to establish and implement two written programs. First, a written program must be drafted which describes, in detail, current operating procedures as well as procedures to be used in the event of an emergency. The Advisory Committee recommended a procedure, apart from the citation mechanism, for OSHA review and approval of an employer's written plans. The agency has determined that the alternative compliance strategy described below will more adequately insure uniform compliance, especially within the context of limited OSHA resources which preclude the advance approval of all abatement plans.

Thus, as detailed in OSHA's Industrial Hygiene Manual, citations are issued for the failure to comply with the requirements of the standard. The citation will set forth "standard alleged violation elements" (SAVE) including specific deficiencies by which the violation is determined. The employer must come into initial (development of a plan), intermediate (thru an expert consultant, ordering requisite materials, etc.) and final compliance (specified controls in place). During the course of implementation, OSHA will periodically monitor the employer's progress in order to ensure compliance with the standard.
to ensure compliance with the elements of the citation. Further appropriate enforcement action will be taken if the permissible limit is still exceeded and the employer fails to develop and implement a technology-forcing program.

The Department is cognizant of the concerns of the unions and the Advisory Committee that the implementation of this standard through the traditional enforcement mechanism may be subject to inconsistent application by OSHA field staff. We would offer several responses. First, such variegated interpretation would not be obviated by any pre-citation plan approval process. Indeed, the same personnel would be reviewing the plan's efficacy regardless of the enforcement or pre-enforcement context in which it was presented. Second, OSHA simply does not have the resources in sufficient numbers to review every coke oven plan required by this standard. Rather, the agency must rely on the determinations reached through periodic inspections and the intensive review and monitoring which will follow such inspections. Third, in the implementation of the standard, field personnel will be advised by a Technical Advisory Unit based in the National office which will gather all coke oven information and coordinate all coke oven citation and settlement policy.

Finally, a difficult compliance issue presented by the promulgation of the new standard involves its relationship, within the context of enforcement, to the employer's legal obligations under the prior standard (29 CFR 1910.1000, 1002). The present standard, at paragraph (f)(1)(i) requires the implementation of specific engineering controls and work practices at the earliest possible time but no later than January 20, 1980. To this end, employers are presently required to develop written programs and to implement specific controls. However, the agency recognizes that employers had a legal obligation under the prior standard to reduce coke oven emissions exposure to the permissible limits through engineering or administrative controls. It is not the intention of the agency, through the promulgation of this standard, to vitiate the legal requirements under the old standard. Rather, OSHA's performance standards represent a continuum of enforceable obligations which have been crystallized in the standard's promulgation.

More specifically, in evaluating whether the employer has instituted controls at the earliest possible time, OSHA compliance personnel would consider not only their performance under the new standard but also his prior obligations under its predecessor. It is OSHA's view that recalcitrant employers who have implemented only a few or no control work practices under the prior CTPV standard should not benefit from a newly extended time frame established under the new standard. Rather, cognizant of their prior legal obligations, such employers would be subject to citation under the new standard for failure to implement controls at the earliest possible time.

(Q) Respiratory protection. The standard requires that respirators be used to achieve compliance with the permissible exposure limit only during the time periods listed under the controls, in work operations in which such controls are not technically feasible or would significantly interrupt production. The standard also prescribes that employers must establish a written respiratory protection program which will include the selection, use, cleaning, and maintenance of respirators.

OSHA recognizes that respirator use does have a role in worker protection (TR 143; 39940). It is important to recognize that, for maintenance procedures and jobs such of lidman (TR 887, 2850). The goal of the standard is the control of emissions at the source which would eliminate the need for respirators. However, since it is apparent that respirators may be necessary, an evaluation of respirators for coke oven use is critical.

The selection of respirators is dependent upon the selection of the substance(s) in the emissions considered to be the cause of the health hazard. The Advisory Committee recommended the use of B(a)P as the best indicator of the hazard, the proposed standard selected respirable particulates. The final standard requires monitoring of the benzene soluble fraction of total particulate matter (BSPTFM) as the hazard indicator. All of these alternatives, however, rely on particulate sampling in keeping with the view that the particulate fraction of coke oven emissions is the predominant material against which workers must be protected (Ex. 2121, pp. 51520; 218, 2151, p. 156; TR 401). Therefore, it is prudent to provide respiratory protection against particulates (TR 402).

Air-purifying respirators with particulate filters are presently issued to coke oven workers (Ex. 2-21, p. 521). The respirator protective efficiency (RPE) of respirators is measured in the National Office which will establish RPE for the filter after tests are conducted by the manufacturer. The selection table (Table I) will provide the respirators which afford the required protection.

The employee must be properly trained to wear the respirator, to know why the respirator is needed and to understand the limitations of the respirator. An understanding of the hazard involved is necessary to enable the employee to take steps for his or her own protection. The respiratory protection program implemented by the employer must concur with the program set forth in 29 CFR 1910.134. This contains basic requirements for proper selection, use, cleaning, and maintenance of respirators.

The standard contains a respirator selection table (Table I) so the employer will provide the respirators which afford the proper degree of protection based on the airborne concentration of coke oven emissions. Three types of respirators are listed in the table. For concentrations of coke oven emissions less than 1500 mg/m³, an air-purifying respirator with a particulate filter is required. This category of respirator has a protection factor of 10 which means that the concentration of the contaminant inside the respirator is 10 times less than the concentration outside the respirator. Tests of this type of respirators were conducted by U.S. Steel during the period 1966 to 1967. Sixteen respirators from five manufacturers were tested (2-121, p. 492-3). Samples for CTPV were collected from both inside the respirator facepiece and from the workplace air. The concentrations were compared, yielding the approximate average protection factor of 10.

Because these respirators operate by negative pressure produced when the wearer inhales, proper fit is critical to prevent leakage of contaminated air around the facepiece.

The employer must check to see that the employees' respirators fit properly. The selection of respirators is based on the wearer's face size. A rapid qualitative fit test can be performed at the start of each shift. Qualitative fit tests can be either a posi-
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tive pressure test, in which the exhalation valve is closed and in which the wearer exhales into the facepiece to produce a positive pressure, is a necessary part of the pressure test, in which the inlet is closed and the wearer inhales so that the facepiece collapses slightly (Ex. 19, Ref. 2). On this basis, a quantitative test for proper fit is to be performed on all employees wearing non-powered air-purifying respirators. This is important because of the variation in face size and the dependence of respirator effectiveness on proper fit. Fit can be tested by use of an irritant smoke tube or a negative pressure test, in proper fit. Fit can be tested by use of an irritant smoke tube (stannic chloride impregnated pumice) which is used to direct an irritant smoke around the facepiece seal. If the particulate filters can be replaced with chemical cartridges, 2-amyl acetate can be used to test facepiece fit. If leakage is noted in either case, it can be concluded that the particular respirator will not protect the wearer (Ex. 19, Ref. 2). Such tests should be performed when the employee is first issued a respirator and then at periodic intervals. The best fitting facepiece style can be made.

For concentrations of coke oven emissions greater than 1500 µg/m³, a powered air-purifying respirator (PAPR) is required. This type respirator consists of a facepiece, usually a half-mask (over the chin), connected by a hose to a filter and a battery powered blower. This blower delivers a continuous flow of air to the wearer. The facepiece is under positive pressure making it a less critical factor than with a non-powered respirator as leakage is from the facepiece outward.

Under contract with AISI, William A. Burgess of Harvard University developed a prototype PAPR for use by coke oven workers. (Ex. 2-175; 19). Several units were fabricated in 1973 and issued to coke oven workers. Worker acceptance was generally high until hot weather was encountered. The hot stream of air in the facepiece was unacceptable. A workable cooler could not be developed within the contract period (Ex. 19). A similar problem was encountered with cold weather. Temperature is the major problem with use of PAPR. As Burgess stated in his testimony, PAPR probably cannot be used during temperature extremes. (Ex. 19, Ref. 3). The PAPR may not be usable three or four months of the year. OSHA recognizes this limitation and is aware that non-powered units may be necessary during those time periods. As workers acceptance is a major factor in respirator use, it is necessary to permit use of non-powered respirators during very hot or cold weather as employees may be more willing to wear them than PAPR. Also, because of the benefits which would accrue from year round usage of the units, OSHA will pursue these early in FY 1977. The Advisory Committee recommends that employees be given a choice between a PAPR and a non-powered respirator with the standard permitting use of the respirator best suited to the employee. This system may be feasible. For this reason, use of Type C supplied air respirators is permitted. As stated in the proposal, there are potential hazards in the use of supplied air respirators. The air supply hose is a mechanical hazard in an area with a great deal of moving machinery such as exists on a coke oven battery. Also, the hose limits the wearer's mobility. The advantages of air supplied respirators, high protection factors and good worker acceptance may prompt development of equipment suitable to some coke oven applications. One such application which can be envisioned is a hybrid air purifying-supplied air device for equipment operators who spend a significant part of their shift at a fixed work station. When operating the equipment a supplied air device would be connected to a single outlet and the unit would operate as a conventional air-purifying respirator. It is this type of modification that suggests that Type C continuous flow or positive pressure air supplied respirator be included in the standard with the cautions presented (Ex. 19, p. 8). The standard is consistent with the recommendations of NIOSH and the Advisory Committee, although neither of these bodies tied respirator selection to airborne concentrations. The Advisory Committee recommends that a single choice between an air-purifying respirator and a PAPR be given to employees. This would permit a choice between a respirator or powered air-purifying respirators which would be available to the employee. The Advisory Committee recommends that a choice between a respirator or powered air-purifying respirators be given to employees. This would permit a choice between a respirator or powered air-purifying respirators which would be available to the employee. Additionally, a choice of different styles of non-powered respirators must be offered if employees are to be fitted properly. At

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The standard requires the employer to provide and ensure that employees use protective clothing and equipment in order to minimize three types of hazards. These are (1) hazards related to exposure to the indicated hazards, (2) hazards related to exposure to any of the indicated contaminants, and (3) hazards from impact. There are two hazards related to protection from impact. First, the excess risk of mortality from genito-urinary cancer, (Ex. 2-14; Ex. 20L), which may result from the absorption through the skin of the carcinogenic constituents of coke oven emissions (TR 477) and skin cancer from exposure to the skin cancer, which results from repeated skin contact with coke oven emissions in order to reduce the incidence of genito-urinary cancer, which results from repeated skin contact with coke oven emissions.

