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EXPOSURE TO COKE OVEN EMISSIONS

Occupational Safety and Health Standards

Title 29—Labor

CHAPTER XVII—OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION, DEPARTMENT OF LABOR

PART 1910—OCCUPATIONAL SAFETY AND HEALTH STANDARDS

Exposure to Coke Oven Emissions

Pursuant to sections 6(b) and 8(c) of the Occupational Safety and Health Act of 1970 (the Act) (84 Stat. 1593, 1599; 29 U.S.C. 655, 657), Secretary of Labor's Order No. 8-76 (41 FR 25089) and 29 CFR Part 1911, Part 1910 of Title 29, Code of Federal Regulations, is hereby amended by adding a new § 1910.1029 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 evidence, that no employee will suffer 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 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 benzene soluble fraction and listing certain carcinogenic components of CTPV namely anthracene, BaP (benzo-a-pyrene), phenanthrene, acridine, chrysene and pyrene. The TLV was established to minimize exposure to the listed carcinogens (Ex. 2-110e).[1] In 1969, the Secretary of Labor promulgated the 1968 Threshold Limit Values of the ACGIH including the CTPV limit of 0.2 mg/m³, under the Walsh-Healey Public Contracts Act (41 U.S.C. et seq.) (34 FR 788–796) after an opportunity for a public hearing and written comments (33 FR 14258). These standards were subsequently adopted as established Federal standards under section 6(a) of the Occupational Safety and Health Act of 1970 (84 Stat. 1593; 29 U.S.C. 655) (36 FR 10466, 36 FR 15101).

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 revoke the applicability of 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 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 controls as interim measures 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, (29 U.S.C. 655(a)) and stated that 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 29 CFR 1910.1000 (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, supplemented by respiratory protection, to reduce employee exposure to coke oven emissions. Acknowledging the absence of reliable dose response data to establish a safe environmental level for exposure to coke oven emissions, NIOSH did not recommend a change in the present CTPV standard but rather stated that it could be used "* * * both as an index of worker 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 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, in accordance with the Federal Advisory Committee Act (84 Stat. 770, 5 U.S.C. App I), and section 7(b) of the Act (29 U.S.C. 656). The Committee was chartered "* * * to study the problem of coke oven emissions with respect to the exposure of workers to such emissions in order to prepare recommendations for an effective standard in the assigned 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 in the development of 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 pubposal itself as well as 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 1999.3(d). Subsequent to the publication of that 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 coke oven emissions draft EIS (40 FR 49816, 49818). In addition to the 45 day comment period specified in 29 CFR 1999.4(g), environmental impact, if any, of the proposed standard was also a issue for the informal hearing as provided by 29 CFR 1999.4(h) and the notice of proposed rulemaking (40 FR 32268).

[1] The exhibit numbers refer to the certified exhibit list. The first number designates the item on the list e.g. exhibit 2 is the Advisory Committee record index, and the second number refers to the particular exhibit where the listed item contains more than one exhibit. The designation "TR" refers to the record transcript. The references are intended to provide examples of record support for the information cited.

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 15-75 (40 FR 54484). While the economic issues were to be considered during the informal hearing scheduled for November 4, 1975, it was not possible to complete the full economic and inflationary impact assessment by that date. Consequently, on October 15, 1975, a FEDERAL REGISTER notice was published (40 FR 48362) 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 4, 1975 and concluded on January 8, 1976.

On March 12, 1976, a notice was published in the FEDERAL REGISTER (41 FR 10625) 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 data, views, arguments 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 on March 26, 1976, indicating the limited scope of the hearing in light of the extensive record developed in the hearing which concluded on January 8, 1976. The seond hearing began on May 4, 1976 and ended on May 14, 1976. A post-hearing comment period was set for June 21, 1976 and the complete record, consisting of 143 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 promulgation of the final standards, OSHA prepared a final environmental impact statement (EIS) in accordance with 29 CFR 1999.5. 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 35200). Several comments were received and have been considered along with the final EIS in the decision to promulgate this standard.

II. BACKGROUND—COKING 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 61 million tons of coke produced annually in the United States, 92% is used in blast furnaces, 5% in foundry 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 $90-$110 a ton when purchased or $60-$80 a ton if produced by a user. An estimated figure of $140 a ton for domestic replacement including transportation costs is cited if demand for coke supplies is increased (Ex. 109).

Two basic processes, as described below, are utilized in the production of coke, one that recovers vapors and other byproducts from the coking process and one that does not (Ex. 2-146; Ex. 80). No new process is presently considered sufficiently advanced to serve as a replacement for currently utilized coking technology (Ex. 2-20; 2-61, Vol. 2; 22-62).

A. *Beehive oven coke production.* Prior to 1910, the use of beehive ovens predominated in the production of coke. By 1910, there were 548 beehive coke plants with over 100,000 ovens. As by-product coke ovens became established, the number of beehive coke ovens declined steadily, except for brief increases during World War II and the Korean War (Ex. 2-27). The number in 1967 was estimated at 2,126 ovens (Ex. 2-20). The usage of these ovens varies with steel demand and in 1974 a peak year for steel demand, they produced 846,000 tons (Ex. 6A 14).

The name "beehive" accurately describes the shape of the oven. The coal is dropped into the opening or "trunnel head" at the top of the oven from the "larry car." The pile of coal is leveled either by machine or by hand to assure uniform coking. The door on the side of the oven is almost completely bricked up following leveling to provide proper heating of the coal. At the end of the coking cycle, the brickwork on the door is removed and the coke is "watered out" prior to removal from the oven by machine or hand (Ex. 80).

B. *By-product coke production.* The first by-product coke ovens in the United States began operation in the 1890's. Industrial expansion resulted in a continued increase in the number of by-product coke plants in the early 1900's. Additional coke and by-product capacity, necessitated by the need for coke oven gas by gas utilities, resulted in 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 1966 to 64 in 1968 (Ex. 2-27). There were 62 plants in 1973 and 1974 (Ex. 6A-14) although other figures presented by AISI and OSHA's IIS indicate there were 65 plants including both blast-furnace and foundry operations. These plants contained 236 batteries and 13,490 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. 2-20; Ex. 149, Ref. 1).

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 series of flues; the regenerative chambers 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 by means of a mechanical "larry car" 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 in a number of coal hoppers which correspond to the number of charging holes, usually either 3 or 4. The car moves down the battery to the oven to be changed. The lids on the oven charging holes are removed, the larry car is positioned over the holes, and the hoppers are emptied (Ex. 2-27). During the charge, the oven is placed under steam aspiration by the use of steam jets located in the standpipes connecting the by-product gas collector main with the oven. This operation, called "charging on the main," is designed to limit the escape of gases from the oven during the charging process so that they can be collected for processing in the by-product plant. After the charge is completed the lids are replaced and the aspiration system shut off (Ex. 2-20)

The "coking time," the time required to produce coke from coal, is governed by numerous factors including the condition and design of the oven heating system, width of the coking chamber coal moisture, and the nature of the coals being coked (Ex. 2-20). A coking time is selected which will give the coke adjacent to the chamber walls a temperature of 1046° C (1900° F) to 1100° C (2000° F) when the coal has been coked all the way through to the center. Actual heating chamber flue temperatures should not exceed 1438° C (2600° F) to 1550° C (2800° F), the maximum safe temperature for the refractory brick. The coking time for blast furnace coke varies from 16 to 20 hours, averaging 17 to 18 hours (Ex. 2-20; 149, Ref 1). Coking times for foundry coke are longer than for blast furnace coke because coke of higher purity is required for foundry operations (Ex. 2-146; 73).

When the coal is coked the doors on each side of the oven are removed and the coke is pushed. A large mechanically operated ram attached to a pusher machine moves the coke out the opposite side of the oven, called the "coke-side," through the "coke-guide" 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 coke wharf, from which it is conveyed to the screening station for sizing, then to the blast furnace, or removed for whatever other purpose it is to be used. 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 coking process 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 cyanide, 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, 285–345m^3 (9,500–11,500 ft.^{3}). 27.5–34 l. (6.5–9 gal.).
Ammonium sulfate, 7–9 kg (15–20 lb.).
Ammonia liquor, 55–135 l. (15–35 gal.).
Light oil, 8–12.5 l. (2–3 gal.).
(Ex. 2–27; 6A–14.)

The coke oven gas contains numerous fixed gases, i.e., those which are gases at 16° C (60° F) and 760 mm pressure. The fixed gases are hydrogen, methane, ethane, carbon monoxide, carbon dioxide, ethylene, propylene, butylene, acetylene, hydrogen sulfide, ammonia, oxygen, and nitrogen. The ammonia liquor is an aqueous solution of a number of ammonium salts condensed from the gas. The tar is a black, viscous liquid which condenses from the gas in the collector main. It is the source of pyridine, tar acids, naphthalene, creosote 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 naphthas.

D. *Summary.* It is apparent from the description of the coking industry that the majority of coking 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 76% of the foundry batteries have been in operation for 20 years or more (Ex. 2–146; 73). The blast furnace batteries constitute 45% of present capacity and are nearing the end of their useful lives (Ex. 2–146; 6A–14). Scheduled replacement and expansion is a complex issue as is discussed in the section on economics. However, it appears that replacement and expansion will be based on the technology currently used for coke production with additional efforts not only to control coke oven emissions but also to operate more efficient coke production and collecting systems.

This increased efficiency is important because the value of the industry lies not only in production of coke for blast furnaces and foundries 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, which are feedstocks for organic chemicals, are 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 coking industry and the nature of that regulation depends on an assessment 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 of coke oven emissions. 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 animals 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 reveal the presence 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 nonmalignant respiratory 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 employee safety and health. These include particularly exposure to high temperatures, fire and moving equipment during the coking operation.

The following sections summarize the material in the record with regard to the hazards outlined above.

A. *Historical data.* It has long been recognized that the combustion or distillation products of coal are carcinogenic 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 Percivall 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 Volkmann in men handling tar and paraffin recovered from the carbonization of lignite. These cases "agreed to the last detail with the so-called chimney-sweep 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, Passey induced skin cancer with an ether extract of chimney soot (Ex. 8–8). Following many years of research on the constituents of coal tar distillates, 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 exposures was limited to single case reports and to the observation by Kennaway that a high proportion of noncutaneous 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 it has been stated that coke ovens are "a carcinogen-rich environment." (Ex. 3, p. 75). Indeed, multiple carcinogens and cocarcinogens have been identified 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(j)fluoranthene, benzo(b)anthracene, and chrysene. The presence of half a dozen 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 (ferric 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 demonstrate that the benzo(a) pyrene must be physically associated with, i.e. adsorbed on, the particulate to achieve an increased tumor incidence (Ex. 26I).

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 many substances including benzo(a)pyrene, did produce a significant number of lung tumors. (TR 695; 732). Scheel concluded that "the presence of particulates in the coal tar has affected the number of lesions found * * *" (TR 697).

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 predate 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 common exposures to the volatile matter and by-products produced by coal carbonization despite the possible variations in plant construction and methods of treating coal (Ex. 8-1; 8-18).

The first report of unusual lung cancer experience 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, not a single lung cancer was noted among the 46 malignant neoplasms observed in the other employees. In the same year that the Japanese reported the lung cancer excesses in gas generator workers, the Kennaway's survey 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 1921 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 1952, 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, these findings were updated confirming the 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. 2-118A).

Specific attention was focused on coke plant workers when, in 1956, 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 by job site. In addition, the authors did note a slight excess when the coke oven worker category was enlarged to include not just those presently employed there but also all 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)

Christian, in 1962, reported lung cancer in 12 of 102 workers employed in the coke department of a large U.S. public utility. This represented about 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 a concentration of cases. 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 coking industry, in the 1950's. During 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 tars (Ex. 2-55A). While both animal and epidemiological studies were conducted, only the epidemiological results will be discussed in this section. The population sample 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 chemical 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 fixed geographical localization (Ex. 2-55 E, p. 14).

As a result of a U.S. Public Health Service, University of Pittsburgh study begun in 1962, 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. 2-33; 2-13; 2-14). This steelworker study is an on-going project and the mortality data is regularly updated. The parts which are relevant here are those 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 expected from 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 10 non-Allegheny County coke plants with a comparable control group without coke oven experience (Ex. 2-14).

The initial study of the Allegheny County plants compared the mortality experience from 1953 to 1961 of 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 1,327 or 2,048. The findings were significant. Coke oven worker mortality from respiratory cancer was 2½ 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 times the lung cancer 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 plant results 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 1951 through 1955 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. 20-J). 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 races. For all plants combined, topside 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 and side oven workers showed increased risks that were statistically significant after five or more years of exposure. (Ex. 2-14 Table 6.)

Updates of 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 979-982). To date, only the Allegheny County 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 2.5 times the expected rate and for side oven only it is 1.7 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 level of confidence. 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 carcinogenity of coke oven emissions was not disputed by participants at the rulemaking proceeding including the five largest steel companies, and the American Coke and Coal Chemicals Institute. As Dr. Halen testified on behalf of AISI, 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 any conclusion is limited because the work histories of the studied population did not contain adequate information on smoking histories (Ex. 82C; TR 995). Indirect tests were applied, however, to the epidemiological observations by comparing the lung cancer rates for heavy cigarette smokers with that for coke oven employees. Even with this assumption, the excess lnng 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 plant, no excess cancer mortality was found (Ex. 52; 128A). The sample population is only 363 employees, however. This is too small a sample size to disprove the carcinogenicity of coke oven emissions. The studies which defined the hazard (Ex. 8-1; 8-19) relied on a vastly larger sample over a wide geographic area and showed that 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 carcinogenic wherever they are generated.

2. *Animal studies.* Since it has not been possible to generate actual coke oven emissions in an experimental setting, laboratory experiments with animals have been conducted utilizing aerosols of coal tar derived from coking 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 694-695, Ex. 27 P). Although the numbers as stated in the hearing differ from those reported in the NIOSH memo (Ex. 27 P) 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. 8-25). Five of the groups were among the "coal tar" occupations. The high rate of bladder cancer in gas workers was also reported by Doll, et al (Ex. 8-18). Brunsgaard (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 specific enough to detail its extent by anatomic site and by type of exposure. The findings of Henry, et al. (Ex. 8-25), suggest a greater level of risk for by-product workers than for workers engaged in the carbonization process. The actual coke oven workers cannot be separated in this study, thus no estimates of their risk can be made. No excess mortality from bladder cancer has been observed to date in coke plant workers in the United States (Ex. 2-14; 20 L).

In their study of steelworker mortality (Ex. 2-14), Redmond, et al. identified eight deaths from kidney cancer among coke oven workers in twelve coke plants from 1951 to 1966. These eight deaths are not clustered in any plant or racial group. Four deaths were in the Allegheny County workers and four deaths were in the non-Allegheny County workers. Four deaths were among white coke oven workers and four deaths 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

Allegheny County cohort, one additional kidney cancer death was reported (Ex. 20 L). 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 (TR 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. None 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 duration of exposure is a factor. 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 1951 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 ovens and those who had partial topside exposure. The excess appears related to employees with 10 or more years exposure (Ex. 20L) and indicates that consideration should 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*.—1. *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 carbon workers reported by Lueke in 1907 (Ex. 8–22). In the same year, the British included in the Workmen's Compensation Schedule "scrotal epithelioma occurring in chimney sweeps and epitheliomatous 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 1900 to 1943, 84 cases of epitheliomatous ulceration, or cancer of the skin, including 40 scrotal cancers, were reported for British coke oven workers. Among men with prior coke oven employment, eleven fatal scrotal cancers were reported.

Redmond, et al reported one skin cancer death in their 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 showed no skin cancer deaths in either coke oven or non-oven workers from 1953–1970 (Ex. 20J).

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 not 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 42 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 is not available. For the period 1971–1974, one skin cancer was found during the company's annual physical examination program. This tumor was diagnosed as actinic in origin, i.e., related to exposure to sunlight. It was noted that only 10.35 percent of the coke plant employees participated in the program (Ex. 52)

The United Steelworkers of America submitted an affidavit from Donald Young, a grievance handler at the Geneva coke plant of U.S. Steel Corporation in Provo, Utah, which provided the results of a survey of employees who had received medical treatment for skin cancer (Ex. 60). The source of the medical treatment i.e. company or personal physician was not stated. According to the affidavit, 9 union members or former members and two supervisors had received such treatment. The time period over which these cases occurred was not given, but the average period of employment in the coke plant was 20 years. All but one of the individuals are said to have had "extensive exposure to coke oven emissions". All are said to have showered after work and to have at least average personal hygiene habits. The affidavit stated that the geographic location of the coke plant (Utah) is not known to have an excess incidence of skin cancer, although the rate for the general population of that area was not given. A number of cases of skin cancer were also reported in employees of the open hearth department and among bricklayers.

In response to Mr. Young's affidavit, Dr. Merle Bundy, Director of Industrial Medicine for the U.S. Steel Corporation undertook a survey of the company medical records of the 11 employees named by Mr. Young in his affidavit as having had medical treatment for skin cancer. The results of Dr. Bundy's survey are reported in U.S. Steel's post-hearing comment in the form of an affidavit (Ex. 148). Dr. Bundy reports that three of the 11 employees never had skin cancer; that the remaining 8 employees have had skin cancer although their work areas were not necessarily closely related to the coke ovens. One of these 8 employees who had been exposed to coke oven emissions for many years had skin cancer 25 years ago and the deceased employee, although he had skin cancer, did not die of skin cancer or any other form of cancer.

Additionally, the medical records of all non-coke oven employees at U.S. Steel's Geneva Works reveal 10 cases of skin cancer in over 4,000 employees, some of them occurring in employees classified as office workers. Dr. Bundy cites the expected 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 at 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.

2. *Animal studies*. Early animal experiments on chemical carcinogenesis 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 Cincinnati, of the carcinogenic properties of coal tar and coal tar fractions derived from coking concluded that repetitive contact of the skin of mice with coal tar or fractions thereof containing benzo(a)pyrene (B(a)P) at a concentration of 0.01 percent or more resulted in the development of squamous cell carcinoma of the skin (Ex. 2–55B). 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 the type of operation and the materials produced as well as to such factors as personal hygiene and medical surveillance (Ex. 2-18) and to the extent such factors can be controlled to prevent 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. 20L).

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, heat, flame, coal and coke dust, and moving and heavy equipment (TR 1983-1989).

One example 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 1988). Other situations of this nature involve minimizing skin contact with coke oven emissions and yet not prescribing protective equipment that adversely 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 similar 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 give due regard to the question of feasibility. While the precise meaning of this term is not clear from the Act or the legislative history, it has generally been construed in a standard-setting context include both technological and economic considerations. It has long been OSHA's practice to thoroughly evaluate the feasibility of its major standards by performing studies of its own and by consideration of the submissions to the public record.

The economic feasibility of the proposed standard for coke oven emissions has been extensively analyzed by OSHA. Two separate studies have been conducted for OSHA, and several days of hearings have been held, focusing primarily upon issues relating to the economic impacts of coke oven emissions control.

The steel industry is the major industry directly affected by the coke oven standard. The foundry, or merchant, coking industry which produces 3 million of the 61 million tons of coke produced annually is also affected. The record establishes that the steel industry is a large, stable and profitable industry. Over the last 8 years, the earnings after taxes of 7 major and 5 smaller steel producers exceeded $857 million per annum (Ex. 109, Table 2-11A). Moreover, the industry is in an expansionary mode. Over the next 8 years, industry spokesmen project that the steel industry will spend nearly $40 billion in new capital expenditures (TR 4271).

As an affirmation of the healthy state of the steel industry, none of the steel industry spokesmen testified that the proposed standard for coke oven emissions would imperil the existence of the coke industry in the United States. Of primary concern to the steel industry is whether the standard is justified given the magnitude of the hazard and the cost of complying with the proposed standard.

A. *Costs.* Estimates of the total annual cost to the affected industry in order to comply with the proposed standard vary from $130 million to $1.28 billion. The variation in these estimates is primarily attributable to differences in underlying assumptions.

DB Associates (DBA) performed two studies for OSHA relating to coke oven emissions. The first study, completed July 1975, was based upon the Advisory Committee's recommendations for a coke oven emissions standard. It provided a preliminary estimate of the cost of compliance which DBA estimated to be $295 million per year (Ex. 108).

With respect to the foundry coke plant operators, the American Coke and Coal Chemicals Institute ACCCI) submitted a post-hearing comment indicating the costs per ton of coke might be higher for such operations than 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 which OSHA made available March 12, 1976, in which two alternative cost-of-compliance scenarios were developed (Ex. 109). Scenario I considered the cost of control measures set forth 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 million 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 total increased 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 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 cost of replacing coke production which could be lost as a result of controls and work practices required under this interpretation. The result was an estimated total annual 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. ACCCI used both figures in submitting its summary estimates.

AISI rejected the Scenario I capital cost estimate on the grounds that strict 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 DBA, 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 4266).

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 4283–4293). In addition, AISI said that other IIS 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 4656).

Coke loss proved to be an issue which aroused considerable controversy. National Steel Corporation and Republic Steel Corporation basically supported the view taken by AISI, but the United Steelworkers contended that portions of the coke loss had already been accounted for. Questions arose concerning several methods by which coke loss could 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 or stockpiles (TR 4142, 4143, 4063, 4069).

CWPS noted that Scenario II estimates were based upon reports from the several coke producers that would not allow access to detailed company data on cost estimates and that had an incentive to overstate costs (TR 4250). Utilizing Inland Steel Corporation's estimates of capital and annual costs which were respectively 10 and 76 percent less than 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 (using a factor of .15); and other annual costs to be $93,300,000. Using a capital recovery factor reflecting only a depreciation assumption, the lower bound estimate is about $139,000,000 (TR 4692–4693). Thus, CWPS estimated the range of annual costs (based on the .15 capital recovery factor) to be between $160 million and $1.28 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 $200 million (TR 4758).

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. From that estimate the USWA deducted $250,511,000 for four items. These included overestimates of costs of $46,725,000 for hygiene facilities, $57,610,000 for double drafting and $123,900,000 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 calculated the value of that credit to be $22,276,000, 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) automatic lid lifters and automatic door and jamb cleaners are contemplated primarily for new or rehabilitated batteries; (2) separate "contaminated" and non-contaminated facilities remote 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) which 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. 4406, 4751).

A wide range of cost estimates was presented by concerned parties at the hearings. OSHA, has concluded it would be 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 costs related to other portions of this final standard OSHA believes that total annual costs are likely to fall in the $200,000,000 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 on 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 research, develop, and implement new technology in order to meet the permissible exposure limit. Cost figures for these elements are too speculative to estimate (Ex. 108).

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 54484), 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 a greater increase in steel prices may be necessary to generate the necessary funds for compliance. An upper bound of $13.29/tons 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 on 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, DBA calculated an upper bound for steel price changes of 0.5 percent and a rise in consumer 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 labor productivity loss. DBA finally concluded that some small steel producers 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.

The steel industry is 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 which costs (or benefits) should be attributed to which regulations and, therefore, OSHA believes that estimates of compliance costs should be considered as ranges 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 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 upper bound estimate 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 inflationary 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.

C. *Benefits.* It is clear that the overriding purpose of the Act is to protect employee safety and health even if such protection results in the expenditure of large sums of money, increased production costs or reduced 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 as to an appropriate methodology to arrive at dollar values for benefits (Ex. 109, p. 56).

There are insuperable obstacles to any attempt to estimate 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 unambiguous determinations 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, dollar values for benefits require a subjective judgment as to social utility or disutility (TR 4580, 4584-5). CWPS suggested a general approach to estimating benefits as the social benefits to society as a whole, including the individuals who comprise it and reflecting any net reduction in their disutilities (TR 4578). For reasons that are discussed more fully below, OSHA believes that there are so many difficulties involved in attempting to assign a dollar value to the benefits of the standard that such figures would not provide a meaningful indication of the true value of the standard.

Industry representatives recognized the seriousness of the health problem and took no position on the number of lives that would be saved by the proposed regulation, and no witnesses were willing to equate dollars with lives (TR 4391, 4398, 4242). The primary issues then, as raised by CWPS, were (1) whether a dollar value for benefits should or indeed could be established; (2) the elements to be included and evaluated as benefits, and (3) the calculation of preventable mortality.

In attempting to perform cost-benefit analysis, it is initially necessary to calculate the number of lives which will be saved by the standard. The IIS calculation of 240 lives (Ex. 109, p. 68) was challenged. The calculations were based on the assumptions that the proposed regulation would be fully effective in eliminating excess risk of death; that the population at risk is equal to the amount of coke plant labor turnover per year multiplied by 45 years to approximate the length of working life, and that the Redmond calculation of the percentage of excess mortality for coke plant workers can be applied to that population at risk. The result of that calculation is that excess mortality per year from all causes among the total exposed population is estimated at 240. In the hearings (TR 4014) OSHA noted that this estimate was based on a stable population, and, if one accounts for deaths from competing causes over the 45 years, the estimate of excess mortality would decline to 211 (TR 4014).

CWPS objected to the assumptions and results of these calculations. However, they also assumed that the standard would eliminate all excess mortality. They estimated that between 8 and 35 lives per year would be saved as a result of the proposed rule (Tr. 4739). CWPS assumed that there would be no relevant labor turnover and considered only coke oven workers (rather than coke plant workers). As a result, the population at risk in any year in CWPS calculations was appropriately 60 percent of that population at risk estimated in the IIS or 21,000 employees.

CWPS, also assumed: (a) For the high rate, that all workers had the same risk as that estimated for long-term workers; (b) for the medium estimate, that the average excess mortality rate applied to their population at risk, and (c) for the low estimate, that workers in the coke plant had no excess risk of death. CWPS derived their estimates by their own methods from published Redmond 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 benefits.

In the course of CWPS' testimony, it was noted that a rate .0016 was used in the calculation of their high (35.4) 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 in coke ovens resulted in the estimate of about 90 as an alternative high estimate of excess mortality under the CWPS assumptions (TR 4739, 4740). If it is assumed that there is a 20% turnover and that the risk is .0041, then the excess mortality would be approximately 109 deaths per year under the methods used by CWPS.

As can readily be seen, estimates of the mortality benefits of the reduced exposure will vary significantly, depending upon the assumptions utilized. 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 prospectively the decrease in mortality which will, we believe, occur as a result of medical surveillance, hygiene facilities, protective clothing and the other provisions of the final rule.

Moreover, were we 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 resulting from coke oven exposure. Moreover, 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, perhaps as many as 20 or more years from now until the standard is fully effective. However, unless exposures are reduced now, we believe the mortality rate will not 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. In 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 analysis 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)." 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-G). Use of this method requires acceptance of the attitude that what is most important to society is simply the resultant net loss or gain 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 (such as a retired person 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-G).

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 in social programs aimed 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 properly differ among programs. He also notes that no democratic voting process is involved directly in such program decisions and, even if that were the case, an independent economic criterion for the value of life would be required for rational decisions (Ex. 110 G). Some have felt that such an independent value could be derived from 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. 109, 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.

It was suggested that the cost-benefit analysis should include an estimate of the dollar benefits of the standard in relation to reduced morbidity. Again, it is not possible to precisely estimate the excess morbidity resulting from exposure to coke oven emissions, although we do know that excess morbidity does result (Ex. 109, p. 67; TR 4888).

CWPS testified that a previous study (of asbestos workers) indicated that the amount of excess morbidity exceeded that of excess mortality, but that the value of illness was several times less than the value associated with death, so that, in that study, equal dollar values were assigned to excess morbidity and excess mortality. They therefore proposed allowing for the value of morbidity by dividing annual costs by 2 before relating annual cost estimates to estimates of excess mortality in any cost-benefit analysis (TR 4744-4746, 4587-4588). Not only is the number of disabling illness which will be prospectively avoided unknown, but, their average duration and the number of nondisabling illnesses and their duration is also unknown (TR 4589).

In these circumstances, we find that it is inappropriate to arbitrarily establish a dollar value on the benefits of the standard relating to anticipated declines in worker morbidity.

CWPS testified that, by relating estimates of benefits (in terms of preventable deaths or their equivalent) to estimates of the costs of compliance, it is possible to estimate the implicit cost of reduced mortality. Moreover, they testified that a decision on implementing a proposed regulation involved acceptance of such an estimate of the implicit cost as the minimum value of a life (TR 4783). However, for reasons noted above, we do not believe we can forcast accurately the amounts of annual reductions in mortality or morbidity that will result from the regulation, nor do we have an independent estimate or standard of the dollar value of life.

Based upon the foregoing and the record as a whole, OSHA finds that compliance with the standard (even if the higher cost estimate were used) is well within the financial capability of the coking industry. Moreover, although we cannot rationally quantify in dollars the benefits of the standard careful consideration has been given to the question of whether these substantial costs are justified in light of the hazards. OSHA concludes 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 NIOSH, 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 $\mu g/m^3$ 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 and work practices are required where necessary and written compliance programs must be developed. Other portions of the standard including those on respirators, protective clothing, hygiene facilities, and exposure monitoring have been revised and clarified as described in detail below.

A. *Scope and application.* This standard applies to workplaces using the process 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 various provisions 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 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 (TR 2494), and since coke ovens are located in an environment with many 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 (T2493–4). Therefore, 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 established is the coke oven battery, including top-side, pushside, coke-side and their machinery, the wharf and the screening station. All of these specific worksites 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 standards or regulations affecting 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 area.

Another aspect of the applicability of this standard is its relationship to the existing standard for coal tar pitch volatiles in 29 CFR 1910.1000 Table Z–1. The existing standard will continue to apply to employee exposures to coal tar pitch volatiles outside of coke plants, such as the petroleum 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 (§ 1910.133), respiratory protection (§1910.134), occupational head protection (§ 1910.135), and occupational foot protection (§ 1910.136). Subpart J—General Environmental Controls (§ 1910.141–149) contains requirements pertaining to toilet facilities (§ 1910.141(c)), washing facilities (§ 1910.141(d)), change rooms (§ 1910.141(e)), and consumption of food and beverages on the premises (§ 1910.141(g))). 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 $\mu g/m^3$ as determined for an eight-hour period. Coke oven emissions is defined as the benzene-soluble fraction of total particulate matter (BSFTPM) 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 BSFTPM which is present during the destructive distillation or carbonization of coal for the production of coke, and to exposures for an eight-hour period. (For a discussion of these subjects refer to the sections on regulated area, scope and application, and exposure monitoring and measurement, respectively.)

It should be noted that the measurement of employee exposure to BSFTPM is not intended to serve as the measurement of a single specific substance which is necessarily a carcinogen itself. Rather, it is intended that this measurement serve as an indicator of exposure to carcinogenic substances present in coke oven emissions. The justification for using an indicator substance has been explained by Dr. Eula Bingham, Chairperson of the Standards Advisory Committee on Coke Oven Emissions (TR 154):

> It is generally agreed that coke-oven emissions are complex mixtures of particulates, vapors and gases. Multiple carcinogens and cocarcinogens have been identified. The precise manner in which carcinogens and cocarcinogens and perhaps even inhibitors interact to produce cancer in man is unknown. Inferences may be drawn from experimental animals and epidemiological studies. There 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 the coke-oven emissions now.
>
> The ideal situation would be to routinely analyze several substances in coke-oven emissions. This was suggested by Dr. Eugene Sawicki (from EPA) to the cokeoven 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. 66). 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), there are four major considerations 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) there should be a reliable analytical method available, (4) the analysis should be rapid 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 BSFTPM as the indicator stance for coke oven emissions is based upon these considerations.

BSFTPM 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 have been related to the excess incidence of cancer among coke oven workers (TR 1753). Furthermore, the major epidemiological study relating exposure to coal tar pitch volatiles (CTPV) to excess mortality and morbidity among coke oven workers used BSFTPM 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 BSFTPM, allows for comparison for scientific purposes between present and previous exposure levels (Ex. 14; TR 1753).

BSFTPM is reasonably specific (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 do measurements of any single compound (TR 1752).

BSFTPM 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 generated 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 rulemaking hearing to that 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, 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" simple (TR 1752; 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 CTPV (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 membrane filter 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 for selection 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 concerns of its own since 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 the solvent. Such a frame of 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 personnel of benzene.

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. The cumulative exposure 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, in which 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 events, whose probability is proportional to the square of the 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. 14). Most of the polynuclear aromatic hydrocarbons (PNA) are concentrated in the RPM and RPM has a high positive correlation with polynuclear aromatic hydrocarbons (PNA) many of which are carcinogenic (Ex. 14). However, there is no epidemiological evidence establishing a relationship between RPM and the observed excess of disease among coke oven workers (Ex. 149, p. 93-94). It should be noted that the major epidemiological study in this area (Ex. 8-29) correlated excess disease to BSFTPM exposure levels because the data was available in that form, and correlations with other substances (including RPM) were not rejected because of biological considerations (TR 1013).

RPM is considered to be a less specific measure of coke oven emissions than BSFTPM (Ex. 14). RPM measurements are highly susceptible to interference from RPM which did not originate from the coking operation (Ex. 149, p. 94; 51, p. 5).

The analytical method used to determine RPM exposure levels is also a simple procedure, requiring careful handling of the sample and controlled humidity (Ex. 14). Minimal training is needed for RPM sampling and analysis (Ex. 14). However, there are problems resulting from the blocking or plugging of the sampling equipment (cyclones) by coal tar aerosols and uncertainty over the proper sampling rate (TR 1776-7). Silver sulfide produced by the reaction of hydrogen sulfide gas present on the coke oven battery with the silver membrane filter used in sampling may result in a weighing error (TR 1775). RPM does not have the advantage of allowing comparisons to a vast amount of previous data, as is the case with BSFTPM (Ex. 14).

Analysis of RPM is more rapid than BSFTPM (Ex. 14). Also, it is less expensive than BSFTPM analysis (Ex. 14). The advantages and disadvantages of total particulate matter (TPM) as the choice for an indicator substance are similar to those discussed for RPM. Additional disadvantages are that TPM has a low correlation with the PNA in the lungs; that TPM may contain a large portion of extraneous material that has nothing to do with carcinogenic effects; and that TPM is less specific than RPM (Ex. 14).

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

B(a)P is highly specific (Ex. 14). It might not, however, reflect total carcinogenic activity of coke-oven emissions (Ex. 14). It has been characterized as both a good (Ex. 14) and bad (Ex. 149, p, 102; 22E) indicator of carcinogenicity in coke-oven emissions.

The methods of analysis for B(a)P 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. 14) and as yielding uncertain (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 exposure to RPM, TPM, or B(a)P to the excess mortality of coke oven workers. Nor is there a study from which excess mortality risks, under different latency periods and different cancer models at specific exposure levels may be determined. There is, however, a study (Ex. 17; 17a) relating inhalation of B(a)P 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 prohibitively expensive, and is subject to minimal interference; and BSFTPM has a large data base 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 that 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 $\mu g/M^3$) was selected as representative of high average background or ambient levels of B(a)P in urban air 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. 14, p. 20–27). The proposed standard correlated RPM levels to the known B(a)P background level (Ex. 1a, 32272) based on data presented to the Advisory Committee and included in its report (Ex. 2–174, Vol. 3; 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 (TR 1755; 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 142). 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 B(a)P is also a significant factor in the correlation. It was reported that personal samplers were approximately 10 times more efficient than high-volume samplers (Ex. 2–157). The actual values 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 214.5). 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 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 (as do the participants in the rulemaking 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 Z–1) have actually been measurements of BSFTPM (Ex. 2–110d). Therefore, 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 was to require that no visible emissions from the coke ovens 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 rather than 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 exists for visible emissions. This 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 and 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 a level of 0.56 mg/m^3 (560 $\mu g/m^3$) to a level of 0.05 mg/m^3 (50 $\mu g/m^3$).

The 0.56 mg/m^3 level has been recommended at different times by various industry participants as representing a safe level of exposure (Ex. 149, p. 66; 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 rough estimates of what would constitute a safe level of exposure. The study gave an example of a worker exposed to less than 0.56 mg/m^3 for a period of 30 years who would accumulate 200 mg/m^3—months of exposure, a level which the data indicate would not increase the risk of lung cancer. The study concluded that a level of 0.2 mg/m^3 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 hearing, Dr. Redmond, one of the authors of the study, explained why 0.56 mg/m^3 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). Dr. Redmond reported that analysis of the data using a latent period model lead to the conclusion that there was no exposure level that could be considered safe (TR 422).

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 for 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/m^3 would reduce the risk of lung cancer 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 time period of 30 years upon which 0.56 mg/m^3 was based was used only by way of example (TR 1013), and in no way represents the maximum time that many workers spend in the coke oven environment (T 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 0.56 mg/m^3 level is based upon the fact that the cumulative exposure interval of less than 200 mg/m^3—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 representing the average exposure (TR 1012). By taking the midpoints 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 average exposure for the interval is 77 mg/m³—months (TR 1012). Following the customary practice of using the midpoint determined average exposure (77 mg/m³—months) would reduce the "safe" exposure for a 30-year period of 0.56 mg/m³ by a factor of 77/200 to approximately 0.22 mg/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, and the other from AISI (TR 1013). The exposure levels of the AISI data were consistently lower than the levels used in the study (Ex. 8–18, Table VII–3; 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 also reveals that this is not even close to 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 0.0468, 0.0510, 0.0593, and 0.0708 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 0.0179, 0.0222, 0.272, and 0.0372 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 demonstrating the feasibility of reducing exposures to significantly lower levels, OSHA rejects the suggestion that setting the permissible exposure limit at 0.56 mg/m³ BSFTPM would provide an adequate measure of employee protection.

The existing standard (29 CFR 1910.1000, Table Z–1 for the benzene-soluble fraction of coal tar pitch volatiles, which is viewed as BSFTPM, sets a maximum permissible exposure at 0.2 mg/m³ (200 ug/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 concluded that her study indicated that this was probably an adequate level of protection (Ex. 8–29, p. 388). In fact, the recalculation of the 0.56 mg/m³ (560 ug/m³) level using the customary midpoint analysis resulted in a level of approximately 0.22 mg/m³ (220 ug/m³) (TR 1012–3). However, Dr. Redmond did report that analysis of the data using a latent period model led to the conclusion that there was no exposure level that could be considered safe (TR 422).

The analysis performed by Dr. Land supported this conclusion (Ex. 82, Table 3). At all of the investigated exposure levels (.05–1.00 mg/m³ BSFTPM), dose models (0, 5, 10 and 15 year lag) and dose-response models (quadratic and linear) a statistically significant excess risk of lung cancer (Ex. 82, Table 3) was 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/³ are 0.0029, 0.0036, 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, the excess risks for the same latency periods are 0.0191, 0.0209, 0.0244, and 0.0294 respectively with corresponding relative risks of 41%, 45%, 52%, and 63% greater than the normal risk.

Putting the above calculations into more general terms, Dr. Land said (TR 3858),

As a final statement, I would just also 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 around .2 milligrams per cubic meter of air, which, I believe, corresponds roughly to the proposed standard, are not negligible, even for those dose response models and latency assumptions that give the smallest estimates of risk.

Then from the point of view of choosing a safe level of exposure, the permissible exposure limit should be 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 technologically 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 B(a)P 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 and there is no scientific data to demonstrate that there is a safe level of exposure to carcinogens 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 coking operations.

The basis of this standard is no permissible exposure over background levels as measured in representative urban environments removed from the influence of coke oven emissions * * *.

This limit is based on an evaluation of the best available scientific evidence, and on a judgment 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 B(a)P was an effort to establish a respirable particulate standard roughly equivalent 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 or future technology.

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 part on policy considerations 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)5 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 the latest available scientific data in the field, the feasibility of the standards, and experience gained under this and other health and safety laws.

OSHA has determined that 150 ug/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 BSFTPM at the 150 μg/m³ level are less than the risks 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 preceeding examples, assuming a linear dose-response model and latency periods of zero, five, ten and fifteen years, the excess 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 1.477 times the normal risk. Assuming a quadratic dose-response model, the excess risks are 0.0016, 0.0020, 0.0025, and 0.0034 respectively, with corresponding relative risks of 1.034, 1.043, 1.053, and 1.072 times the normal. The lowering of the permissible exposure limit clearly represents a lowering of the risks associated with exposure to coke oven emissions.

The level of 150 $\mu g/m^3$ is a feasible one. Although the industry generally has failed to utilize emissions 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/m^3 (Ex. 68), exposure levels below 150 $\mu g/m^3$ 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 $\mu g/m^3$ level. Three job categories (larryman, cokeside helper, and quench car 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 exposure was measured. OSHA is mindful that many of the measurements taken by NIOSH at Fairfield show levels above 150 $\mu g/m^3$, 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 has no filtered-air cabs or standby pulpits (TR 2066). Nor does Fairfield have all of the additional controls that are not specifically required, but may be helpful, 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 restricted 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. Department of Labor*, 509 F. 2d 301 (c.A.2, 1975) cert. denied).

OSHA agrees with the statement of David J. Burton, the contractor who performed the technological and economic feasibility studies, that "* * * implementation of the standard and of efforts to control employee exposure will undoubtedly create an atmosphere in which 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; 66F; 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. 2-61, p. 128-160).

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 finds that the level of 150 ug/m^3 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 ug/m^3 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. The reasons for this are three-fold. First, the National Air Sampling Network estimate of benzene-soluble organic matter background levels (approximately 10 ug/m^3) 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 background falls below the limit of detectability (approximately 20 ug/m^3) of the sampling method (Ex. 2-223). Third, as stated earlier, there is general agreement that BSFTPM is the indicator substance whose measurement is least affected by interference from background (TR 1928; TR 2493-4). It should be noted that OSHA acknowledges that the 150 ug/m^3 level is not absolutely safe and that the risks associated with lower levels of exposure which were considered (e.g. 50 ug/m^3 and 100 ug/m^3) are correspondingly lower. However, as an exercise of rational Agency discretion, OSHA has determined that based upon the evidence available at this time, a permissible exposure limit lower than 150 ug/m^3 may not be feasible. This, of course, does not preclude the possibility that the level will be lowered in the future if the evidence 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 provision apply to employees working in the RA. The precautionary signs mandated in this standard are required to be posted in the RA. Employees working 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, p4). 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 exposures to coke oven emissions.

In requiring the establishment of the RA's and limiting access thereto, the standard follows the approach of the Advisory Committee (Ex. 3, p. 15), the proposed standard (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, 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, 8-19, 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). Additionally 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 may not be 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 insure full application of the important provisions triggered by employment in the RA. No such problem exists regarding the wharf, since it is necessarily adjacent to the coke oven battery.

The RA also includes the beehive oven(s) and its machinery. This method of coke production involves the carbonization of coal and results in coke oven emissions being present during the process. (Ex. 80; 149, Ref 1). Since employees on a beehive coke oven are exposed to coke oven emissions, OSHA has determined that it is appropriate to ensure that these workers 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 15).

Both the proposed standard and the Advisory Committee report also established "any coke plant work area where the permissible exposure limit is exceeded" as an RA (Ex. 1a, p 322278; 3, p 15). The final standard does not follow that approach. The permissible exposure limit of this standard only applies in the RA. (See discussion of Permissible Exposure Limit). Any area where the permissible exposure limit could be exceeded, would, by definition already be a part of the RA. Areas of the coke plant outside of the RA are covered by the existing CTPV standard. (See discussion of Scope and Application)

The proposed standard and the Advisory Committee recommendation required that a daily roster of all persons who enter the RA be made and maintained for at least forty years or the duration of employment plus 20 years whichever is longer (Ex. 1a, p. 32278, 32280; 3, p. 15). The final standard does not require that a roster be kept.

OSHA agrees with the view of various participants that rosters would be of no use in limiting access to the coke oven battery (TR 2433); that other records such as medical records and results of exposure monitoring required by the standard would provide more useful information and obviate the need for a roster (TR 2434); and, that since in practice, only authorized persons are allowed on the coke oven battery (TR 2433), a roster would not be necessary in order to determine to which employees other requirements of the standard would apply.

E. *Exposure monitoring and measurement.* The standard requires each employer who has a place of employment where coke oven emissions are present to monitor employees in the regulated area to measure their exposure to coke oven emissions oven an eight hour period without regard to the use of respiratory protection. Section 6(b)(7) of the Act (29 U.S.C. 655) mandates that any standard promulgated under subsection 6(b) shall, where appropriate, provide for monitoring or measuring employee exposure at such locations and intervals, and in such manner as may be necessary for the protection of employees. There are various reasons which make it appropriate for employers to measure employee exposure to coke oven emissions.

First, employers have a legal obligation imposed by this standard to ensure that their employees are not exposed to coke oven emissions above the permissible exposure limit of 150 $\mu g/m^3$. Exposure monitoring informs the employer whether that obligation is being met. Second, if the employer determines that employee exposures exceed the permissible exposure limit, then there is an obligation to institute engineering and work practice controls, in order to reduce exposures to a permissible level of exposure. Hence, exposure monitoring evaluates the effectiveness of the installation of engineering and work practice controls and informs the employer whether additional controls need be instituted. Third, if the permissible exposure limit is exceeded even after the specifically required and the additional engineering and work practice controls have been instituted, then there is an obligation to use respiratory protection to reduce exposures to a permissible level of exposure. Moreover, the selection of a particular respirator depends on the level at which employees are being exposed. Therefore, exposure monitoring is necessary in order to determine whether respiratory protection is required at all, and if so, which respirator is to be selected.

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 employees are being exposed to coke oven emissions (which contain carcinogenic constituents) at levels exceeding that prescribed by this standard and therefore should be notified as required by the Act.

Finally, the results of exposure monitoring are part of the information which is supplied to the physician.

The need to conduct exposure monitoring was generally accepted by participants in the rulemaking process (Ex. 144, p. 110; Ex. 1477, p. 12; TR 1781). A requirement that monitoring be done was included in both the proposed standard (Ex. 1a, p. 32278) and the Advisory Committee's report (Ex. 3, p. 25–9). In view of this support and for the reasons stated above, the standard establishes a requirement for employers to monitor employee exposure to coke oven emissions.

This requirement is limited to employers who have a place of employment where coke oven emissions are present. (For a discussion of this limitation see the Scope and Application section). The requirement is also limited to employees in the regulated area. Since the permissible exposure limit applies only in the regulated area, and many of the reasons for requiring exposure monitoring involve employee exposure relative to the permissible exposure limit, the requirement has been so limited.

The standard requires that the measurements be made by monitoring which is representative of each employee's exposure to coke oven emissions over an eight-hour period without regard to the use of respiratory protection. Exposure measurements for each individual employee would, of course, be the best indication of that employee's exposure. However, this may be too burdensome, as some industry participants have suggested (TR 773; 1794; 1799; 1966; 2142). Monitoring which is truly representative of an employee's exposure would provide the necessary information and in many instances would involve fewer samples (TR 1795). The Advisory Committee recommendation (Ex. 3, p. 26) and the proposed standard (Ex. 1a, p. 32278) both included provisions for representative monitoring, and there was general support for the concept. In view of this support and in order to reduce the burden on employers without sacrificing the necessary information, the standard requires representative monitoring. It should be noted that individual exposure measurements would certainly be considered to be representative and are not precluded by this requirement.

The employee exposure measurements are to be made without regard to the use of respiratory protection. In order to use the results of exposure monitoring to evaluate the effectiveness of the required engineering and work practice controls, to determine whether additional controls must be instituted, and to ascertain which, if any, respirator must be used, it is necessary to know employee exposure levels without the use of respiratory protection.

The standard requires the employer to collect full-shift personal samples including at least one sample during each shift for each job classification within each coke oven battery. All of these requirements are intended to ensure that the monitoring is truly representative of an employee's exposure.

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 personal samples (Ex. 3, p. 25) and the proposed standard also followed that approach (Ex. 1a, p. 32278).

Exposure conditions on a coke oven battery vary from shift to shift (TR 2809). 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 tend to be affected by the variability 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 recommendation essentially followed this approach (Ex. 3, p. 25). The proposed standard did not address these issues. The standard has added these 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, the time period required by the proposed standard (Ex. 1a 32278) and recommended by the Advisory Committee (Ex. 3 p. 25).

Since exposure conditions also vary from job to job (Ex. 8–29, Table II) and from battery to battery (Ex. 2–223), monitoring which is to be representative of an employee's exposure should generally not include exposure measurements from more than one job classification or from more than one battery. An exception might be repair or maintenance personnel who work in the same general area and on more than one battery during a shift. In such cases, it may be possible to construct a representative sampling scheme including several job classifications. The exposure conditions within each job classification should generally be similar enough, however, so that the exposure measurement of one employee would be representative of other employees with that same job classification on the same coke oven battery on the same work shift. Therefore, the standard requires samples to be collected for each job classification within each coke oven battery.

The standard lists examples of specific job classifications which must be sampled as part of a representative monitoring scheme. The list is taken from the major epidemiological study of coke oven workers (Ex. 8–29, Table I). The intent of providing examples of job classifications is to indicate the degree of specificity of classification which is necessary for representative monitoring. For example, the job classification of coke oven worker would be too broad to be meaningfully representative. Likewise, the classifications of topside and side oven worker would also be too broad. OSHA recognizes that job classifications are not uniform throughout the industry (Ex. 8–29, p. 383), but the Agency does feel that employers will be able to develop their own classifications of equal specificity by reference to the examples provided.

The Advisory Committee report (Ex. 3 p. 26, 28) included a requirement that each job classification be sampled. Only the larry car operator and lidman were specifically mentioned, however. The proposed standard did not include details for a representative monitoring scheme (Ex. 1a, 32278). The standard requirements for the content of the representatives scheme, including specific job classifications have been added for the reasons explained above.

The standard requires that employers repeat the required monitoring and measuring of employee exposure at least every three months. The monitoring must be done at least this often in order to detect seasonal variations in exposure conditions (TR 168; 1798; 2809–2810). Annual or semi-annual monitoring, as some participants have suggested, would not account for this important environmental variable. Of course, the standard does not preclude the employer from monitoring more frequently. However, more frequent monitoring is not required for two reasons. First, substantial changes in exposure conditions are not generally expected to occur from month-to-month (TR 2143). Second OSHA agrees with industry participants that more frequent periodic monitoring would be too burdensome (TR 773; 1794; 1966; 2142). This is a departure from the approach followed in the proposed standard (Ex. 1a, p. 32278) which required periodic monitoring at least every three months if the initial determination were at or below the permissible exposure limit; however, if the initial determination were above the permissible exposure limit, then monitoring was required at least monthly. The shift to less frequent monitoring was made for the reasons explained above.

The proposed standard also provided that employers could switch from monthly to quarterly monitoring if two consecutive measurements were below the permissible exposure limit (Ex. 1a. p. 32278). The standard deleted this provision because now all periodic monitoring is required at least quarterly.

The Advisory Committee recommended that monitoring of RPM be done semi-annually and, monitoring of B(a)P and various polynuclear aromatic hydrocarbons be done annually. (Ex. 3, p. 25–27.) The standard requires monitoring of a different substance for the reasons explained in the discussion of Permissible Exposure Limit. The decision to require more frequent monitoring than the Advisory Committee recommended was made in order to detect the seasonal variations, as explained above, so that the purposes (for which monitoring is required) may be accurately and promptly effectuated.

The standard requires that whenever there has been production, process, or control change which may result in new or additional exposures to coke oven emissions, or whenever the employer has any other reason to suspect an increase in employee exposure, the employer shall repeat the required monitoring and measurements for those employees affected by such change or increase. A redetermination which was also included in the proposed standard (Ex. 1a, p. 32278) and the Advisory Committee report (Ex. 3, p. 27) is required in order to ensure that the most recent monitoring accurately represents the existing exposure conditions. This is necessary so that the employer may take the appropriate actions such as providing the appropriate respiratory protection.

The standard, as the proposed standard (Ex. 1a, p. 32278) did and as the Advisory Committee report essentially did (Ex. 3, p. 28), requires an employer to notify each employee in writing of that employee's representative exposure measurement within five working days after receipt of the results of any required measurement. Section 8(c)(3) of the Act (29 U.S.C. 667) requires employers to promptly notify an employee who is exposed in excess of the permissible exposure limit. The standard extends that right to employees exposed at or below the limit and clarifies the time period involved. OSHA believes that informing employees of their exposure measurement at or below the permissible exposure limit contributes to their understanding of their work and its attendant hazards. The success of an emissions control strategy that so intimately involves worker cooperation is highly dependent on such understanding (Ex. 2–18, p. I–11). A period of five working days is felt to be a reasonable time in which to notify the employees. The Advisory Committee recommended that employees be notified immediately, but did not require that the notification be in writing (Ex. 3, p. 28). The five day limit fulfills the statutory requirement of promptness, yet accommodates the need to allow time for the written notification, which is intended to provide objective evidence of compliance with this provision, to be completed.

Section 8(c)(3) of the Act (29 U.S.C. 667) also provides that whenever measurement results indicate that an employee is exposed in excess of the permissible exposure limit, the employer must also notify the employee of the corrective action being taken to reduce exposure to or below the limit. The standard incorporates this statutory obligation.

The employer is required to use a method of monitoring and measurement with an accuracy (at 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 mg/m³. Problems with the accuracy of the benzene-soluble method of analysis lie primarily in the extraction step using a Sohxlet 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; and (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, while approaching a factor of two, 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 for B(a)P that appeared 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; TR 440). 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 BSFTPM 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.*—1. *General.* The standard contains the general requirements that the employer control employee exposure to coke oven emissions through 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 the employer can establish 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 beehive ovens, a general obligation is imposed to reduce exposures in accordance with (f)(1)(iii).

OSHA believes that the most effective means of controlling employee 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 because of the many 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 still 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, etc. Therefore, since reduced 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 which will be achieved by implementing particular engineering and work practice controls (e.g. TR. 1558). Therefore, there may be instances where employers are able to achieve lower levels than they had anticipated. Finally, requiring employers to implement controls only where they expect to reach the permissible exposure limit with such controls would provide an incentive to employers to conservatively estimate the effectiveness of controls and could divert attention from reducing exposures, to establishing that particular controls would not reduce exposure to or below the permissible exposure limit. In these circumstances, particularly noting the goal of compliance with the permissible exposure limit solely by means of engineering and work practice controls, we have concluded that it is necessary to require employers to reduce levels by means of engineering and work practice controls which can be implemented to the lowest level achievable by these controls, even when such controls are not sufficient to reduce levels to or below the permissible exposure limit.

The proposal would have permitted work practice controls only where engineering controls were not sufficient to reduce exposure to or below the permissible exposure limit. The Advisory Committee, the USWA, and employer groups all suggested that for engineering controls on coke ovens to be effective, appropriate work practices are necessary (e.g. TR. 1414; 1583, 1977, 2157, 2466; 2475–81; and 3506–7). We agree. Therefore, the final rule requires a combination of engineering and work practice controls on a coequal basis.

One of the important considerations in the development of the coke oven emission standard was the question of feasibility. Based on the record in this proceeding, OSHA has made a series of determinations as to both the economic and technological feasibility of the standard. As to economic feasibility, the agency concluded that the standard is well within the resources of the industry and that those companies that may have the greatest burden are those that have done the least to meet their existing obligations.

With regard to technological feasibility, there are two areas where feasibility determinations have been made. The first relates to the specified minimum controls for by-product coke oven batteries and the second deals with the requirement for the development and implementation of additional controls.

The controls that are specified have been developed for by-product batteries and all of them have been and continue to be implemented on such batteries as part of a control system to reduce employee exposure. In selecting the mandated controls, the question of technological feasibility was considered and evaluated for each item and the discussion of these assessments are contained in the specific preamble section based on that assessment, OSHA has reached the conclusion that the specified controls are the minimum available technology for the industry; that they are technologically feasible on virtually all of existing coke oven batteries. 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 problems or of a claim that specified certain control might not be needed because 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 in some circumstances some of the controls may not be technologically feasible on a particular battery. Therefore, the standard explicitly recognizes that an employer may 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 its 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 a reasonable alternative are relevant. For example, if a battery is nearing the end of its useful life, exposures are well in excess of the permissible exposure limit and effective controls are infeasible because of design, weight or technological factors, OSHA believes that the requirement to implement feasible engineering controls would include rehabilitation 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 additional technological research is 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 become clogged and blocked by tar or hard carbon compounds. As a result the aspiration system may not be able to adequately remove the gases, again causing emissions. In addition, wear and tear of operation under high temperatures causes deterioration of equipment, and warping, cracks and misalignment in the oven structure.

The principle of control is simple and applicable to all coke oven batteries—contain the emissions within the ovens and use the gas collection system to remove them. In order to effectuate this degree of control, the emission control program also must direct attention to the routine, regular cleaning, maintenance and repair of the battery itself and the associated equipment.

As noted above, the final 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 236 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 readily acknowledge 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 employee 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 below 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) (i) (i) (*a*) of the standard requires employers to institute engineering and work practice controls at the earliest possible time but not later than January 20, 1980. 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. 36). OSHA believes that 6 months is not a reasonable period for such operators. OSHA recognizes that the design, procurement, and installation of all engineering controls cannot be accomplished immediately. However, the thrust of the final requirement 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 and order the appropriate 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 allowed until January, 1976 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. 68G), dated May, 1974, required filtered air on the larry car and in the rest area by February, 1976. The OSHA agreement with Koppers Co. (Ex. 68J) dated November, 1975, allowed until May, 1976 for the installation of a filtered air system for the lunch 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 operating techniques 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 operation in 1957 and 1958 respectively (Ex. 41A). 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 equipment including a jumper pipe, modified larry car hoppers, and, new steam nozzles were installed. Stage charging has been operational on 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) requires that there be no visible emissions from charging equal to or greater than 20% opacity for any period of more than one minute in any sixty minutes from any of the plant's five batteries by June 1, 1977. This order was signed in October, 1975.

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

The OSHA agreement with Alan Wood Steel (Ex. 68E) required stage charging by August, 1976. The agreement was finalized in November, 1975. The OSHA-Armco agreement (Ex. 680), signed June, 1974, required sequential charging by October, 1975.

The OSHA-Koppers settlement (Ex. 68J) of November, 1975 required the work to install stage charging, including larry car hopper volumetrics, to be completed by December, 1975. Additional equipment such as coal vibrators and leveler bar air seals were required by September, 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. 68B) required control of door emissions from the plant's five batteries over a five-year period (November, 1975–March, 1980).

At Lackawanna (Ex. 68A), control of door emissions was required over two years (December, 1973–December, 1975) and over 16 months (June, 1974–October, 1976) at Armco (Ex. 680).

The 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 diaphragms, refractory insulating plugs, and latches (TR 1973). The sealing diaphragm design was altered to facilitate repairs and sealing. The door jambs 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 75 ovens (150 doors) could be fitted with 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 technique for large-scale door replacement 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 jambs 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 inspectin, maintenance, cleaning and repair of the all equipment and strict adherance to prescribed schedules. Employees must be properly trained in such work practices 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 long delivery delays can be expected especially with many operators attempting to secure these items simultaneously from a limited number of suppliers. Based on OSHA's experience with other standards, i.e., vinyl chloride, OSHA is hopeful that the suppliers of coke oven equipment and materials can increase their 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 20, 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 a specification standard would "limit the development of new technology or necessitate frequent revision of the standard" (Ex. 1a, p. 32273). Since minimum controls are specified 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 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 (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 its flash-vaporized.

(c) The coal 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–14).

Coal consists primarily of high-molecular weight aromatic hydrocarbons of the benezene family. Under the conditions of charging, some of these hydrocarbons are directly vaporized (anthracene, chrysene, phenanthrene, napthalene). 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 particule fused to form tar) in the charging gases. Char and pyrolytic carbon are also components of charging smoke, as well as coal dust. It may be presumed that most of the oxygen in the air displaced from the oven is destroyed by combustion reactions. The 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–14–17; Ex. 8–43).

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. For instance, coal for foundry coke has lower volatile content and may, therefore, lead to less emissions (Ex. 73). Finer grinds of coal lead to more smoke and dust (Ex. 2–20, p. III–17).

a. *Stage charging.* The fundamental principle for control of charging emissions is to contain the emissions. This is accomplished by maintaining an open gas channel to the collector main, providing adequate suction in the gas channel and maintaining complete closure of all points not under negative pressure.

The traditional approach to allevation of charging emissions has been to draw them off into the collector main. This practice, called "charging on the main," is based on the use of the steam aspiration system to produce a draft in the ovens during charging (Ex. 2–20, p. III–18). To improve the effectiveness of the aspiration, techniques have been developed to ensure that the evolved gases travel from the oven to the collector main(s). The principal technique for doing this is called "stage charging." Although there are certain equipment requirements, stage charging is primarily an operating technique. Ordinarily, the outer hoppers are discharged first (either separately or simultaneously) and the third hopper is discharged 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 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 into the oven to prevent the path of the gases to the collector main from being blocked. The order in which the hoppers are discharged, and the volume of coal in each hopper is strictly 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 exposures of topside employees (Ex. 2–127). A rehabilitation program for Batteries 5 and 6 was initiated in 1973 (TR. 2013) 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).

After rehabilitation and stage charging, the larry car operator's CTPV exposure was reduced to 0.57 mg/m³ (average of 8 samples) and the lidman's to 0.84 mg/m³ (average of 18 samples) (Ex. 2–127). Samples collected at NIOSH at Batteries 5 and 6 at Fairfield indicated average CTPV exposure of the larry car operators to be 0.36 mg/m³ (average for 6 samples). Average exposure of the lidman was 0.39 mg/m³ (average of 12 samples) (2–223). While employees in these job classifications 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 USWA 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 no data yet exists to define the performance of 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. 1398). 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 when subsequent hoppers begin discharging. Sequential charging uses an automatically timed sequence to control the discharge of coal from the hoppers. 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 larry car for sequential charing was developed under joint auspices 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 larry car had three primary components (1) automatic sequencing of operations, (2) an air conditioned cab to protect the operator from the emissions, and (3) a single spot 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 and reliability problems.

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 larry cars*. Five of the presently operating tall batteries are equipped with scrubber larry cars. A shroud covers each charging hole and emissions rise in the shroud and are ignited and burned. The smoke from this burning is passed through a gas scrubbing system. All of this equipment is mounted on the larry car. There are two emissions sources in this system. One is around the shroud or drop sleeve where poor capture will allow emissions to escape and the other is effluent from the scrubber. The primary variables that affect the performance of larry 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 sleeves. 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. 1494–5, 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 larry car, we are unable to conclude that the scrubber larry car provides or is likely to provide adequate protection to employees. This is not to say that scrubber larry may not, at some point provide adequate protection. Therefore, while we have not expressly permitted scrubber larry cars, employers who can establish that the use of the scrubber larry will provide a place of employment as safe and healthful as those which would prevail if the employer utilized one of the permissible forms of charging may utilize the variance procedures.

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. Pipeline charging systems use 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. The dry, hot coal flows like a fluid which makes the coal charge self leveling. One emissions source, leveling through the chuck hole is thereby eliminated. Potential sources of emissions are the topside holes and standpipes. 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 these lids sealed properly no 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 had been in operation for 16 months at the time of the visit. One of the topside lids must be partially opened during charging to relieve the immense 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 pipes have been moved from the side of the battery to the top. This seems to relieve some of the pressure and 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 will not permit us to do so. However, a general requirement has been imposed to design and operate pipeline or enclosed 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, 2161, 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 by the use 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 of U.S. Steel (TR. 2052–5). It has been estimated that a jumper pipe reduces smoke emissions by two-thirds during charging (Ex. 2–27, p. 35; 2–93). Existing batteries can be retrofitted with jumper pipes. Retrofitting with a second collector main is more difficult, (TR

3513a), although a second collector main has been retrofitted at C.F. and I's plant at Pueblo, Colorado (TR 2594).

In view of the evidence, as cited above, on the necessity for double drafting and the retrofittability 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 AISI 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 steam generating capacity and piping 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 volumetrics may require major modification of the larry car (TR 1567) such controls are important in order to prevent blockage of the gas passage (TR 1627). Mechanical 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 coal from the larry car hopper to the oven (Ex. 2–37c). To accomplish this, the standard requires the use of devices, such as stainless steel liners for the larry car hoppers, coal vibrators, or pneumatic shells, to facilitate a rapid continuous flow of coal into the oven.

No information on this type of equipment was presented to the Advisory Committee and, therefore, no recommendation of this equipment appears in the report. For the same reasons, this item is not in Appendix B to the proposed standard. The NIOSH criteria document makes no reference to this equipment. However, such devices have been utilized by employers as part of an effective charging program (Ex. 68J). 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 the 100 psi is used in the larry car hoppers. (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 to facilitate coal flow is a valuable tool for reducing emissions (TR 2280–1, 2387). Indeed, National Steel indicated that stage charging could not be successful at reducing emissions without this equipment (TR 2387). Employees of both U.S. Steel's Fairfield and Clairton Works consider this equipment an effective tool for reducing emission (TR 3076–7, 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 ovens 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 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, 1564, 2057–8, 2164–5). This control was included in the Advisory Committee Report having been recommended by both the USWA (Ex. 2–139) and industry representatives (Ex. 2–163). The NIOSH criteria document, while not specifying individually operated drop sleeves, per se, does recommend that charging hole lids be replaced as soon as possible after the coal has emptied from the hoppers. Use of individually operated drop sleeves will permit this to be done with relative ease and thus ensure the proper performance of a critical step in stage or sequential charging.

The removal of tar and carbon build-up can be accomplished in three ways: (1) manually, i.e. an employee stands over a gooseneck and cleans it 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 1647, 1675); (2) flail-type or mechanical cleaners, i.e. motor driven cutting discs which are manually guided into the gooseneck (Ex. 2–221, No. 7). This method effectively cleans goosenecks and does not seem to expose employees to emissions. In addition, it does not require exact alignment of the standpipe. There have been reports that liquor sprays have been damaged and that flails need to be replaced fairly frequently (TR 2215, 2327–8, 1675).; and (3) cookie-cutter or automatic gooseneck cleaner, i.e. a disc on a mechanical arm which moves into the gooseneck opening (Ex. 66C–1). Since it is an automatic device, proper alignment is necessary to effectively clean the gooseneck. There is no employee exposure. It was suggested that automatic cleaners may lose their effectiveness over time and that they may not be adaptable to every battery.

As has been stated previously, adequate aspiration is essential for stage charging. This can only be carried out if goosenecks and standpipes remain free of tar and carbon build-up 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 1½ 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 or 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 (f) (2) (g).

This equipment, especially the mechanical cleaners, can be retrofitted on many existing batteries and is effective in cleaning goosenecks while keeping the employee at a distance from the emission source (TR 1674, 3531-3). 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). Standpipes caps must still be cleaned manually at the present time (TR 2215). 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, 2076-8).

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 that inspection and cleaning are done on a regular basis (Ex. 2-163, 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 diameter. 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. 68L). 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 (Ex. 2-63).

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 which is placed in the gooseneck (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 ing the aspiration system operating propcharge and cleaned as necessary (Ex. 3, p. 40). In view of the importance of keeperly 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 mounted on 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 as premature opening will adversely 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 III) can be placed over the open chuck door and the leveler bar passes 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 can be maintained the air seal 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 exceed 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 between the door and buckstay may not be present and installation of an air seal may not, therefore, be necessary.

Several companies have installed air seal, 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 if such seals could be retrofitted (TR 2156-6) and Koppers 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 2326). National was the only participant to state that maintenance of the air seals causes additional employee exposure (TR 2326). OSHA believes, however, that if maintenance is done when the air seal is not actually in use, no increase in exposure will occur.

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. 2-163) and USWA (Ex. 2-139) 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. I-4).

In order to function properly, the seals must be structurally sound and must be regularly inspected and, if needed, repaired (Ex. 2-220). The requirement 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 of inspection 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 the flow of gas 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 1343, 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 a compressed air system which blows 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 (TR 2081) 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 disincentive to do it. Accordingly, the standard requires carbon cutter or compressed air, or both.

Some batteries may not have roof carbon problems (TR 765, 1566, 2173), 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 collector main(s).

The standard requires that a detailed written procedure for charging be developed and placed in operation. The procedure shall consist of all the necessary actions to be performed and their proper 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 open 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)(i)(d) of the standard. The exact distribution of the coal charge among the hoppers will vary although the outer hoppers usually hold the bulk of the charge (Ex. 2–19; 2–37C; 41A). The volume of these two hoppers must be adjusted so that the coal peaks after discharge will be as close to the coal line as possible and still assure that a free space will exist at the roof of the oven before and during leveling (Ex. 41A). The larry car must be properly aligned over the charging holes and the drop sleeves lowered to fit tightly over the open charging holes. The aspiration system is turned on and the outermost hoppers are to be released individually or simultaneously depending upon the ability of the aspiration system to handle the gases evolved. At U.S. Steel's Fairfield Works, the procedure for Batteries 5 and 6 calls for release of the coal from hopper no. 4 after hopper no. 1 has already started (Ex. 41A). The procedure at U.S. Steel's Clairton Works calls for discharge of the two outer hoppers simultaneously (Ex. 2–37C). Similar procedures are in operation at Koppers foundry coke plant (Ex. 68J). After these hoppers have emptied completely the dropsleeves are to be raised and the charging lids replaced. This is necessary for the aspiration system to maintain adequate suction, as discussed previously. Alternatively, the larry car may also have independently operated slide or shear gates at the bottom of each hopper which can be closed to prevent emissions from travelling out through the empty hopper (Ex. 2–37C). The third hopper is then released and emptied and the charging hole relidded. The volume must be controlled so the peak reaches the coal line and does not block the tunnel head (Ex. 2–37C; 41a). The last hopper, containing the smallest proportion of the charge, is then released. After this hopper is stopped, sufficient coal should remain backed up into the hopper to assure a level charge after leveling (Ex. 41A). The gas channel is now essentially blocked. At this point, the chuck door is opened, the air seal positioned, and leveling begins. After leveling is complete, the lid is then replaced on the last charging hole. If a jumper pipe is in use, it is moved and the lids replaced. Only after all the lids are replaced is the aspiration system turned off (Ex. 2–18; 2–37C; 3; 41A).

This is the same basic procedure recommended by the Advisory Committee and in use at Fairfield and Clairton (Ex. 2–37C; 3; 41A). At Fairfield, the lids are not replaced after each hopper is 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, however. The use of the slide gates instead of relidding 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 battery (Ex. 2–19). The stage charging process requires a well-trained operating crew (2–19; TR 1975). The success of stage charging at Fairfield is credited in part 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 hoppers discharging at the same 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 permit a discharging sequence 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 oven 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.

3. *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 efficient repair 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 collector 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 p. 9). 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 sealing equipment i.e. seals, jambs, 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 main 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 during 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 jamb. These leaks may last for a substantial period of time. The pressure of the metal edge against the metal jamb is not sufficient, absent formation of the tar seal, to prevent emissions (Ex. 75).

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 attention paid 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 permissible exposure limit from sampling taken on the push side of the battery. Examples of these exposures for pusher side door machine operators range from .3 mg/m³ to 1.0 mg/m³ CTPV for 5 Bethlehem Steel plants (Ex. 49), and .16 mg/m³ to .38 for Battery No. 5 at Fairfield. The door cleaner on the pusher side had exposures of .5 mg/m³ to 3.2 mg/m³ 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 not only an explosion hazard but also increase the incidence of emissions (TR 1567, 1575). Both the Advisory Committee recommendations (Ex. 3) and the Report of the Industry Members of the Advisory Committee (Ex. 4) included similar requirements as did the recommendation of the United Steelworkers of America (TR 3536, 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 2019–2020). The need for such facilities was cited by the Advisory Committee (Ex. 3) the Report of Industry Members of the Advisory Committee (Ex. 4) and representatives of employers and employees (TR 1568, 2018, 3536–37). While door repair facilities are often located at the coke plants (TR 2018, Ex. 68J) smaller facilities (TR 2331) as well as larger operations needing major door repair programs may rely on outside contract work (TR 2016). Since the purpose of the requirement is to assure that repair of doors and door sealing edges take place as soon as possible, the location of the repair facility has not been specified in the standard. Therefore in order to comply with this provision an employer may rely on both in-house and outside repair facilities, provided these resources are readily accessible and sufficient to meet the requirements.

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. (TR 2019). Both the Advisory Committee and the Industry Report (Ex. 3; Ex. 4) contained similar recommendations as to the necessity for maintaining an adequate number of spare doors. The standard, as recommended by USWA (Ex. 144 p. 74) does not specify a percentage of spare doors based on the information provided by the U.S. Steel, Fairfield, Ala. plant (TR 2017) because the record does not support extension of this number to other facilities as part of a minimum specification standard. The number of spare doors necessary for each battery will vary, depending upon conditions. In any event, absent extremely unusual circumstances, the failure to make necessary repairs because of the unavailability of spare doors will violate the requirement.

Chuck door gaskets are usually sheets of material such as tar paper covered-asbestos that, when placed either over the full internal surface of the leveler door or the sealing surface under the leveler door knife edge, serve to control chuck door emissions on a temporary basis until the door can be repaired or replaced (TR 1685, 2472; Ex. 68J). The participants varied in their opinions as to the effectiveness of this control device. Chuck door leaks are a serious problem and the location of the chuck door near the top of oven would make cleaning difficult. In surveys conducted at Republic Steel Corporation's facility in Gadsen, chuck door leaks constituted an average of 14 emission sources versus 8 and 2, respectively, for coke side and pusher side doors. Similar chuck door problems were observed at the Koppers St. Paul, Minn. facility evaluated by EPA personnel for OSHA. In the reports submitted, of 8 pusher side doors observed, 7 had chuck door emissions and one-half of those had chuck door leaks only. Similar proportions were observed in the second report (Ex. 68J).

Concern as to the complete effectiveness of the gaskets was expressed by several industry representatives (TR 2173, 2395). However, other operators have had some success in their use (TR 2472, 2396, 1684–5). The gaskets were recommended by the Advisory Committee (Ex. 3) and were recommended for use by EPA consultants (Ex. 68J). Evidence on improvements in gasket design was submitted by USWA (Ex. 62B). Based on the evidence in the record of the door emissions problem (particularly chuck doors) contained the records and testimony that gaskets, as a temporary measure, can reduce emissions for one or more coking cycles, pending door repair, OSHA has included gaskets in the minimum requirements. Oven door gaskets, which were recommended by the Advisory Committee and listed in Appendix B to the proposal are not included in the final standard as a requirement because the record does not support their technological feasibility, at present or in the near future to reduce door emissions (TR 2331, 3537).

The final control in this area is the heat shield on door machines. The general function of heat shields on door machines is to protect the operator or door cleaner from emissions and radiant heat during the necessary cleaning operations. These shields have been installed on the door machines at least since 1971 (Ex. 149, Ref. 1). In the Battelle report on oven door seals, the practicality of such equipment as an adjunct to proper cleaning practices was evaluated and judged to be a simple operation (Ex. 75 p. 164). In general participants objected not to the feasibility of the installation of heat shields where not currently in use, but rather to the relationship of this device to control of employee exposure (TR 1569, 2174, 2332). Such an argument ignores the function of the shields as outlined above and as stated by Bethlehem Steel. They protect the employee primarily from radiant heat in order to allow the quick, thorough door cleaning necessary to prevent subsequent emissions (TR 2473). No one suggested that radiant heat did not present a hazard to employees on the coke side or that such shields were ineffective. It was suggested that pusher side employees were not exposed to as great a hazard because these employees are not in close proximity to the radiant heat. The shields were recommended by the Advisory Committee for door machines and the proposed standard specified applicability to both pusher and coke side door machines. Based on the evidence in the record, however, the requirement in the final standard is limited to coke-side door machines (Ex. 5A–13 and 16; Ex. 68J).

There are two other types of engineering controls related to the control of door emissions, namely automatic door and jamb cleaners, and high pressure water systems. The Advisory Committee recommended the latter for existing batteries and the former for new or rehabilitated batteries. The proposal, which made no distinction between types of batteries, contained both these items as part of the recommended guidelines. The standard does not require either item for existing batteries. The use of high pressure water to assist in door cleaning has not been shown to be routinely necessary on most batteries. Rather, it may be a useful supplement to existing door cleaning programs (TR 1438, V Ex. 2–69C). Other types of high pressure water systems, such as those attached to the door cleaner machines or located at the battery ends do not appear feasible to retrofit on any substantial portion of existing coke ovens (TR 1568–9, 2332). Similar retrofit problems are encountered with automatic door and jamb cleaning equipment although such equipment has been and will in all likelihood continue to be installed on new batteries. (TR 1569–70 2217, 2333). The effectiveness of these devices is discussed in the section on new coke batteries.

Another control device for capturing door emissions is the canopy. These canopies consist of small hoods built over the doors. Canopies were tried experimentally at the Burns Harbor plant of Bethlehem Steel Corporation (TR 3549; Ex. 66 F–3), and have been used in Japan (TR 3789). The USWA feels that these canopies could reduce exposure of topside workers to door emissions (TR 3549–50) and may be an effective substitute for gaskets (TR 3818). At the hearing on

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, however, informed OSHA, in a letter dated May 20, 1976 (EX. 137) that canopies were to be installed on only five ovens. Armco stated that if this experiment indicates that the canopy system proves capable of improving the topside environment, the system would be extended to the balance of the ovens as rapidly as 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. 66F–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 use would be premature.

The second component of the coking emissions control provisions is in the area of work practices. These sections generally supplement the engineering controls discussed above and are designed to ensure effective programs for the reduction of emissions. Checking of the pressure control system was discussed under engineering controls. The remaining provisions deal with repairing, inspecting, cleaning and sealing doors. The most 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 sets forth minimum requirements for effective emissions control. Since it is generally agreed that further technological improvements in door design are necessary and will be undertaken (Ex. 75), OSHA has attempted to provide enough flexibility to accommodate future technology.

The standard requires the repair, replacement and adjustment of the various oven sealing components. These parts i.e. oven doors, chuck doors and door jambs 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 on the battery then the same parts are to be cleaned each coking cycle to provide an effective seal. In order to effectively implement both the repair and cleaning segments of a door emission control program, the standard also requires the establishment of an inspection and corrective action program. There is agreement between industry, labor and EPA as to the basic components of, and need for, these three requirements (TR 1348–1352; 2014–2052; 3062–65; 3113–23).

In order to reduce door emissions from self-sealing doors, any gaps between the sealing edge and the jamb that result from thermal warpage or damage, e.g. improper spotting of the door machine causing the door edge to hit the door jamb or buckstay during replacement, must be controlled (Ex. 75, TR 2018, 2027). This repair and replacement of the door and jamb parts is required as necessary and the required performance is to obtain metal-to-metal fit, i.e. that 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 operation. However, programs for periodic jamb and door replacement are currently part of a number of coke oven emission control programs (Ex. 68B; Ex. 2–69C; Ex. 68–K; Ex. 68N; TR 1973 3066). 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 proper door cleaning, the necessity for cleaning each cycle, along with other aspects of the emission control program, impact on the production schedules that can be set by coke oven operators (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). Coke oven builders, as reported in the Battelle Report, recommend such cleaning before each coking cycle (Ex. 2–20). 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).

It should be noted that the requirement is for cleaning so as to provide an effective seal. This language has been used in place of the language, in the Advisory Committee recommendations and the proposal, for a metal-to-metal 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 3547–8). Therefore, cleaning is required to the extent necessary to provide this seal. Cleaning of the doors and jambs 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 that have 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 by requiring an inspection system and corrective action program. Details, and a discussion of the effectiveness of one such program, were provided by Mr. Burton on U.S. Steel (TR 1977, 2026–7). Similar emission evaluation programs are incorporated in the emission control programs of other coke plants (TR 1462; Ex. 68B; Ex. 68J).

The final work practice procedure under coking emissions deals with luted doors and defines the applicable criteria to prevent emissions from those doors. Consequently, such doors are to be luted each coking cycle and reluted as necessary to control emissions. As with other doors, luted doors and door jambs can also warp or be damaged and require adjustments, repair, or replacement. (Ex. 75; Ex. 68J), and such a program is required by the standard.

The Advisory Committee report contained a recommendation that the coal mixture, moisture and grind be selected to minimize reduction in emissions, 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, forcing 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 both the standpoint of employer compliance and OSHA enforcement and is, therefore, not included.

The specifics of the previously discussed work practices are to be written up for each battery to account for battery variations such as design, age, and current operating conditions. The program must reflect an intent to comply with the standard.

Such a written program assures that all the elements are considered and can be used not only to evaluate the effectiveness of the program but also to train employees. For example, in implementing the cleaning requirement, the written program could specify job assignments, cleaning tools and a check-off or reporting system for the operating crew depending on the needs of that particular plant.

4. *Pushing emission controls.* The standard places primary emphasis on work practices and procedures to reduce employee exposure to pushing emissions. The pushing process commences at the end of the scheduled coking cycle when the pusher machine ram is inserted through the open oven door, pushing the coked coal out of the oven on the coke side and into the quench car or hot car. The coke is then transported to the quench tower where it is cooled by water, discharged into the coke wharf and sent to the screening station.

The main source of emissions is the hot coke as it is pushed from the oven on the coke side. Coke side bench employees and machine operators are exposed to these emissions. It is difficult to separate out employee exposure solely to pushing emissions because coke side employees are also exposed to door emissions during the coking cycle. However, estimates of coke side employee exposure include, for example, a range of .08 mg/m^3 to .43 mg/m^3 CTPV for coke side door machine operators at Fairfield (Ex. 2–223; Ex. 71) and 0.1 mg/m^3 to 3 mg/m^3 CTPV at several Republic Steel Cleveland batteries (Ex. 74, Item 2) and .40 mg/m^3 CTPV for the same job position at a foundry coke plant (Ex. 73A, Table 1). Quench car 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 detectable to .37 mg/m³ CTPV at Fairfield (Ex. 2-223; 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 (Ex. 2-11; Ex. 2-27) so that employee exposure to BSFTPM would 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 detailed below, such procedures should be sufficient to control employee exposure in many coke oven operations. However, there may be some batteries where additional pushing emission controls 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-side shed, 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 coke side bench, thus also requiring the employees in that area to work under the shed to perform door cleaning, repair and related pushing operations. The benefits and disadvantages of the shed 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. 2-93; Ex. 2-124; Ex. 2-167-168). 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 coke side shed will not reduce employee exposure. However, based on the sampling data from 2 sheds presented to the Advisory Committee, there is also no statistically significant increase in employee exposure (Ex. 2-167-168). Some concern, however, has been expressed that use of the shed will result in lax maintenance practices, thereby exposing employees to higher emissions than would occur at an unshedded battery, that the exposure data available are not sufficient to adequately characterize the full impact on employees, and that a shed may also present additional occupational health problems, for example increased heat stress (TR 2445-7). On the other hand, because door and pushing emissions are captured by the shed, exposure on the battery topside from the emissions blowing across the battery are likely to be reduced (Ex. 2-124; Ex. 2-61, Vol. I). Based upon the foregoing, we cannot say that coke side sheds will necessarily increase employee exposures. Accordingly, the final rule does not expressly prohibit their use.

The final standard, insofar as it concerns pushing emissions, focuses primarily on work practices to reduce these emissions. The first of these work practices requires that coal and coke spillage be quenched and not shovelled into a heated oven. Spillage results when an oven is pushed and coke and coal either is dragged back by the pusher ram or does not properly land in the quench car during the push. Such spillage may be sizeable in some plants (TR 3777-8). Both the Advisory Committee recommendations and the guidelines in the proposal included a requirement for hoppers on bench level equipment for the spillage, and also the work practice of not shovelling the material back into the oven. If any of this material is not fully coked out, i.e. green coke or coal, then upon contact with the heated oven, the material will volatilize, releasing coke oven emissions to the bench level employees and also to topside employees through the open standpipe (TR 813, 2570: Ex. 2-221-20 and 20A.). Based on the testimony in the record, it does not appear necessary to specify the use of hoppers primarily because of retrofit problems (TR 2332) and the availability of alternative procedures such as that used by Ford Motor Co. whereby the coal spillage is shoveled from the bench where it is picked up by maintenance personnel (TR 812-813, 3319). Therefore the standard merely requires the spilled coal or coke to be quenched as soon as practicable and not shovelled back into the oven.

In addition to the control of spillage emissions, the standard requires a detailed written procedure for the implementation of a series of work practices relating to the control of pushing emissions. The first of these is a routine practice of coke oven batteries (TR 1575) and was recommended by the Advisory Committee, industry and employee representatives. It requires that at the end of the coking cycle, i.e. prior to pushing the oven, that the oven be dampered off to control emissions. When an oven is dampered off, the air passage from the oven to the collector main is sealed so that air does not enter the collector main and gas does not leak into the coke oven environment. In addition the standpipe caps may be raised and charging hole lids removed (Ex. 144 TR 1575. 2210. 2211).

Apart from emissions from spillage and failure to damper off the oven at an appropriate time, pushing emissions primarily result from pushing green coke, i.e. that which "emits tarry vapors or flammable gases" (Ex. 2-19) and has a high volatile content as discussed previously. There are three main operating variables that affect the amount of green coke: temperature, coking time, and heat distribution in the oven. (Ex. 2-19). 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. 2-19; TR 1496-7, 2091-4, 2476-77, 3072-73). Based on the evidence in the record, there is substantial support for these four criteria or goals, but not sufficient evidence to specify detailed procedures uniformly applicable to achieve these goals. Therefore, the standard requires the employer to develop procedures for each battery to meet the specified criteria. The first one requires heating for a sufficient period to insure proper coking. Both the Advisory Committee recommendations and the proposal recommended that coke shall not be pushed unless thoroughly "coked out". Given the nature of the coking process, which depends on time and temperature, there is, as in any chemical/physical reaction, a point at which no further reaction will occur. If the oven has been charged properly and the heating system provides sufficient heat to the coal mass, then the coal should be "coked out" or properly coked when the oven is scheduled to be pushed (Ex. 2-19). However, where the oven is over-charged, the coal at the top will not heat properly, thus limiting the completion of the coking reaction regardless of the amount of time in the oven (Ex. 2-19). In addition, to the extent that heating flues are blocked or there is damage to the oven brickwork, which affects the temperature, a longer coking time also will not usually reduce green pushes (Ex. 2-19). These ovens should be pushed even though not thoroughly coked out in order to eliminate the problem for subsequent pushes (TR 1498; 2094).

On the other hand, there are certain practices, unrelated to the problems discussed above, that result in pushing green coke. In general, these involve pushing with an insufficient coking schedule, or pushing ahead of the scheduled coking time for production purposes or employee relief time, or by accident, i.e. the oven had been under repair and was charged late (TR 2092, 2940-1, 3037, 3320). It is situations such as these that the first criteria is designed to control without unduly restricting the occasional need to push an oven with some green coke which will never be coked out.

The second criteria is intended as a corollary to the first criteria for coking time to ensure the development of a system for preventing green pushes to the maximum extent possible as recommended by USWA (Ex. 144). Several items that could be utilized in such a system were discussed by Mr. Bloom of EPA (TR 1496–97) and Mr. Burton of U.S. Steel, Fairfield (TR 2091–94). While these items are not included in the standard, they would appear to be examples of appropriate procedures available to employers under this provision.

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 ovens. This is particularly a problem with the flues at the end of the ovens which are in part subject to temperature fluctuation when the doors are removed and replaced and may become clogged (Ex. 2–19). Continual checking of the heating system is necessary on a routine basis (TR 1575). The standard requires a detailed written program to cover those areas and to assure that 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 observation (TR 2092–4; Ex. 68J). For these reasons the standard does not limit action to one coking cycle but rather requires action to be taken as soon as possible depending on the nature and extent of the corrective action necessary.

5. *Maintenance and repair program.* The standard requires the employer to develop a detailed, written procedure establishing a maintenance and repair program for essential battery components relating to the control of coke oven emissions. The necessity for the effective functioning of these items, including the required work practices, have been discussed under the individual control sections. The components covered in the maintenance and repair program include the offtake system, e.g. standpipes, collector mains, and aspiration system; heating system, e.g. flues, gas lines, and nozzles; oven brickwork; and coke oven doors, as well as battery machinery and other controls. All of these items are considered necessary and appropriate components of a good coke oven emission control program and indeed they are also necessary to preserve the proper functioning of the battery (TR 1571, 1574, 1575, 1578, and Ex. 114, App. A, p. 112). A similar program for maintenance and repair was recommended by the Advisory Committee and also incorporated into the report of the industry members of the committee (Ex. 3, Ex. 4). One essential component of this program is the preservation of alignment of the battery, both as to charging holes and in relation to the larry car, as well as the offtake system. (TR 2167–8). Proper alignment reduces the amount of air that may enter the oven thus adversely affecting the pressure to evacuate the gases and it will also minimize coal spillage on the top of the battery (TR 1564). Since that mechanized or automatic cleaning equipment is used to clean goosenecks and standpipes, the alignment of these parts of the offtake system must be preserved (TR 1625, 1632).

An excellent illustration of such a program was provided in the testimony of Mr. Burton of U.S. Steel (TR 2019–20; 2021, 2027, 2086–88) and in the U.S. Steel paper on stage charging: The cleaner and tighter the aspiration and offtake is, the more efficient the aspiration will be." This points to the need for a definite, continuing program of cleaning and maintenance. These items were identified and set up on a definite maintenance cycle, with assigned responsibility. Every effort is made to continue this effective maintenance (Ex. 41A, p. 5).

Apart from the maintenance and repair program for the previously discussed components, the standard also requires maintenance of the regulated area in a neat, orderly condition, free of coke and coal spillage and debris. This provision is designed to prevent not only hazards to employees such as tripping, slipping, or injury from the derailing of battery equipment, but also to prevent exposure to emissions caused by coal spillage that may create exposure to coke oven emissions (Tr. 2090–1, 3524–5: Ex. 66F).

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 battery components over a substantial period of time (TR 1571, 1574–5, 2326–7). However, since any delay in the implementation of these repairs can affect employee exposure to coke oven emissions, e.g. leaks from standpipes, chuck doors, or oven brickwork, the standard requires that temporary repair measures be instituted prior to charging the oven for the next coking cycle. Examples of the types of repairs contemplated by this section are luting, sealing, or welding of offtake equipment leaks, or installation of chuck door gaskets (TR 1577; 2085–6; 2933). While industry representatives generally stated that immediate repairs are not possible, that factor must be balanced against the risk of continued employee exposure in setting a timeframe for control of these emissions. Therefore, while acknowledging that permanent repairs may not be capable of immediate implementation, the standard requires both temporary and permanent repairs to be performed as soon as possible.

One of the key components of this standard is the specification of a program of detailed work practices, maintenance and repair activities. While one or more of these items have been instituted on a large number of coke oven batteries, it is apparent that implementation has to date been far from effective in reducing employee exposure. While part of the reason for such deficiency is the failure to establish these requirements on a routine basis, another important reason is that they are highly dependent upon the personnel available to perform the activities. It is apparent that, given the state of the art in controlling coke oven emissions from existing batteries, and to some extent new batteries, there will continue to be heavy reliance on work practice controls. This may necessitate the use of additional personnel to ensure that the benefits of reduced coke oven exposure can be attained. A capsule summary of the philosophical and practical considerations of this issue was presented by Mr. Smith of the USWA (TR 3698–3702) in his comparison of the need to improve the U.S. Steel Clairton batteries with the results at the U.S. Steel Fairfield batteries. The conclusion of both the company and union personnel was that additional personnel were essential to the effective implementation of the improvement program at Clairton (Ex. 2–69C).

The importance of this point is apparent in contrasting the amount of attention paid to work practice control at U.S. Steel, Fairfield with that at other plants. The emission control program required additional topside, 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 2095–2098). 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 3379 80). In order to implement many of the necessary requirements of this standard, additional personnel may be needed, for example, during inspection and cleaning of the goosenecks and standpipes every coking cycle (TR 2921–2), reluting oven doors (Ex. 68J), or cleaning of doors and jambs (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 determine now 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 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, OSHA believes 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 some increase in the number of personnel seems likely. However, failure to mandate the required work practices would inevitably perpetuate the high risk to employees because the engineering controls alone would be ineffective. Accordingly, OSHA believes the benefits which will ultimately be derived from a vigorous control program exceed the risks from exposure to the reduced 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 supply.

These installations are intended to reduce employee exposure to coke oven emissions by isolating the employee rather than by eliminating the emissions at their source. This type of control is acceptable industrial hygiene practice 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 the effectiveness of a filtration system in removing multiple contaminants from the Air (Ex. 2-37J). The system filtered carbon monoxide (CO): total hydrocarbons: total sulfur: measured as sulfur dioxide (S 2): total particulates, and nitrogen oxide and dioxide (NO/NO2). Concentrations of coal tar pitch volatiles (benzen-soluble fraction) (CTPV) were reduced from an outside concentration of 1.89 mg/m³ to 0.28 mg/m³ and from 1.00 mg/m³ to 0.17 mg/m³. These pairs of measurements demonstrate reductions of over 80% by the use of filtered air equipment. Other control measures which may have been in use at this plant were not given in the report (Ex. 2-37J). In its presentation to the Advisory Committee, AISI provided "before and after" sampling data for several coke plants on which various controls had been installed (Ex. 2-146). On one battery, described as being 22 years old, with a single collector main, the larry car operator's CTPV exposure averaged 3.75 mg/m³. After installation of new charging hole rings and lids, automatic lidlifters, improved drop sleeves, steam aspiration, manual sequential charging and a filtered air system for the larry car cab, the operator's average exposure dropped to 1.21 mg/m³. This is still well above the permissible exposure limit but represents a 67% reduction in exposure. Additional controls could presumably reduce exposure even further. The high concentrations of CTPV at this plant are probably due to problems other than inefficiency of the filtered air system.

At U.S. Steel's Fairfield Works, concentrations of CTPV in the larry car cab averaged 0.26 mg/m³ on Battery No. 5 and 0.45 mg/m³ on Battery No. 6 (Ex. 2-223). No filtered air systems are in use at this plant. The generally low exposure levels at this plant have been credited, as previously discussed, to careful attention to proper work practices and procedures as well as engineering controls. Supplementation of these procedures with filtered air, OSHA believes, would reduce exposures even further. A reduction of 67%, as reported by AISI, would give average exposures of .08 mg/m³ and 0.15 mg/m³ in the larry car cabs. Similar reductions could be expected at other work stations such as door machine, quench car, and topside (lidman).

AISI submitted data on a 22 year old, double collector main battery (Ex. 2-146) with an air-conditioned topside pulpit. The lidmen's average CTPV exposure was 1.35 mg/m³. Stage charging had not yet been implemented at this battery at the time the samples were taken.

Filtration alone cannot be expected to reduce concentrations below the permissible exposure limit. Bethlehem Steel Corporation undertook a pilot study at its Johnstown, Pa. coke plant to develop air filtration and air conditioning systems for equipment cabs and lunchrooms (Ex. 2-93; TR 2449). The sampling data from the larry car cab showed an average CTPV concentration of 0.10 mg/m³ inside the cab and 0.64 mg/m³ outside. In addition to the filtered air supply, the battery was equipped with sequential charging, a jumper pipe, steam aspiration, improved drop sleeves and door cleaning and maintenance. Because of the necessity to leave the cab during normal operation, the larry car operator's average CTPV exposure was 0.38 mg/m³. Exposure prior to installation of controls was 4.0 mg/m³. Bethlehem reported that use of all of the above mentioned controls reduced exposures to 1/30th of those before the controls were installed. Filtered air reportedly was responsible for reducing exposures to 1/6 the previous levels (Ex. 2-93, TR 2450).

Problems with filtered air systems have been identified although the technology is proven. OSHA finds that these systems are feasible on most batteries (Ex. 2-174, p. 80; Ex. 149, p. 153). The effectiveness of filtered air systems may be diminished in cases where the employee continually moves in and out of the cab during the performance of his or her duties (TR 1571; Ex. 149, p. 153). Open cabs on some equipment would be difficult to enclose (TR 1570). John Munson of U.S. Steel, a member of the Advisory Committee, recommended that filtered air with controlled temperature be provided for topside (Ex. i.e. larry car cabs, lidmen's shelters) and lunch areas (2-174, p. 80; Ex. 2-163). AISI representative, Richard Phelps, agreed that installation was generally feasible on pusher machines, quench cars and stand-by pulpits (TR 1634-5). The engineering problems of installing filtered air systems on larry cars are not insurmountable (TR 815-6).

An employee of Bethlehem Steel testified that controlled temperature filtered air systems are in use on all larry cars, pusher machines, and topside stand-by sheds at the two coke plants in Johnstown. These installations work well, with apparently minimal maintenance problems (TR 2909-11). Air filtration systems are now included in plans for all of Bethlehem's plants (TR 2475). Air conditioned larry cars are also being used successfully at U.S. Steel's Clairton Works (TR 3141-2).

In addition to filtration, OSHA believes that temperature controls will make the environment in the enclosure more pleasant, thus encouraging proper use (e.g. keeping cab doors closed). It may also make the enclosed cab seem less confining. Without temperature controls, the positive pressure filtration system would blow hot air in the summer and cold air in the winter which would make working in the enclosed cab or staying in the stand-by pulpit intoler able, thereby defeating its purpose.

Filtered air with temperature controls was recommended by the Advisory Committee for all equipment cabs, stand-by pulpits for topside, the wharf, screening station, and lunch areas. The NIOSH criteria document recommends positive pressure filtered air supply for pusher cabs, larry car cabs, door machine cabs, quench car cabs, and topside stand-by pulpits for lidmen. No mention is made 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 45% of the total 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. 63-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 as of promulgation of the standard. As control technology improves, the standard contemplates that new and rehabilitated batteries be equipped with such controls in order to comply with paragraph (f). It should be noted that best available technology is not limited to commercially 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 employee health will be benefitted.

The Advisory Committee recommended that automatic door and jamb cleaners, automatic lid lifters, filtered air equipment cabs and topside standby pulpits, goosenecks that can accommodate automatic cleaning equipment, remote-controlled dampering-off systems, and double collector mains or an enclosed charging system, be mandatory for all new and rehabilitated batteries. OSHA, as discussed earlier, has required filtered air systems for existing batteries. This type of equipment can contribute greatly to substantial reductions in employee exposure and, wherever feasible, should be installed.

The participants are in agreement that remote-controlled dampering-off systems have not been shown to be feasible. Such equipment has only been installed in larry cars at two plants (Ex. 144, App. A, p. 18). These devices, actuated by the larry car operator, consist of an hydraulic cylinder system attached to a bar which engages and either lifts or lowers the damper arm. Operation of this system requires near-perfect alignment of standpipes and goosenecks. This alignment is difficult to maintain, especially as a battery ages. Once a battery has begun to distort, it is very difficult to bring the battery back into alignment. Although misalignment can be minimized, it is presently difficult, if not impossible to keep a battery in a condition where remote controlled dampering-off systems could be used (TR 1632–3).

The problems of alignment also are involved in the operation of automatic gooseneck cleaners as discussed previously. The Advisory Committee recommended that new and rehabilitated coke batteries be required to have goosenecks which can accommodate automatic cleaning equipment. Although there has been discussion of automatic gooseneck cleaners, there is no information in the record as to what special design of gooseneck may be required to accommodate such devices. The success of gooseneck cleaners does depend on the gooseneck design (Ex. 2–163, Ex. 2–220); but standpipe alignment is also critical, so although the goosenecks may accommodate automatic cleaners, over time such cleaners may lose their effectiveness. OSHA does not believe that automatic gooseneck cleaners should be required to the exclusion of other non-manual methods, such as mechanical cleaners, since the automatic type offer no special advantage and, in the long run, may prove less effective.

Automatic lid lifters are mechanical devices which remove and replace charging hole lids eliminating this task from the lidman's duties. This removes the lidman from exposure which is reported to be greatest during relidding (Ex. 2–63, p. 12; Ex. 21–121, p. 332). The automatic lid lifters can rotate the lid and effect a seal (Ex. 2–120, p. 24; Ex. 2–196), eliminating the need for the lidman to stand over an open or partially open charging hole. These devices have not been developed to the point where they can generally be retrofitted (Ex. 2–121, p. 86; Ex. 2–163; TR 2212–3, 2329–30, 2471, 3508–9). Problems exist with the added weight (e.g. TR 1566, 2329–30) and clearance (TR 1566). Two attempts to retrofit automatic lid lifters were unsuccessful (Ex. 2–151, p. 120–1). (2–151, p. 120–1). Only one plant has successfully retrofitted automatic lid lifters (TR 3509).

OSHA recognizes that problems exist with the operation of automatic lid lifters. Although they may be effective for removal and replacement of lids, mechanical problems do exist (e.g. TR 2284). Also, currently used lid lifters have difficulty removing lids which have been sealed with a slurry, forcing operators to seal lids with loose coal dust (Ex. 66–2). OSHA believes, however, that these problems can be solved by altered lid lifter designs or a differently formulated slurry. Although automatic lid lifters have not eliminated the need for the lidman they can remove this employee from a point of substantial exposure.

Automatic door and jamb cleaners have also been successful at reducing employee exposures. This refers primarily to the mechanical scraper-type cleaners (Ex. 66F-1, Ex. 66H–1) although not to the exclusion of other automatic devices, such as high pressure water systems, which will be discussed later. Automatic door and jamb cleaners are presently being installed on almost all new ovens being built in the U.S. (Ex. 2–163; Ex. 145, Attachment 1). These devices have not eliminated the need for some manual cleaning (Ex. 2–19) especially in the corners (Ex. 66H–2). However, it is difficult to clean the entire door by hand (Ex. TR 1648), particularly on tall (6 meter) ovens. Two installations with tall batteries, visited by OSHA personnel had automatic door and jamb cleaners (Ex. 66 F–3, Ex. 66 H–2). Automatic door and jamb cleaners can effectively remove major build-ups of heavy tar, sludge and carbon (Ex. 2–19, p. 72). Therefore, automatic door and jamb cleaners can reduce exposures of employees whose duties include cleaning of doors and jambs. The manual touch-up that may be necessary would require that the employee be exposed to the emissions for less time and to smaller amounts.

There has also been extensive discussion of the use of high pressure water systems (HPW) for cleaning doors. The use of HPW for the cleaning of doors is not generally a routine practice but rather is in individual cases being tested to supplement existing door cleaning programs (Ex. 2–69 C, TR 1438). HPW is effective in the stripping of carbon and other build-ups from steel parts (Ex. 2–19, p. 74). Republic Steel testified that there was only one HPW for cleaning doors in operation and it was not as effective as manual cleaning (TR 2171). USWA reported HPW was in use at the Stelco plant at Hamilton, Ontario (Ex. 144, App. A, p. 79) and that its use was beginning in the U.S. (TR 3539–40).

Questions have been raised concerning possible safety hazards from HPW. First, there is the danger of the water spray itself. The water pressure of these units is approximately 6000 pounds per square inch (TR 3629). This pressure can kill a person struck by the blast of water (TR 1437, 2473). Additionally, the problem of the water freezing on the bench area in cold weather was mentioned (TR 849, 2171). Bernard Bloom of EPA, in response to a question, noted that HPW cleaning of carbon, performed by the Heist Corporation at U.S. Steel's Clairton Works, operates twelve months a year (TR 1437–8). It was not stated whether this involved cleaning of coke oven doors however, Bethlehem Steel reported that contracting firms do perform HPW cleaning of coke oven doors (TR 2473). The report to AISI by Battelle Columbus Laboratories (Ex. 2–19) considered HPW as a very effective means of door cleaning with the added advantage of not distorting or scarring the surfaces cleaned as might occur with scrapers (Ex. 2–19, p. 74).

Coke plant operators feel, however, that HPW for door cleaning is still experimental (TR 2473, 2646). It was stated that HPW for cleaning coke oven doors is technology under development that requires specialized equipment and a redesigned door lining (TR 2473). To date, HPW has not been used to clean door jambs (TR 2171, 2473, 3540). HPW for cleaning doors can be a stationary installation and doors can be brought to the station for cleaning jambs, on the other hand, it would have to be a mobile system which has not been perfected (TR 3540).

The record is mixed on the subject of HPW. It has been termed experimental, yet there are apparently private contractors regularly performing HPW cleaning.

It is clear that such equipment cannot generally be retrofitted on existing batteries (TR 23312, 2474). 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 door jambs. The uncertainty in the record 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 main and a jumper pipe. 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 tunnel 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 permanent installation and the possibility of human error which is present in the use of a jumper pipe is minimized (TR 3678). It is estimated that only 20 per cent of existing single main batteries could be retrofitted with a second main (Ex. 2-61, p. 14), making use of jumper pipes necessary. New batteries can be constructed with two collector mains, however. OSHA recognizes that installation of a second collector main on some rehabilitated batteries may be infeasible due to space limitations or other difficulties. The Advisory Committee, recognizing that the retrofitting of a second collector main is not generally feasible on existing batteries, recommended that double mains be required on new and rehabilitated batteries using conventional charging systems (Ex. 3, p. 38).

Alternatives to larry car charging are enclosed systems which charge the ovens by means of pipelines or a conveyor. There are presently five pipeline charged batteries in operation in the U.S. Pipeline charging is a method for controlling charging emissions which is applicable to new coke ovens (Ex. 2-146). This system has been described under "Charging". Pipeline charging apparently cannot be retrofitted on existing batteries (Ex. 2-220). As has been previously discussed, problems do presently exist in the operation of pipeline charging, however, these problems are not considered insurmountable and pipeline charging can be operated in an emission-free manner (TR 1561). The Advisory Committee recommended pipeline charging as an alternative to conventional charging with double collector mains for new and rehabilitated batteries (Ex. 3, p. 38). As part of OSHA's desire to have new and rehabilitated batteries constructed with the most advanced engineering controls to reduce employee exposure to coke oven emissions, such batteries may utilize effective pipeline or other enclosed charging systems. The standard defines a rehabilitated battery as one which receives a major overhaul, rebuilding, renovation or restoration. Whether a battery is viewed as an existing battery or a new or rehabilitated battery will, of course, depend upon the facts. Certainly a battery which is rebuilt from the ground or from the pad up will be viewed as a rehabilitated battery. On the other hand, routine major repairs will not be viewed as rehabilitation. The intent of the standard is to require that employers who invest substantial resources to make a battery more productive or profitable, also utilize the best technology to make the battery safer and more healthful for employees, in the same process.

8. *Emergencies.* The standard requires that no charging take place where an emergency (i.e., a massive release of coke oven emissions) occurs until the cause of the emergency is properly repaired, unless the employer can establish that the cause of the emergency cannot be determined unless the oven is again charged. The proposal did not contain such a requirement, although the Advisory Committee recommended that no charging be permitted until the cause of certain leaks is repaired.

Obviously, there are inevitable minor leaks which occur on the oven. OSHA believes that all such repairs should be made as soon as possible, but not necessarily before charging takes place. This is not to say that employers can or should ignore or treat minor leaks lightly. Indeed, one of the principal reasons for Fairfield's success in dramatically reducing exposures is the attention focused upon all leaks, including minor ones. On the other hand, there are defects which result in massive releases of coke oven emissions. For example, if a standpipe bursts, the aspiration system fails, or the heating flue is defective, causing a green push, a massive release of coke oven emissions will occur. In these circumstances, the standard prohibits further charging until necessary repairs are made. It should be noted that occasionally the only way to determine the cause of a defect is to charge the oven, and analyze the cause of the problem. In this limited circumstance, the standard permits charging.

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 projected engineering controls and work practices, specifically delineated in the standard, which will reduce employee exposures to or below the permissible exposure limit. Such a written program will set forth specific time frames by which the engineering controls and workpractices will be in place. If the employer has implemented all required controls and practices within specified time frames, and permissible exposure limits are nonetheless exceeded, then the standard requires the formulation and implementation of a second written program—compelling the employer to utilize any existing technology and to develop new technology necessary to achieve full compliance with the standard.

OSHA derives legal support for a technology-forcing standard from the rulings of the Courts of Appeals (See e.g., *Society of Plastics Industry* v. *U.S. Department of Labor*, 509 F. 2d 301 (C.A. 2, 1975) cert. denied; *AFL-CIO* v. *Brennan*, 530 F. 2d 109, 121-122 (C.A. 3, 1975). Moreover, the coke oven emissions standard marks the first attempt by the Secretary to combine the specificity of a standard which particularizes required engineering controls and work practices with the flexibility which permits employers to tailor their written programs to the exigencies of their batteries. In addition, the specificity of the final standard finds further support in section 6(b)(7) of the Act which states in pertinent part: "Where appropriate, such standard shall also prescribe suitable protective equipment and control or technological procedures to be used in connection with such hazards * * *" (Emphasis added.) Furthermore, a standard which specifies a compendium of required controls and practices is promulgated in cognizance of similar plans which have been developed in the context of litigation (Ex. 68J; 68K). Nevertheless, although these agreements marked an important first step under the former general, non-specific CTPV standard, they further underscore the necessity for a uniform standard of compliance which directs employers to specific abatement programs and allows the Secretary more easily to monitor an employer's progress in achieving full compliance.

Another issue for discussion under this section involves the efficacy of OSHA's enforcement procedures in insuring uniform compliance with the requirements of this standard. 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 will be issued for the failure to comply with the requirements of the standard. The citation will set forth "standard alleged violation elements" (SAVE) including specific time frames by which the cited employer must come into initial (development of a plan), intermediate (hiring an expert consultant, ordering requisite materials, etc.) and final compliance (specific controls in place). During the course of implementation, OSHA will periodically monitor the employer's progress in order 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 lead to its 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 deterrence achieved through periodic general inspections and the intensive review and monitoring which will follow such inspections. Third, in the implementation of this 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 [illegible] obligation under the prior standard to reduce coke oven emission exposures by means of feasible engineering and 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 views the two standards as representing 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 the employer's 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 controls or 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.

(G) *Respiratory protection.* The standard requires that respirators be used to achieve compliance with the permissible exposure limit only during the time period necessary to install or implement feasible engineering and work practice controls, in work operations in which such controls are not technically feasible or are not yet sufficient to reduce exposure to the permissible limit, or in hazardous operations or emergencies. These restrictions on the use of respirators are consistent with the requirements of 29 CFR 1910.1000(e) and with good industrial hygiene practice (Ex. 2-121, p. 489; TR 400, 888). Respirators are to be considered secondary to the objective of preventing contamination of the coke oven environment (TR 400, 863). Proper facial fit is essential, but, due to variations in individual facial dimensions, such fit is difficult to maintain (Ex. 2-18, 2-150). Coke oven work is strenuous and the increased breathing resistance of the respirator reduces their acceptability (2-121, p. 245; TR 864). Heat stress also limits the wearability of respirators at coke ovens (TR 398). Safety problems presented by respirators must be considered. Respirators limit vision (2-18); this can be significant on a coke battery where numerous mechanical hazards exist and the employee's ability to see is important. Speech is also limited. Voice transmission through a respirator can be difficult, annoying, and fatiguing. Movement of the jaw in speaking may cause leakage (2-18). Communication may make the difference between a safe, efficient operation and confusion and panic, especially in difficult and dangerous jobs (2150). Skin irritation can result from wearing a respirator in hot weather, such irritation can cause considerable distress and disrupt work schedules (2150).

It is clear that respirators cannot be considered as the primary means of employee health protection. We have carefully considered all these problems and have nonetheless concluded that if the PEL is exceeded then employees must use the respirators provided.

OSHA recognizes that respirator use does have a role in worker protection (TR 143; 399400). This is especially true 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 coke oven 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 (BSFTPM) 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 basic material against which workers must be protected (Ex. 2121, pp. 51920; 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. 255, p. 521). These are usually quarter-mask respirators which filter the air as the wearer's breath draws air through the filter.

There are numerous factors which affect the performance of this type of respirator. These include the efficiency of the filter material and the fit of the facepiece on the wearer. Also important is wearer acceptance and training. Proper fit of the respirator is critical. As a negative pressure is created within the facepiece when the wearer breathes, unfiltered air may enter the facepiece if gaps exist (TR 866). Obtaining a proper fit on each employee may require the employer to provide two or three different mask styles since the mask of only one manufacturer will fit probably only three out of every four persons (TR 872).

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 conform to 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 $\mu g/m^3$, 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 and that leakage is at a minimum. A rapid qualitative fit test can be performed at the start of each shift. Qualitative fit tests can be either a positive pressure test, in which the exhalation valve is closed and in which the wearer exhales into the facepiece to produce a positive pressure, or a negative pressure test, in which the inlet is closed and the wearer inhales so that the facepiece collapses slightly (Ex. 19, Ref. 2). On an annual basis a quantitative fit test is to be performed on all employees wearing non-powered air-purifying respirators. This is important because of the nature of the hazard (cancer) and the dependence of respirator effectiveness on 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, isoamyl 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 the respirator so selection of the best fitting facepiece style can be made.

For concentrations of coke oven emissions greater than 1500 $\mu g/m^3$, 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 fit 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, p. 8). 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 these units, OSHA will pursue, through NIOSH, research to adapt air conditioning components to these units.

The higher protection factor afforded by PAPR makes use of these devices more desirable whenever possible. Burgess estimates the protection factor of a PAPR with a filter 98% efficient against coke oven emissions (BSFTPM), and a flow rate of 4 cubic feet per minute, to be approximately 30. If a higher efficiency filter is used, the protection factor may increase. The protection factor of 30 would mean an outside concentration of 4500 $\mu g/m^3$ BSFTPM will be reduced to 150 $\mu g/m^3$ inside the facepiece.

The Advisory Committee recommended that employees be given a choice between powered and non-powered air-purifying respirators (Ex. 3, p. 63). OSHA concurs and the standard requires the employer to provide a PAPR to any employee who requests one. Either a powered or non-powered respirator is permitted in the lower concentration range (not greater than 1500 $\mu g/m^3$). The wearing of a non-powered respirator may be difficult for medical reasons, e.g. chronic lung disease. Since there are no objective medical tests to determine the employee's ability to wear a non-powered respirator, the determination must be left to the subjective evaluation of the employee. This provision of the standard becomes effective after January 20, 1978 when respirator use will no longer be voluntary. During the voluntary use period, employees need not use their respirators except in the vicinity of visible emissions, this will permit periods of relief for those employees who find wearing a non-powered respirator difficult. The one year delay will also permit respirator manufacturers to increase the supply of PAPR.

Both the Advisory Committee and the proposal included the use of high efficiency particulate filters for air-purifying respirators. High efficiency was defined as 99.97% efficient against 0.3 micrometer diameter particles. In his statement at the hearing, Burgess recommended that high efficiency filters not be required (Ex. 19, p. 5). Performance data of filter media against coke oven emissions is limited to information released by one AISI member company (Ex. 2–21), Burgess's own evaluation of candidate filter media for the PAPR (Ex. 2–21), and data developed by MSA Research Corporation under NIOSH contract (Ex. 2–149; Ex. 19, Ref. 5). The first two studies revealed inconsistent performance based on CTPV sampling. Burgess tested resin felt, glass fiber high efficiency media, and resin impregnated deep wool batting. The high efficiency filter was only 90% efficient. In the NIOSH study, fume filters showed more consistent efficiency in the mid-ninety percent range. Based on these data, OSHA has deleted the requirement that only high efficiency filters be used. The variability of performance of this type of medium in testing makes it undesirable to limit the acceptable type of filter to a single type.

The standard requires that respirators be selected from among those approved for protection against dust, fume and mist by NIOSH under the provisions of 30 CFR Part II. The NIOSH approval schedule calls for testing of dust, fume and mist respirators against silica dust and mist and lead fume. High efficiency respirators are also tested against an aerosol of dioctyl phthalate (30 CFR Part II, Subpart K). There presently is no testing against coke oven emissions; NIOSH is developing such a test procedure, however. As a result, respirators approved by NIOSH for particulates are permitted until January 20, 1979, after which time only those respirators tested and approved by NIOSH for protection against coke oven emissions will be permitted.

Presently, only one manufacturer's PAPR is certified by NIOSH (Ex. 76 A, Approval No. TC–21C–136, June 20, 1973). Other PAPR's are available, such as one demonstrated to the Advisory Committee by the USWA (Ex. 2–151 p. 355–369). This device is one of two PAPR's manufactured in Great Britain and in use on coke ovens there. Neither of these has been submitted to NIOSH for testing and certification. There will be a time lag between the effective date of this standard and the time that PAPR's are available commercially on a large scale in the U.S. One British manufacturer, when queried by the USWA, felt that stepped-up production, to meet an increased demand, was possible (Ex. 2–151, p. 357). American manufacturers are also developing PAPR's.

At certain work locations a supplied air 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 "drop" could be attached to a quick disconnect at the belt and the device could operate as a supplied air respirator with high protection factor. When the operator must leave the cab he would release the airline and the unit would operate as a conventional air-purifying respirator. It is this type of modification that suggests that the 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 recommended that employees be given a choice between an air-purifying respirator and a PAPR regardless of the airborne concentration of coke oven emissions. The Committee considered worker acceptance to be the major factor in respirator use. At concentrations of coke oven emissions less than 1500 $\mu g/m^3$, the standard permits use of either powered or non-powered respirators. Additionally, a choice of different styles of non-powered respirators must be offered if employees are to be fitted properly. At concentrations of greater than 1500 $\mu g/m^3$, however, OSHA believes that the basic requirement for the PAPR is justified due to the greater level of protection which can be afforded by these devices. The use of PAPR's must include consideration of temperature extremes, as discussed above, and the ability of a particular employee to wear such a device. Individuals with pulmonary conditions such as emphysema which restrict exhalation may not be able to wear a positive pressure respirator (Ex. 2-151, p. 370). In such cases allowance must be made for the wearing of a non-powered respirator.

The standard makes the wearing of respirators voluntary, except when employees are in the vicinity of visible emissions, for the time period ending one year from the effective date. While exposures in excess of the permissible exposure limit do constitute a hazard, OSHA believes that it is necessary to mitigate some of the problems associated with implementing a program of respiratory protection such as the fitting and training of employees. During the one year voluntary period, control measures, such as installation of filtered air systems and improved work practices can be implemented. These controls will result in an improved work environment which will 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 or her 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, e.g. around the neck, and then use it when in the vicinity of a visible emissions. The proposal required use of respirators whenever employees were exposed in excess of the permissible exposure limit. This would have essentially required the wearing of respirators by large numbers of coke oven workers for the entire work shift. The one-year period of voluntary respirator use will alleviate this burden while the necessary adjustments for implementation of a respirator program are made.

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 breath harder to overcome this resistance. The wearing of the respirator becomes increasingly more 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 change filters when the need arises.

The wearing of a respirator in a dusty 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 coke oven emissions.

(H) *Protective clothing and equipment.* 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 repeated skin contact with coke oven emissions, (2) hazards related to exposure to the heat and flame generated by the coking process, and (3) hazards from impact.

There are two hazards related to repeated skin contact. 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 (TR470). Second, skin cancer, which results from repeated skin contact with the products of coal combustion and distillation (Ex. 8-22; Ex. 8-23). Protective clothing and equipment is intended to minimize skin contact with coke oven emissions in order to reduce the incidence of genito-urinary cancer and to continue the apparently successful control of skin cancer mortality and morbidity that has resulted from the use of protective clothing and equipment and good hygiene practices (TR 727, 1096, 1108-9). Specifically, jackets and pants and, to a lesser extent, the gloves and face protection, serve this purpose and are required, in part, for that reason.

It is primarily a burn hazard which is related to exposure to the heat and flame generated by the coking process (TR 1985; Ex. 19F, Appendix A). The burns may result from direct body contact with flame, or hot objects such as a piece of coke, or from the clothes of a coke oven worker catching fire. Therefore, the standard requires (1) face shields or vented goggles to protect against blasts of heat and flames, molten and incandescent material, and dust hitting the face (TR 411; 1984) and, (2) clothing which covers the body and is also flame resistant, including jacket, pants, gloves, and insulation from hot surfaces for footwear (TR 411; TR 1985; Ex. 19F, Appendix A).

It should be noted that the protective clothing and equipment which relates to skin contact with coke oven emissions and to exposure to heat or flame generated by the coking process, need not be provided if the employer establishes that such equipment is not necessary, i.e. that the affected employees are not exposed to the indicated hazards. This provision is in recognition that some employees may not be faced with these hazards and may not require this protection (TR 411). However, OSHA believes that where such hazards are prevalent, it is better to presume that all coke oven workers need to be protected, unless the employer establishes otherwise.

The third type of hazards are those which occur from impact. These include being struck by moving equipment (TR 1984, 1986) and falling objects (Ex. 19F, Appendix A). Safety shoes, which are intended to protect the feet and toes from injury due to impact (TR 1985), and protective helmets, which are intended to protect the head against impact (TR 1986), are required for all coke oven employees. This is a practice which already exists in the industry (TR 1984-5).

The protective clothing and equipment required in the standard is generally the same as that in the proposed standard (Ex. 1a, p. 32279) and the Advisory Committee report (Ex. 3, p. 69). Both of these documents required that full body covering be provided and that it be rain-proof and heat resistant also. This type of clothing would reduce the ability to dissipate body heat, causing excessive body heat buildup and an increase in the potential for heat stress (TR 410-11; TR 1983-84). For this reason, the requirement is not included in the standard.

The Advisory Committee report also suggested that smocks or aprons and all clothes underneath the full body covering be provided. Since there is no evidence in the record to indicate that these articles offer additional protection against the hazards encountered, they have not been included in the standard.

Both documents also suggested that the face shields and goggles be appropriate for protection against the viewing of incandescent coke. There was evidence that no eye damage results from radiant or convected heat from incandescent coke (TR 1985) and that tinting of eye protection would reduce or impair employee vision, possibly resulting in more frequent accidents (TR 1984). Therefore, the requirement has been deleted from the standard.

The standard also requires that the employer clean, launder, or dispose of the required protective clothing in order to ensure that the flame resistant properties of the clothes are maintained, and to eliminate any potential exposure that might result were the clothing to be laundered by the employee at home or in a commercial laundry (TR 3034).

The standard also requires that protective clothing be provided in a clean and dry condition at least weekly. Since repeated skin contact with coke oven emissions creates a potential for skin cancer, OSHA believes that the regular cleaning of contaminated work clothing plays an important role in the prevention of this hazard. The proposed standard required that clean equipment and clothing be provided daily (Ex. 1a, p. 32279). However, based on evidence that weekly cleaning was sufficient to protect against the hazard (TR411), and in order to lessen the burden placed upon employers, OSHA has changed the requirement accordingly. OSHA has also limited the cleaning requirement to the protective clothing since required equipment such as protective helmets and safety shoes do not warrant the same type of care. The standard does require that protective clothing and equipment be maintained and replaced as needed in order to ensure effectiveness.

The standard provides that the employer ensure that all protective clothing is removed at the end of each work shift only in change rooms, and that the clothing that is to be laundered, cleaned, or disposed of be placed in a closable container in the change room. The purpose in requiring such a container is to prevent the contaminants on the clothing 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.

The proposed standard (Ex. 1a, p. 32279) and Advisory Committee report (Ex. 3, p. 70) both limited the handling of contaminated protective clothing and equipment to authorized persons. The standard does not include such a limitation because OSHA believes that the closed container provision will serve to protect whomever removes the contaminated articles from the change room.

Finally, the standard requires employers to inform those who handle the contaminated articles of the potentially harmful effects of exposure to coke oven emissions. This provision is designed to make clear the need to use proper care in handling of the contaminated articles.

(I) *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 ingestion of 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 likely to be at a minimum. The standard does this by prohibiting the presence or consumption of food or beverages, the presence or use of smoking products and the application of cosmetics in the regulated area. The standard also requires that positive pressure, filtered air lunchrooms be readily accessible for employees. Lunchrooms must be readily accessible to encourage employees to make use of them. Positive pressure filtered air is required to create a lunchroom with a relatively emission-free air supply and to minimize the amount of air from outside the lunchroom blowing inside whenever the door is opened. The air supply is also required to be temperature controlled so that the lunchroom does not become unbearably 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 not to leave the door open in order to lower the temperature in hot weather, thus minimizing the opportunities for emissions to blow into the lunchroom.

Second, the standard requires the use of hygiene practices and facilities which are intended to remove the coke oven emissions collected on employees so that these emissions are not subsequently ingested. The standard does this by requiring that employers ensure that employees wash their hands and faces prior to eating. Since washing is required, the standard also repeats the existing obligation to provide washing facilities and lavatories in accordance with § 1910.141 (d) (1) and (2) of this Part.

Repeated contact with coal combustion and distillation products can induce skin cancer (Ex. 8–22; Ex. 8–23). However, no significant excess incidence of skin cancer has been exhibited by American coke oven workers (Ex. 20L, Ex. 2–14). This has been attributed to good hygiene practices engaged in by the workers (TR 2365). In an attempt to continue the current success in preventing skin cancer, the standard includes various provisions aimed at minimizing repeated skin contact with coke oven emissions. Thus, not only is protective clothing and equipment required (see Protective Clothing and Equipment), but since protective clothing and equipment alone will not eliminate skin contact with coke oven emission (TR 411), the standard requires change rooms and showering, and prohibits the application of cosmetics in the regulated area.

The standard requires the employer to provide change rooms equipped with storage facilities for street clothes and separate storage facilities for protective clothing and equipment whenever employees are required by this standard to wear protective clothing and equipment. The purpose of this requirement is to reduce the possibility of an employee having skin contact with coke oven emissions which were collected on the employee's street clothes as a result of those clothes having been in the same storage facility as the employee's contaminated protective clothing and equipment. It should be noted that this requirement repeats the existing obligation to provide change rooms in § 1910.141(e) of this Part.

The standard requires showering at the end of each shift, which has been cited as one of the most significant factors in preventing skin cancer among coke oven workers (TR 2365). OSHA believes that, although it is reported that workers currently engage in this practice, it is necessary to create a legal obligation to do so, in order to ensure continuation of this practice. The standard also repeats the existing obligation to provide shower facilities whenever showers are required under S1910.141(b) (3) of this Part.

The standard also requires employers to ensure that employees do not apply cosmetics in the regulated area. This is intended to prevent employees from sealing coke oven emissions on to their skin.

There are two other provisions of the standard which require discussion. First, drinking water is permitted to be consumed in the regulated area. Although this exception to the prohibition against the presence or consumption of beverages in the regulated area contradicts the theory of minimizing the possibility for ingestion of coke oven emissions, there is a counterbalancing argument which justifies its inclusion. The record demonstrates that it is necessary for workers on the battery to be able to drink water to prevent heat stress (TR 1987–88; TR 1991; Ex. 7, item 5; Ex. 5A, item 4); hence, the consumption of water is permitted. Employers should position the water supply so that contamination from emissions is minimized, yet is readily accessible to the employees.

Second, 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 certainly may be present and consumed in a lunchroom even though the lunchroom is part of the regulated area.

Both the Advisory Committee report (Ex. 3) and the proposed standard (Ex. 1A) followed essentially the same approach as the standard in the area of hygiene facilities and practices. The proposal (Ex. 1A, p. 32279) did, however, include two major requirements that the standard has deleted. The proposal required that locker facilities and showers be arranged so that the showers serve to demarcate between potentially contaminated and uncontaminated areas and that lavatory and toilet facilities in contaminated areas be arranged so that no access is available to an uncontaminated area. OSHA agrees with participants who have suggested that the additional protection, if any, that these requirements would provide is small (Ex. 5A, items 5, 7, 26, 33; TR 1989), and the burden that they would create does not justify their inclusion (Ex. 5A, items 5, 7, 26, 33).

(J) *Medical Surveillance.* The standard requires each employer to institute a medical surveillance program for all employes who work in regulated areas at least 30 days per year. The record, including recommendations from NIOSH in its Criteria Document (Ex. 2–18, p. I–5), clearly indicates that a medical surveillance program is appropriate in dealing with the problem of employee exposure to coke oven emissions; hence, pursuant to the Act, this standard has prescribed it. The authority, indeed the requirement, to include medical surveillance in an OSHA standard is found in subsection 6(b) (7) of the Act:

> * * * where appropriate, any such standard promulgated under subsection 6(b) shall prescribe the type and frequency of medical examinations or other tests which shall be made available, by the employer or at his cost, to employees exposed to such employment related hazards in order to most effectively determine whether the health of such employees is adversely affected by such exposure.

Medical surveillance has been limited to employees who work in regulated areas. This has been done because the regulated areas which have been established (the coke oven battery and the beehive oven and its machinery) are the 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 coke oven or on a pusher machine and quench car) (Ex. 2–18, p. I–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), Criteria Document (Ex. 2–18, p. I–5) and various participants (Ex. 5a, item 21; Ex. 5a, item 4).

Because 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 1930), some cut-off point for the required medical surveillance program was 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 500 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 90 day cut-off point 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 2260).

The other alternative, that of using the term "regularly assigned" as suggested in the Criteria Document (Ex. 2–18, p. I–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 on how special repair crews 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 furnance and merchant coke operations (Ex. 68F, Ex. 68K). The Advisory Committee spent a substantial amount of time discussing this issue and determined that a time period, rather than the nature of the assignment should govern coverage. (Ex. 2–213, p. 94–106.) There is no evidence to support revision of that approach. Therefore, 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 provide 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 possible 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 from the employee 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. I–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 be conducting a medical examination. However, certain parts of the required exam (e.g. taking of a history) do not necessarily require the physician's expertise and 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 required by OSHA standards be provided at no cost to the employee. The proposed standard (Ex. 1a, p. 33279) 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. I–6).

Both the proposed standard and Advisory Committee report included in this provision, a requirement that all medical examinations be given during the employees' normal working hours. Since coke ovens are operated on a 24 hour basis, and since the 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 exams. 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 fitness of each employee 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 proposed standard (Ex. 1a, p. 32279), Advisory Committee report (Ex. 3, p. 59), and Criteria Document (Ex. 2–1, p. I–5) all contained requirements for an initial or preplacement exam, identical or similar to that required in the standard.

Compilation of an employee's work history and comprehensive medical history are 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 inclusion 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 exam 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. V–6, I–6). The International Labour Office UICC/Cincinnati (ILO U/C) rating is useful in obtaining uniform quality in the reading of x-rays (Ex. 2–138, p. 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, 2526; Ex. 18 p. 8). For these reasons, the standard includes both tests, as suggested 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. I–6).

The determination of a baseline weight is necessary to measure changes in weight. The standard includes it as did 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, Advisory 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 sugar, albumin and hematuria. 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 many years in the field of cervical cancer (TR 906). The application of similar medical techniques to respiratory 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 where certain other alleged indicators are present (Ex. 5a, item 7; TR 1902, 2460). Some 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). Coke oven workers are also a high risk population, as was recognized by several medical witnesses. (TR 384, 2527.) Therefore, it is not accurate to say that the studies are 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 achieving 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 detection 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, while 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 where several 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 method (TR 1175–6), so that 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 those cancers detected by cytology have a better prognosis. (TR 1179–80, 1191–92).

The major limitation that was suggested 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, TR 2524), but is merely a matter of convenience. It is clear from the record that induction of sputum through the inhalation of an aerosol results in a satisfactory sputum sample (Ex. 18B; TR 1181–3; TR 1190–1). It is inappropriate to limit the use of the test on a basis unrelated to the existence of the disease.

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. 2–14, p. 628; TR 908) which develops in the body of the kidney (TR 908). The development of this type of cancer limits detection after a certain point in time, because as the tumor grows, it blocks the lumina until it increases 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, the appearance of symptoms, or the existence 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 a carcinoma from normal to atypical, 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 are at this time no additional detection procedures comparable to the x-ray. General reference is made to the use of urinalysis in place of urine cytology as the primary screening 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 surveillance to the seemingly susceptible individual 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 to say that interpreting the cytological results will not create any medical or administrative problems for the physician in terms of diagnosis and continued exposure of the particular employee. However, with improved cytologic techniques it appears possible to localize which kidney is affected 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 cytotechnology schools for the nonphysician in the United States (TR 913) and over 3,000 registered cytotechnicians in the United States (TR 393). In addition, training in pathology is increasing for practicing physicians as well as for recent graduates (TR 913–914). While one participant indicated some difficulty in obtaining analyses 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 included a requirement to perform urinary cytology examinations as part of an employee's preplacement exam (Ex. 3, p. 59). The Criteria Document included a requirement to perform sputum cytology examinations as part of an employee's preplacement exam (Ex. 2–18, p. I–6). The proposed standard included a requirement to perform both urinary and sputum cytologies 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 in the final standard reflects OSHA's belief that, for the various reasons stated above, both cytological tests are an important part of a medical surveillance program for coke oven workers. Subsequent cytological exams are to be provided for the high risk population.

The standard provides that medical examinations which include those tests and measurements required for an initial exam be performed semi-annually for all employees who work in regulated areas at least 30 days per year and who either are at least 45 years of age or have worked at least five years at coke ovens. For those employees who neither are 45 years of age nor 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 onset of disease 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 old or with five years employment 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 the epidemiological studies which break down employment into five year intervals, it appears that the excess cancers 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 5–6, p. 627–8).

Many of the differences between the final standard, the proposed standard, the Advisory Committee report, and –15 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 OSHA's 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 successor employer) 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 in a regulated area 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 cytologies, on a semi-annual basis. In view of 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 in the regulated area is that only these employees are felt to be at high risk (see discussion of high risk population, above). Employers are required to make a full medical examination available to an employee who has not had one within six months of termination of employment. This will inform the employee of the condition of his 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 time 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 regulation, a description of the affected employee's duties as they relate to the employee's exposure, the results of the employee's exposure measurement, if any, or 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 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 to the physician only once, unless, for example, the duties change. Exposure measurements will be cumulative so that the results of each monitoring are to be sent to the physician. However, since sampling will be done on a representative basis, the language of the standard was clarified to require the physician to receive either the employee's actual exposure measurements, if available, or the estimated level. Neither the Advisory Committee report nor the Criteria Document included provisions for the information provided to the physician. The standard follows the approach taken in the proposed standard (Ex. 1a, p. 32279–80).

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 by the physician 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 employer 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 will insure that the employee is informed of the results of the medical exam and may take any appropriate action. There is evidence that employees presently do not receive the results of their medical exams (TR 3028). The purpose in requiring that specific findings or diagnoses unrelated to occupational exposure not be included in the written opinion is to encourage employees 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 report included provisions 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 employee fitness, 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 used in the proposed standard makes basically the same requirements, but uses different language. The standard does require an additional analysis not 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 also required that 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 substitute alternative medical exams for those exams specified provided that they result in at least equal assurance of detecting pertinent medical conditions. This type of provision is designed to allow some flexibility in the minimum medical exam requirement where there is a great deal of uncertainty as to the appropriate screening test. Several medical witnesses stated that they were not aware of any suitable alternatives (TR 1902, 2527) and suggested that the regulation should set out the minimum procedures, eliminating the need for an alternative exam provision (Ex. 5a, item 11; TR 1736). Accordingly, the section on alternative medical exams has been deleted from the standard. If at some time in the future, suitable alternative medical exams are developed, the employer may seek a variance to demonstrate equivalent effectiveness. Since the standard specifies only the minimum requirements, the physician is, of course, free to employ any additional tests or more sensitive techniques to analyze the results of the specified exams (Ex. 5a, item 29). Neither the Criteria Document nor the Advisory Committee report included a provision for an alternative medical exam.

The proposed standard included a provision prohibiting the exposure of an employee to coke oven emissions if the employee would be placed at increased risk of material impairment to his or her health from such exposure. Under the proposal, this determination could be based on the physician's written opinion. The proposal did not include any provision requiring the transfer of that employee to another job, nor did it include the Advisory Committee recommendation that any removal from exposure "shall not result in loss of earnings or seniority status to the affected employee." These provisions have been referred to collectively as rate retention.

In this proceeding, representatives of unions indicated their great concern regarding any requirement for the mandatory removal of employees because of increased risk in the absence of a rate retention right for employees so removed. The major argument presented was that the absence of a rate retention provision would constitute a major disincentive to employees to submit to physical 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 creates a dilemma antithetical to the purposes of the Act—namely, the employee's need to choose between continuing to work but risking his life by continuing to do so, and protecting his health, but losing his job.

This dilemma was articulated by Dr. Eula Bingham, Chairperson of the Advisory Committee, who said: "It is to me an impossible situation for a worker to be afraid to take a physical examination because he is going to lose the job that he uses to feed his family. It is unbelievable." (TR. 1093)

The record contains testimony regarding cases where employees were reluctant to take physical examinations because of their fear that they will lose 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 evidence on the scope of the problem or on the number of employees who would be at increased risk from exposure to coke oven emissions and who would be affected by such a provision. Further, there is a range of different 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 collective bargaining agreements in the coke oven industry. With respect to the later issue, it is not clear, for example, what rights a transferred employee would have under a rate retention provision in relation to other employees with seniority under applicable collective bargaining agreements and what principles would govern the termination of the retained rate.

There are additional areas in which the record does not contain sufficient information. The record does not focus on the issue of whether an employer should be responsible for the employee's retention of his rate of pay where the medical condition which is the basis for the transfer is caused by conditions other than coke oven exposure; or the applicability of the rate retention requirement in circumstances where it is difficult or impossible to determine the specific etiology of the employee's medical condition.

Finally, it would appear that the same considerations discussed above would militate in favor of a rate retention provision under other health standards to be issued by the Agency. However, the record contains no evidence on the impact of such a provision within a larger industrial framework and assesses the extent to which varying circumstances in other industries would warrant different treatment of this issue. We do not believe that this important issue should be dealt with in a piecemeal fashion and, accordingly, decline to make a determination on the issue until these broader ramifications are explored.

While we are not providing for rate retention in the standard, we are convinced that further exploration of this issue is necessary in order to deal in considerably more depth with the numerous issues raised by such a provision. It is therefore our intention to conduct prompt further study, through an advisory committee or other means, of the need and implications of rate retention as an aspect of an OSHA health standard. On the basis of this study, the Agency will take further action under the Act, as appropriate, regarding rate retention.

In the meantime, we have also determined to modify the proposed standard to delete the mandatory removal provision. In our view, the issue of mandatory removal is closely related to the issue of rate retention and neither should be addressed in the present standard. The Agency's further study of rate retention will also involve consideration of the mandatory removal question.

(K) *Employee information and training.* The standard requires the employer to provide a training program for employees working in the regulated area. 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 Criteria Document (Ex. 2-18, p. I-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, item 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 Advisory Committee 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 this recommendation.

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 as of the effective date of 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 must be provided at least quarterly. OSHA believes that an annual training program is both necessary and sufficient to fulfill the purposes of training, but that during 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 appendixes 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 recordkeeping 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(b)(7) 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 a matter of policy, 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 when the control of potential safety and health problems involves the cooperation of employees, the success of such a program is highly dependent upon the worker's understanding of the hazards attendant to that job (Ex. 2–18, p. I–10, 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 sign will serve as an objective check on whether employees are actually being informed of this hazard.

Since even persons who are only on a coke oven occasionally, may face an increased risk of cancer (Ex. 82), OSHA does not believe that the hazard to these people is overstated by the required sign. Also, as is the case with a regular employee, the warning signs would serve as an added impetus to occasional visiting employees to utilize any protective equipment which has been provided (Ex. 2–18).

Several participants suggested that signs will not be necessary because the other provisions of the standard will insure reduction of exposure and elimination of the resultant hazard. While that is to be hoped, OSHA believes that the use of signs is part of the standard's multifaceted approach to reduction of employee exposure to coke oven emissions.

Finally, given the epidemiologic evidence of the human carcinogenicity of coke oven emissions, the charge that the signs will cause undue alarm appears unfounded. This is especially so when balanced against the positive results anticipated, as described above. For all of the reasons set forth, OSHA feels that it is appropriate to use precautionary signs which warn of a cancer hazard. Additionally, the phrases "authorized personnel only" and "no smoking" relate directly to requirements in the standard which limit access and activities within regulated areas. (See discussions of Regulated Areas and of Hygiene Facilities and Practices.)

The standard also requires that areas where the permissible exposure limit is exceeded be posted with signs which inform of the existence of danger and the requirement to use respiratory protection. The word "danger" is used for three reasons: (1) To attract the attention of workers; (2) to alert workers to the fact that they are in a dangerous area, i.e., an area where the permissible exposure limit is exceeded; and (3) to emphasize the importance of the message to follow.

The phrase "respirator required" is used to inform the employees of the areas in which the permissible exposure limit is exceeded and the use of respiratory protection is mandated by the standard. Since exposure levels in the regulated area may be within the permissible exposure limit, a requirement separate from that of subsection (4) of this paragraph has been established.

It should be noted that the wording required for signs in this paragraph is slightly different from the wording suggested in the Criteria Document, Advisory Committee report, and proposed standard. The substance of the information, however, contained in the signs is basically the same.

The standard does not require that warning signs 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.

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 be subject to various legal 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 legend on the signs be kept visible to employees by illuminating and cleaning the signs when necessary. These two requirements are designed to ensure the effectiveness of the warning signs.

Statements which contradict or detract from the intended effect of the sign are clearly counterproductive to using signs to convey information. Similarly, if the legend on a sign cannot be read because of either darkness or an unclean condition, then there is no purpose in requiring signs to be posted. The use of precautionary labels on containers of protective clothing contaminated with coke oven emissions is required. Such a requirement was included in the proposal (Ex. 1a, p 32280). In light of the skin cancer hazard associated with coke oven emission. We are mindful that no evidence presently exists that laundry workers who handle contaminated clothing exhibit an excess of cancer. However, no evidence exists to the contrary, and in light of our experience which other carcinogens (e.g. asbestos) and the prophylactic nature of the Act, we have decided to include a requirement for precautionary labels for contaminated clothing. The word "cancer" is not required to appear on the label because in these circumstances, we believe it would be unduly alarming. On the other hand, * * * OSHA believes it is appropriate that individuals who are engaged in handling and laundering the contaminated clothing be apprised of the hazard and practices to be avoided when handling the clothing.

M. *Recordkeeping.* Section 8(c)(3) of the Act (29 U.S.C. 667) mandates the promulgation 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 monitor employee exposure to coke oven emissions.

The standard provides that this record must include information which is intended to identify the employee and to accurately reflect the employee's exposure. Specifically, it must include: (a) The names, social security numbers and job classifications of the employees monitored, (b) the date(s), number, duration and results of each of the samples taken, including a description of the representative sampling procedure used to determine employee exposure where applicable, (c) the type of respiratory protective devices worn by the employee, if any, (d) the environmental variables that could affect the measurement of employee exposure, and (e) a description of the sampling and analytical methods used, and evidence of their accuracy.

The standard requires that this record be maintained for at least 40 years, or for the duration of employment plus 20 years, whichever is longer. OSHA believes that this retention period is necessary and appropriate for the development of information regarding the causes and prevention of occupational illnesses related to exposure to coke oven emissions. To be useful for this purpose an exposure monitoring record must be retained long enough to allow health effects related to employee exposure to become manifest. Some of the health effects related to exposure to coke oven emissions, specifically the development of cancer, do not become manifest for at least 20 years (TR. 919–920). Therefore, a retention period which encompasses both the period of exposure and the period of latency has been selected. Since the latency period may exceed 20 years, a minimum retention period of 40 years has been established to cover employees who have experienced shorter periods of exposure, i.e. less than 20 years.

The requirement to make exposure monitoring records and the content thereof prescribed in the standard are consistent with the approaches followed in the proposal (Ex. 1a, p. 32280) and the Advisory Committee recommendations (Ex. 3, p. 65–68). There was also no significant disagreement by the participants. The retention period which is the same as in the proposal, does differ from the period (of at least 50 years or employment plus 20 years whichever is greater) suggested by the Advisory Committee (Ex. 3, p. 65). OSHA believes that a minimum period of 40 years will serve essentially the same purpose and be less burdensome to employers than the suggested 50 year minimum.

Industry participants objected to a 40-year minimum retention period. One argument is that the requirement is unduly burdensome and unreasonable, relying, in part, on section 8(d) of the Act, which states that any information obtained under the Act shall be obtained with a "minimum burden" on employers. (Ex. 5A, item 12; Ex. 7, item 5, 8, 13). OSHA regards the 40-year retention period as minimally burdensome since it is within the organizational framework and resources of the steel industry (Ex. 2015, p. 37–38, 70–71; Ex. 2–138: p. 226–238). The industry already has the facilities for dealing with the extensive recordkeeping required for its medical and personnel records (Ex. 2–85, p. 70–71); it is not unreasonable nor overly burdensome 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 responsible for recordkeeping beyond the latency period for cancer; therefore, a retention period for the term of employment plus 20-years is reasonable (Ex. 45; Ex. 5A, items 12, 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 (like exposure monitoring records) are both 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 employee'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 intended 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 surveillance program have been explained in that section. It is basically these requirements which dictate the content of the medical records.

The standard added to the content requirements of the proposal by requiring that either the employer or the designated physician keep the histories developed, results of the medical examinations, and procedures, guidelines or standards used to interpret the results. This was done to aid in the evaluation of an individual employee's health. Otherwise, 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 greater. Employers again felt that this requirement was too burdensome and unnecessary for the same 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 been 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 also 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.

Normal x-rays and slides need not be maintained for the full retention period. Only the x-rays for the most recent 5 years, and the slides and written description for the most recent 10 years, are required to be kept. Although the normal result is also useful in health evaluation (TR. 1216; 1197) it was felt to be too burdensome to employers to require them to keep all normal results. Based upon the evidence presented by medical witnesses, that retention of the initial x-ray and x-rays from the most recent 5 years would be sufficient for medical treatment (TR. 1216–7; 1903–4; 2462; 2528–9), and that 10 years of the most recent slides and descriptions would be necessary (TR. 1734–36;) and sufficient (TR. 1197) to assure confidence in the interpretation of results, OSHA has revised the standard accordingly.

The retention period in the standard generally follows the proposed standard and is shorter than the minimum 50 year period recommended by the Advisory Committee. The reason for this difference is the same as for the shortened minimum period for exposure monitoring records explained above.

The final standard requires that all records required to be maintained by the recordkeeping section be made available upon request to the Secretary and Director for examination and copying. The purpose of this section is to insure compliance with the recordkeeping regulations and to provide data necessary for development of information regarding the cause and prevention of occupational illness.

In requiring that all records be made available to the Secretary and Director, the final standard follows the proposed standard as well as the recommendation of the Advisory Committee report. No objections to this provision were received.

The final standard requires that employees or their designated 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 access to current exposure records to designated physicians of employees and former employees because the designated physicians are authorized to have access to employee or former employee medical records in which the exposure of the employee 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)(3) of the Act contemplates nothing more than mere access, thereby justifying examination of the records by the employee, but not justifying copying of the records. However, OSHA regards the right to inspect as commonly carrying with it the right to make copies, without which the right to inspect would be practically valueless.

This participant also argued that the access right is intended to be limited to the employee's exposure records. However, section 8(c)(3) of the Act explicitly provides "employees or their representatives with an opportunity to observe * * * monitoring or measuring * * * and to have access to the records thereof." Such monitoring or measuring is by section 8(c)(3), the required monitoring or measuring, and is not intended to be limited to the monitoring or measuring of the particular employee.

This participant's objection to access to required monitoring or measuring records to the designated representative of a former employee has been incorporated. The standard has eliminated access to required monitoring records to both the former employee and the former designated representatives on the ground that no purpose is served by permitting the former employee to have access to current required monitoring records.

The standard requires that former employees or their designated representatives be provided access to examine and copy required monitoring and measuring records indicating their own exposures. The purpose of this provision is to protect the former employee's health over his entire lifespan by permitting him access to records indicating his exposure to potentially carcinogenic substances. It should be noted that the former employee or his designated representative may not necessarily be restricted to records indicating only his own exposure. Because the final standard permits monitoring which is "representative" of an employee's exposure, not monitoring of each individual employee's exposure, the former employee can also have the right to access to all those measurements from which his exposure was determined to gain assurance that his exposure measurement was properly calculated.

In requiring that former employees or their designated representatives be provided access to examine and copy required monitoring and measuring records indicating their own exposures, the final standard does not follow the proposed standard. The proposal authorized access to required exposure measurements to former employees and their representatives, without distinguishing required exposure records from records indicating the employee's own exposures. The final standard makes separate provision for the former employee's access to records indicating only his own exposures 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 their 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 because section 8(c)(3) of the Act, while explicitly authorizing access by employees or former employees to records indicating their own exposure, does not explicity make provision for this access right by the designated representative of the former employee. It should be noted that section 8(c)(3) also does not explicitly provide for access to the designated representative of a current employee. Denying access to the records of individual exposure by designated representatives would result in a denial of access to the information by a former employee where he is incapacitated and unable to inspect the records or simply not able to understand them. Allowing access to these records to the designated representative of a former employee is consistent with the main purposes of the Act, mainly to 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 final standard requires that required employee medical records be made available upon request for examination and copying to a physician designated by the affected employee or former employee. The purpose of this provision is to protect 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 for examination and copying to a physician designated by their affected employee or former employee, the standard follows the proposed standard. The Advisory Committee report gave this access right to the employee's authorized representative. In restricting access to medical records to the employee's designated physician, the standard takes into account the special character and sensitivity of the components of a medical record. The criteria document, like the standard, authorized access by designated physicians to all medical records. The standard also authorizes access to medical records to the medical representative of the Secretary of Labor consistent with the criteria document.

The standard requires, with regard to the transfer of records, that in the event the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained under the recordkeeping section. The purpose of this section is to ensure that the records will be protected and preserved for the required retention period.

In requiring the successor employer to receive and retain all records required to be maintained, in the event the employer ceases to do business, the standard follows the proposed standard. The Advisory Committee report did not address this issue. No comments regarding this aspect of the transfer of records were received from industry participants.

The standard requires that in the event an employer ceases to do business and there is no successor to receive and retain the records for the prescribed period, the records are to be transmitted by registered mail to the Director. The purpose of this provision is to ensure that records are preserved for the requisite retention period.

In requiring the records to be transmitted by registered mail to the Director, where there is no successor employer, the final standard follows the proposed standard. The Advisory Committee report did not address the issue.

An industry participant, objecting to the requirement of transmittal by registered mail only, argued that an employer should have a right to select the best means of shipment, especially where the volume of records varies widely. But the purpose of requiring transmittal by registered mail only is to ensure that the records will be received.

To relax the requirements with regard to the means of shipment would lower the degree of accountability to which the employer is held and would increase the possibility that the records would not be handled with due care.

The proposed standard contained requirements for recordkeeping of mechanical ventilation measurements, and rosters. The substantive requirements to make these measurements and to keep a roster no longer exist, hence the requirements to keep the corresponding records have been deleted from the standard.

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)(3) 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 agents. In accordance with this section, the standard contains provisions for such observation. To ensure that this right is meaningful, observers would be entitled to an explanation of the measurement procedure, to observe all steps related to the measurement procedure, and to record the results obtained.

The observer, whether an employee or designated representative, must be provided with, and is required to use, any personal protective devices required to be worn by employees working in the area that is being monitored, and must comply with all other applicable safety and health procedures.

(O) *Effective date.* In order to ensure that affected employers and employees will be informed of the existence of the provisions of this standard, and that employers are given an opportunity to familiarize themselves and their employers are given an opportunity to familiarize themselves and their employees with the existence of the new requirements, pursuant to section 6(b)(4) of the Act, the effective date of this standard will be delayed ninety days until January 1977. Both the proposed standard (Ex. 1a, p. 32281) and the Advisory Committee Report (Ex. 3, p. 70) provided for a delayed effective date of thirty days from the date of promulgation, although they did include start-up dates which, in effect, extended the effective date beyond the thirty day period for various portions of the regulation. However, OSHA has decided that, in view of the highly technical nature of the standard, and for the reasons stated above, a ninety day delay of the effective date is appropriate.

(P) *Appendices.* The two appendices included with the regulation are not intended to create any additional obligations not otherwise imposed or to detract from any existing obligation.

Accordingly, pursuant to sections 6(b) and 8(c) of the Occupational Safety and Health Act of 1970 (84 Stat. 1593, 1599, 29 U.S.C. 655, 657), Secretary of Labor's Order No. 8-76 (41 FR 25059), and 29 CFR Part 1911, Part 1910 of Title 29, Code of Federal Regulations is hereby amended by adding a new § 1910.1029 as set forth below.

Signed at Washington, D.C., this 19th day of October 1976.

MORTON CORN,
Assistant Secretary of Labor.

Section 1910.1029 is added to Title 29, Part 1910 as set forth below:

§ 1910.1029 Coke oven emissions.

(a) *Scope and application.* This section applies to the control of employee exposure to coke oven emissions, except that this section shall not apply to working conditions with regard to which other 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 whose duties require the person to enter a regulated area, or any person entering such an area as a designated representative of employees for the purpose of exercising the opportunity to observe monitoring and measuring procedures under paragraph (n) of this section.

"Beehive 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" 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 or her 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 coal 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 coal 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, all hoppers are discharging simultaneously.

"Pipeline charging" means any apparatus used to introduce coal 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.

(c) *Permissible exposure limit.* The employer shall assure that no employee is exposed to coke oven emissions at concentrations greated than 150 micrograms per cubic meter of air (150 $\mu g/m^3$), averaged over any 8-hour period.

(d) *Regulated areas.* (1) 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 topside and its machinery, pushside and its machinery, coke side and its machinery, and the battery ends; 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 (for 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*) Tar chaser;

(*c*) Larry car operator;

(*d*) Luterman;

(*e*) Machine operator, coke side;

(*f*) Benchman, coke side;

(*g*) Benchman, pusher side;

(*h*) Heater;

(*i*) Quenching car operator;

(*j*) Pusher machine operator;

(*k*) Screening station operator;

(*l*) Wharfman;

(*m*) Oven patcher;

(*n*) Oven repairman;

(*o*) Spellman; 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) of this section for those employees affected by such change or increase.

(3) *Employee notification.* (i) 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 measurements 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 measurement.* 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 $\mu g/m^3$.

(f) *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:

(1) *Priority of compliance methods*—(i) *Existing coke oven batteries.* (*a*) The employer shall institute the engineering and work practice controls listed in paragraphs (f)(2), (f)(3) and (f)(4) of this section in existing coke oven batteries at the earliest possible time, but not ater than January 20, 1980, except to the extent that the employer can establish that such controls are not feasible. In determining the earliest possible time for institution of engineering and work practice controls, the requirement, effective August 27, 1971, to implement feasible administrative or engineering controls to reduce exposures to coal tar pitch volatiles, shall be considered. 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.

(*b*) The engineering and work practice controls required under paragraphs (f)(2), (f)(3) and (f)(4) of this section are minimum requirements generally applicable to all existing coke oven batteries. If, after implementing all controls required by paragraphs (f)(2), (f)(3) and (f)(4) 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, whenever 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.

(ii) *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.

(iii) *Beehive ovens.* The employer shall institute engineering and work practice controls on all beehive ovens at the earliest possible time 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. In determining the earliest possible time for institution of engineering and work practice controls, the requirement, effective August 27, 1971, to implement feasible administrative or engineering controls to reduce exposures to coal tar pitch volatiles, shall be considered. 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.

(2) *Engineering controls.* (i) *Charging.* 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*) One of the following methods of charging:

(*1*) Stage charging as described in paragraph (f)(3)(i)(*b*) of this section; or,

(*2*) Sequential charging as described in paragraph (f)(3)(i)(*b*) of this section except that paragraph (f)(3)(i)(*b*)(*3*)(*iv*) of this section does not apply to sequential charging; or

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

(*b*) 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;

(*c*) Aspiration systems designed and operated to provide sufficient negative pressure and flow volume to effectively move the gases evolved during charging into the collector mains, including sufficient steam pressure, and steam jets of sufficient diameter;

(*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 wi ll 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;

(*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 leveler 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 coking operations:

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

(*b*) Ready access to door repair facilities capable of 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.

(3) *Work practice controls.* (i) *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:

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

(*2*) Inspection and cleaning of goosenecks and standpipes prior to each charge to a specified minimum diameter sufficient to effectively move the evolved gases from the oven to the collector mains;

(*3*) Inspection for roof carbon build-up prior to each charge and removal of roof carbon as necessary to provide an adequate gas channel so that the gases are effectively moved from the oven into the collector mains;

(*4*) Inspection of the steam aspiration system prior to each charge so that sufficient pressure and volume is maintained to effectively move the gases from the oven to the collector mains;

(*5*) Inspection of steam nozzles and liquor sprays prior to each charge and cleaning as necessary so that the steam nozzles and liquor sprays are clean;

(*6*) Inspection of standpipe caps prior to each charge and cleaning and luting or both as necessary so that the gases are effectively moved from the oven to the collector mains; and

(*7*) Inspection of charging holes and lids for cracks, warpage and other defects prior to each charge and removal of carbon to prevent emissions, and application of luting material to standpipe and charging hole lids where necessary to obtain a proper seal.

(*b*) Establishment and implementation of a detailed written charging procedure, designed and operated to eliminate emissions during charging for each battery, consisting of at least the following elements:

(*1*) Larry car hoppers filled with coal to a predetermined level in accordance with the mechanical volumetric controls required under paragraph (f)(2)(i)(*d*) of this section so as to maintain a sufficient gas passage in the oven to be charged;

(*2*) The larry car aligned over the oven to be charged, so that the drop sleeves fit tightly over the charging holes; and

(*3*) The oven charged in accordance with the following sequence of requirements:

(*i*) The aspiration system turned on;

(*ii*) Coal charged through the outermost hoppers, either individually or together, depending on the capacity of the aspiration system to collect the gases involved;

(*iii*) The charging holes used under paragraph (f)(3)(i)(*b*)(*3*)(*ii*) of this section relidded or otherwise sealed off to prevent leakage of coke oven emissions;

(*iv*) If four hoppers are used, the third hopper discharged and relidded or otherwise sealed off to prevent leakage of coke oven emissions;

(*v*) The final hopper discharged until the gas channel at the top of the oven is blocked and then the chuck door opened and the coal leveled;

(*vi*) When the coal from the final hopper is discharged and the leveling operation complete, the charging hole relidded or otherwise sealed off to prevent leakage of coke oven emissions; and

(*vii*) The aspiration system turned off only after the charging holes have been closed.

(*c*) 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 jambs so as to provide a continuous metal-to-metal fit;

(*c*) Cleaning of oven doors, chuck doors and door jambs 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 quenched 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 ovens 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;

(*4*) Inspection, adjustment and correction of heating flue temperatures and defective flues 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 goosenecks, standpipes, standpipe caps, charging hole lids and castings, jumper pipes and air seals for cracks, misalignment or other defects and prompt implementation of the necessary repairs as soon as possible;

(*b*) Maintaining 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, chuck doors, door jambs and seals; and

(*i*) Repairs instituted and completed as soon as possible, including temporary repair measures instituted and completed where necessary, including 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.* (i) The employer shall provide positive-pressure, temperature controlled filtered air for larry car, pusher machine, door machine, and quench car cabs.

(ii) The employer shall provide standby pulpits 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 initiate 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 (f)(2) through (f)(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 employees 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 (j) of this section.

(i) 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 (j)(1)(ii) of this section; and

(*d*) Any employee medical complaints related to exposure to coke oven emissions.

(ii) 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 (j)(2) 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 demonstrated atypia, if such atypia persists 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) 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 make available upon request employee medical records required to be maintained by paragraph (m)(2) of this section to a physician designated by the affected employee or former employee.

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

(ii) Whenever the employer ceases to do business and there is no successor employer to receive and retain the records for the prescribed period, these records shall be transmitted by registered mail to the Director.

(iii) 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 or shall continue to retain such records.

(n) *Observation of monitoring*—(1) *Employee observation*. The employer shall provide affected employees or their representatives an opportunity to observe any measuring or 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 all other 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.

(o) *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 topside and its machinery, pushside and its machinery, and the screening station; and the wharf the beehive ovens and machinery.

II. HEALTH HAZARD DATA

Exposure to coke oven emissions is a cause of lung cancer, and possibly kidney cancer, in humans. Although it does not have a ex- cess 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 or 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 coking process. This clothing should include such items as jacket and pants and flame resistant gloves. Protective equipment should include face shield or vented 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 wash your face, and hands before eating. You must shower at the end of the work shift. Do not take used protective clothing out of the change rooms without your employer's permission. Your employer is required to provide for laundering or cleaning of your protective clothing.

V. SIGNS AND LABELS

Your employer is required to post warning signs and labels for your protection. Signs must be posted in regulated areas. The 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 limit, the signs should also 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 employment in the regulated areas when 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 B INDUSTRIAL HYGIENE AND MEDICAL SURVEILLANCE GUIDELINES

I. INDUSTRIAL HYGIENE 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 encased in three-piece plastic (polystyrene) field monitor cassettes. The cassette face cap should be on and the plug removed. The rotameter should be checked every 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 classification, sampling should be repeated. It is advisable to sample each shift on 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 dionized water, acetone, and allowed to dry completely. The glassware is rinsed with nanograde benzene before use. The Teflon cups are cleaned with benzene then with aceto e.

2. Pre-weigh 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 funnels.

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

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 (j) 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 14" X 17" posterior-anterior chest x-ray and a ILO/UC rating to assure some standardization of x-ray reading, pulmonary function tests (FVC and FEV 1.0), weight, urinalysis, skin examination and a sputum and urinary cytologic examination. These tests are to serve as the baseline for comparing the employee's future test results. Periodic exams include all the elements of the initial exams except that the cytologic tests are to be performed only on those employees who are 45 years of age or older or who have worked for 5 or more years in the regulated area; periodic exams are to be performed semiannually 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 deemed necessary.

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 used (manufacturer, model, etc.) should be recorded with the results as reliability and accuracy varies and such information may be important in 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 per cent (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 six months on workers who are 45 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 cytologys 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.

(Secs. 6, 8, 84 Stat. 1593, 1599 (29 U.S.C. 655, 657); Secretary of Labor's Order 8-76 (41 FR 25059); 29 CFR Part 1911.)

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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)–(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 permissable exposure limit 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) Notwithstanding any other requirement of this section, until January 20, 1978, the wearing of respirators shall be at the discretion of each employee where the employee is not in the vicinity of visible emissions.

(2) *Selection.* (i) Where respirators are required under this section, the employer shall select, provide and assure the use of the appropriate respirator or combination of respirators from Table I below.

TABLE I

RESPIRATORY PROTECTION FOR COKE OVEN EMISSIONS

Airborne concentration of coke oven emissions	*Required respirator*
(*a*) Any concentration.	(*1*) A Type C supplied air respirator operated in pressure demand or other positive pressure or continuous flow mode; or
	(*2*) A powered air-purifying particulate filter respirator for dust, mist, and fume; or
	(*3*) A powered air-purifying particulate filter respirator or combination chemical cartridge and particulate filter respirator for coke oven emissions.
(*b*) Concentrations not greater than 1500 μg/m³.	(*1*) Any particulate filter respirator for dust, mist and fume, except single-use respirator; or
	(*2*) Any particulate filter respirator or combination chemical cartridge and particulate filter respirator for coke oven emissions; or
	(*3*) Any respirator listed in paragraph (g)(2)(i)(*a*) of this section.

(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)(i)(*b*) of this section, or a powered air purifying respirator as provided in paragraph (g)(2)(i)(*a*) 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 by NIOSH 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)(2) 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 (i)(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 changeroom.

(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.

(ii) The employer shall provide shower facilities in accordance with § 1910.141 (d)(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.* (i) The employer shall assure that employees working in the regulated area wash their hands and face prior to eating.

(ii) 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.* (i) 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 (i)(1)-(i)(3) of this section.

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

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

(ii) This program shall provide each employee covered under paragraph (j) (1)(i) of this section with an opportunity for medical examinations in accordance with this paragraph (j).

(iii) 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.

(iv) 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 a 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"x17" 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 (FEV 1.0) 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.

(3) *Periodic examinations.* (i) The employer shall provide the examinations specified in paragraphs (j)(2)(i)-(vi) of this section at least annually for employees covered under paragraph (j)(1) (i) of this section.

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

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

(iv) Whenever an employee has not taken the examinations specified in paragraphs (j)(3)(i)-(iii) of this section within the six (6) months preceding the termination of employment, the employer shall provide such examinations to the employee upon termination of employment.

(4) *Information provided to the physician.* The employer shall provide the following information to the examining physician:

(i) A copy of this regulation and its Appendixes;

(ii) A description of the affected employee's duties as they relate to the employee's exposure;

(iii) The employee's exposure level or anticipated exposure level;

(iv) A description of any personal protective equipment used or to be used; and

(v) Information from previous medical examinations of the affected employee which is not readily available to the examining physician.

(5) *Physician's written opinion.* (i) The employer shall obtain a written opinion from the examining physician which shall include:

(*a*) The results of the medical examinations;

(*b*) 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 the employee's health from exposure to coke oven emissions;

(*c*) Any recommended limitations upon the employee's exposure to coke oven emissions or upon the use of protective clothing or equipment such as respirators; and

(*d*) A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions which require further explanation or treatment.

(ii) The employer shall instruct the physician not to reveal in the written opinion specific findings or diagnoses unrelated to occupational exposure.

(iii) The employer shall provide a copy of the written opinion to the affected employee.

(k) *Employee information and training*—(1) *Training program.* (i) The employer shall institute a training program for employees who are employed in the regulated area and shall assure their participation.

(ii) The training program shall be provided as of January 20, 1977 for employees who are employed in the regulated area at that time or at the time of initial assignment to a regulated area.

(iii) The training program shall be provided at least annually for all employees who are employed in the regulated area, except that training regarding the occupational safety and health hazards associated with 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.

(iv) 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 for 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;

(*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.* (i) The employer shall make a copy of this standard and its appendixes readily available to all employees who are employed in the regulated area.

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

(l) *Precautionary signs and labels*—(1) *General.* (i) 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.

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

(iii) 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.* (i) The employer shall post signs in the regulated area bearing the legends:

DANGER

CANCER HAZARD

AUTHORIZED PERSONNEL ONLY

NO SMOKING OR EATING

(ii) 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: