

A REPORT PREPARED BY
THE AMERICAN IRON AND STEEL INSTITUTE
UNDER CONTRACT NO.: HSM-99-72-137
WITH THE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
TO PROVIDE INFORMATION AND DATA FOR USE IN PREPARATION
OF A CRITERIA DOCUMENT FOR COKE PRODUCING OPERATIONS

American Iron and Steel Institute
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I. INTRODUCTION

This report is submitted in fulfillment of HSM-99-72-137 awarded to the American Iron and Steel Institute on June 30, 1972, by the National Institute for Occupational Safety and Health (NIOSH). The duration of this contract was for the period July 1, 1972 - October 31, 1972.

PURPOSE

The purpose of this report is to provide NIOSH with information and data which may be used in the development of a Criteria Document for Coke Producing Operations. Specifically, this report is confined to the work practices section of the Criteria Document and is intended to present information in order to reduce exposures to coke oven emissions from coke producing operations. "Work practices," as used in this report, refer to the operating techniques and procedures in performing the tasks essential for the production of coke. The term is not to be related in any way to the practices developed through custom which may qualify as "protected practices."

SCOPE OF WORK

The contractor has undertaken through the use of job descriptions and extensive in-plant studies conducted by AISI member companies, as well as studies by governmental agencies, the following in the scope of its work:

- A. Evaluate each job involved on the basis of what the job entails, the time spent in carrying out each of the associated duties, characteristics of the job contributing to the exposure, and potential time that might be spent in an area with little or no exposure.

- B. Evaluate the feasibility of the use of respiratory protective devices which include the visual and mobility demands of the job and the relationship of filter resistance to respiratory demands.
- C. Evaluate feasibility of the construction of filtered-air and conditioned air booths to be conveniently accessible to the workman during those times when he is not occupied with his duties but otherwise would be excessively exposed.
- D. Evaluate the feasibility of administrative controls, such as rotation of workmen and work schedules.
- E. On the basis of the above, prepare recommendations to alter present work practices to reduce the exposure to coke oven emissions.

NATURE OF THE AIR CONTAMINANT

It is the opinion of the contractor that the term, "coal tar pitch volatiles," is being, and has been, improperly applied to the benzene soluble portion of the total collected airborne particulates from coke oven emissions. This has already created in the minds of the interested groups an assumption which is invalid from a scientific viewpoint.

A "coal tar pitch volatiles" standard is only applicable to those operations where tar is solely in use or the air sampling and chemical analytical method is specific for coal tar. Neither criteria is met when it is arbitrarily applied to coke oven emissions. Airborne particulates occurring topside on coke batteries consist mostly of coal and coke particulates with a small quantity of polycyclic aromatic hydrocarbons. The

extraction of coal and coke particulates with benzene will yield an appreciable soluble fraction. For example, one member company collected a series of eight full shift respirable dust samples in a coal mine. These samples yielded a concentration of benzene solubles averaging 0.22 mg/M³. Marting⁽¹⁾ reported on the emissions from coke ovens during the charging of an 18-ton oven with coal at 8-10% moisture involving a three-minute charging interval "off the main." This "off the main" charging indicates that no steam aspiration was applied to the main to collect the bulk of the emissions from charging. This is in contrast to the "on the main" practice used in most coke ovens in the United States. The emissions were as follows: particulate matter - 2.2 lbs./charge; water vapor - 15.4 lbs./charge; and tar vapor - 0.66 lbs./charge. If the water vapor is eliminated from consideration, since it would be evaporated off in drying the filter used in air sampling, the coal tar would comprise only 23% of the total particulates. Masek⁽²⁾ states that benzene extraction generally yields not only the polycyclic compounds but equally the soluble fractions present in the whirled-up coal dust. He concludes that the pollution values established for the atmospheres of black-coal coke oven plants are not always a reliable measure of the potential danger. Finally, of even greater significance are the results of research initiated by the American Iron and Steel Institute in 1968 and conducted by Esso Research.⁽³⁾ This work demonstrated that the polycyclic aromatic hydrocarbons constituted only

(1) Marting, D.C., Coke Plant Air Pollution Problems, Presented at American Institute of Metallurgical Engineers, Atlantic City, April, 1968.

(2) Masek, V., The Use of Silver Membrane Filters in Sampling for Coal Tar Pitch Volatiles in Coke Oven Plants, American Industrial Hygiene Journal, September-October, 1970.

(3) Kay, M. I., and Elliot, J.J., A Study of the Composition of Coke Oven Volatiles, March, 1968.

2.1-3.1% of the total collected particulates. This analytical work was done on samples collected from the front platform of a larry car.

In view of the above information, it should be clear that the present practice of applying a "coal tar pitch volatiles" standard to coke oven emissions is invalid unless the air sampling and analytical procedures are specific for this most complex group of compounds. This practice was arbitrarily set by the Pennsylvania Health Department, who stated that its action was based upon a study made of the carbon electrode industry in Pennsylvania. This study has not been published so that it could be subject to scientific scrutiny. Any information documenting a health standard must be subject to scientific evaluation.

II. COKE MAKING

Coke is the residue from the destructive distillation of coal. (4)
It is a cellular porous substance which is heterogeneous in both physical and chemical properties. These properties will vary depending on the type of coals used and the method of operation of the coking facilities which also exerts a profound influence on the quality and yield of coke.

There are two basic types of coke. The first type is used as a reducing agent and source of energy for the smelting of oxides of iron to produce metallic iron (pig iron). The process occurs in the blast furnace and the coke used is designated as blast furnace coke. The smelting of iron ores accounts for use of more than 90% of the coke produced in the United States. The second type is used as a source of energy to melt pig iron for use in the foundry industry. Coke used in this category is generally classified as merchant coke.

THE COKE INDUSTRY

The coke industry in the United States, as of December 31, 1971, according to the latest reports from the Bureau of Mines - U.S. Department of the Interior (5) was composed of 62 coke oven plants and 6 bee-hive coke plants. Of the 62 coke oven plants, 48 can be classified as blast furnace coke plants, and 14 as merchant coke plants. The plants are located in 18 states with major concentrations in Alabama, Indiana, Ohio, and Pennsylvania. This is because most of the blast furnace coke plants are located near to basic steel making facilities.

(4) Chapter 4 - The Making, Shaping and Treating of Steel, Ninth Edition, 1971. United States Steel Corporation.

(5) Coke Producers in the United States - Coke Producers Annual August 23, 1972, U.S. Department of Interior - Bureau of Mines.

COKE PRODUCTION AND CONSUMPTION

Total production and use of coke in the United States and the major uses of coke for the calendar year 1970 are shown in Table II-1 below. (6)
(The figures for 1971 are not considered representative of industry performance in recent years.)

Table II-1

COKE PRODUCTION AND USE IN THE UNITED STATES

Calendar Year - 1970

	<u>1000 Ton Units</u>
<u>Coke Production</u>	
Blast Furnace Plants	59,739
Merchant Plants	5,915
Bee-Hive Plants	<u>871</u>
Total Production	66,525
 <u>Coke Consumption</u>	
To Blast Furnaces	61,184
To Foundries	3,269
To Other Industrial Uses	<u>2,289</u>
	66,742

(6) Mineral Industry Surveys - Bureau of Mines - February 17, 1972.

The coke used in blast furnaces fostered production of 91,848,000 tons of metallic iron (pig iron). This was the basic material for the production of 131,514,000 tons of raw steel in the United States in 1970. The coke plants in the United States range in size from a one battery unit having fewer than 50 coking chambers to a plant having 20 batteries with 1,375 coking chambers. Annual coke production will range from less than 200,000 tons per year for the smaller plants to well over 7,000,000 tons per year for the largest plant. The age of the coke oven batteries ranges from those just put into operation to more than 50 years. Table II-2 shows the age distribution of coke ovens in the United States.

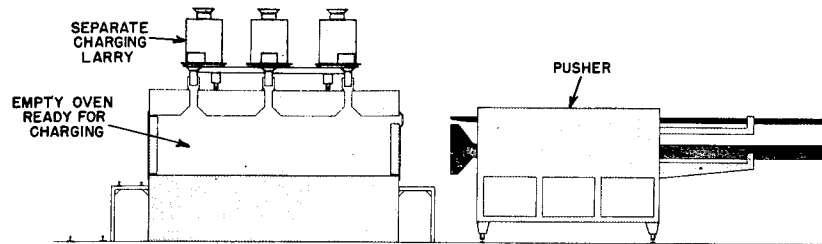
COKE MAKING PROCESS

The by product coke making process, being a true distillation process uses a retort oven. Coal is "charged" into the oven chamber, which is then sealed to exclude air and heat is applied from external sources. The temperature of the coal is raised over a period of 14 to upwards of 36 hours, depending on the type and nature of the coke to be made, to temperatures in excess of 1900°F. This causes the destructive distillation of the coal in which the volatiles are driven off and collected in the by product recovery system, leaving a mass of coke in the oven chamber.

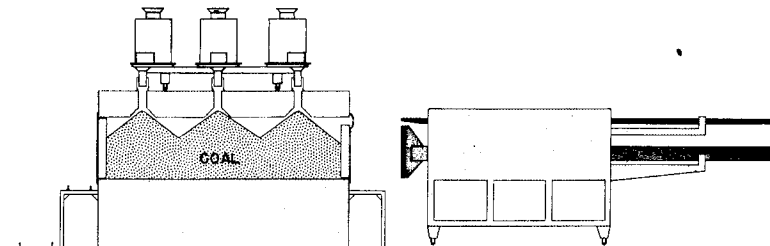
At the end of the coking cycle, the oven chamber is opened and the hot coke "pushed" from the oven, after which it is cooled or "quenched" with water. Figure II-1 shows the basic steps involved in charging and pushing a by product coke oven.

By product coke ovens consist essentially of three main parts; namely, the coking chambers, the heating chambers, and the regenerative chambers - all constructed of high quality refractory brick. The coking

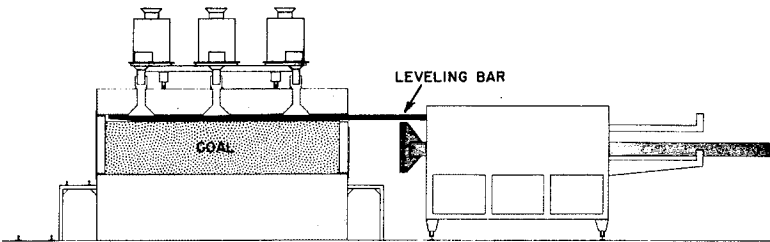
CHARGING, LEVELING AND PUSHING OPERATIONS IN ONE COKING CYCLE OF A BY-PRODUCT COKE OVEN



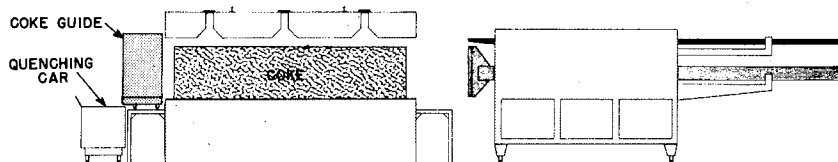
A. THE CHARGING LARRY, WITH HOPPERS CONTAINING MEASURED AMOUNTS OF COAL, IS IN POSITION OVER CHARGING HOLES FROM WHICH COVERS HAVE BEEN REMOVED. THE PUSHER HAS BEEN MOVED INTO POSITION.



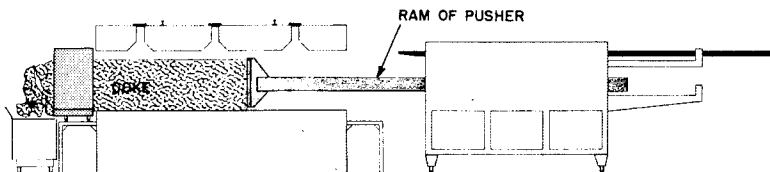
B. THE COAL FROM THE LARRY HOPPERS HAS DROPPED INTO THE OVEN CHAMBER, FORMING PEAKED PILES.



C. THE LEVELING DOOR AT THE TOP OF THE OVEN DOOR ON THE PUSHER SIDE HAS BEEN OPENED, AND THE LEVELING BAR ON THE PUSHER HAS BEEN MOVED BACK AND FORTH ACROSS THE PEAKED COAL PILES TO LEVEL THEM. THE BAR NEXT IS WITHDRAWN FROM THE OVEN, THE LEVELING DOOR AND CHARGING HOLES ARE CLOSED, AND THE COKING OPERATION BEGINS.



D. COKING OF THE COAL ORIGINALLY CHARGED INTO THE OVEN HAS BEEN COMPLETED (IN ABOUT 18 HOURS) AND THE OVEN IS READY TO BE "PUSHED." THE OVEN DOORS ARE REMOVED FROM EACH END, AND THE PUSHER, COKE GUIDE AND QUENCHING CAR ARE MOVED INTO POSITION.



E. THE RAM OF THE PUSHER ADVANCES TO PUSH THE INCANDESCENT COKE OUT OF THE OVEN, THROUGH THE COKE GUIDE AND INTO THE QUENCHING CAR.

Schematic representation of the sequence of operations involved in charging, leveling and pushing in one coking cycle of a by-product coke oven.

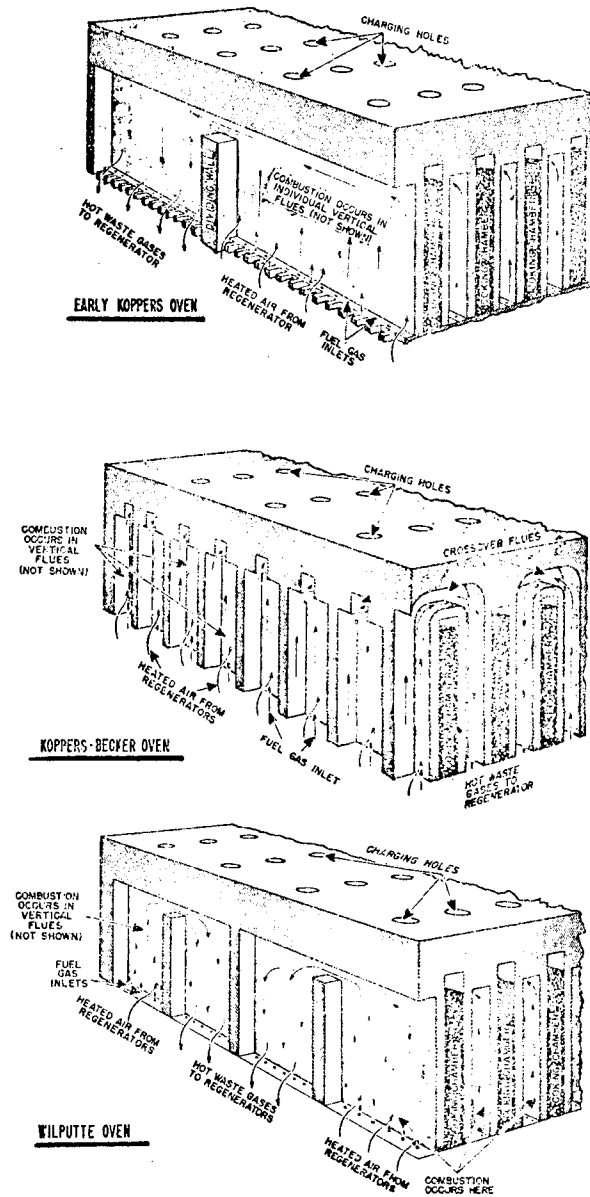
FIGURE II-1

chambers are rectangular in section, varying from 30 to 50 feet in length, from 10 to 20 feet in height, and 12 to 20 inches in width. From 10 to 100 ovens constitute a battery of ovens, in which coking chambers alternate with heating chambers so that, in effect, there is a heating chamber on each side of each coking chamber. The regenerative chambers are underneath the heating and coking chambers. Figure II-2 shows the general arrangement of the heating systems employed in the three most common types of by product ovens used in the United States.

The ends of the coking chambers are equipped with refractory lined doors which are removed to permit "pushing" of the coke at the end of the cycle. The doors on the early batteries were sealed by filling the opening between the door and the jamb with "luting" mud. This is an onerous task and all batteries constructed in recent years are equipped with so-called "self sealing" type doors, which are held tightly against the jamb by means of heavy springs or a screw type latch.

The coke oven, as previously mentioned, is constructed of very special high quality refractories, involving many different and complicated shapes. Initial heating of a new battery can require as long as three months, and once the refractory mass is in the operating range (above 1600°F), it is general industry practice, in order to protect the refractory, to maintain the oven in a hot condition throughout its useful life. Occasionally, when a battery undergoes major rehabilitation of the brickwork, it will be cooled and reheated.

Accessories and auxiliary equipment which are basic to the operation of a by product coke oven are described in the following sections.



Schematic representation of the differences in firing methods employed in the three most common types of by-product coke ovens used in the United States. Individual flues are not shown. The firing procedures shown are for a single phase of heating which is reversed at the end of a specified period, at which time the flow directions indicated by the arrows become reversed.

FIGURE II-2

(a) Gas Collection System

The coke oven is equipped with one or two offtakes to carry off the volatile products liberated in the coking process. Where one offtake is provided, it is through the roof of the oven at one end of the oven, and where two are provided, there is one at each end of the oven. The volatile products pass through the duct or ducts in the oven top and enter a refractory-lined standpipe (sometimes referred to as an "ascension pipe"). This in turn is connected to a collecting main through a damper-valve which is used to isolate the oven from the collection main during the pushing cycle.

(b) Coal Storage Bins and Charging Larry Cars

All modern by product coke ovens are designed to take a definite volume of coal per charge and are charged from a larry car operating between the overhead coal-storage bins and the ovens on a track supported by the battery top. The desired amount of coal for an oven charge is drawn from the storage bin into the larry car hoppers. The gravity-discharge larry and the mechanically-unloaded larry are the two main types in use at the present time. The coal is charged into the oven from the larry car hoppers through charging holes provided in the roof of the oven. The oven chamber and the heating system are designed for a coal charge of definite volume, having a level top surface a definite distance below the oven roof, usually one foot. The number of charging holes and the physical characteristics of the coal have a definite bearing on the time required for charging the oven with coals. To prevent escape of gases from the oven during charging, it has now become standard practice at most

plants to "charge the oven on the main." Charging on the main is accomplished by steam-jet aspiration, which puts the oven chamber under suction during the charging and leveling operation.

(c) Pusher Side Equipment

The pusher-side equipment is generally similar on all types of ovens. The pusher may be a combination of three machines, a leveler, a door extractor, and a pusher so designed that it operates on a track parallel to but independent of, the battery. In many plants, the door-handling equipment is a separate, self-propelled machine, operating on its own tracks. The function of the door extracting element of this machine is to remove and hold the pusher-side door during the pushing operation. It is operated from the elevated cab which contains all the machine controls. The function of the leveling element is to level the coal charge in the oven, leaving a free-gas space below the roof of the charged oven. This is done by a leveling-bar carried by the pusher-machine structure in such a position that it may be introduced through a suitable opening in the top of the pusher-side door. When this bar is moved in and out of the oven, the scraper plates level the humps of coal into the valleys

The function of the pushing element is to push the coke cake from the oven. This is done by an electrically-powered ram, equipped with a suitable head that, when spotted immediately in front of the oven to be pushed, may be moved forward until all the coke has been pushed from the oven and through the coke guide into the quenching car spotted on the opposite side of the oven.

Where self-sealing doors are not used, it is necessary to provide equipment for the preparation of luting mud and for conveying the luting mud to the doors to be luted. The mud is usually prepared in the conventional-type wet put mill from returned luting mud, coke breeze cleaned from the oven benches, and certain amounts of wet clay.

The pusher side of the battery is equipped with a bench serving as a walkway along the entire length of the battery and as a working platform for men serving the pusher-side doors and jambs.

(d) Coke-Side Equipment

The coke side of the battery is equipped with a door-extracting machine, coke guide, and, when using luted doors, a luting buggy. The coke-side equipment operates on a track integral with the coke-side bench.

The function of the door machine is to remove and hold the coke-side door during the pushing of an oven and to place an attached coke guide in the proper position to conduct the coke across the bench into a quenching car operating on a ground level track which is parallel with the battery.

The design and operation of the door extractor is generally similar to the door extractor of the pusher machine.

The coke guide is equipped with a movable lattice framework that is power operated from the door machine. When spotted at the oven to be pushed, this movable framework prevents coke spillage at this point during pushing.

III. COKE MAKING MASTER JOB DESCRIPTIONS AND CLASSIFICATIONS

Many of the jobs at a coke oven facility are formally described and classified in the Job Description and Classification Manual, dated January 1, 1963, agreed to by the United Steelworkers of America - AFL-CIO (U.S.W.) and the Coordinating Committee Steel Companies.

Eight job descriptions in which the work described is generally common to the Industry and are representative of the tasks required to operate a coke battery have been selected.

Although a degree of uniformity exists within the Coordinating Steel Companies due to a history of coordinated bargaining with the U.S.W., detailed job descriptions for each plant will vary because bargaining relationships and agreements may vary widely from company to company within the Industry and from plant to plant within a company. In addition to the subjects covered on a coordinated basis, each company has entered into agreements on matters of a local nature, many of which are peculiar to a particular location. Also many companies have acquired plants and have inherited agreements in existence at those plants, and there are locations that have agreements with unions other than the U.S.W.

The following list identifies the jobs selected and their "Primary Function." Included in the Appendix of this Report are the Job Descriptions and the Master Job Classifications for each of the jobs listed.

<u>Job</u>	<u>Primary Function</u>
Job No. 6 - Heater:	"Observes and regulates gas reversals and checks temperatures on one or more by-product coke oven batteries to produce coke from coal."
Job No. 8 - Larryman:	"Operates larry car in charging coal into coke ovens."
Job No. 9 - Lidman:	"To pull lids and otherwise assist in the preparation of the ovens for pushing and charging."
Job No. 10 - Pusher Operator:	"Operates pusher machine to push coke from ovens, to level coal charge, and to remove and replace oven doors on the pusher side."
Job No. 11 - Door Machine Operator:	"Operates door machine in removing and replacing doors on coke side of ovens."
Job No. 12 - Door Cleaner:	"Cleans doors and jambs on coke ovens."
Job No. 13 - Quencher Car Operator:	"Operates quench car to transport coke to quencher and coke wharf."
Job No. 15 - Oven Patcher:	"Patches coke ovens and auxiliary equipment with refractory slurries."

IV. DATA ANALYSIS

EXPOSURE DATA

Questionnaires were sent to all AISI member companies having coke plants requesting exposure data on coke oven emissions relative to workers on and around the coke ovens. Environmental data requested were personal air samples (respirable and total dust) for the coke oven jobs outlined in Section III. Standard industrial hygiene sampling procedures using battery-operated sampling pumps and membrane filter media were used, as well as a benzene extraction - gravimetric analysis, for all data reported by AISI companies. The samples represent 8-hour time-weighted average exposures.

Exposure data were returned from 74% of the companies that received questionnaires and were obtained during the period 1968-1972. The data represent a wide range of coke oven operations which involved many variables, including both new and old batteries, different operating practices, and a wide range of meteorological conditions under which the samples were obtained.

The data are tabulated in Table IV-1 according to the list of jobs described in Section III as being common to all or nearly all coke ovens. The number of samples obtained at each job are as shown. The concentrations of coke oven emissions reported in milligrams per cubic meter represent the maximum and minimum average of the plant averages submitted. The mean shown is the overall average of the individual plant averages. A total of 802 total and 257 respirable particulate samples are included in the AISI data; 198 respirable particulate samples are included in the NIOSH data; and 210 total particulate samples are included in the Pennsylvania data. Such average data are not representative of conditions at any one coke plant.

Coke oven data obtained in studies conducted by NIOSH in cooperation with AISI and five member coke plant operating companies have been

summarized and included under corresponding work positions for comparison. These data are from Summary Data Reports I and II prepared by NIOSH. Some of the data in Report II have been open to question and are being reevaluated by NIOSH.

It was found that some NIOSH analyses for respirable coke oven emissions were reported to be greater than the corresponding total samples from which the respirable fraction was obtained, but all were included to determine the ranges and averages shown in the table. It should be understood that any comparisons made or conclusions drawn must be conditional, depending on the results of the reevaluation.

Unpublished data from studies made by the Pennsylvania Department of Environmental Resources are also included. The studies were made in 1968-1969.

Average exposures to respirable dust calculated from the NIOSH data indicate about the same average exposure for the larry car operator as the average calculated from the AISI data, but only one-half the exposure calculated for the quench car operator. All other average exposures show NIOSH results about 1.8 to 2.6 times greater than the AISI results (lidman, door cleaner, door machine operator, pusher machine operator). All comparisons between NIOSH and AISI data are for respirable dust (benzene soluble fraction).

In all but one case, the Pennsylvania calculations of average concentrations, based on total air samples, were 1.2 to 2.1 times greater than the AISI results. As noted earlier, these data were obtained in 1968-1969 and are not representative of present conditions.

The larryman and lidman jobs, as is generally known, and according to the data, are exposed to higher concentrations of coke oven emissions.

Workers located on the bench and away from the top of the battery are seen to have average exposures one-half or less than those of top side workers.

Table IV-1

A SUMMARY OF EXPOSURES OF COKE OVEN WORKERS
TO COKE OVEN EMISSIONS (BENZENE SOLUBLE FRACTION)

A Summary of Separate Air Sampling Studies by AISI Member
Companies, NIOSH, and Pennsylvania Department of Environmental Resources

Operator (Source of info.)	No. of Samples		Range** (mg/m ³)		Average***	
	T*	R*	T	R	T	R
<u>Larry car operator</u>						
AISI	106	47	0.78-6.4	0.59-4.8	2.2	2.9
NIOSH	-	33	-	0.1-13.2	-	2.8
PA	39	-	0.28-8.8	-	3.1	-
<u>Lidman</u>						
AISI	140	52	1.0-5.6	0.70-4.1	2.6	2.0
NIOSH	-	46	-	0.3-8.0	-	3.6
PA	61	-	0.42-18	-	3.2	-
<u>Door Machine Operator</u>						
AISI	85	30	0.13-5.1	0.43-2.0	1.2	0.79
NIOSH	-	37	-	0.1-5.6	-	1.4
PA	25	-	0.04-6.5	-	2.1	-
<u>Door Cleaner/Luterman</u>						
AISI	172	52	0.31-3.2	0.14-1.8	1.1	0.65
NIOSH	-	37	-	0.1-12.3	-	1.7

Table IV-1 (continued)

Operator (Source of info.)	No. of Samples		Range** (mg/m ³)		Average***	
	T*	R*	T	R	T	R
<u>Patcher</u>						
AISI	10	11	0.71-1.3	0.40-6.6	0.99	0.57
<u>Heater</u>						
AISI	60	21	0.12-2.4	0.18-0.67	0.57	0.33
PA	39	-	N.D.-3.0	-	1.1	-
<u>Quench Car Operator</u>						
AISI	70	17	0.05-1.2	0.21-1.4	0.44	0.45
NIOSH	-	13	-	0.1-0.4	-	0.2
PA	23	-	N.D.-7	-	0.94	-
<u>Pusher Operator</u>						
AISI	78	27	0.15-0.82	0.11 1.0	0.40	0.34
NIOSH	-	32	-	0.1-4.2	-	0.8
PA	23	-	N.D.-0.93	-	0.39	-

* T = Total Dust (Respirable and Non-respirable)
R = Respirable Fraction

** AISI DATA is a range of the mean coke oven emission concentrations reported for each coke plant studied.

*** AISI DATA is the average of mean concentrations for each coke plant studied.

N.D. = None Detected

V. COKE WORKER TIME STUDY DATA

Table V-1 indicates the format of a questionnaire which was sent to eighteen AISI member companies having one or more coke plants. Approximately 66% of the companies returned information on the jobs selected for this study. The purpose of the questionnaire was to determine the typical work time in a high or low exposure area as well as the stand-by time which could be spent in areas having a reduced or zero exposure to coke oven emissions. The areas were segregated into three groups:

Area 1 - "Between Pinion Walls" is that section of the battery that lies between the first and last oven and is subject to the most severe exposure.

Area 2 - "Top Side - End Platforms" are the areas on the ends of the battery and are subject to much less exposure.

Area 3 - "Other Areas" include all other areas away from the top of the battery proper such as reversing rooms, lunch areas, etc., that are subject to very little if any exposure.

Reporting companies submitted data which were prepared to represent working practices as determined by competent supervisory personnel at the respective coke plants. Time limits imposed by this contract did not permit detailed watch-board studies to be made. The results in Table V-1, as shown in the high-low columns, indicate a wide variation in the work practices among the various coke plants. In some cases, workers are shown to be active on the topside or on the bench for a major portion of the turn while in other cases a relatively small fraction of the turn time is spent in actual work in such areas. Although stand-by time, where it exists, is shown as a single number, the amount of time practically available to spend in low exposure

areas, especially fixed controlled air rooms, may be limited if many short periods of stand-by time comprise these total figures. Consequently, these overall times listed can be used to project the potential reduction in exposures only in a general way.

Table V-1 (continued)

	Between Pinion Walls			Topside and Platforms			Other Areas			Total Stand-by
	Hours Per Turn			Hours Per Turn			Hours Per Turn			Hours Per Turn In Reduced Exposure Area
	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	
<u>Door Machine Operator- Job No. 11</u>										
(Coke Side Only)										
Working	6.0	2.7	4.0	--	--	--	1.0	0	.2	
Stand-by	3.7	0	1.8	--	--	--	5.3	.5	2.0	2.0
Total	<u>7.3</u>	<u>2.7</u>	<u>5.8</u>	--	--	--	<u>5.3</u>	<u>.7</u>	<u>2.2</u>	
<u>Door Cleaner-Job No. 12</u>										
Working	6.3	1.7	3.8	--	--	--	1.7	0	.2	
Stand-by	4.0	0	1.3	--	--	--	6.0	.5	2.7	2.7
Total	<u>7.3</u>	<u>1.9</u>	<u>5.1</u>	--	--	--	<u>6.1</u>	<u>.7</u>	<u>2.9</u>	
<u>Quencher Car Operator- Job.No. 13</u>										
Working	4.6	2.8	3.4	--	--	--	3.5	0	1.3	
Stand-by	2.0	0	.6	--	--	--	6.3	.7	2.7	2.7
Total	<u>5.5</u>	<u>2.8</u>	<u>4.0</u>	--	--	--	<u>8.0</u>	<u>2.5</u>	<u>4.0</u>	
<u>Patcher-Job. No. 15</u>										
Working-Topside	1.7	0	.6	.1	0	--	--	--	--	
Working-Bench	5.2	1.6	3.1	.1	0	--	2.2	0	.2	
Working-Other	3.0	0	.5	--	--	--	1.9	0	.4	
Stand-by	2.5	0	.3	.3	0	--	6.0	1.1	2.7	2.7
Total	<u>6.5</u>	<u>2.0</u>	<u>4.6</u>	<u>.3</u>	<u>0</u>	--	<u>6.0</u>	<u>1.5</u>	<u>3.4</u>	

VI. RESPIRATORY PROTECTION

CONTAMINANT CHARACTERISTICS

There has been limited study to characterize the contaminant arising from coke oven emissions. ⁽⁷⁾ It is felt that its identity changes in both physical and chemical composition depending on the operating conditions of the coke oven and the characteristics of the coal being coked. The particle size ranges from gross particulates which settle out quickly in the vicinity of the ovens to a significant fraction in the respirable range which represents approximately forty per cent of the suspended particulates. The form of the particulate phase, as revealed by scanning electron microscopy, is a complex of discrete granular particulates, including coal and coke, flocs of sub-micron fume, and condensed fractions. It is important in this discussion to recognize that this is a complex and unique aerosol.

There are other contaminants present in the coke oven smoke. Limited studies by AISI member companies have shown that sulfur dioxide, hydrogen sulfide, and carbon monoxide are present in concentrations normally below the respective TLVs. For this reason, respirators designed only for protection against particulates are necessary for coke oven workers. The validity of this conclusion will be discussed later in this section.

CURRENT RESPIRATOR PRACTICE

Current respirator practice was determined through a questionnaire sent to all AISI member companies with coke producing facilities. The results of this survey are shown in Table VI-1.

(7) Masek, V., "The Composition of Dusts From Work Sites of Coke Ovens," Staub-Reinhalt. Luft., 30, No. 5, pp. 34-37 (May, 1970) (Translation)

Some explanation of the method used to abstract the information from the questionnaire is necessary. The classification of workers who wore respirators on a regular basis was expressed as topside personnel, workers at, or above, the bench level, and all oven personnel. "Topside workers" include lidmen, larrymen, tar chasers, and heaters. Those working "at or above bench level" are the topside workers, pushermen, door machine operators and door cleaners. "All oven personnel" includes all the above listed job categories in addition to foremen and oven laborers.

Respirator acceptance was graded as good, fair, or poor, as noted in Table VI-1. A review of the replies in this Table reveals that all 24 plants have respirators in use. The respirators in use at the various plants are listed in Table VI-2 with an identification of the facepiece type and the number of plants where used. All respirators in use at coke facilities were oral-nasal "on-the-chin" or quarter facepieces, with the exception of one "under-the-chin" facepiece.

FEASIBILITY OF RESPIRATORY PROTECTION

Conventional Air-Purifying Respirators

A variety of respiratory protection devices have previously been suggested for coke oven applications. In this section of the report a review of the performance characteristics of these devices is presented.

a. Facepiece Design

As demonstrated later in this section, the seal between the respirator facepiece and the wearer's face is the major source of leakage on conventional (negative pressure) air-purifying respirators. It will also be shown that a respirator with a leakage of 5% when sealed to a test manikin may have leakages of 15% to 20% when worn by a worker who has not been

properly instructed in its use. The facial seal must, therefore, receive major attention in any discussion of respirator performance.

The "under-the-chin" or half-mask will, through effective fitting and a choice of masks, fit most workers. The major advantage of this type respirator is that the chin cup stabilizes the facepiece on the face. The facial seal can usually be maintained during facial movements when talking, or due to involuntary movements during work. However, this type of facepiece creates acceptance problems.

A review of Table VI-2 reveals that the great majority of dust respirators used on coke ovens are "on-the-chin" facepieces. This mask has considerable merit. It is lightweight, compact, easy to adjust and position on the face, and causes less discomfort from heat than the half-mask, due to its reduced seal area. In addition, it can accommodate a large percentage of the population since it can be "floated" on the face to achieve fit. The "on-the-chin" mask does not, however, have the suspension stability of the "under-the-chin" facepiece. If the "on-the-chin" mask is used with limited facial movement, one can achieve protection values at least equal to the "under-the-chin" type.

b. Replacement Filter Dust Respirators

1. Manikin Tests

Although widely used on coke ovens, little performance data for coke oven particulates are available on dust respirators. Limited test data have been provided on the performance of selected filter respirators from sealed manikin tests by one AISI member company as shown in Table VI-3. Other respirators introduced recently have not been evaluated. These manikin tests were conducted on larry cars at a single coke works at a flow rate of

RESUME OF RESPIRATOR SURVEY

Company No.	Respirator(s) Mfgr.	In Use Model	Worn By	Acceptance
1	MSA	Dustfoe 66	ATI	Good
2	MSA Willison	Dustfoe 77 560	Bench level up	Good
3	MSA AO	Dustfoe 77 Sure-Guard R2090	Bench level up	"No problem"
4	Willison (43 cartridge)	No. 841	Lidmen Larrymen	Fair
5	MSA	Dustfoe 77	Lidmen Larrymen	Poor
6	Not stated		ATI	Good
7	MSA	Dustfoe 77	Bench level up	Fair
8	Willison	Monomask 600-A	Bench level up	"Not pleased"
9	Weish	7165	Larrymen Door cleaner Lidmen Door mach. operator	Good
10	MSA	Dustfoe 66 Dustfoe 77	ATI	Varies in plant

Table VI-1 (continued-2)

Company No.	Respirator(s) Mfr.	In Use Model	Worn By	Acceptance
11	MSA	Custom Cumfo (H filter)	Lidmen Larrymen	Good
12	MSA	Dustfoe 66	Lidmen Larrymen	Poor
13	MSA MSA	Dustfoe 66 Dustfoe 77	All	Not stated
14	MSA	Dustfoe 66	Bench level up	Fair
15	MSA	Dustfoe 77	All	Fair
16	Willson	Monomask (600-A)	Bench level up	Fair
17	MSA Willson AO Welsh	Dustfoe 66,77 Monomask (600-A) R 8100 (R 100) 7165	All	Good
18	MSA	Dustfoe 77	None	Poor
19	AO MSA	R 2090 Dustfoe 77	Bench level up	Good
20	Welsh	7165	Bench level up	Good
21	MSA	Dustfoe 77	Bench level up	Fair
22	MSA	Dustfoe 66	All	Good

Table VI-1 (continued-3)

Company No.	Respirator(s) Mfgr.	In Use Model	Worn By	Acceptance
23	We1sh	7100	ATI	Good
24	Willson	560	None	Poor

Table VI-2

RESPIRATOR USAGE BY TYPE

<u>Respirator</u>	<u>Type Facepiece</u>	<u>No. Plants Where Used</u>
MSA Dustfoe 66	1/4	7
MSA Dustfoe 77	1/4	10
MSA Custom Cumfo, Type H Ultrafilter	1/2	2
Willson 560	1/4	1
Willson No. 841 Gas Mask	1/4	1
Wilson Monomask (600 A)	1/4	1
AO Sure-Guard R 2090	1/4	2
AO R 8100 (R 100)	1/4	1
Welsh 7165	1/4	3

56.6 lpm using silver membrane filters for sampling of coke oven emissions. These data, although limited in quantity and variety of conditions, do provide useful information in evaluating the performance of filter respirators on coke ovens.

The 1971 data demonstrate that high quality resin impregnated wool, such as used in the MSA Dustfoe 66* (new) and the Willson Monomask 600A, can provide high removal efficiencies. This is consistent with tests of the single use respirator (Welsh 7165) which also uses a similar filter resin-wool which showed efficiencies in the mid-ninety percentile on manikin tests. (See pages 36 and 37).

It is obvious from the 1967 test data in Table VI-3 that no extrapolation can be made from other test results to evaluate the performance of filter media for coke oven emissions. It was expected that the Type S and H cartridges used with the MSA Custom Cumfo would exhibit consistent efficiencies in the high-ninety percentile for any particulate and yet these cartridges performed poorly against coke oven emissions. The Type H cartridge has been tested against 0.3 μ m DOP in the high ninety percentile. Against coke oven particulates, it was outclassed by the resin-impregnated wool media. This apparent anomaly was also noted in the AISI development of a powered air-purifying respirator in which high efficiency media (99.98% DOP) provided removal efficiencies for coke oven emissions in the mid-eighty percentile. This fact also suggests that testing of particulate filters under existing Bureau of Mines/NIOSH approval schedules may not be useful in rating a filter for use against coke oven emissions.

* The mention of a company or a registered name product in this report is not an expressed or implied endorsement of any product.

The data in Table VI-3 also demonstrate the variability of performance of a given filter media due apparently to changes in the characteristics of the coke oven particulates.

2. Wearing Tests

Limited coke oven wearing test data are available on replacement filter, "on-the-chin" respirators. No data are available on "under-the-chin" devices. The "on-the-chin" tests by one AISI member company indicate an average protection factor of 10 based on nine full shift wearing tests on the topside of coke ovens.

Single Use Filter (Dust) Respirators

An evaluation of disposable air-purifying respirators was completed during 1971 by W. A. Burgess as a part of the AISI sponsored study on respiratory protection for coke oven workers. The major respirator manufacturers in the United States were asked to submit their disposable respirators for efficiency and acceptance tests on coke ovens. A number of the manufacturers stated they were not ready for field study. However, American Optical Company and Welsh Manufacturing did agree to participate in this study. American Optical Company had received U.S. Bureau of Mines Approval BM-21-107 on its A0 Disposable Dust/Mist Respirator. At the time of the study Welsh Manufacturing had submitted its Welsh 7165 Disposable Respirator for approval. This respirator has since been granted Approval No. BM-21B-219.

The field evaluation was conducted in two separate topside tests. In the first test the efficiency of the basic filter media would be evaluated for the benzene soluble fraction of coke oven emissions. If the media tests were acceptable, it was then planned to conduct wearing tests on coke ovens. The efficiency of the filter media used on both respirators was evaluated

by sealing test masks to a manikin and drawing air through the mask at 32 lpm for a period of three to four hours. Larry cars were used as the exposure location. Air samples were collected with silver membrane filters at the mask exposure position and from the test duct downstream of the mask.

The results of the manikin tests, shown in Table VI-4, indicate efficiencies in the mid-90% range. These tests demonstrate adequate media filtration efficiency for coke oven application. The low increase in resistance to flow of the test respirators during the test period was acceptable and data indicate that the wearer should not find the breathing resistance of either mask objectionable.

A series of eight half-shift man tests were then conducted on the two disposable respirators. The respirators were worn topside on the battery by three subjects and inside and outside air samples were taken on silver membrane filters using personal air sampling pumps. The subjects walked the ovens, talked, occasionally lifted their masks, but were not working. However, the subjects deliberately exposed themselves to heavy smoke plumes. The test data on the man tests indicate, as expected, that the leakage of benzene soluble coke oven emissions was somewhat higher on the man tests than the manikin tests due to facial seal leakage. This demonstrates the variation in protection anticipated with air-purifying respirators depending on individual fit. However, the average protection factor under actual wearing conditions on the topside of a coke oven was 8.0 for the Welsh 7165 and 5.2 for the A0 Dust/Mist Respirator. These data are shown in Table VI-5. A more extensive topside wearing study was conducted by a member company of the AISI in the manner described above. A series of fourteen (14) full shift

man tests were conducted. The test data revealed an average protection factor for the Welsh 7165 of 10.0 and 5.0 for the American Optical disposable mask.

These two studies indicate that quality, single use, disposable respirators will provide high level protection on coke ovens. The studies also confirm the data presented on "on-the-chin" reusable dust respirators which show that these respirators will provide protection factors equal to "under-the-chin" models based on half and full shift wearing tests on coke ovens.

A limited acceptance study was also conducted at two coke plants. Ten coke oven workers at each plant wore each of the two types (American Optical and Welsh) on alternating days. Interviews were conducted at the end of the test period to determine the subjective response of the workers. While a number of workers found the AO respirator acceptable, the Welsh respirator was preferred by most workers. One of the major differences between these two respirators is the exhalation valve. The low resistance valve on the Welsh 7165 insures a cool breathing mask. Facial leakage on quality disposable respirators will not be significantly greater than on conventional respirators with replaceable filters.

Based on this study, it appears that the disposable air-purifying respirator has an application on those coke oven operations where the concentrations of benzene soluble coke oven emissions are not greater than 2 mg/cu.m.

The comments on acceptance of the disposable type filter respirator obtained in this survey in 1971 are consistent with the observations of the participating plants in the AISI study (Table VI-1), which show good acceptance of the single disposable respirator in routine use on coke ovens.

Chemical Cartridge Respirators

Under the discussion of coke oven contaminants, it was stated that certain gaseous contaminants on the coke ovens were present in concentrations less than the applicable TLV. Due to the overriding importance of the particulate emissions, it does not appear appropriate to include respiratory protection for these gases.

It has been stated that benzene soluble contaminants are present not only in a particulate form which can be collected by filtration, but also as a high vapor pressure material which could be collected by an adsorbent, such as charcoal used in chemical cartridge respirators. A series of respirator tests on a coke oven battery conducted by an AISI member company using a paint spray type respirator, which included both a particulate filter and adsorbent chemical cartridge, showed that the efficiency (particulate plus vapor) of the respirator only approximated that for a good dust respirator. These limited data support the view that the chemical cartridge respirator will not provide an improvement in efficiency for coke oven emissions. In addition, a respirator equipped with both a filter and chemical cartridge is heavier, more bulky, and presents higher breathing resistance.

Supplied-Air Respirators

The supplied-air respirator, which includes both hose masks and air line respirators, provides high level protection with good wearer acceptance in applications other than coke ovens. The details of the equipment and its normal application base are familiar to environmental health specialists and need not be discussed here. Hose masks are used with full facepiece devices for entry into tanks and enclosed spaces. It obviously has no possible use on coke ovens.

The conventional continuous flow air line respirator supplying an oral-nasal mask with 4 cfm, or a hood or helmet at 6 cfm, can provide efficiencies in excess of 99.0%.

The supply for air line respirators can be a compressed gas supply from a manifold, a low pressure air system serviced by an acceptable plant compressor, or conceivably, an individual air pump with suitable air cleaning system located in the work environment. The serious disadvantage is that the wearer must trail an umbilical in the form of an air line or hose. The workers on the coke ovens must have complete mobility to perform their tasks without hazard and assure their personal safety by allowing immediate egress from the work area.

Therefore, there are no applications for supplied air respirators on the coke oven.

Powered Air-Purifying Respirator

During 1969-1970, an AISI funded program to develop a powered air-purifying respirator (PAPR) suitable for coke oven workers was conducted by W. A. Burgess. It was hoped that such a device would improve worker protection and acceptance when compared to conventional air-purifying respirators.

PAPR consists of a battery powered motor-blower which draws the contaminated air through an air cleaning component and discharges it to a mask, hood or helmet. These devices, ranging from the small Fenzy to the backpack of Personal Environmental Systems, have been described elsewhere. (8)

(8) Burgess, W. A., "Personal protection devices," Chapter in Industrial Hygiene Highlights, Vol. 1: 319-343, Ed. by L. V. Cralley, Industrial Hygiene Foundation, Pittsburgh, Pa. (1968).

Table VI-3

RESPIRATOR EFFICIENCY STUDY, COMPANY A

SEALED MANIKIN TEST

<u>Respirator</u>	<u>No. Samples</u>	<u>Efficiency for Be Sol. COE *%</u>		
		<u>Average</u>	<u>Minimum</u>	<u>Maximum</u>
<u>1967 (10 lpm)</u>				
MSA Dustfoe 66 (old)	3	85.6	82.7	86.7
MSA Custom Cumfo (S filter)	3	91.4	88.3	94.6
MSA Custom Cumfo (H filter)	3	87.1	76.8	96.1
MSA Dustfoe 77	3	69.4	45.9	89.6
MSA Dustfoe 66 (old)	2	52.6	38.2	67.0
Willson Monomask 600 A	3	81.6	72.6	88.7
<u>1971 (56.6 lpm)</u>				
MSA Dustfoe 66 (new)	7	96.4	91.5	99.2
Willson Monomask 600 A	5	78.0	33.2	97.5
MSA Dustfoe 66 (old)	2	56.8	45.0	68.5

* Coke Oven Emissions (COE)

The PAPR developed under the AISI project is a relatively compact, belt worn unit weighing approximately three pounds and delivering a minimum of 4 cfm for an eight hour period.⁽⁹⁾ The media studied under this development program revealed efficiencies consistent with those described above for conventional respirator filter media. The choice of a resin impregnated deep wool batting was based on media collection efficiency in the 90% range and acceptable resistance to flow at the desired supply rate.

One hundred units were evaluated in actual wearing tests by workers during the first development year and at later dates. A summary of the protection afforded by these units is shown in Table VI-6. All tests were conducted with personal sampling pumps using silver membrane filters. An average protection factor of 37 was noted in ten tests with oral-nasal masks and two tests with helmets showed protection factors of 100. In a separate series of field studies topside, a member AISI company found an average protection factor of approximately 40 in seven tests using the PAPR with an oral-nasal mask.

Acceptance of the device was initially reviewed at 10 coke oven facilities during the first year and in two subsequent years at selected coke oven plants. The response varied from a wish to wear one continuously to a refusal to wear the device during the study. The major criticisms of the initial unit was the hose-mask air delivery system. Many workers felt that the hose was bulky and awkward to work with. Over additional test periods it was found that mask systems prompted complaints about supply air temperature in winter and summer.

(9) Burgess, W. A., "Design of a Powered Air-Purifying Respirator for Coke Oven Workers," American Industrial Hygiene Association Journal, Vol. 32, No. 11 (November, 1971).

The initial study endorsed the concept, and subsequently, various air supply methods, including a light weight hose-mask system and an inexpensive helmet supply system, were developed. The disposable mask was a vacuum formed facepiece with foam peripheral seal which could be disposed of at the end of the week. The helmet system achieved the integrated head, eye, and respiratory protection that seemed necessary on coke ovens. To increase acceptance of a helmet system and the mask system during hot weather, a light weight dry-ice air cooler has been developed and is now being evaluated.

The present development of the PAPR is advanced to the point where it can be applied on coke oven operations at certain seasons. Extremes of summer and winter conditions may require alternate use of a conventional dust respirator until a suitable cooler and helmet system is available.

RECOMMENDATIONS ON RESPIRATORS FOR COKE OVEN WORKERS

General Considerations

As expected, there is no single answer to the application of respirators on coke ovens. A number of general considerations do apply, however, and can be the basis for a respirator application guide. The first concerns the contaminant which warrants our attention. The bulk of the polynuclear aromatic hydrocarbons are associated with the particulate emissions from the ovens. A dust respirator, shown to be specifically effective in removing benzene soluble coke oven emissions is felt to represent the most effective respiratory control with relatively good acceptance by the worker. This air-purifying device can take several forms.

The second general consideration is an awareness of the difficulty of the problem in establishing an effective respirator program for coke oven workers. Acceptance of the program by workers offers the most difficult of challenges.

Respirator Application Guide

Previous discussion has indicated that a number of respiratory protection devices have application on coke ovens. The efficiency of these devices based on actual man tests on coke ovens and other industrial experience suggest that the protection factors shown on Table VI-7 can be assigned these devices and can be recommended for the assigned applications.

In selecting respirators it should be noted that the table refers to Time Weighted Average (TWA). This implies that the concentration of the benzene soluble fraction of coke oven emissions must be determined, as well as the work time for each of the work areas involved and for the standby locations.

Finally, the respirator selected for use must be compatible with the various safety apparel and equipment that coke oven workers must wear and use during the course of their work.

Table VI-4

PERFORMANCE OF DISPOSABLE RESPIRATORS ON MANIKIN TESTS IN LARRY CAR

Respirator	Particulate Concentration, mg/m ³ Outside Respirator C ₆ H ₆ Sol.	Inside Respirator C ₆ H ₆ Sol.	Leakage, Per Cent C ₆ H ₆ Soluble
1. A0 1	3.73	0.52	13.9(1)
2. A0 2	5.14	0.21	4.1
3. A0 3	2.00	0.03	1.3
4. A0 4	2.27	0.05	2.1
5. W1	3.73	0.50	13.3(1)
6. W2	5.14	0.36	7.0
7. W3	2.0	0.03	1.3
8. W4	2.27	0.14	6.1

(1) These tests are invalid since masks were not adequately sealed to the manikins.

Table VI-5

PERFORMANCE OF DISPOSABLE RESPIRATORS ON MAN TESTS ON TOPSIDE

Test Respirator	Particulate Concentration, mg/m ³ Outside Respirator C ₆ H ₆ Sol.	Inside Respirator C ₆ H ₆ Sol.	Protection Factor
1. W1	7.02	2.62	3.7
2. W2	4.91	0.82	6.0
3. W3	4.91	1.11	4.4
4. W4	3.41	0.19	18.2
			Average 8.0
5. A0 1	7.02	1.19	5.4
6. A0 2	7.02	2.00	3.5
7. A0 3	6.42	0.75	8.6
8. A0 4	3.80	1.32	2.9
			Average 5.2

Table VI-6

PERFORMANCE OF AISI PAPR MAN TESTS

<u>Study No.</u>	<u>Respirator</u>	<u>Worker</u>	<u>Protection Factor</u>
1	AISI PAPR Supplying MSA Custom Cumfo	Larryman	77.0
		Larryman	40.0
		Lidsman	67.0
		Lidsman	14.9
		Larryman	22.1
2	AISI PAPR Supplying Acme DuoSeal	Subject, Topside	41.8
		Subject, Topside	41.0
		Lidsman	19.2
		Larryman	23.8
		Subject, Topside	22.2
Average of 10 tests			PF=37.0
3.	AISI Helmet Shroud outside, tied Shroud outside, not tied	Lidsman	100.0
		Lidsman	100.0
		Lidsman	13.0 25.0 13.5

$$\text{Protection Factor} = \frac{C_o}{C_r}$$

Where C_o = concentration in ambient air
 C_r = concentration inside respirator fall piece

Table VI-7

COKE OVEN RESPIRATOR APPLICATION GUIDE

<u>TWA Exposure (mg/cu.m)</u>	<u>Respirator</u>	<u>Protection Factor</u>
≈ 10	PAPR with helmet	50
≈ 6	PAPR with half-mask	30
≈ 2	Replacement filter oral- nasal mask and single use "on-the-chin" masks	10

Note: In each case the filter media used on the respirator must be shown to provide efficiencies against benzene soluble particulates at least greater than the stated overall efficiency.

VII. ADMINISTRATIVE CONTROLS

INDIVIDUAL PLANT SURVEYS

It can be recognized from analysis of exposure data (Section IV) and time study data (Section V) that both the exposure and work load for the coke oven workers varies widely from plant to plant. In order to establish a base for evaluating workers' exposures, each company should make, or have made by recognized industrial hygienists and industrial engineers, coke oven workers' exposures and time studies for each individual coke plant. The data resulting from these individual plant surveys should be used as a guide for establishing the need at that particular plant for changes in work procedure, operating procedures, engineering controls (Section VIII), and use of respiratory protective devices (Section VI) to reduce coke oven workers' exposure.

WORK PROCEDURES

The term "work procedures," as used in this study, includes administrative procedures which may be considered as a means of reducing exposures to coke oven emissions. Job rotation or adjustment of work schedules, for example, might be used to limit a worker's time of exposure. However, considerations are interwoven with labor agreements and may involve changes in complex relationships.

Hours of work, job content, and job assignments are matters involving the employer-employee relationship and are either covered directly by agreements or affect other matters that are covered by agreements. Thus, changes in these areas generally cannot be made unilaterally. For example, employees are entitled to jobs on the basis of seniority agreements and cannot arbitrarily be reassigned to another job for a part of a turn or for

a full turn if such reassignment is in violation of those agreements. Many local agreements throughout the industry bestow privileges upon employees to elect jobs, shifts, or assignments of their preference. Where such agreements exist these privileges may not arbitrarily be taken away.

It is impossible to anticipate all the ramifications involved because of the many existing restrictive agreements and the existence of protected practices under the Local Working Conditions Agreements. However, it can be assumed that job restructuring, job combination and job rotation will create problems at all or some locations in the following areas:

- Seniority
- Lines of progression
- Overtime assignments
- Jurisdictional claims
- Hours of work
- Job preference
- Shift preference
- Scheduling
- Training opportunities
- Rates
- Incentives
- Crew sizes
- Spell assignments

Definitions of the above listed terms are so complex in character and application that they could not be properly dealt with in the purview of this report.

It should be further emphasized that there may be a wide variation in application from company to company within the industry and from plant to plant within a company.

OPERATING PROCEDURES

It is to be recognized that workers' exposure can be reduced if certain basic procedures, generally common to operation of coke ovens, are incorporated into the operating procedures which each company develops for its individual coke batteries. These basic procedures are:

Prior to Charging Coal

- a. Gooseneck and standpipes should be inspected, and, where necessary, buildup should be removed to insure free flow of gas.
- b. Liquor sprays on goosenecks should be cleaned to assure adequate flushing liquor flow at all times.
- c. Aspiration systems should be inspected for any accumulation of tar and carbon buildup. The aspiration system should be inspected before any coal is charged into the oven.
- d. Standpipe caps should be closed and properly sealed.
- e. The charging holes should be inspected, and, where necessary any carbon buildup which will effectively impede the flow of coal into the oven shall be removed.
- f. The larry car hoppers should be filled with coal to a predetermined level as established for each individual hopper so that the oven is properly filled.
- g. The larry car should be properly spotted over the oven to be charged.

Charging of Coal

- a. The coal should be charged into the oven in accordance with a specific procedure as established for each battery which will insure that the charging operation can be completed in the shortest possible time consistent with the least evolution of smoke to the atmosphere.
- b. Procedures should be established so that the leveling operation is inaugurated and carried out in a manner to minimize the evolution of smoke to the atmosphere.
- c. Charging hole lids should be replaced as soon as possible after the coal has emptied from the hoppers. Charging hole lids that do not seat properly should be sealed to prevent leakage.
- d. The aspiration system should not be turned off until all the charging hole lids have been replaced.
- e. The top of the battery should be maintained in a neat, orderly condition free of excess coal.
- f. Procedures should be established to adjust, repair, or replace self-sealing coke oven doors which fail to seal after the oven is charged, prior to the next coking cycle which starts on the next daylight turn after the leak is discovered. Luted doors which fail to seal after the oven is charged should be reluted as soon as practicable.

Coking of the Coal Charge

- a. The coal charge should be uniformly heated for a sufficient period to insure proper coking. For each battery, procedures

should be established for measuring, adjusting, and maintaining of heating flue temperatures to achieve this objective.

- b. Procedures should be established for checking the oven back pressure controls to maintain uniform pressure conditions in the collecting main.

Pushing of Coke

- a. For each battery, procedures should be established for dampering off the ovens at the end of the coking cycle and removal of the charging hole lids to minimize emissions.
- b. Procedures should be established so that doors and jambs are cleaned before the doors are replaced after the coke is pushed.

VIII. ENGINEERING CONTROLSCONTROLLED AIR SYSTEMSIntroduction

In considering the reduction of coke oven employees' exposures to coke oven emissions, one method of control that merits consideration is the provision of controlled air to either enclosed cabs of operating equipment (i.e., larry car, pusher machine, door machine, coke car, etc.) or to other enclosed areas (i.e., Lidman's area, etc.) where the practice would be to have employees spend their available time during the normal work day. Providing filtered air with lower concentrations of coke oven emissions could reduce the employees' time-weighted average exposure in the 8-hour work day. The magnitude of this reduction will depend on the overall continued effectiveness of the controlled air system and the ability of the employees to remain in the "controlled" environment and still accomplish their normal work duties. However, due to the variations in environmental conditions and operating practices at each coke oven facility, the evaluation of the feasibility of this approach becomes complex.

Currently, there are only a few installations in the United States with controlled air systems that are attempting this approach. Since these have only been in operation for less than two years, it is still too early to establish representative experience from them. The larry car cab system at Plant A is still in the process of being evaluated and is not yet in full production use. The larry car cab and other area systems in Plants B, C, and D are in use, but with varying degrees of effectiveness and problems.

Factors Affecting Controlled Air System Design for Coke Oven Batteries

In the design of any controlled air system, certain basic factors must be considered in order to attempt to accomplish adequate contaminant control. Whenever sufficient technology is available to define all the parameters of these basic factors, then reasonable success can be expected. However, with such a complex mixture of contaminants as in coke oven effluents, and the variations in environmental conditions, successful reduction of contaminants to an enclosed environment will depend on the use of the best available information and the experience with use.

Unfortunately, this approach leads to costly maintenance and high replacement costs as new technology is developed.

a. Concentration and Particle Size

Because of the nature of the operation, release of contaminants from coke oven operations vary with weather conditions, operating conditions (mechanical and human), and physical conditions of the coke oven battery facilities. Studies conducted to evaluate airborne contaminants on coke oven batteries to date have been primarily oriented toward evaluations of personnel exposures and not for concentrations to challenge a controlled air system. Therefore, estimating the loading on this system will depend on evaluations at each individual facility.

With such a contaminant as coke oven effluent, it is important to recognize that effective control must be made of "benzene soluble material" as well as "total particulates." Limited studies carried out at one battery of a coke oven facility (Larry Car Cab System) indicate that better collection was obtained for "total particulates" (95%) than for the benzene soluble fraction (46%). This implies a relationship to particle size and

benzene soluble material. Other limited studies conducted at this same facility have shown that there is "increasing" benzene soluble material with "decreasing" particle size and a need to efficiently collect particles in the 1 to 2 microns aerodynamic diameter range. Due to the density of these particles, their physical diameter may be two to three times their aerodynamic diameter.

Since the contaminants may be carried to a filtration/collection device as a function of their aerodynamic properties, the number of particles and their physical size and shape become important considerations for their collection. Therefore, more representative studies must be conducted to better define these properties.

b. Degree of Collection

In establishing the degree of collection required to reduce concentrations of coke oven emissions, attention must be given again to some of the unique characteristics of coke oven effluents.

Assuming that the previously discussed particle size association is representative, i.e., decreasing size, increasing benzene soluble material, high efficiency equipment would be necessary with predicted high maintenance and operating costs because of significantly rapid loading.

In limited studies inside Larry Car Cabs, a bi-modal distribution of particle sizes of the total particulates and benzene soluble fraction was found with peaks at 1 to 2 microns and greater than 10 microns aerodynamic equivalent diameters. With this type of particle size distribution, a primary filter/collector would provide longer life to the high efficiency secondary collector.

c. Characteristics of Air Stream

Coke ovens operating at high temperatures affect the density of the effluent air stream and the contaminants being carried with it. In turn, the intermittent generation of steam from the coke quenching operations and the effect on the production of corrosive contaminants further adds to the problem.

In addition, water vapor acts as a "poison" to an activated carbon filter and hinders any attempt for collection of gases and vapors. Likewise, organic vapors, even in small concentrations, also hinder the effectiveness of activated carbon for collection of some gases.

Although the concern is to reduce coke oven emission (benzene soluble fraction) concentrations, other gases in concentrations much less than health hazard concern, must be considered in the overall effect on filter media and corrosion of the system.

d. Characteristics of Contaminants

Of the factors affecting air filtration/collection system design, one of the most important is describing the characteristics of the contaminants.

Depending on the location on the coke oven battery, aerosol mixtures range from solid, irregular-shaped coal/coke particulates to smooth, spherical carbonaceous-organic material in various percentages. This includes agglomeration of the smaller aerosols on to the larger aerosols and adsorption of vapors.

Because of the process and temperatures involved, coke oven effluents are also considered to contain tarry, sticky material.

Although it is felt that this agglomeration and adsorption of

benzene soluble material occurs, it is not known to what degree this material may be re-entrained or vaporized after collection with the velocities of the air stream provided in the controlled air system. This aspect will require further study.

Comparison of Existing Controlled Air Filtration/Collection Systems

Having briefly reviewed some of the factors affecting controlled air (filtration/collection) of coke oven effluents for enclosed spaces, it is important to relate these factors to some existing installations.

In various coke plants in the industry, there are different controlled air systems with several applications. Plant A's larry car cab system was designed for an estimated loading of 9.0 mg/M³ coke oven emissions (benzene soluble fraction) with collection efficiency of 99.9% down to 1.0 micron particle size, and a discharge concentration not exceeding the current permissible limit for CTPV. A temperature of 72°F also is to be maintained in both winter and summer inside the cab.

Although the larry car is not yet in full production use, the controlled air system has been operated for extended periods at the end of the coke battery, an area of reduced concentrations to coke oven emissions. During this trial period the controlled air system has experienced problems in temperature control, and the activated carbon trays, made of carbon steel, have had to be replaced after several months because of corrosion. The primary filter has experienced periodic plugging, and the secondary cloth bag filter averages approximately 10 to 14 days between changes, depending on experimental activities.

This system was installed on a newly constructed larry car. With its physical size and electrical power requirements, it would be extremely

difficult to install this complete system on existing larry cars.

Conditioned air systems at Plants B and D are modifications to existing installations.

Plant B provides similar "air delivery" to Plant A in its larry car cab and lidman's controlled area, but with 2.0 to 2.6 air changes per minute to the smaller volume to be ventilated. Heating and cooling capabilities are provided, with foam glass filter and an activated carbon bed. Filter units are cleaned daily with compressed air and changed twice weekly in the lidman's controlled area.

No performance evaluations have been made as yet. Unfortunately, personnel do not choose to remain in these conditioned air spaces during their available time.

Plant D's approach to conditioned air systems provide smaller air changes per minute in larry car cabs, pusher car cabs, and coke car cabs, as well as controlled air areas for the lidman. The pre-filter approach has been applied with the use of rigid, pleated fiberglass filters and followed by a secondary moderately efficient, larger surface area filter. The pre-filters are changed once per week, and the secondary filters are changed once per month. Heating capabilities are included in the system and cooling capabilities are to be installed.

Performance evaluations have been made which indicate significant reductions in the benzene soluble fraction inside the enclosure. Although this performance is considered satisfactory, problems with corrosion of the carbon steel ductwork are experienced.

Plant C's larry car cab system incorporates a pre-filter, cloth bag type secondary filter and an activated carbon bed. Collection efficiency studies conducted on the performance of this system have found efficiencies

of 90% for total particulates and 87% for CTPV. These are significant reductions inside the cab.

However, due to the required work activities of larrymen outside the cab on existing larry cars, their exposure would not be reduced in the same magnitude as would be the larrymen in the controlled cab of Plant A where they are required to remain for all normal work activities.

Conclusion

The systems above described are all in the developmental stages and as yet have not been operated for sufficient period of time to evaluate their total effectiveness. Although the various basic factors necessary to be considered for design have been incorporated as much as possible, major problems in corrosion, personnel acceptance, and maintenance do exist. However, where performance evaluations have been made, results have indicated that a significant reduction in the benzene soluble fraction of coke oven emissions has been achieved.

The feasibility of this approach remains within the limitations of the individual coke oven facility. Only experience with use and further study of the necessary parameters will resolve the feasibility of this approach for use on coke oven facilities.

OTHER ENGINEERING CONTROLS

Where coke oven worker exposure data as developed for the particular coke plant show extensive exposure for the particular job, certain engineering controls can possibly be installed, if design and configuration of the machine permits, to reduce worker exposure. Such controls can include but are not necessarily be limited to the following:

Pusher Operator

- a. A controlled air supply could be ducted from the rear of the pushing machine to the operating cab.
- b. A smoke boot or comparable device could be installed on the leveler bar.

Quench Car Operator

A controlled air supply could be provided for the operator's cab.

Larryman - Lidman

- a. Provide a controlled air operating and standby pulpit topside.
- b. If design and configuration of the larry car permits, provide one or more of the following;
 - (1) controlled air operating cab
 - (2) mechanical lid lifters
 - (3) individual drop sleeves, operated either from battery top of operator's cab.
 - (4) mechanized goose neck cleaners
 - (5) remote controlled dampering off and charging systems.

Door Machine Operator and Door Cleaner

If design and configuration of door machine (and of pusher machine) permits, provide one or more of the following:

- a. Automatic door and jamb cleaners.
- b. Controlled air cab for door machine operator.

Since the engineering controls suggested above will involve new technology, adaptation to existing equipment and extended break-in periods, it must be recognized that substantial time periods will be involved. It must be further recognized that it is not possible to predict the performance of these systems in any given situation.



IX. CONCLUSIONS

The coke industry in the United States varies widely in size and age of plants and in methods of operation. Therefore, it is not deemed practical to develop a uniform set of specific standards intended to reduce the exposure of coke oven workers to coke oven emissions either on an individual job or total work force basis. The conclusions presented here constitute guides which should be considered in the establishment of practicable programs to reduce worker exposure to coke oven emissions.

- a. General operating procedures, as described in the text, will aid in the reduction of coke oven emissions and exposures. These procedures relate to the charging of coal, the coking of the coal charge and the pushing of the coke. They can be incorporated into the operating procedures for many batteries. (Section VII - pages 51, 52, and 53.)
- b. Coke batteries vary so widely from plant to plant that administrative control of worker exposure to coke oven emissions cannot be universally prescribed. Individual plant surveys are needed to define local problem areas. Collective bargaining agreements (national and local) and local labor relations customs preclude the use of job rotation of employees on coke ovens or adjustments of work schedules as a feasible solution. (Section VII - pages 49 and 50.)
- c. Engineering Controls:
 1. Means for providing controlled air to work/standby locations are under development by the industry but have not been proven for general use. Many variables exist and major problems are still being resolved. (Section VIII - pages 55-61.)

2. Other control measures have shown promise in reducing coke oven emissions and presumably the associated exposures. (Section VIII - pages 61 and 63.)
 3. Application of any given control measure may not be feasible at some plants and appropriate feasibility studies are therefore necessary in every case. (Section VIII - pages 61 and 62.)
 4. Engineering controls suggested will require substantial time periods for development and installation with no assurance of ultimate performance. (Section VIII - page 63.)
- d. The use of proper respiratory protective equipment is an effective means of reducing exposures when assigned according to Table VI-7 of this report. (Section VI - page 47.)
 - e. Exposures to coke oven emissions, as determined by industry surveys are generally less than those determined by NIOSH and the Pennsylvania Department of Environmental Resources. NIOSH is reevaluating its own survey results because of discrepancies found. The Pennsylvania data are rather old (1968-69) and do not reflect recent improvements in coke oven operation. (Section IV - page 18.)
 - f. Larrymen and lidmen are exposed to higher concentrations of coke oven emissions. Workers located on the bench and away from the top of the battery have average exposures one-half or less than those of top side workers. (Section IV - page 18 and 19.)

- g. Workers at some plants may be exposed on the topside or the bench for a major portion of the turn while at other plants a relatively small fraction of the turn time is spent in high exposure areas. The amount of time practically available to spend in low exposure areas is influenced greatly by the length of the individual standby time periods. (Section V)
- h. The expression "coal tar pitch volatiles (benzene soluble fraction)," sometimes abbreviated "CTPV," is not applicable to coke oven emissions since these emissions consist mostly of coal and coke particulates with only a small percentage of polycyclic hydrocarbons. (Section I)
- i. The Threshold Limit Value for "CTPV," per se, was based on limited unpublished data not accessible to the general scientific community for evaluation. (Section I)



MASTER JOB CLASSIFICATION

JOB TITLE HEATER Job No. 6

Factor	Reason for Classification	Code	Classification
1.	PRE-EMPLOYMENT TRAINING This job requires the mentality to learn to: Direct and control the heating of one or more coke oven batteries in the production of coke and gas.	C	1.0
2.	EMPLOYMENT TRAINING AND EXPERIENCE This job requires experience on this or related work of 19 to 24 months inclusive.	E	1.6
3.	MENTAL SKILL Considerable judgment required to regulate equipment to maintain temperatures to produce coke to meet specifications.	D	2.2
4.	MANUAL SKILL Operates variable controls, valves and gauges. Makes simple adjustments to heating equipment.	B	.5
5.	RESPONSIBILITY FOR MATERIAL Close attention for majority of turn to regulate temperatures to coal and fuel mixtures to obtain proper physical properties and coke size. Improper heating would result in off-quality coke which is useable. Excess cost estimated \$1/ per ton. Reduced coke quality resulting from 1/2 turn's production. 708 tons/turn x 1/2 x \$1/ton = \$354.	D	2.4
6.	RESPONSIBILITY FOR TOOLS AND EQUIPMENT Sustained high degree of care and attention required to prevent damage to ovens and brickwork where responsibility is placed on the operator and not entirely on automatic devices.	E	3.0
7.	RESPONSIBILITY FOR OPERATIONS Responsible for the heating of coke to maintain coking schedule on one or more batteries of ovens.	E	3.0
8.	RESPONSIBILITY FOR SAFETY OF OTHERS A high degree of attention required to prevent explosion of gases exposing most of the battery crew.	D	1.2
9.	MENTAL EFFORT Close mental and visual application required to regulate temperatures and drafts. Visual inspection of oven walls, flues and coke. Reads pyrometers, gauges and charts.	D	1.5
10.	PHYSICAL EFFORT Light physical exertion. Operates light hand controls and valves, makes minor repairs and adjustments. Some climbing, walking for observation and inspection, and use of heavy tools.	B	.3
11.	SURROUNDINGS Exposed to extreme heat for intervals while inspecting flues and checking ovens.	C	.8
12.	HAZARD Accident hazard moderate. Probable injuries consist of moderate burns, cuts and bruises.	B	.4

Job Class 18 Total 17.8

MASTER JOB DESCRIPTION and CLASSIFICATION

DEPARTMENT COKE PLANT Job No. 6

JOB TITLE HEATER

DATE 1-1-63

MASTER JOB DESCRIPTION

PRIMARY FUNCTION:

Observes and regulates gas reversals and checks temperatures on one or more by-product coke oven batteries to produce coke from coal.

TOOLS AND EQUIPMENT:

Coke ovens, reversing equipment, indicating and regulating meters and controls, pyrometers, rods, hand tools, etc.

MATERIALS:

Coal, coke, gas, water, air, steam, miscellaneous supplies.

SOURCE OF SUPERVISION:

Foreman

DIRECTION EXERCISED:

Closely directs Heater Helper. General direction to Oven Crew.

WORKING PROCEDURE:

1. Inspects coke as ovens are pushed to check temperatures and distribution of heat and reports unusual conditions.
2. Checks indicators and regulators, makes necessary adjustments and notifies Supervisor of major repairs needed.
3. Takes and records coke and flue temperature readings for each battery.
4. Takes cross wall temperatures and gas analysis as required.
5. Inspects flue equipment with gas on and gas off, and makes cross wall area inspection.
6. Establishes gas pressure and stack draft to insure proper combustion and temperatures in all oven flues.
7. Keeps record of pushing schedule and notifies Supervisor of irregularities.
8. Swabs gas reversing cocks, crossovers and upright piping and adjusts gas pressure in mains.
9. Prepares record of average daily and monthly coke and flue temperatures, gas pressure and waste heat temperatures.
10. Manually reverses heating equipment and sets controls in case of power failure.
11. Purges main with steam in case of gas failure.
12. Makes regular inspection trips to collector main and flushing pressure control points and adjusts pressure as necessary.
13. Instructs Booster and Exhauster Engineer when to raise or lower suction as required.
14. Makes emergency patching repairs to ovens' walls.
15. Makes report of all heating operations.

The above statement reflects the general details considered necessary to describe the principal functions of the job identified, and shall not be construed as a detailed description of all of the work requirements that may be inherent in the job.

MASTER JOB DESCRIPTION and CLASSIFICATION

Job No. 8

DEPARTMENT CODE PLANT JOB TITLE LARRYMAN
 SUB DIVISION BATTERIES DATE 1-1-63
 MASTER JOB DESCRIPTION

PRIMARY FUNCTION:

Operates larry car in charging coal into coke ovens.

TOOLS AND EQUIPMENT:

Larry car, scale, collecting mains, lid hooks, cleaning bars, shovel, wheelbarrow, broom, hammer, etc.

MATERIALS:

Coal, etc.

SOURCE OF SUPERVISION:

Supervised by Battery Foreman. Periodically contacted by and given instructions by Battery Foreman.

DIRECTION EXERCISED:

None.

WORKING PROCEDURE:

1. Operates larry car controls in spotting car under coal bins. Operates bin controls in filling and properly distributing coal in larry car hoppers. Moves car to oven charging holes, and operates controls in charging coal into oven.
2. Replaces and seals charging hole lids and opens damper to turn gas into collecting mains.
3. Assists in poking damper boxes and collecting mains.
4. Cleans plugged standpipes, charging holes, liquor sprays and tar sprays.
5. Relieves pressure on ovens by pulling caps on standpipes or opening bleeders in case of loss of suction.
6. Cleans damper boxes and goosenecks.
7. Sweeps and cleans larry car and battery top.

The above statements reflect the general details considered necessary to describe the principal functions of the job identified, and should not be construed as a detailed description of all of the work requirements that may be inherent in the job.

MASTER JOB CLASSIFICATION

JOB TITLE LARRYMAN Job No. 8

Factor	Reason for Classification	Code	Classification
1.	PRE-EMPLOYMENT TRAINING This job requires the mentality to learn to: Operate larry car and perform various tasks on coke oven battery.	B	.3
2.	EMPLOYMENT TRAINING AND EXPERIENCE This job requires experience on this or related work of from 3 to 6 months of continuous progress to become proficient.	B	.4
3.	MENTAL SKILL Operates simple machine and makes minor changes on repetitive jobs.	B	1.0
4.	MANUAL SKILL Operates larry car controls and uses various hand tools in removing lids, etc.	B	.5
5.	RESPONSIBILITY FOR MATERIAL Ordinary care required to prevent damage to materials. Improper charging of ovens may result in loss of coke and by-products. Improper dampering of ovens would result in loss of gas. \$50 or under	B	.3
6.	RESPONSIBILITY FOR TOOLS AND EQUIPMENT Moderate care and attention required to prevent damage to larry car, scale, ovens, etc.	C	.4
7.	RESPONSIBILITY FOR OPERATIONS Charges coal into ovens, tends lids, etc., in maintaining operation of a large producing unit.	D	3.0
8.	RESPONSIBILITY FOR SAFETY OF OTHERS Considerable care and attention required. Operates larry car on top of batteries where others are exposed. Poor visibility on top of batteries.	C	.8
9.	MENTAL EFFORT Light mental and visual application required to operate larry car and properly distribute coal to ovens, etc.	B	.5
10.	PHYSICAL EFFORT Moderate physical exertion required to operate larry car controls, use hand tools in removing and replacing lids, opening and closing dampers, cleaning standpipe, etc.	C	.8
11.	SURROUNDINGS Exposed to extreme heat, fumes and dust.	B	3.0
12.	HAZARD Exposed to severe burns and explosions.	C	.8
Job Class <u>11</u>			Total <u>10.8</u>

MASTER JOB DESCRIPTION and CLASSIFICATION

DEPARTMENT COKE PLANT Job No. 9

SUB DIVISION BATTERIES JOB TITLE LIDMAN

DATE 1-1-63

MASTER JOB DESCRIPTION

PRIMARY FUNCTION:

To pull lids and otherwise assist in the preparation of the ovens for pushing and charging.

TOOLS AND EQUIPMENT:

Bars, shovel, broom, protective clothing, etc.

MATERIALS:

Coke, coal, etc.

SOURCE OF SUPERVISION:

Battery Foreman issues verbal instructions and Gas Tender assigns and directs work.

DIRECTION EXERCISED:

None.

WORKING PROCEDURE:

1. Mixes luting mud with water to form a sealing mixture to seal charging lids as required.
2. Works in close cooperation with Gas Tender.
3. Removes lids from ovens to be pushed; replaces lids on ovens that have been charged. Uses long handled lidding broom with wooden handle and steel bristles to sweep coal spillage into the oven charged before replacing lids. Also uses heavy lid hook and long handle shovel.
4. Wears heavy clothing, shoes, leggings and lidding mask when necessary.
5. Occasionally cleans charging holes with bar and checks holes to see that they are clean.

The above statement reflects the general details considered necessary to describe the principal functions of the job identified, and shall not be construed as a detailed description of all of the work requirements that may be inherent in the job.

MASTER JOB CLASSIFICATION

JOB TITLE LIDMAN Job No. 9

Factor	Reason for Classification	Code	Classification
1.	PRE-EMPLOYMENT TRAINING This job requires the mentality to learn to: Remove and replace lids on coke ovens.	A	Base
2.	EMPLOYMENT TRAINING AND EXPERIENCE This job requires experience on this or related work of Up to and including 2 months of continuous progress to become proficient.	A	Base
3.	MENTAL SKILL Perform simple repetitive manual tasks.	A	Base
4.	MANUAL SKILL Use bars and other rough tools.	A	Base
5.	RESPONSIBILITY FOR MATERIAL Performs task where damage is not likely. Possible loss of gas by careless sealing of lids. \$50 or under.	A	Base
6.	RESPONSIBILITY FOR TOOLS AND EQUIPMENT Damage to rough hand tools is unlikely.	A	Base
7.	RESPONSIBILITY FOR OPERATIONS Performs simple routine work requiring some coordination with others.	B	.5
8.	RESPONSIBILITY FOR SAFETY OF OTHERS Likelihood of injury to others is low. May put lids on too soon and cause burns to others.	A	Base
9.	MENTAL EFFORT Minimum mental application required to perform simple routine work.	A	Base
10.	PHYSICAL EFFORT Moderate physical exertion to use bars to pull lids, large brooms to sweep spillage, etc.	C	.8
11.	SURROUNDINGS Exposed to extreme heat, dust and fumes. Works outside in all weather.	E	3.0
12.	HAZARD Exposed to burns from hot materials and gas flashes. May be struck by larry car.	C	.8
Total			5.1

Job Class 5

MASTER JOB CLASSIFICATION

JOB TITLE PUSHER OPERATOR Job No. 10

DEPARTMENT COKE PLANT JOB TITLE PUSHER OPERATOR Job No. 10
 SUB DIVISION BATTERIES DATE 1-1-63

MASTER JOB DESCRIPTION

PRIMARY FUNCTION:

Operates pusher machine to push coke from ovens, to level coal charge, and to remove and replace oven doors on the pusher side.

TOOLS AND EQUIPMENT:

Pusher machine, coke ovens, scraper, bar, shovel, broom, etc.

MATERIALS:

Coal, coke

SOURCE OF SUPERVISION:

Foreman

DIRECTION EXERCISED:

Direct Door Cleaner and Interman

WORKING PROCEDURE:

1. Operates controllers to control machine movement.
2. Removes door from oven to be pushed.
3. Lines up ram for pushing and waits for signal from Door Machine Operator (Coke side).
4. Pushes ovens in a regular sequence and maintains proper sequence when starting a new series.
5. Cleans and resets door.
6. Levels coal charge in oven previously pushed.
7. Reports to Foreman any irregularities in machine operation or difficulties experienced in pushing coke.
8. Records ovens pushed.

The above statement reflects the general details considered necessary to describe the principal functions of the job. Identification, and shall not be construed as a detailed description of all of the work requirements that may be inherent in the job.

Factor	Reason for Classification	Code	Classification
1.	PRE-EMPLOYMENT TRAINING This job requires the mentality to learn to: Operate pusher machine using judgment in moving and spotting the machine and in pushing coke from ovens.	B	.3
2.	EMPLOYMENT TRAINING AND EXPERIENCE This job requires experience on this or related work of 3 to 6 months inclusive.	B	.4
3.	MENTAL SKILL Performs semi-routine job in following pushing schedule and exercises judgment in applying pressure on stuck ovens to prevent damage to oven walls.	C	1.6
4.	MANUAL SKILL Operates variable controls and levers to manipulate bridge, pusher-ram, door jack and leveling bar.	B	.5
5.	RESPONSIBILITY FOR MATERIAL Use ordinary care in selecting and pushing proper oven. Pushing wrong oven would result in material loss which is variable but could not exceed \$50.	B	.3
6.	RESPONSIBILITY FOR TOOLS AND EQUIPMENT Close attention and care required to prevent damage to walls of oven when pushing coke.	D NI	2.0
7.	RESPONSIBILITY FOR OPERATIONS Operate an important part of a major producing unit.	B	3.0
8.	RESPONSIBILITY FOR SAFETY OF OTHERS Considerable care and attention required in operating pushing machine to avoid striking workman on bench when moving pusher machine.	C	.8
9.	MENTAL EFFORT Moderate mental and visual application required to operate controls, manipulating bridge, ram, door extractor and leveling bar.	C	1.0
10.	PHYSICAL EFFORT Moderate physical exertion to operate controls, levers, and to clean and lute doors.	C	.8
11.	SURROUNDINGS Exposed to extreme heat for intervals while cleaning and luting doors.	C	.8
12.	HAZARD Accident hazard moderate. Probable injuries consist of moderate burns encountered when cleaning doors.	B	.4
Total			11.9

Job Class 12

MASTER JOB DESCRIPTION and CLASSIFICATION

Job No. 11

DEPARTMENT COKE PLANT JOB TITLE DOOR MACHINE OPERATOR

SUB DIVISION BATTERIES DATE 1-1-63

MASTER JOB DESCRIPTION

PRIMARY FUNCTION:

Operates door machine in removing and replacing doors on coke side of ovens.

TOOLS AND EQUIPMENT:

Door extracting machine, various controls, cleaning bars, safety bars, coke guide, etc.

MATERIALS:

Coke, etc.

SOURCE OF SUPERVISION:

Supervised by Battery Foreman. Directed by Gas Inspector.

DIRECTION EXERCISED:

None.

WORKING PROCEDURE:

1. Keeps a record on blackboard in door machine of ovens pushed. Must know pushing sequence so that proper oven will be prepared for pushing.
2. Operates door machine controls in removing oven door and positioning coke guide.
3. Signals Pusher Operator to begin push when Quencher Car Operator is in position to receive coke at coke guide.
4. Operates door machine in replacing door after coke has been pushed from oven.
5. Replaces safety bars, where used, on oven doors, after doors are replaced.
6. Assists in luting of doors and cleaning of burned clay and tar deposits from doors and door jambs. Cleans coke and debris from walks and tracks.
7. Performs Luterman's duties in addition to Door Machine Operator's duties when batteries are operating at reduced tonnage.

The above statement reflects the general details considered necessary to describe the principal functions of the job identified. Read, and shall not be construed as a detailed description of all of the work requirements that may be inherent in the job.

MASTER JOB CLASSIFICATION

JOB TITLE DOOR MACHINE OPERATOR Job No. 11

Factor	Reason for Classification	Code	Classification
1.	PRE-EMPLOYMENT TRAINING This job requires the mentality to learn to: Operate door machine in removing and replacing coke oven doors. Requires judgment.	B	.3
2.	EMPLOYMENT TRAINING AND EXPERIENCE This job requires experience on this or related work of from 3 to 6 months of continuous progress to become proficient.	B	.4
3.	MENTAL SKILL Operates door machine on repetitive work. Recognize obvious defects and correct.	B	1.0
4.	MANUAL SKILL Operates door machine controls and uses hand tools in cleaning, etc.	B	.5
5.	RESPONSIBILITY FOR MATERIAL Ordinary care required. Improper positioning of coke guide or improper signals to Pusher Operator before quencher car is in position to receive coke would result in spillage. Clean-up cost \$50 or under.	B	.3
6.	RESPONSIBILITY FOR TOOLS AND EQUIPMENT Moderate care and attention required to prevent damage to door machine and coke guide.	C	.7
7.	RESPONSIBILITY FOR OPERATIONS Operates integral part of battery equipment. Responsible for continuity of coke oven operation.	D	2.0
8.	RESPONSIBILITY FOR SAFETY OF OTHERS Operates door machine where others are exposed but probability of accident is low.	C	.8
9.	MENTAL EFFORT Moderate mental and visual application required in following sequence of operations and operating door machine.	C	1.0
10.	PHYSICAL EFFORT Moderate physical exertion required to operate door machine controls. Uses hand tools in cleaning doors and door jambs, cleaning walks, luting, etc.	C	.8
11.	SURROUNDINGS Exposed to extreme heat, dust and fumes. Works outside in all weather.	E	3.0
12.	HAZARD Accident hazard moderate. Exposed to hot coke and moving equipment.	B	.4
Total			11.2

Job Class 11

MASTER JOB CLASSIFICATION

Job No. 12

JOB TITLE DOOR CLEANER

Factor	Reason for Classification	Code	Classification
1.	PRE-EMPLOYMENT TRAINING This job requires the mentality to learn to carry out the highly repetitive task of scraping carbon from doors and jambs. Operate powered elevator car where little judgment is required.	A	Base
2.	EMPLOYMENT TRAINING AND EXPERIENCE This job requires experience on this or related work of up to and including 2 months.	A	Base
3.	MENTAL SKILL Perform simple highly repetitive routine task of scraping carbon and residue from coke oven doors and jambs.	A	Base
4.	MANUAL SKILL Uses cutter bars to cut in door and scraper bar to clean jambs.	B	.5
5.	RESPONSIBILITY FOR MATERIAL Perform simple task of scraping carbon from door where damage to material is not likely. UNDER \$50	A	Base
6.	RESPONSIBILITY FOR TOOLS AND EQUIPMENT Some attention and care required to recognize obvious trouble and shut down elevator car to minimize damage.	B	.2
7.	RESPONSIBILITY FOR OPERATIONS Performs service function closely associated with major production unit.	C	1.0
8.	RESPONSIBILITY FOR SAFETY OF OTHERS Ordinary care required to prevent injury when coordinating with crew or when operating elevator car where another crewman is occasionally exposed.	B	.4
9.	MENTAL EFFORT Light mental application required to perform work of scraping carbon from doors and jambs requiring some coordination with process.	B	.5
10.	PHYSICAL EFFORT Moderate physical exertion required to use medium weight tools to scrape carbon, shovel spillage and clean up work area and equipment.	C	.8
11.	SURROUNDINGS Exposed to extreme heat approaching the point of endurance, dust, dirt and fumes when cleaning doors and jambs.	E	3.0
12.	HAZARD Exposed to moderate accident hazards from working around moving machinery and hot coke. Subject to moderate burns, fractures and severe bruises.	B	.4
Job Class 7			Level 5.8

MASTER JOB DESCRIPTION and CLASSIFICATION

Job No. 12

DEPARTMENT COKE PLANT JOB TITLE DOOR CLEANER
 SUB DIVISION BATTERIES DATE 1-1-63

MASTER JOB DESCRIPTION

PRIMARY FUNCTION:

Cleans doors and jambs on coke ovens.

TOOLS AND EQUIPMENT:

Cleaning tools such as scrapers, bars, brooms, shovel, elevator car, etc.

MATERIALS:

Coal and/or coke.

SOURCE OF SUPERVISION:

Foreman

DIRECTION EXERCISED:

None

WORKING PROCEDURE:

1. Cleans carbon, tar, mud and residue from oven doors, jambs and sill plates with hand tools such as cutter bars or scrapers.
2. Shovels and disposes of debris and spillage.
3. Extinguishes fires around oven doors.
4. Opens and closes chuck door with bar.
5. Dumps spillage hoppers.
6. Shovels and sweeps coke spillage, etc., from bench into oven or wheelbarrow.
7. Operates controls on elevator car to reach top of door of jamb.

The above statement reflects the general details considered necessary to describe the principal functions of the job itself. It shall not be construed as a detailed description of all of the work requirements that may be inherent in the job.

MASTER JOB DESCRIPTION and CLASSIFICATION

Job No. 13

DEPARTMENT COKE PLANT JOB TITLE QUENCHER CAR OPERATOR

SUB DIVISION BATTERIES DATE 1-1-63

MASTER JOB DESCRIPTION

PRIMARY FUNCTION:

Operates quench car to transport coke to quencher and coke wharf.

TOOLS AND EQUIPMENT:

Quench car, bars, shovels, brooms.

MATERIALS:

Coke, water.

SOURCE OF SUPERVISION:

Foreman

DIRECTION EXERCISED:

None

WORKING PROCEDURE:

1. Checks quench car for operating condition.
2. Spots quench car beside coke guide according to coke oven pushing schedule.
3. Moves car when oven is pushed so as to distribute hot coke evenly in quench car.
4. Travels with hot coke to quenching tower and positions quench car under sprays.
5. Pushes control button at quench tower to turn on water sprays which shut off automatically based on preset time cycle.
6. Travels with quenched coke to wharf and dumps coke.
7. Cleans up coke spillage.
8. Reports need for quench car repairs to supervision.
9. Keeps cab in clean and orderly condition.

MASTER JOB CLASSIFICATION

JOB TITLE QUENCHER CAR OPERATOR Job No. 13

Factor	Reason for Classification	Code	Classification
1.	PRE-EMPLOYMENT TRAINING This job requires the mentality to learn to: Exercise judgment in the operation of quencher car to distribute coke properly, follow pushing schedule.	B	.3
2.	EMPLOYMENT TRAINING AND EXPERIENCE This job requires experience on this or related work of 3 to 6 months inclusive.	B	.4
3.	MENTAL SKILL Make minor changes in routine in repetitive operation of quencher car involving oven selection and positioning of car.	B	1.0
4.	MANUAL SKILL Operate variable controls to control movement and dumping of quencher car.	B	.5
5.	RESPONSIBILITY FOR MATERIAL Use ordinary care to prevent damage. Mechanically transport material not easily damaged. Loss of coke and cost of cleanup labor would normally not exceed \$50.	B	.3
6.	RESPONSIBILITY FOR TOOLS AND EQUIPMENT Moderate attention and care to prevent damage to quencher car by collision.	C	.7
7.	RESPONSIBILITY FOR OPERATIONS Handle coke from coke oven batteries with quencher car.	C	1.0
8.	RESPONSIBILITY FOR SAFETY OF OTHERS Operate power driven equipment where others are exposed but probability of accident is low.	C	.8
9.	MENTAL EFFORT Light mental or visual application required to operate quencher car where there is some variety but action to be taken and decisions to be made are limited.	B	.5
10.	PHYSICAL EFFORT Light physical exertion required to operate quencher car, clean tracks.	B	.3
11.	SURROUNDINGS Exposed to extreme heat for intervals but not extended periods.	C	.8
12.	HAZARD Accident hazard moderate. Occasionally exposed to hot objects that may cause moderate burns.	B	.4
		Total 7.0	

The above statement reflects the general details considered necessary to describe the principal functions of the job identified, and shall not be construed as a detailed description of all of the work requirements that may be inherent in the job.

MASTER JOB CLASSIFICATION

JOB TITLE OVEN PATCHER Job No. 15

MASTER JOB DESCRIPTION and CLASSIFICATION

Job No. 15

DEPARTMENT COKE PLANT JOB TITLE OVEN PATCHER

SUB DIVISION BATTERIES DATE 1-1-63

MASTER JOB DESCRIPTION

PRIMARY FUNCTION:

Patches coke ovens and auxiliary equipment with refractory slurries.

TOOLS AND EQUIPMENT:

Trowels, chisel bars, cement spray guns, hammers, screwdrivers, sand blast machine, etc.

MATERIALS:

Refractory cements, water, sodium silicate, asbestos rope, etc.

SOURCE OF SUPERVISION:

Supervised by Patcher Foreman. Not closely supervised. Patcher Foreman generally has several crews working throughout plant.

DIRECTION EXERCISED:

Directs Patcher Helper.

WORKING PROCEDURE:

1. Receives instructions from Patcher Foreman as to materials to be used in patching.
2. Mixes required slurries to proportions as specified by Foreman.
3. Patches oven door jams with cement spray gun or hand trowel, refits jamb castings, replaces oven floor brick, lines doors, standpipes and goosenecks.
4. Packs bulkheads and windboxes with asbestos and clay slurry; packs joints and cracks in standpipe - gooseneck assembly.
5. Repairs joints and goosenecks.
6. Patches oven gas guns; patches battery tops, pinion walls, regenerator walls, stack damper hoods, spalled oven walls, etc.
7. Resets charging hole castings.
8. Occasionally shapes bricks roughly.
9. Assists in unloading refractory cements, etc.

The above statement reflects the general details considered necessary to describe the principal functions of the job. Identical, but shall not be construed as a detailed description of all of the work requirements that may be inherent in the job.

Factor	Reason for Classification	Code	Classification
1.	PRE-EMPLOYMENT TRAINING This job requires the mentality to learn to perform manual tasks in patching doors and ovens requiring judgment.	B	.3
2.	EMPLOYMENT TRAINING AND EXPERIENCE This job requires experience on this or related work of from 7 to 12 months of continuous progress to become proficient.	C	.8
3.	MENTAL SKILL Exercise judgment in patching and repairing coke ovens and auxiliary equipment.	C	1.6
4.	MANUAL SKILL Uses hand tools and operates cement gun and sand blast machine.	B	.5
5.	RESPONSIBILITY FOR MATERIAL Ordinary care required to prevent damage. Waste refractory material, etc. \$50 or under	B	.3
6.	RESPONSIBILITY FOR TOOLS AND EQUIPMENT Some attention and care required to prevent damage to cement gun and sand blast machine.	B 10	.2
7.	RESPONSIBILITY FOR OPERATIONS Responsible for maintaining patching work on coke ovens.	D	2.0
8.	RESPONSIBILITY FOR SAFETY OF OTHERS Ordinary care and attention required. Works with others where individual acts may injure others.	B	.4
9.	MENTAL EFFORT Light mental and visual application required to perform oven patching and repair work where there is some variety, but actions to be taken and decisions to be made are limited to few possibilities.	B	.5
10.	PHYSICAL EFFORT Moderate physical exertion required to use hand tools and operate cement gun, etc. Unloads refractory cements and materials.	C	.8
11.	SURROUNDINGS Exposed to extreme heat while working on batteries. Exposed to extreme conditions of dust and fumes.	D	1.6
12.	HAZARD Works around moving equipment such as larry cars, pushers, etc. Exposed to flames and hot materials and equipment.	C	.8
Total			9.8

Job Class 10

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16. Abstracts Work practices of coke oven workers are examined in order to find procedures to reduce exposures to coke oven emissions from coke producing operations. Evaluation were made of each job, the feasibility of the use of respirators, construction of filtered air and conditioned air booths, administrative controls, and general operating procedures. Because of widely varying coke plants in the United States, only general recommendations are made, among them some relating to the charging of coal, the coking of the coal charge and the pushing of coke. Other recommendations are: individual plant surveys to define local problem areas; engineering controls; definition of exposure time; and abandonment of the coal tar pitch volatile standard of emission which is deemed not applicable to coke-oven emissions.

17. Key Words and Document Analysis. 17a. Descriptors

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