The standard requires that employees wear air-purifying respirators when they detect an increase in breathing resistance. When the filter becomes loaded, the movement of air through the filter becomes restricted, forcing the employee to breathe harder to overcome this resistance. The wearing of the respirator becomes increasingly uncomfortable and it may not be used as a result. To aid in the minimizing of the discomfort of wearing a respirator and to keep the respirator working efficiently, the employee must be allowed to make changes to the filter if the need arises. However, the wearing of a respirator in an oxygen-deficient atmosphere can result in skin irritation as the dust may accumulate around the facepiece seal. To prevent this irritation and to minimize the discomfort of respirator use, employees must be allowed to periodically wash their faces and respirator facepieces in order to remove any accumulation of contaminated dusts. The employee would be required to have the respirator at all times.

The one-year period of voluntary respirator use, which would reduce the amount of time in which respirators would be necessary. The voluntary nature of respirator use in the first year does not reduce the employer's obligation to train employees in the proper use of respirators and to make the appropriate respirators available. Indeed, since the employee is being granted a greater responsibility for his own protection, special attention must be given to the training program so the employee can make an informed choice. The employee would be required to have the respirator at all times.

The standard requires that employees wearing air-purifying respirators be permitted to replace the respirator filter whenever they detect an increase in breathing resistance. When the filter becomes loaded, the movement of air through the filter becomes restricted, forcing the employee to breathe harder to overcome this resistance. The wearing of the respirator becomes increasingly uncomfortable and it may not be used as a result. To aid in the minimizing of the discomfort of wearing a respirator and to keep the respirator working efficiently, the employee must be allowed to make changes to the filter if the need arises. However, the wearing of a respirator in an oxygen-deficient atmosphere can result in skin irritation as the dust may accumulate around the facepiece seal. To prevent this irritation and to minimize the discomfort of respirator use, employees must be allowed to periodically wash their faces and respirator facepieces in order to remove any accumulation of contaminated dusts.

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that protective clothing and equipment be maintained and replaced as needed in change rooms.

The standard provides that the employer ensure that all protective clothing is located in the closed container for each employee. The standard also provides that the container be located in the change room of the employer. The purpose of requiring such a container is to prevent employees from contaminating themselves with the dust and oil that is produced in coke oven work. The standard requires that all employees be provided with suitable protective clothing and equipment.

Second, the standard requires the use of protective clothing and equipment that is intended to remove the coke oven emissions collected on employees so that these emissions are not subsequently ingested. The standard also provides that the employer must ensure that the protective clothing and equipment is properly maintained and cleaned.

Finally, the standard provides that the activities which are prohibited in the regulated area may be conducted in various locations specified for such purposes. For example, food and beverages may be consumed in a change room even though the change room is part of the regulated area.

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First, it limits those activities which might result in ingestion of coke oven emissions to areas where coke oven emissions are not formed. This includes areas such as the inside of the coke oven battery and the coke oven itself.

The standard requires the employer to provide a lunchroom with a temperature controlled air supply and to minimize the presence or consumption of food or beverages in the regulated area. Lunchrooms must be freely accessible to ensure employees to make use of them. Positive pressure filtered air is required to create a lunchroom with a temperature controlled air supply. The air supply is also required to be temperature controlled so that the lunchroom does not become unreasonably hot in the summer or cold in the winter, making employees reluctant to use it. In addition, a lunchroom with a temperature controlled air supply will encourage employees to use it.

The standard requires that employees do not apply cosmetics to the skin area. This is intended to prevent employees from looking soil emissions on their skin. Employees are required to be provided with a change room, it is appropriate to limit the removal of contaminated clothing to that area.

The proposed standard (Ex. 1A, p. 327279) and Advisory Committee report (Ex. 3, p. 70) both limit the handling of contaminated protective clothing and equipment to authorized persons. The standard does not include such a limitation. This is because the standard requires that the closed container provision will serve to prevent stains from coming into contact with an individual handling the container or being released in the change room. Since the container is to be located in the change room, it is appropriate to limit the removal of contaminated clothing to that area.

(1) Hygiene facilities and practices. As discussed above (see Carcinogenicity), coke oven workers exhibit a significant excess incidence of cancer of the genitourinary system (Ex. 2-14; Ex. 20L). Although the precise route of entry into the body is uncertain, this cancer may result from the ingestion of the carcinogenic constituents of coke oven emissions (TR 439; TR 469-470). The standard addresses the problem of reducing employee exposure to coke oven emissions in two ways.

First, it limits those activities which might result in ingestion of coke oven emissions to areas where coke oven emissions are not formed. This includes areas such as the inside of the coke oven battery and the coke oven itself.

The standard requires the employer to provide a lunchroom with a temperature controlled air supply and to minimize the presence or consumption of food or beverages in the regulated area. Lunchrooms must be freely accessible to ensure employees to make use of them. Positive pressure filtered air is required to create a lunchroom with a temperature controlled air supply. The air supply is also required to be temperature controlled so that the lunchroom does not become unreasonably hot in the summer or cold in the winter, making employees reluctant to use it. In addition, a lunchroom with a temperature controlled air supply will encourage employees to use it.

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work sites which have been associated with increased morbidity and mortality. (See discussion of Regulated Area.) All employees who would have been covered under the medical surveillance programs suggested by the Advisory Committee, (all coke oven employees) (Ex. 3, p. 58); in the Criteria Document (workers regularly assigned to work in any location on a pusher, sidestraight, and quench car) (Ex. 2–18, p. 1–5); and in the proposed standard (employees who work in a regulated area) (Ex. 1a, p. 32279) are covered under the standard. To the extent that the coverage differs, the differences can be explained by the decision to use language which ensures the most complete coverage.

The standard requires that medical surveillance be instituted for all employees who work at least 30 days per year in regulated areas. This time period, which was the same as that in the proposed standard (Ex. 1a, p. 32279), differed from those suggested by the Advisory Committee (Ex. 3, p. 59), the Criteria Document (Ex. 2–18, p. 1–5) and various participants (Ex. 5a, item 21; Ex. 5a, item 4). The record shows some employees are assigned to work at coke ovens on a temporary basis, e.g. during vacation periods (TR 820) or certain types of repair work (TR 830), some cut-off point for the required medical surveillance program must be considered appropriate. However, because the medical evidence to support any specific point in time to start initial examinations is not available (TR 820), it is important that the time period selected be sufficiently inclusive without being administratively impracticable. From the record, it is apparent that there are a number of employees who work for at least 30 days at the coke oven (TR 2351) and that in one instance, this may include close to 600 employees (Ex. 74, item 5). At a minimum, these employees should be examined prior to entry into work in the regulated area.

The Advisory Committee recommended a time period in order to exclude temporary assignments (Ex. 3, p. 59). This has been revised to 30 days in the standard in order to provide maximum protection to exposed employees. It does not appear that such a provision would be either administratively impracticable or burdensome, while it would provide at least a basic medical evaluation of the exposed population. It should be noted that the 30 days can be calculated either in days or hours as suggested by one industry participant (TR 2360).

The record indicates that of using the term "regularly assigned" as suggested in the Criteria Document (Ex. 2–18, p. 1–5), while sounding deceptively simple, might result in administrative chaos, since there is no coherent uniform industry-wide definition of what constitutes a "regular assignment." Although there may be agreement that it includes the standard job positions on a coke oven battery (TR 1930; TR 2350), there is no consensus on which maintenance and labor jobs would be included, nor is it clear what special supplementary jobs would be covered (TR 1930; TR 2350). Even if some agreement could be reached in this area, the job classifications and titles vary from plant to plant (Ex. 2–166) and between blast furnace and merchant coke operations (Ex. 68F, Ex. 69). The Advisory Committee found a substantial amount of time discussing this issue and determined that a time period, rather than the nature of the assignment should govern the coverage. While OSHA has no evidence to support revision of that approach. OSHA has determined that a specific time period is the most effective and administratively feasible method to adopt and that the 30 day period in the standard will provide a basis for an adequate medical surveillance program.

The standard requires that the medical surveillance program include each covered employee with an opportunity for medical examination. As noted above, the authority and requirement for this provision is found in subsection 6(b) (7) of the Act. The proposed standard, Advisory Committee report, Criteria Document, and various participants also followed this approach.

The employer is required to inform any employee who refuses a medical examination of the health consequences of such refusal. By this requirement, OSHA hopes to insure that when an employee has refused an examination, the employee has done so as an informed decision, rather than out of ignorance of the possible consequences. The requirement that the employer obtain a signed statement indicating that the employee understands the risk involved in the refusal to be examined has two purposes. It is intended to serve as an objective check on whether the employee has actually been informed of the consequences by the employer, and to insure that the employee actually understands those consequences. These reasons explain the extra requirements provided for in the standard, not provided for in the Advisory Committee report (only required signature to confirm refusal; Ex. 3, p. 58) and the Criteria Document (issue not addressed; Ex. 2–18, p. 1–5–8).

All examinations and procedures are required to be performed by or under the supervision of a licensed physician and provided without cost to the employee. While the physician will usually be selected by the employer, the standard does not so mandate, leaving the employer free to institute alternative procedures such as joint selection with the employee or selection by the employee. Clearly, a licensed physician is the appropriate person to conduct a medical examination. However, certain parts of the required examination (e.g. taking of a history) do not necessarily require the physician's expertise. It may be conducted by another person under the supervision of the physician. As noted above, subsection 6(b) (7) of the Act mandates that medical examinations and procedures which were OSHA standards be provided at no cost to the employee. The proposed standard (Ex. 1a, p. 32279) and Advisory Committee report (Ex. 3, p. 58) also included these requirements. The Criteria Document did not specifically address these questions but did refer to a "responsible physician" (Ex. 2–18, p. 1–6).

Both the proposed standard and Advisory Committee report included in this provision, a requirement that all medical examinations be given during the employee's normal working hours. Since coke ovens are operated on a 24 hour basis, any employer is responsible for the cost (Ex. 5a, items 7, 11, 22, 29; TR 2317, 2370, 2584, 2619), it is appropriate not to restrict the hours of availability of the examinations. Therefore, the standard does not include a requirement that exams be provided during normal working hours.

The standard provides that a work history, medical history and medical examination be performed at the time of initial assignment to the regulated area or upon institution of a medical surveillance program (subject to the 30 day requirement). The purposes of this requirement are to make an initial assessment of the employee's health condition and to work in the regulated area, and to establish a baseline health condition against which changes in an employee's health may be compared. The record (Ex. 1a, p. 32279; Advisory Committee report (Ex. 3, p. 59), and Criteria Document (Ex. 2–1, p. 1–5) all contained requirements for an initial or preplacement medical examination similar to that required in the standard.

Compilation of an employee's work history and comprehensive medical history is required by the standard. As noted above, the purpose of this requirement is to aid in the assessment of fitness to work and in the detection of changes in physical condition. The Advisory Committee report and the Criteria Document recommended the taking of these histories, and the proposed standard followed the same approach. Upon the recommendation of various medical witnesses, (TR 1899, 2151, 2314, 2526) smoking histories have been included as a specific component of the medical history section. This point differs from the Advisory Committee report, Criteria Document and proposed standard, but was done because the smoking habits of an individual affect other components of the medical surveillance program such as sputum cytology and pulmonary function, and because smoking is related to the respiratory diseases found in excess in coke oven workers (TR 1192–1194).

The various tests that comprise the medical examination are designed to be used in an initial assessment of an employee's health and to detect changes in health which may occur. Their specific utilities are described below.

A 14'" by 17'" x-ray is a screening test of proven value in the detection of lung cancer (Ex. 2–18, p. 8–V, 6–1). The International Labour Office UICC/Cincinnati (ILO/U/C) rating is useful in obtaining uniform quality of employee x-rays (TR 6–23, 165, 178, March 19, 1975). Both of these were included in the Advisory Committee report, Criteria Document and proposed standard (p. 32279).

Pulmonary function tests including forced vital capacity (FVC) and forced
expiratory volume at one second (FEV) are useful for detecting restrictive (FVC) and obstructive (FEV) pulmonary diseases (TR 1186, 1187, 1899, 2151, 2314, 2315). For these reasons, the standard includes both tests. It is as-

gested in the Advisory Committee report (Ex. 3, p. 58-59). The proposed standard did not include FEV, and the Criteria Document referred only to respiratory function evaluation (Ex. 2-18, p. 1-6).

The determination of a baseline weight is necessary to measure changes in weight. The standard included weight measurement in the proposed standard. The Advisory Committee report required a complete physical examination which would probably include weight measurement (Ex. 3, p. 58). The Criteria Document did not include it.

The standard, proposed standard, Ad-

visory Committee report and Criteria Document all included a requirement that urinalysis be done. The Criteria Document listed the test as being for red blood cells, whereas the others listed it as testing for albumin and aci-
turia. Urinalysis will be used primarily to detect tumors that are at a later stage of their development.

The use of cytology, that is, the study of cells and particularly the pathological changes in cells, as a screening device to detect the early progression from normal to atypical to premalignant and malignant lesions, has been used successfully for the early detection of certain cancers. CTR 906. The application of similar medical techniques to respira-
tory cancer, and more recently, urinary cancer, has received increasing approval as an effective screening device (TR 906, 1175-76, 1196; Ex. 2-18 and Ex. 2-173).

Questions and objections raised by some of the participants to the use of cytology relate primarily to its inclusion as a screening device for all employees rather than being left to the discretion of the physician in individual cases or when certain other alleged indicators are present (Ex. 5a, Item 7; TR 1902, 2460). The concern was expressed that the efficacy of cytology had not been demonstrated as a screening device for a well population, i.e., where the group to be screened was primarily without disease symptoms. A number of the cytology studies utilized people with existing symptoms or other populations considered to be at a high risk with regard to cancer. (TR 388, 388a, 1200). Cokе oven workers are also a high risk population, as was recognized by several medical witnesses. (TR 384, 2527). Therefore, it is not apparent that the standard is not applicable to this industrial population. Rather, it raises the question of how to define the high risk population. In addition, through the use of cytology as a screening device, it is expected that while the number of cases detected, as a percentage of the population may be smaller, the prognosis for survival of those detected will increase, thus achiev-
ing the goal of an effective screening program. (TR 388a, 1179-80, 1200-1). The standard recognizes the medically valid screening function of cytology, and, therefore, requires a baseline test as part of the initial examination (and then additional sputum and urinary cytology only after an employee reaches a high risk population of at least five years of employment in the regulated area or 45 years of age).

Both cytology and chest x-rays are recognized methods for the early detec-
tion of lung cancer (TR 386). Both of these procedures are screening devices and as such generally have low sensitivities but high specificities (TR 1181-2). Sensitivity refers to the percentage of positive tests in the screened population, whereas specificity relates to the accuracy and the frequency of a person with a positive test having the disease. Under this framework, if the sputum results are positive, the individual is likely to have the disease. However, because of the low sensitivity, they may be negative when cancer is present. This result is minimized when sputum specimens are taken and in such cases, the sensitivity approaches 100% (TR 386). The combination of both x-ray and sputum cytology has an additive value as a screening device, so that if cytology will detect some types of cancers, e.g., of the larger central bronchi (Ex. 2-204; TR 388a), while x-rays will detect others, e.g., peripheral bronchogenic cancers (Ex. 2-204; TR 388a). Using both methods, as required by the standard, not only improves early detection of lung cancer, but it also appears that these cancers detected by cytology have a better prognosis. (TR 1197-80, 1191-92).

The major limitation that was sug-
gested to limit the scope of the sputum cytology examination was to restrict it to those employees with a productive or spontaneous cough (Ex. 5a, Item 12; TR 1902, 2460). Such a limitation, however, bears no relationship to the employee's risk of lung cancer (TR 1902, 2524), but is merely a matter of convenience. It is clear from the record that induction of sputum by inhalation of aerosol results in a satisfactory sputum sample (TR 188B; TR 1181-3; TR 1190-1). It is inappropriate to limit the use of the test on a basis unrelated to the existence of symptoms.

The importance of urinary cytology lies in its ability to detect cell changes from normal to cancerous at a very early stage in the development of the cancer and before it can be detected by the basic urinalysis exam. The primary type of kidney cancer in coke oven workers is adenocarcinoma (Ex. 5-14, p. 628; TR 908). A second type of kidney cancer is the renal cell carcinoma (TR 908). The development of this type of cancer limits detection after a certain point in time, because as the tumor grows, it affects renal function, causing an increase in size and breaks through into the pelvis (TR 908-909). It is at this late stage that kidney cancer is currently being detected, either by x-rays, or the appearance of tumors, or the ex-

istence of blood in the urine (TR 911). The survival rate is approximately 50% (TR 909). However, urinary cytology can be used to screen cells from the urine and to detect the early development of a carcinoma from normal to preinvasive and preneoplastic to cancerous (TR 910).

Like sputum cytology, urinary cytology is a detection or screening procedure rather than a diagnostic tool. Unlike sputum cytology, there is no additional detection procedure comparable to the x-ray. General reference is made to the use of urinalysis in place of urinary cytology as the primary screen-
ing device for all employees. This has been suggested particularly where there is hematuria or blood in the urine (Ex. 5a, Item 7, TR 2460). However, it is clear from the record that urinalysis is very nonspecific and will primarily pick up tumors that have already broken into the pelvis and are at a later stage in their development (TR 916).

The goal of the cytological screening tests is the early detection of cancer so as to provide increased medical surveil-

lance to those susceptible individuals and thereby increase the chances of survival. It is important to note that the therapeutic response to kidney cancer is removal of the kidney (TR 924). This is not a limitation, however, in interpreting the cytological results will not create any medical or administrative problems for the physician in terms of diagnosis and continued care of the particular employee. However, with improved cytolO gic techniques it appears possible to localize which kidney is af-

ected and perform the necessary surgery (TR 931-932).

In addition to the scientific practicality of the exams, it is also important that the personnel be available to perform the required analysis. There are over 100 cytotecnologY schools for the nonphysician in the United States (TR 913) and over 3,000 registered cytotechnologists in the United States (TR 389). In addition, training in pathology is in-

creasing for practicing physicians as well as for recent graduates (TR 913-914). While one participant indicated some difficulty in obtaining a sufficient number of cytology tests when they were included in one set of annual exams (TR 771), it is not anticipated that this will be a continuing problem and, indeed, as the demand increases, not only will more personnel be available, but the cost may decrease (TR 918-919).

The Advisory Committee report in-

cluded a requirement that perform urinary cytology examinations as part of an em-

ployee's preplacement exam (Ex. 3, p. 59). The Criteria Document included a requirement to perform sputum cytology examinations as part of the em-

ployee's preplacement exam (Ex. 2-18, p. 1-6). The proposed standard included a requirement to perform both urinary and sputum cytology as part of the initial exam if the employee were a member of a high risk population. The decision to include baseline cytological examinations as part of the initial exam was the result of that standard finds it be-

lieved that, for the various reasons stated above, both cytological tests are an im-

portant part of a medical surveillance program for coke oven workers. Sub-
The standard requires that when an employee who has worked in a regulated area at least five years or is 45 years of age transfers, or is transferred to, employment with that employer (or successors) or works outside of the regulated area, medical exams for that employee shall be continued. It should be noted that, by virtue of having worked five years or being 45 years old, this employee would be a member of the high risk population and would be eligible for the full medical exam, including cytological and histological tests.

In general, the various commenters define the high risk population in a similar manner, i.e., those at least 45 years of age or have worked at coke ovens for five years, the standard provides that medical exams need only be performed annually, and need not include sputum or urinary cytology.

An annual period has been chosen to provide an acceptable frequency of examination and to conform with the current practice of the industry (TR 3153-4, 3289-90). In the case of the semi-annual exams, the increased frequency and the additional cytological examinations have been chosen to provide prompt detection of the conditions for the high risk population (TR 387-8).

In general, the various commenters define the high risk population in a similar manner, i.e., those at least 45 years of age or have worked at coke ovens for five years in a regulated area. (TR 1729, 1900.) In some instances both the age and years at work were considered necessary to define high risk (TR 2318, 2526). The Criteria Document did not contain any definitions. The Advisory Committee recommended different categories for urine cytology (40 years old or five years employment) and sputum cytology (50 years old or 20 years employment). The standard defines the high risk group the same for purposes of both sputum and urine cytology (five years employment or 45 years of age) in order to include additional workers believed to be at greater risk of developing cancer. The 45 years of age or older group encompasses the standard population for screening tests for cancer (Ex. 2-204; TR 387) and for mortality due to cancer (TR 908). On the basis of studies cited in the break down employment into five year intervals, it appears that the excess cancer in coke oven workers reach statistical significance at five or more years of exposure (Ex. 20, Tables 2-6; Ex. 20L; Ex. 2-13, Table VI, p. 60; Ex. 2-14, Table 5-8, p. 627-8).

Many of the differences between the final standard, the proposed standard, the Advisory Committee report, and the Criteria Document are the result of the varying definitions of high risk population as described above. To that extent and to the extent that there are any differences in the scope and timing of the periodic medical examinations, the differences can be explained by the belief that the high risk population requires more frequent and more comprehensive testing than the remainder of the population.

The standard requires that when an employee who has worked in a regulated area at least five years or is 45 years of age transfers, or is transferred to, employment with that employer (or successors) or works outside of the regulated area, medical exams for that employee shall be continued. It should be noted that, by virtue of having worked five years or being 45 years old, this employee would be a member of the high risk population and would be eligible for the full medical exam, including cytological and histological tests.

In the greater incidence of cancer among the high risk population and the latency period involved, OSHA believes it is important to continue medical surveillance of the high risk population after their employment in the regulated area in order to detect any harmful effects that might result from having worked there. Neither the Advisory Committee report nor the Criteria Document included a provision for transfer exams. The proposed standard required that transfer exams be given to all employees who move from the regulated area. The reason for limiting the application of transfer exams in the standard to employees 45 years old or with five years employment is that only these employees are felt to be at high risk (see discussion of high risk population, above). Employers are required to inform the examining physician of any diagnosed medical condition available to an employee who has not had one within six months of termination of employment. This will inform the examining physician of the condition of the employee’s health at the time of leaving, and will serve as a basis for determining how his health has been affected during the period of employment.

Neither the Advisory Committee report nor the Criteria Document included a provision for exit exams. The proposed standard required exit exams for employees who had not received one within three months of termination. The change was made to six months to be consistent with the period between exams for the high risk population, the most frequently examined group.

The employer is required to provide the physician with certain information. This information includes a copy of the employee’s medical record which will include employee’s duties as they relate to the employee’s exposure, the results of the employee’s exposure measurement, if any, the employee’s anticipated or estimated exposure level, a description of any personal protective equipment used or to be used, and information from previous medical examinations of the affected employee to the extent that they are not readily available to the physician. The purpose in making this information available to the physician is to aid in the evaluation of the employee’s fitness to work in the regulated area and fitness to wear personal protective equipment. It should be noted that the standard does not require that a copy of the regulation be given to the physician for each employee. One copy would be sufficient, provided the employer assures the physician that the physician is aware of which employees are covered by this standard. Items that relate to individual employees or categories of employees (such as the description of job duties) need be transmitted only once, unless, for example, the duties change, Exposure measurements will be cumulative so that

The employer is required to obtain a written opinion from the examining physician containing: the physician’s opinion as to whether the employee has any detected medical conditions which would place the employee at increased risk of material impairment of health from exposure to coke oven emissions; the results of the medical examination; any recommended limitations upon the employee’s exposure to coke oven emissions and upon the use of protective clothing and equipment such as respirators; and a statement that the employee has been informed of any medical conditions which require further examination or treatment. This written opinion must not reveal specific findings or diagnoses unrelated to occupational exposure, and a copy of the opinion must be provided to the affected employee. The purpose in requiring the examining physician to supply the employee with a written opinion containing the abovementioned analyses is to provide the employer with a medical basis to aid in the determination of initial placement and ability to use protective clothing and equipment of employees. Requiring that the opinion be in written form will serve as an objective check that employers have actually had the benefit of the information in making these determinations. Likewise, the requirement that the employee be provided with a copy of the physician’s written opinion requires that the employer be informed of the results of the medical examination and any appropriate action. There is evidence that employees may not receive the results of their medical examinations (Ex. 1a, p. 3227-80).

The purpose in requiring that specific findings or diagnoses unrelated to occupational exposure not be included in the written opinion is to require employers to submit to medical examination by removing the fear that employers may find out information about their physical condition that has no relation to occupational exposures.

The Criteria Document did not include a provision requiring a written opinion by the examining physician. The Advisory Committee included a provision requiring that a written opinion, including a summary of all relevant test data relied on by the physician and specific reasons to support an employer’s determination of disease, be supplied to the employer and that a copy thereof be supplied to the employee (Ex. 3, p. 60-61). The final standard, which follows the approach taken in the proposed standard makes basically the same
requirements, but uses different language. The standard does require an addition, however, that it included by the Advisory Committee, i.e., the employee's ability to use protective clothing and equipment. This has been done to provide more protection to employees. The proposed standard would require that, in both cases, the physician's written opinion contain the physician's determination as to whether exposure to coke oven emissions would directly or indirectly aggravate any detected medical condition. This provision has been deleted from the standard for two reasons: (1) It is vague, in that it is unclear what "aggravate" means; and (2) it adds nothing to the requirement to determine whether an employee has any detected medical conditions which place the employee at increased risk of material impairment of health from exposure to coke oven emissions.

The proposed standard contained a provision permitting the physician to subsequently require alternative medical examinations because they would fear that an adverse medical opinion could result in loss of employment. As a result, the purpose of the medical surveillance requirements would be subverted and early detection of illness would, too often, not occur. It was also suggested that the absence of a rate retention provision militates against the Act's purpose of protecting the health of employees and that employees are more likely to change jobs because they fear that an adverse medical opinion will result in their loss of their jobs or be transferred to lower-paying jobs, (Ex. 2-210; TR 3099-3100) and cases where employees were in fact transferred to lower paying jobs or laid off because of the results of medical examinations.

The Agency agrees that the approach taken in the proposed standard confronts the employee with a difficult choice and we are sympathetic to the concerns reflected in the unions' position on this issue. However, we believe that the present record does not contain sufficient evidence on the propriety, scope and implications of a rate retention requirement so as to constitute an adequate basis for the incorporation of such a provision in the standard.

The record is deficient in this regard in a number of relevant areas. In the first place, the record does not contain specific information as to the relative merits of various types of provisions. In addition, the record is silent on the interplay between these various types of rate retention provisions and the record contains no evidence on the relative merits of various types of provisions. In addition, the record is silent on the interplay between these various types of rate retention provisions and the record contains no evidence on the relative merits of various types of provisions. In addition, the record is silent on the interplay between these various types of rate retention provisions and the record contains no evidence on the relative merits of various types of provisions. In addition, the record is silent on the interplay between these various types of rate retention provisions and the record contains no evidence on the relative merits of various types of provisions. In addition, the record is silent on the interplay between these various types of rate retention provisions and the record contains no evidence on the relative merits of various types of provisions. In addition, the record is silent on the interplay between these various types of rate retention provisions and the record contains no evidence on the relative merits of various types of provisions. In addition, the record is silent on the interplay between these various types of rate retention provisions and the record contains no evidence on the relative merits of various types of provisions. In addition, the record is silent on the interplay between these various types of rate retention provisions and the record contains no evidence on the relative merits of various types of provisions. In addition, the record is silent on the interplay between these various types of rate retention provisions and the record contains no evidence on the relative merits of various types of provisions. In addition, the record is silent on the interplay between these various types of rate retention provisions and the record contains no evidence on the relative merits of various types of provisions. In addition, the record is silent on the interplay between these various types of rate retention provisions and the record contains no evidence on the relative merits of various types of provisions. In addition, the record is silent on the interplay between these various types of rate retention provisions and the record contains no evidence on the relative merits of various types of provisions. In addition, the record is silent on the interplay between these various types of rate retention provisions and the record contains no evidence on the relative merits of various types of provisions.

The need to train employees was agreed upon by virtually all of the participants in the rulemaking proceeding, and a training requirement was included in the Advisory Committee report (Ex. 2-18, p. 1-10, 11), the Advisory Committee report (Ex. 3, p. 54), and the proposed standard (Ex. 1A, p. 32280).

There was disagreement, however, as to which employees should receive this training. Industry participants have suggested that it be limited to those employees who work on the coke oven battery, the area where the hazards are present (Ex. 5A, items 4, 11, 12, 26; Ex. 7, items 5). By defining the regulated area in terms of the battery, wharf and screening station (see Regulated Area), the standard has limited the training requirements to those employees who work in the area where the hazards related to exposure from coke oven emissions exist (Ex. 2-14; Ex. 20L), hence, resolving this dispute. This was also the approach followed in the proposal and the Criteria Document. The Agency recommended that every employee be trained (Ex. 3, p. 54). OSHA believes
that it is necessary to train only those individuals who work in the hazardous area, and has, therefore, differed from the recommendations.

The training program is required to be provided within one week of the effective date of the standard for employees who are employed in the regulated area and at the time of initial assignment for employees who are not employed in the regulated area. Under the standard, OSHA believes that it is important to train employees as soon as possible in order to maximize the benefits of the training program, and has acted accordingly.

The standard requires that the training program be provided at least annually, however, during the first year following the effective date of the standard, training regarding hazards associated with exposure to coke oven emissions and the purpose, proper use, and limitations of respiratory protective devices is provided at least quarterly. OSHA believes that an annual training program is both necessary and sufficient to fulfill the purposes of training, but that the first year following the effective date of the standard, when the use of respiratory protection in certain circumstances is at the employees' option, it is especially important that employees make informed choices regarding the use of such respiratory protection. The more frequent training during the optional respirator period is intended to ensure that the choice is an informed one.

The content of the training program is intended to apprise the employees of (1) the hazards to which they are exposed; (2) the necessary steps to protect themselves, including avoiding exposures, respiratory protection and medical surveillance; (3) their role in reducing emissions; and (4) their rights under this standard. Section 6(b)(7) of the Act makes it clear that these are appropriate goals of an employee training program, and the standard, therefore, includes them.

The employer is required to make a copy of the standard and its appendices available to affected employees. This requirement, in combination with the review provided for as part of the training program, is intended to ensure that employees understand their rights and duties under this standard.

The employer is also required to provide, upon request, all materials relating to the training program to the Secretary and the Director. This is intended to provide an objective check of compliance with the content requirements of the standard. It should be noted that the recording and requirement regarding the training program which had been included in the proposal (Ex. 1a, p. 32280) has been deleted in the standard. This places greater reliance on access to training materials as a check to ensure that employees are being properly trained.

L. Signs and Labels. OSHA believes that it is important, and indeed section 6(d) of the Act requires, that appropriate forms of warning, as necessary, be used to apprise employees of the hazards to which they are exposed in the course of their employment. OSHA believes, as evidenced by the mandatory requirement that employees should be given the opportunity to make informed decisions on whether to work at a job under the particular working conditions extant. Furthermore, there is evidence that exposure to the lenticular substances is associated with the development of potential safety and health problems involving the cooperation of employees, the success of such a program is highly dependent upon the use of protective clothing. The hazards attendant to that job (Ex. 2-18, p. 1-11).

In light of the serious nature of the hazard of exposure to coke oven emissions, OSHA does not believe that periodic training alone will adequately apprise employees of the carcinogenic hazard. However, coupled with the training requirements, OSHA believes that the requirement to post signs will adequately do so. Additionally, the appearance of the phrase "cancer hazard" on the warning signs, which apprise employees of the hazard, is intended to ensure that the choice is an informed one.

The use of signs or labels required by other statutes, regulations, or ordinances, in addition to, or in combination with, signs required by this standard is permitted. OSHA recognizes that employers may use precautionary labels for contaminated protective clothing, as required by the recordkeeping requirements to use warning signs and labels.

The purpose of this provision of the standard is to allow the employer to comply with these various requirements in an administratively convenient manner.

The standard requires that no statement which contradicts or detracts from the effect of any sign required by this paragraph shall appear on or near any such required sign. It also requires that the language on the signs be kept visible to employees by illuminating and cleaning the signs when necessary. This two requirements are designed to ensure the effectiveness of the warning signs.

Statements which contradict or detract from the intended effect of a sign are clearly counterproductive to using signs to convey information. Similarly, if the language on the signs cannot be read, either because of darkness or an unclear composition, then the purpose in requiring signs to be printed both in English and in the predominant primary language of non-English speaking workers, if any, as recommended in the Criteria Document. The need for such a requirement has not been established in the record.

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The use of labels or signs required by other statutes, regulations, or ordinances, in addition to, or in combination with, signs required by this standard is permitted. OSHA recognizes that employers may use precautionary labels for contaminated protective clothing, as required by the recordkeeping requirements to use warning signs and labels.
M. Recordkeeping. Section 8(c)(3) of the Act (29 U.S.C. 667) mandates the promulgation of regulations requiring employers to maintain accurate records of employee exposures to potentially toxic materials or harmful physical agents which are required to be monitored or measured. Accordingly, the standard requires employers to keep an accurate record of all measurements taken (pursuant to paragraph (e) of this section) to identify employee exposure to coke oven emissions.

The standard provides that this record must include information which is intended to identify the employee, to accurately reflect the employee's exposure, and to use these facilities for exposure recordkeeping as well.

Another argument made by industry participants is that the 40-year retention period is unreasonable in light of the approximate 20-year latency period for lung cancer. The employer, it is said, should not be required to keep records for 40 years beyond the latency period for cancer; therefore, a retention period for the term of employment plus 20 years is reasonable (Ex. 48, 52 A., items 12D, 20; Ex. 7, items 5, 8, 13). This argument ignores the possibility of a latency period lasting longer than 20 years. As noted above, OSHA has established a minimum retention period of 40 years in order to allow for a longer latency period and to cover employees who work less than 20 years.

The standard also requires that the employer keep an accurate medical record for each employee who is subject to medical surveillance. Section 8(c)(1) of the Act authorizes the promulgation of regulations requiring an employer to keep such records regarding the employer's activities relating to the Act as are necessary or appropriate for the enforcement of the Act or for developing information regarding the causes and prevention of occupational illnesses. OSHA believes that medical records are necessary and appropriate to both the enforcement of this standard and the development of information regarding the causes and prevention of illness related to exposure to coke oven emissions.

Like all records, medical records serve as an objective check that an employer has actually performed the substantive requirements of the standard. More importantly, as explained above, it is necessary to relate employee's medical effects with their exposures in order to develop information regarding cause and prevention. Medical records are necessary and appropriate for this purpose. In addition, medical records are necessary for the proper evaluation of an individual's health. For all of these reasons, medical records have been required in the standard.

The standard provides that the medical records must include information which is necessary to identify the employee, to accurately reflect the employee's health, and to establish that the employee has had an opportunity to participate in a medical examination. The reasons for requiring the various aspects of the medical examination and procedures, guidelines or standards used to interpret the results have been explained in that section. It is based on these requirements which dictate the content of the medical records.

The standard essentially followed the approach of the proposal and the Advisory Committee. The need for keeping medical records and the content of the records was generally not disputed by the participants, although the retention period was.

The standard requires that medical records be maintained for at least 40 years, or for the duration of employment plus 20 years, whichever is longer. Employers again felt that this requirement was too burdensome and unnecessary for some of the reasons expressed regarding exposure monitoring records. OSHA believes, however, that the same justification applies to the retention period for both records, and has acted accordingly.

In addition, specific retention periods for x-rays and cytologic examination slides have established. The initial x-ray and slide must be retained for the full retention period because they serve as a baseline against which all future evaluations are measured. Any x-ray with a demonstrated abnormality, all subsequent x-rays, any slide with demonstrated atypia, if such atypia persists for 3 years, and all subsequent slides and written descriptions must be maintained for the full retention period. OSHA believes that these results which indicate abnormality and atypia are useful in the evaluation of an employee's physical condition and the development of information regarding the cause and prevention of illness.
RULES AND REGULATIONS

The Advisory Committee report recommended that employees or their representatives be provided access to examine and copy records of required monitoring and measuring. The purpose of this provision is to ensure current employees that their exposure is being properly monitored and measured and that they are working in a safe and healthful environment.

In requiring that employees or their designated representatives be provided access to examine and copy records of required monitoring and measuring, the standard does not follow the proposed standard. It provided for access to required monitoring and measuring records to former employees and their designated representatives as well as to current employees and their representatives. The standard restricts access to required monitoring and measuring records to current employees and their representatives because there is no apparent reason for former employees to inspect current monitoring and measuring records having no relation to their own exposure. The Advisory Committee report recommended that employees or their representatives, former employees, and designated physicians of employees and former employees have access to required exposure records. The standard does not provide for employees to current monitoring and measuring records to designated physicians of employees and former employees because the designated physicians are authorized to have access to employee or former employees’ monitoring and measuring records in which their exposure is recorded.

Therefore, no purpose is served in providing for access to current monitoring records to the designated physician of an employee or former employee.

An industry participant objected to the copying entitlement of the availability section in the proposed standard, arguing that section 8(c) of the Act specifically provides for “safe and healthful resources” (section 2(b)). Therefore, section 8(c) (3) must be read to include designated representatives of the former employee as having access rights to those records indicating the former employee’s own exposure.

The final standard requires that required employee medical records be made available upon examination and copying to a physician designated by the affected employee or former employee. The purpose of this provision is to provide the employee’s health by authorizing his designated physician to have access to medical records useful in the diagnosis of illness.

In requiring that employee medical records be made available upon request, it is apparent that the standard does not distinguish access to required monitoring records having no relation to their own exposure because he is entitled to such access for the protection of his own health, but has no reason to require access to current monitoring records having no relation to his own exposures. Moreover, section 8(c) (3) of the Act specifically provides for the employee’s or former employee’s access right to records indicating his own exposures. The final standard makes separate provision for the former employee’s access to records indicating only his own exposure because he is entitled to such access for the protection of his own health, but has no reason to require access to current monitoring records having no relation to his own exposures. The Advisory Committee report did not distinguish access to required monitoring records from access to records indicating the employee’s own exposures.

An industry participant objected to the access right of the designated representative of a former employee under section 8(c) (3) of the Act, while explicitly authorizing access by employees or former employees to records indicating their own exposure, does not explicitly make provision for this access right by the designated representative of the former employee. It should be noted that section 8(c) (3) does also provide for “safe and healthful resources” (section 2(b)). Therefore, section 8(c) (3) must be read to include designated representatives of the former employee as having access rights to those records indicating the former employee’s own exposure.
The proposed standard and the Advisory Committee report included requirements to keep records of respirator usage and employee training. The standard does not include these requirements. Both the respiratory protection program and all materials relating to the employee information and training program must be provided upon request to the Secretary and the Director. Since the main purpose of requirements to keep the records in these areas is enforcement, OSHA believes that this goal will be served by having such information available upon request.

N. Observation of Monitoring. Section 8(c) of the Act requires that employers provide employees or their representatives with the opportunity to observe monitoring of employee exposures to toxic materials or harmful physical conditions with regard to which Federal agencies exercise statutory authority to prescribe or enforce standards affecting occupational safety and health.

(b) Definitions. For the purpose of this section: "Authorized person" means any person specifically authorized by the employer to enter a regulated area for the purpose of exercising the opportunity to observe monitoring and measuring procedures under paragraph (n) of this section.

"Coke oven" means a coke oven in which the products of carbonization other than coke are not recovered, but are released into the ambient air.

"Coke oven emissions" means a retort in which coke is produced by the destructive distillation or carbonization of coal.

"Coke oven battery" means a structure containing a number of slot-type coke ovens.

"Coke oven emissions" means the benzene-soluble fraction of total particulate matter present during the destructive distillation or carbonization of coal for the production of coke.

"Director" means the Director, National Institute for Occupational Safety and Health, U.S. Department of Health, Education, and Welfare, or his designee.

"Emergency" means any occurrence such as, but not limited to, equipment failure which is likely to, or does, result in any massive release of coke oven emissions.

"Existing coke oven battery" means a battery in operation or under construction on January 20, 1977, and which is not rehabilitated.

"Rehabilitated coke oven battery" means a battery which is rebuilt, overhauled, renovated, or restored such as from the pad up, after January 20, 1977.

"Secretary" means the Secretary of Labor, U.S. Department of Labor, or his or her designee.

"Stage charging" means a procedure by which a predetermined volume of coke in each larry car hopper is introduced into an oven such that no more than two hoppers are discharging simultaneously.

"Sequential charging" means a procedure, usually automatically timed, by which a predetermined volume of coke in each larry car hopper is introduced into an oven such that no more than two hoppers commence or finish discharging simultaneously although, at some point, one or more of the hoppers are discharging simultaneously.

"Pipeline charging" means any apparatus used to introduce coke into an oven which uses a pipe or duct permanently mounted onto an oven and through which coal is charged.

"Green push" means coke which when removed from the oven results in emissions due to the presence of unvolatilized coal.

The employer shall establish regulated areas and shall limit access to them to authorized persons.

(2) The employer shall establish the following as regulated areas:

(i) The coke oven battery including the topside machinery, pushside machinery, coke side machinery, coke hopper, coke battery; the wharf, and the screening station.

(ii) The beehive oven and its machinery.

(e) Exposure monitoring and measurement—(1) Monitoring program. (i) Each employer who has a place of employment where coke oven emissions are present shall monitor employees employed in the regulated area to measure their exposure to coke oven emissions.

(ii) The employer shall obtain measurements which are representative of each employee's exposure to coke oven emissions over an eight-hour period. All measurements shall determine exposure without regard to the use of respiratory protection.

(iii) The employer shall collect full-shift (or at least seven continuous hours) personal samples, including at least one sample during each shift for each battery and each job classification.
within the regulated areas including at least the following job classifications: (a) Lidman; (b) Trackman; (c) Larry car operator; (d) Luter man; (e) Machine operator, coke side; (f) Benchman, coke side; (g) Benchman, pusher side; (h) Hester; (i) Quenching car operator; (j) Trencher machine operator; (k) Screening station operator; (l) Wharfman; (m) Oven patcher; (n) Oven repairman; (o) Spillman; and (p) Maintenance personnel.

(iv) The employer shall repeat the monitoring and measurements required by this paragraph (e) (1) at least every three months.

(2) Redetermination. Whenever there has been a production, process, or control change which may result in new or additional exposure to coke oven emissions, or whenever the employer has any other reason to suspect an increase in employee exposure, the employer shall repeat the monitoring and measurements required by paragraph (e) (1) (i) of this section for those employees affected by such change or increase.

(b) Notification. (1) The employer shall notify each employee in writing of the exposure measurements which represent that employee’s exposure within five working days after the receipt of the results of measurement required by paragraphs (e) (1) and (e) (2) of this section.

(ii) Whenever such results indicate that the representative employee exposure exceeds the permissible exposure limit, the employer shall, in such notification, inform each employee of that fact and of the corrective action being taken to reduce exposure to or below the permissible exposure limit.

(4) Accuracy of measurements. The employer shall use a method of monitoring and measurement which has an accuracy with a confidence level of 95% of not less than plus or minus 35% for concentrations of coke oven emissions greater than or equal to 150 µg/m³.

(5) Methods of compliance. The employer shall control employee exposure to coke oven emissions by the use of engineering controls, work practices and respiratory protection as follows:

(i) Priority of compliance methods—

(a) Existing coke oven batteries. (a) The employer shall institute the engineering and work practice controls listed in paragraphs (f) (1) and (f) (2) which have an accuracy with a confidence level of 95% of not less than plus or minus 35% for concentrations of coke oven emissions greater than or equal to 150 µg/m³.

(b) The employer shall institute the engineering and work practice controls listed in paragraphs (f) (2) and (f) (3) of this section as minimum requirements generally applicable to existing or new coke oven batteries. If, after implementing all controls required by paragraphs (f) (2) and (f) (3) of this section or after January 20, 1980, whichever is sooner, employee exposures still exceed the permissible exposure limit, employers shall research, develop and implement any other engineering and work practice controls necessary to reduce exposure to or below the permissible exposure limit.

(c) New or rehabilitated coke oven batteries. The employer shall institute the best available engineering and work practice controls on all new or rehabilitated coke oven batteries to reduce and maintain employee exposures at or below the permissible exposure limit, except to the extent that the employer can establish that such controls are not feasible. Wherever the engineering and work practice controls which can be instituted are not sufficient to reduce employee exposures to or below the permissible exposure limit, the employer shall nonetheless use them to reduce exposures to the lowest level achievable by these controls and shall supplement them by the use of respiratory protection which complies with the requirements of paragraph (g) of this section.

(d) Existing coke oven batteries. (a) One of the following methods of charging:

(1) Sequential charging as described in paragraph (f) (3) (i) and (ii) of this section or;

(b) Pipeline charging or other forms of enclosed charging in accordance with paragraph (f) (2) (i) of this section, except that paragraphs (f) (2) (i), (f) (3) (i) and (f) (3) (ii) of this section do not apply;

(c) Drafting from two or more points in the oven being charged, through the use of double collector mains, or a fixed or moveable jumper pipe system to another oven, to effectively remove the gases from the oven to the collector mains; and

(d) Mechanical volumetric controls on each larry car hopper to provide the proper amount of coal to be charged through each charging hole so that the tunnel head will be sufficient to permit the gases to move from the oven into the collector mains;

(e) Devices to facilitate the rapid and continuous flow of coal into the oven being charged, such as stainless steel liners, coal vibrators or pneumatic shells; and

(f) Individually operated larry car drop sleeves and slide gates designed and maintained so that the gases are effectively removed from the oven into the collector mains;

(g) Mechanized gooseneck and standpipe cleaners;

(h) Air seals on the pusher machine levelers bars to control air infiltration during charging; and

(i) Roof carbon cutters or a compressed air system or both on the pusher machine rams to remove roof carbon.

(ii) Coking. The employer shall equip and operate existing coke oven batteries with all of the following engineering controls to control coke oven emissions during charging operations:

(a) A pressure control system on each battery to obtain uniform collector main pressure; and

(b) Ready access to door repair facilities and the prompt and efficient repair of doors, door sealing edges and all door parts;

(c) An adequate number of spare doors available for replacement purposes;

(d) Chuck door gaskets to control chuck door emissions until such door is repaired, or replaced; and

(e) Heat shields on door machines.
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(3) Work practice controls. (1) Charging. The employer shall operate existing coke oven batteries with all of the following work practices to control coke oven emissions during the charging operation:

(a) Establishment and implementation of a detailed, written inspection and cleaning procedure for each battery consisting of at least the following elements:

(i) Prompt and effective repair or replacement of all engineering controls;

(ii) Inspection and cleaning of goose-necks and standpipes prior to each charging.

(iii) Liquor sprays prior to each charge and existing coke oven batteries with all of the detailed, written inspection and cleaning procedure established and implemented for the control of coke oven emissions during coking, consisting of at least the following elements:

(a) Checking oven back pressure controls to maintain uniform pressure conditions in the collecting main;

(b) Repair, replacement and adjustment of oven doors and chuck doors and replacement of door jams so as to provide a continuous metal-to-metal fit;

(c) Cleaning of oven doors, chuck doors and door jams each coking cycle so as to provide an effective seal;

(d) An inspection system and corrective action program to control door emissions to the maximum extent possible; and

(e) Luting of doors that are sealed by luting each coking cycle and reluting, replacing or adjusting as necessary to control leakage.

(b) Establishment and implementation of a detailed written charging procedure, designed and operated to eliminate emissions during charging of each pipeline or enclosed charged battery.

(ii) Coking. The employer shall operate existing coke oven batteries pursuant to a detailed written procedure established and implemented for the control of coke oven emissions during coking, consisting of at least the following elements:

(a) Checking oven back pressure controls to maintain uniform pressure conditions in the collecting main;

(b) Repair, replacement and adjustment of oven doors and chuck doors and replacement of door jams so as to provide a continuous metal-to-metal fit;

(c) Cleaning of oven doors, chuck doors and door jams each coking cycle so as to provide an effective seal;

(d) An inspection system and corrective action program to control door emissions to the maximum extent possible; and

(e) Luting of doors that are sealed by luting each coking cycle and reluting, replacing or adjusting as necessary to control leakage.

(iii) Pushing. The employer shall operate existing coke oven batteries with the following work practices to control coke oven emissions during pushing operations:

(a) Coke and coal spillage nuanced as soon as practicable and not shoveled into a heated oven; and

(b) A detailed written procedure for each battery established and implemented for the control of emissions during pushing consisting of the following elements:

(1) Dampering off the oven and removal of charging hole lids to effectively control coke oven emissions during the push;

(2) Heating of the coal charge uniformly for a sufficient period so as to obtain proper coking including preventing green pushes;

(3) Prevention of green pushes to the maximum extent possible:

(d) Inspection, adjustment and correction of heating fuel temperatures and defective flames at least weekly and after any green push, so as to prevent green pushes;

(5) Cleaning of heating flues and related equipment to prevent green pushes, at least weekly and after any green push.

(iv) Maintenance and repair. The employer shall operate existing coke oven batteries pursuant to a detailed written procedure of maintenance and repair established and implemented for the effective control of coke oven emissions consisting of the following elements:

(a) Regular inspection of all controls, including goose-necks, standpipes, standpipe caps, charging hole lids and castings, jumper pipes and air seals for misalignment or other defects and prompt implementation of the necessary repairs as soon as possible;

(b) Maintenance of the regulated area in a neat, orderly condition free of coal and coke spillage and debris;

(c) Regular inspection of the damper system, aspiration system and collector main for cracks or leakage, and prompt implementation of the necessary repairs;

(d) Regular inspection of the heating system and prompt implementation of the necessary repairs;

(e) Prevention of miscellaneous fugitive topside emissions;

(f) Regular inspection and patching of oven brickwork.

(g) Maintenance of battery equipment and controls in good working order;

(h) Maintenance and repair of coke oven doors, chimney doors, door jams and seals.

(i) Repairs instituted and completed as soon as possible, including temporary repair measures instituted and completed where necessary, but not limited to:

(1) Prevention of miscellaneous fugitive topside emissions; and

(2) Chuck door gaskets, which shall be installed prior to the start of the next coking cycle.

(4) Filtered air. (1) The employer shall provide positive-pressure, temperature-controlled filtered air for the control of emissions during pushing operations, including pusher machine, door mechanism, and quench car cabs.

(2) The employer shall provide stand-by pumps on the battery topside, at the wharf, and at the screening station, equipped with positive-pressure, temperature-controlled filtered air.

(5) Emergencies. Whenever an emergency occurs, the next coking cycle may not begin until the cause of the emergency is determined and corrected, unless the employer can establish that it is necessary to institute the next coking cycle in order to determine the cause of the emergency.

(6) Compliance program. (i) Each employer shall establish and implement a written program to reduce exposures solely by means of the engineering and work practice controls specified in paragraphs (1) (2) through (1) (4) of this section.

(ii) The written program shall include at least the following:

(a) A description of each coke oven operation by battery, including work force and operating crew, coking time, operating procedures and maintenance practices;

(b) Engineering plans and other studies used to determine the controls for the coke battery;

(c) A report of the technology considered in meeting the permissible exposure limit;
RESPIRATOR REQUIRED
(3) Labels. The employer shall apply precautionary labels to all containers of protective clothing contaminated with coke oven emissions. The label shall bear the following legend:

CAUTION
CLOTHING CONTAMINATED WITH COKE EMISSIONS
DO NOT REMOVE DUST BY BLOWING OR SHAKING

(m) Recordkeeping.—(1) Exposure measurements. The employer shall establish and maintain an accurate record of all measurements taken to monitor employee exposure to coke oven emissions required in paragraph (e) of this section.

(i) This record shall include:
(a) Name, social security number, and job classification of the employee monitored;
(b) The date(s), number, duration and results of each of the samples taken, including a description of the sampling procedure used to determine representative employee exposure where applicable;
(c) The type of respiratory protective devices worn, if any;
(d) A description of the sampling and analytical methods used and evidence of their accuracy; and
(e) The environmental variables that could affect the measurement of employee exposure.

(ii) The employer shall maintain this record for at least 40 years or for the duration of employment plus 20 years, whichever is longer.

(2) Medical surveillance. The employer shall establish and maintain an accurate record for each employee subject to medical surveillance as required by paragraph (i) of this section.

(a) The record shall include:
(A) The name, social security number, and description of duties of the employee;
(B) A copy of the physician's written opinion;
(C) The signed statement of any refusal to take a medical examination under paragraph (1)(i)(ii) of this section; and
(D) Any employee medical complaints related to exposure to coke oven emissions.

(b) The employer shall keep, or assure that the examining physician keeps, the following medical records:

(A) A copy of the medical examination results including medical and work history required under paragraph (1)(ii) of this section;
(B) A description of the laboratory procedures used and a copy of any standards or guidelines used to interpret the test results;
(C) The initial x-ray;
(D) The x-rays for the most recent 5 years;
(E) Any x-ray with a demonstrated abnormality and all subsequent x-rays;
(F) The initial cytologic examination slide and written description;

(g) The cytologic examination slide and written description for the most recent 10 years; and

(h) Any cytologic examination slides with delays, if such slides persist for 3 years, and all subsequent slides and written descriptions.

(iii) The employer shall maintain medical records required under paragraph (m)(2) of this section for at least 40 years, or for the duration of employment plus 20 years, whichever is longer.

(3) Availability. (i) The employer shall make available upon request all records required to be maintained by paragraph (m)(2) of this section to the Secretary and the Director for examination and copying.

(ii) The employer shall make available upon request records of employee exposure measurements required by paragraph (m)(1) of this section for inspection and copying to affected employees, former employees, and their designated representatives.

(iii) The employer shall maintain all records required to be maintained by paragraph (m)(2) of this section to the Secretary and the Director for examination and copying.

(iv) Whenever the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by paragraph (m)(2) of this section.

(v) However, if the employer ceases to do business and there is no successor employer, the records shall be transmitted by registered mail to the Director.

(vi) At the expiration of the retention period for the records required to be maintained under paragraphs (m)(1) and (m)(2) of this section, the employer shall transmit these records by registered mail to the Director.

(vii) The employer shall maintain records of employee exposure to coke oven emissions conducted pursuant to paragraph (e) of this section.

(n) Observation of monitoring.—(1) Employee observation. The employer shall provide affected employees or their representatives an opportunity to observe any monitoring of employee exposure to coke oven emissions conducted pursuant to paragraph (e) of this section.

(2) Observation procedures. (i) Whenever observation of the measuring or monitoring of employee exposure to coke oven emissions requires entry into an area where the use of protective clothing or equipment is required, the employer shall provide the observer with and assure the use of such equipment and shall require the observer to comply with applicable safety and health procedures.

(ii) Without interfering with the measurement, observers shall be entitled to:
(A) An explanation of the measurement procedures;
(B) Observe all steps related to the measurement of coke oven emissions performed at the place of exposure; and

(c) Record the results obtained.

(4) Effective date. This standard shall become effective January 20, 1977.

(p) Appendixes. The information contained in the appendixes to this section is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.

APPENDIX A—COKE OVEN EMISSIONS SUBSTANCE INFORMATION SHEET
I. SUBSTANCE IDENTIFICATION
A. Substance: Coke Oven Emissions
B. Definition: The benzene-soluble fraction of total particulate matter present during the destructive distillation or carbonization of coal for the production of coke.
C. Permissible Exposure Limit: 150 micrograms per cubic meter of air determined as an average over an 8-hour period.

D. Regulated areas: Only employees authorized by your employer should enter a regulated area. The employer is required to designate the following areas as regulated areas: the coke oven battery, including top-side and bottom-side machinery, push-side and its machinery, the screening station, and the whirl the breather ovens and machinery.

II. HEALTH HAZARD DATA
Exposure to coke oven emissions is a cause of lung cancer, skin cancer, and cancer in humans. Although it does not have a excess number of skin cancer cases in humans, repeated skin contact with coke oven emissions should be avoided.

III. PROTECTIVE CLOTHING AND EQUIPMENT
A. Respirators: Respirators will be provided by your employer for routine use if your employer is in the process of implementing engineering and work practice controls where engineering and work practice controls are not feasible or insufficient. You must wear respirators for non-routine activities or in emergency situations where you are likely to be exposed to levels of coke oven emissions in excess of the permissible exposure limit. Until January 20, 1978, the routine wearing of respirators is voluntary. Until that date, if you choose not to wear a respirator you do not have to do so. You must still have your respirator with you and you must still wear it if you are near visible emissions. Since how well your respirator fits your face is very important, your employer is required to conduct fit tests to make sure the respirator seals properly when you wear it. These tests are simple and rapid and will be explained to you during your training sessions.

B. Protective clothing: Your employer is required to provide, and you must wear, appropriate, clean, protective clothing and equipment to protect your body from repeated skin contact with coke oven emissions and from the heat generated during the coke-making process. This clothing should include such items as jacket and pants and flame resistant gloves. Protective equipment should include face shields, safety goggles, protective helmets and safety shoes, insulated from hot surfaces where appropriate.

IV. HYGIENE FACILITIES AND PRACTICES
You must not eat, drink, smoke, chew gum or tobacco, or apply cosmetics in the regulated area, except that drinking water is permitted. Your employer is required to provide lunchrooms and other areas for these purposes.

Your employer is required to provide showers, washing facilities, and change rooms. If you work in a regulated area, you must
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V. SIGNS AND LABELS

Your employer is required to post warning signs and labels for your protection. Signs must warn that a cancer hazard is present, that only authorized employees may enter the area, and that no smoking or eating is allowed. In regulated areas where coke oven emissions are above the permissible exposure limits, the area must be marked with a sign to warn that respirators must be worn.

VI. MEDICAL EXAMINATIONS

If you work in a regulated area at least 30 days per year, your employer is required to provide you with a medical examination every year. The medical examination must include a medical history, a chest x-ray, pulmonary function test, weight comparison, skin examination; a urinalysis and a urine and sputum cytology exam for the early detection of urinary or lung cancer. The cytology exams are only included in the initial exam until you are either 45 years or older, or have 5 or more years of employment in the areas where the medical exams including these tests are to be given every 6 months. The examining physician will provide a written opinion to your employer containing the results of the medical exams. You should also receive a copy of this opinion.

VII. OBSERVATION OF MONITORING

Your employer is required to monitor your exposure to coke oven emissions and you are entitled to observe the monitoring procedure. You are entitled to receive an explanation of the measurement procedure, observe the steps taken in the measurement procedure, and to record the results obtained. When the monitoring procedure is taking place in an area where respirators or personal protective clothing and equipment are required to be worn, you must also be provided with and must wear the protective clothing and equipment.

VIII. ACCESS TO RECORDS

You or your representative are entitled to records of your exposure to coke oven emissions upon request to your employer. Your medical examination records can be furnished to your physician upon request to your employer.

IX. TRAINING AND EDUCATION

Additional information on all of these items plus training as to hazards of coke oven emissions and the engineering and work practice controls associated with your job will also be provided by your employer.

APPENDIX II - INDUSTRIAL HYGIENE AND MEDICAL SURVEILLANCE GUIDELINES

A. SAMPLING (Benzene-Soluble Fraction Total Particulate Matter)

Samples collected should be full shift (8-hour) samples. Sampling should be done using a personal sampling pump with pulsation damper at a flow rate of 2 liters per minute. Samples should be collected on 0.8 micrometer pore size silver membrane filters (37 mm diameter) preceded by Gelman glass fiber type A filters enclosed in three-piece plastic (polystyrene) field monitor cassettes. The cassette face cap should be on and the plug removed. The rotameter should be checked, each hour to ensure that proper flow rates are maintained.

A minimum of three full-shift samples should be collected for each job classification on each battery, at least one during and the night. If disparate results are obtained for particular job classifications, sampling should be repeated. It is advisable to sample each shift more than one day to account for environmental variables (wind, precipitation, etc.) which may affect sampling. Differences in exposures among different work shifts may indicate a need to improve work practices on a particular shift. Sampling results from different shifts for each job classification should not be averaged. Multiple samples from same shift may be used to calculate an average exposure for a particular job classification.

B. ANALYSIS

1. All extraction glassware is cleaned with dichromic acid cleaning solution, rinsed with tap water, then dried. Benzene, aceton, and allowed to dry completely. The glassware is rinsed with benzene benzene before use. The Teflon cups are cleaned with benzene benzene then with acetone.

2. Pre-weight the 2 ml Perkin-Elmer Teflon cups to one hundredth of a milligram (0.01 mg) on a Perkin-Elmer autobalance AD 2. Tare weight of the cups is about 50 mg.

3. Place the silver membrane filter and glass fiber filter into a 15 ml test tube.

4. Extract with 5 ml of benzene for five minutes in an ultrasonic cleaner.

5. Filter the extract in 15 ml medium glass fritted funnel.

6. Rinse test tube and filters with two 1.5 ml aliquots of benzene and filter through the fritted glass filter.

7. Collect the extract and two rinses in a 10 ml Kontes graduated evaporative concentrator.

8. Evaporate down to 1 ml while rinsing the sides with benzene.

9. Pipet 0.5 ml into the Teflon cup and evaporate to dryness in a vacuum oven at 40°C for 3 hours.

10. Weigh the Teflon cup and the weight gain is due to the benzene-soluble residue in half the sample.

II. MEDICAL SURVEILLANCE GUIDELINES

A. GENERAL

The minimum requirements for the medical examination for coke oven workers are given in paragraph (1) of the standard.

The initial examination is to be provided to all coke oven workers at the time of initial assignment to a job in the regulated area. The examination includes at least 144: X-rays. In addition, a chest x-ray and a ILO/UC rating to assure some standardization of x-ray reading, a pulmonary function test (PFT and FEV 1.0), weight, urinalysis, skin examination and a sputum and urinary cytologic examination. These tests are to be performed on those employees who are 46 years of age or older and to have worked for 5 or more years in the regulated area; periodic exams are to be performed semi-annually for this group instead of annually. The examination contents are minimum requirements, additional tests such as lateral and oblique x-rays or additional pulmonary function tests may be performed if desired.

B. Pulmonary function tests

Pulmonary function tests should be performed in a manner which minimizes subject and operator bias. There has been shown to be learning effects with regard to the results obtained from certain tests, such as FEV 1.0. Best results can be obtained by multiple trials for each subject. The best of three trials or the average of the last three of five trials may be used in obtaining reliable results. The type of equipment, manufacturer, model, etc.) should be recorded with the results as reliability and accuracy varies among such equipment. The evaluation of test results. Care should be exercised to obtain the best possible testing equipment.

C. Sputum cytology

Sputum can be collected by aerosol inhalation during the medical exam or by spontaneous early morning cough at home. Sputum is induced by transoral inhalation of an aerosolized solution of eight percent (8%) sodium chloride in water. After inhaling as few as three to five breaths the subject usually yields an adequate sputum specimen. A minimum of three samples should be collected by the subject at home. All sputum should be collected directly into sixty percent (60%) alcohol.

Scientific evidence suggests that chest x-rays and sputum cytology should be used together as screening tests for lung cancer in high risk populations, such as coke oven workers. The tests are to be performed every two months on workers 46 years of age or older or have worked in the regulated area for 5 or more years. Since the tests seem to be complementary, it may be advantageous to alternate the test procedures. For instance, chest x-rays could be obtained in June and December and sputum cytology could be obtained in March and September. Facilities for providing necessary diagnostic investigation should be readily available as well as chest physicians, surgeons, radiologists, pathologists and immunotherapists to provide any necessary treatment services.

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(d) Monitoring data obtained in accordance with paragraph (e) of this section;

(e) A detailed schedule for the implementation of the engineering and work practice controls specified in paragraphs (f) (2) through (f) (4) of this section; and

(f) Other relevant information.

(iii) If, after implementing all controls required by paragraphs (f) (2) through (f) (4) of this section, or after January 20, 1980, whichever is sooner, the permissible exposure limit is still exceeded, the employer shall develop a detailed written program and schedule for the development and implementation of any additional engineering controls and work practices necessary to reduce exposure to or below the permissible exposure limit.

(iv) Written plans for such programs shall be submitted, upon request, to the Secretary and the Director, and shall be available at the worksite for examination and copying by the Secretary, the Director, and the authorized employee representative. The plans required under paragraph (f) (6) of this section shall be revised and updated at least every six months to reflect the current status of the program.

(7) Training in compliance procedures. The employer shall incorporate all written procedures and schedules required under this paragraph (f) in the education and training program required under paragraph (k) of this section and, where appropriate, post in the regulated area.

(g) Respiratory protection—(1) General.

(i) Where respiratory protection is required under this section, the employer shall provide and assure the use of respirators which comply with the requirements of this paragraph (g). Compliance with the permissible exposure limits may not be achieved by the use of respirators except:

(a) During the time period necessary to install or implement feasible engineering and work practice controls; or

(b) In work operations such as maintenance and repair activity in which engineering and work practice controls are technologically not feasible; or

(c) In work situations where feasible engineering and work practice controls are not yet sufficient to reduce exposure to or below the permissible exposure limit; or

(d) In emergencies.

(ii) Not later than January 20, 1978, whenever respirators are required by this section for concentrations not greater than 1500 µg/m³, the employer shall provide, at the option of each affected employee, either a particulate filter respirator as provided in paragraph (g) (2) (b) of this section, or a powered air-purifying respirator as provided in paragraph (g) (2) (c) of this section.

(iii) The employer shall select respirators from among those approved for protection against dust, fume, and mist by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR Part 11, except that not later than January 20, 1979, the employer shall select respirators from among those approved for protection against coke oven emissions.

(3) Respirator program. The employer shall institute a respiratory protection program in accordance with § 1910.134 of this part.

(4) Respirator usage. (i) The employer shall assure that the respirator issued to the employee exhibits minimum facepiece leakage and that the respirator is fitted properly. The employer shall perform quantitative fit tests annually for each employee who uses a non-powered, particulate filter respirator.

(ii) The employer shall allow each employee who uses a filter respirator to change the filter elements whenever an increase in breathing resistance is detected and shall maintain an adequate supply of filter elements for this purpose.

(iii) The employer shall allow employees who wear respirators to wash their face and respirator facepiece to prevent skin irritation associated with respirator use.

(h) Protective clothing and equipment—(1) Provision and use. The employer shall provide and assure the use of appropriate protective clothing and equipment, such as but not limited to:

(i) Flame resistant jacket and pants;

(ii) Flame resistant gloves;

(iii) Face shields or vented goggles which comply with § 1910.133(a) of this part;

(iv) Footwear providing insulation from hot surfaces;

(v) Safety shoes which comply with § 1910.136 of this part; and

(vi) Protective helmets which comply with § 1910.135 of this part.

(2) Cleaning and replacement. (i) The employer shall provide the protective clothing required by paragraphs (h) (1) (i) and (ii) of this section in a clean and dry condition at least weekly.

(ii) The employer shall clean, launder, or dispose of protective clothing required by paragraphs (h) (1) (i) and (ii) of this section.

(iii) The employer shall repair or replace the protective clothing and equipment as needed to maintain their effectiveness.

(iv) The employer shall assure that all protective clothing is removed at the completion of a work shift only in change rooms prescribed in paragraph (l) (1) of this section.

(v) The employer shall assure that contaminated protective clothing which is to be cleaned, laundered, or disposed of, is placed in a closed container in the change room.

(vi) The employer shall inform any person who cleans or launders protective clothing required by this section, of the potentially harmful effects of exposure to coke oven emissions.

(i) Hygiene facilities and practices. (1) Change rooms. The employer shall provide clean change rooms equipped with storage facilities for street clothes and separate storage facilities for protective clothing and equipment whenever employees are required to wear protective clothing and equipment in accordance with paragraph (h) (1) of this section.

(2) Showers. (i) The employer shall assure that employees working in the regulated area shower at the end of the work shift.

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TABLE I

<table>
<thead>
<tr>
<th>Airborne concentration of coke oven emissions</th>
<th>Required respirator</th>
</tr>
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<tbody>
<tr>
<td>Any concentration.</td>
<td>(a) (i) A Type C supplied air respirator operated in pressurized or other positive pressure or continuous flow mode; or</td>
</tr>
<tr>
<td>(b) Concentrations not greater than 1500 µg/m³.</td>
<td>(A) A particulate filter respirator for dust, mist, and fume; or</td>
</tr>
<tr>
<td>(c) Concentrations greater than 1500 µg/m³.</td>
<td>(B) A powered air-purifying particulate filter respirator for dust, mist, and fume; or</td>
</tr>
</tbody>
</table>

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FEDERAL REGISTER, VOL. 41, NO. 206—FRIDAY, OCTOBER 22, 1976
(i) The employer shall provide work facilities in accordance with § 1910.141.

(3) of this Part.

(3) Lunchrooms. The employer shall provide lunchroom facilities which have a temperature controlled, positive pressure, filtered air supply, and which are readily accessible to employees working in the regulated area.

(4) Lavatories. (1) The employer shall assure that employees working in the regulated area wash their hands and face prior to eating. (2) The employer shall provide lavatory facilities in accordance with § 1910.141(d) (1) and (2) of this Part.

(5) Prohibition of activities in the regulated area. (1) The employer shall assure that in the regulated area, food or beverages are not present or consumed, smoking products are not present or used, and cosmetics are not applied, except that these activities may be conducted in the lunchrooms, change rooms and showers required under paragraphs (1) (1) and (2) of this section.

(2) Drinking water may be consumed in the regulated area.

(1) Medical surveillance. (1) General requirements. Each employer shall institute a medical surveillance program for all employees who are employed in the regulated areas at least 30 days per year.

(2) This program shall provide each employee covered under paragraph (j) of this section with an opportunity for medical examinations in accordance with this paragraph (j).

(3) The employer shall inform any employee who refuses any required medical examination of the possible health consequences of such refusal and shall obtain a signed statement from the employee indicating that the employee understands the risk involved in the refusal to be examined.

(4) The employer shall assure that all medical examinations and procedures are performed by or under the supervision of a licensed physician, and are provided without cost to the employee.

(2) Initial examinations. At the time of initial assignment to a regulated area or upon the institution of the medical surveillance program, the employer shall provide medical examination including at least the following elements:

(i) A work history and medical history which shall include smoking history and the presence and degree of respiratory symptoms, such as breathlessness, cough, sputum production, and wheezing;

(ii) A 14” x 17” posterior-anterior chest x-ray and International Labour Office UICC/Cincinnati (ILO U/C) rating;

(iii) Pulmonary function tests including forced vital capacity (FVC) and forced expiratory volume at one second (FEV1.0) with recording of type of equipment used;

(iv) Weight;

(v) A skin examination;

(vi) Urinalysis for sugar, albumin, and hematuria;

(vii) A sputum cytology examination; and

(viii) A urinary cytology examination.

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(3) Periodic examinations. (1) The employer shall provide the examinations specified in paragraphs (j) (2) (1) (7) (vii) of this section at least semi-annually for employees 45 years of age or older with five (5) or more years employment in the regulated area.

(2) Whenever an employee who is 45 years of age or older with five (5) or more years employment in the regulated area, the employer shall continue to provide the examinations specified in paragraphs (j) (2) (1) (7) (vii) of this section semi-annually, as long as that employee is employed by the same employer or a successor employer.

(3) Whenever an employee has not taken the examinations specified in paragraph (j) (2) (1) (7) (vii) of this section at least annually the employee's exposure to coke oven emissions and the purpose, proper use, and limitations of respiratory protective devices shall be provided at least quarterly until January 20, 1978.

(4) The training program shall include informing each employee of:

(a) The information contained in the substance information sheet for coke oven emissions (Appendix A).

(b) The purpose, proper use, and limitations of respiratory protective devices required in accordance with paragraph (g) of this section.

(c) The purpose of and a description of the medical surveillance program required by paragraph (j) of this section including information on the occupational safety and health hazards associated with exposure to coke oven emissions; and

(d) A review of all written procedures and schedules required under paragraph (f) of this section; and

(e) A review of this standard.

(2) Access to training materials. (1) The employer shall make a copy of this standard and its appendices readily available to all employees who are employed in the regulated area.

(3) The employer shall provide all materials relating to the employee information and training program to the Secretary and the Director.

(1) Precautionary signs and labels—(i) General. (1) The employer may use labels or signs required by other statutes, regulations or ordinances in addition to, or in combination with, signs and labels required by this paragraph.

(2) The employer shall assure that no statement appears on any sign required by this paragraph which contradicts or detracts from the effects of the required sign.

(3) The employer shall assure that signs required by this paragraph are illuminated and cleaned as necessary so that the legend is readily visible.

(2) Signs. (1) The employer shall post signs in the regulated area bearing the legends:

DANGER
CANCER HAZARD
AUTHORIZED PERSONNEL ONLY
NO SMOKING OR EATING

(2) In addition, not later than January 20, 1978, the employer shall post signs in the areas where the permissible exposure limit is exceeded bearing the legend: