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INHALABLE PARTICULATE SOURCE CATEGORY REPORT FOR THE METALLURGICAL COKE INDUSTRY

Draft Final Report

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SECTION 1

INTRODUCTION

The purpose of this program was to provide a summary of the best available information on particulate matter emissions in the Metallurgical Coke Manufacturing industry. The program objective was to develop reliable total and size specific emission factors. This included total particulate emission rates and particle sizing data, where available, for controlled and uncontrolled sources.

A second objective of this program was to prepare an update of Section 7.2, Coke Manufacturing, in AP-42 "A Compilation of Emission Factors," which was last revised in October 1980. An additional objective was to investigate and present a current description of the Metallurgical Coke Manufacturing industry.

An intensive literature search was conducted and the obtained particulate and particle size emissions data were reviewed, analyzed, summarized and rankec according to the criteria provided in the report "Technical Procedures for Developing AP-42 Emission Factors and Preparing AP-42 Sections," April 1980. The data were rated as follows:

- A = Tests performed by a sound methodology and reported in enough detail for adequate validation. These tests are not necessarily EPA reference method tests, although such reference methods are certainly to be used as a guide.
- B = Tests that are performed by a generally sound methodology but lack enough detail for adequate validation.
- C = Tests that are based on an untested or new methodology or that lack a significant amount of background data.
- D = Tests that are based on a generally unacceptable method but may provide an order-of-magnitude value for the source.

After ranking the obtained data, emission factors were calculated using the highest quality data available. The quality of the data used to develop each emission factor is indicated by the emission factor rating. The following ratings were applied to each emission factor:

- A = Excellent--Developed from A-rated test data taken from many randomly chosen facilities in the industry population. This source category* is specific enough to minimize variability within the source category population.

- B = Above Average--Developed only from A-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industries. As with the A rating, the source category is specific enough to minimize variability within the source category population.

- C = Average--Developed only from A- and B-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. As with the A rating, the source category is specific enough to minimize variability within the source category population.

- D = Below Average--The emission factor was developed only from A- and B-rated test data from a small number of facilities, and there may be reason to suspect that these facilities do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of the emission factor are footnoted in the emission factor table.

- E = Poor--The emission factor was developed from C- and D-rated test data, and there may be reason to suspect that the facilities tested do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of these factors are always footnoted.

Process and control system operating data as well as general industry description information were obtained, evaluated, summarized and presented as general background information. It was not the objective of this program to provide detailed engineering analyses, product specifications, or detailed evaluations of trends in the industry.

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*Source category: A category in the emission factor table for which an emission factor has been calculated; generally a single process.

This report is structured according to the "Outline for Source Category Reports" which was included in the technical directive to conduct this program. There is necessary duplication of information between Section 4, the proposed AP-42 section, and Sections 1 through 3 of the report in order that the proposed Section 4 can stand alone once inserted into AP-42.

No environmental measurements were conducted during this program, therefore, no separate QA section is contained in this report. The quality of the existing data has been evaluated as described above.

SECTION 2

INDUSTRY DESCRIPTION

The U.S. Metallurgical Coke Manufacturing Industry is comprised of 40 to 50 production facilities. Basically, a coke plant converts coal into coke by thermal distillation. Virtually all coke plants heat coal (usually blending different grade coals) in slot or by-product ovens. The temperature in these ovens is usually in excess of 2,000°F, with the temperature being dependant on the grade or quality of coke desired. The coal is heated for 12 to 30 hours and then removed from the ovens. The resulting coke is quickly cooled by quenching with water.

The coke formed is a solid form of carbon with very little volatile matter. There are many types of coke that can be made by varying the coking time and temperature; however, the majority of the coke produced is blast furnace coke. Figure 1 shows the United States coke plant production for the years 1962 through 1982.

Metallurgical blast furnace coke is defined as a strong and porous carbonaceous residue resulting from the high temperature distillation of selected grades of bituminous coals.[1] Blast furnace coke is produced in batch operations in by-product coke ovens.

The major processes involved in coke production by the by-product method are:

1. Coal Handling
2. Preheating, if required
3. Coal Charging
4. Coke Oven Combustion (underfiring)
5. Coke Pushing

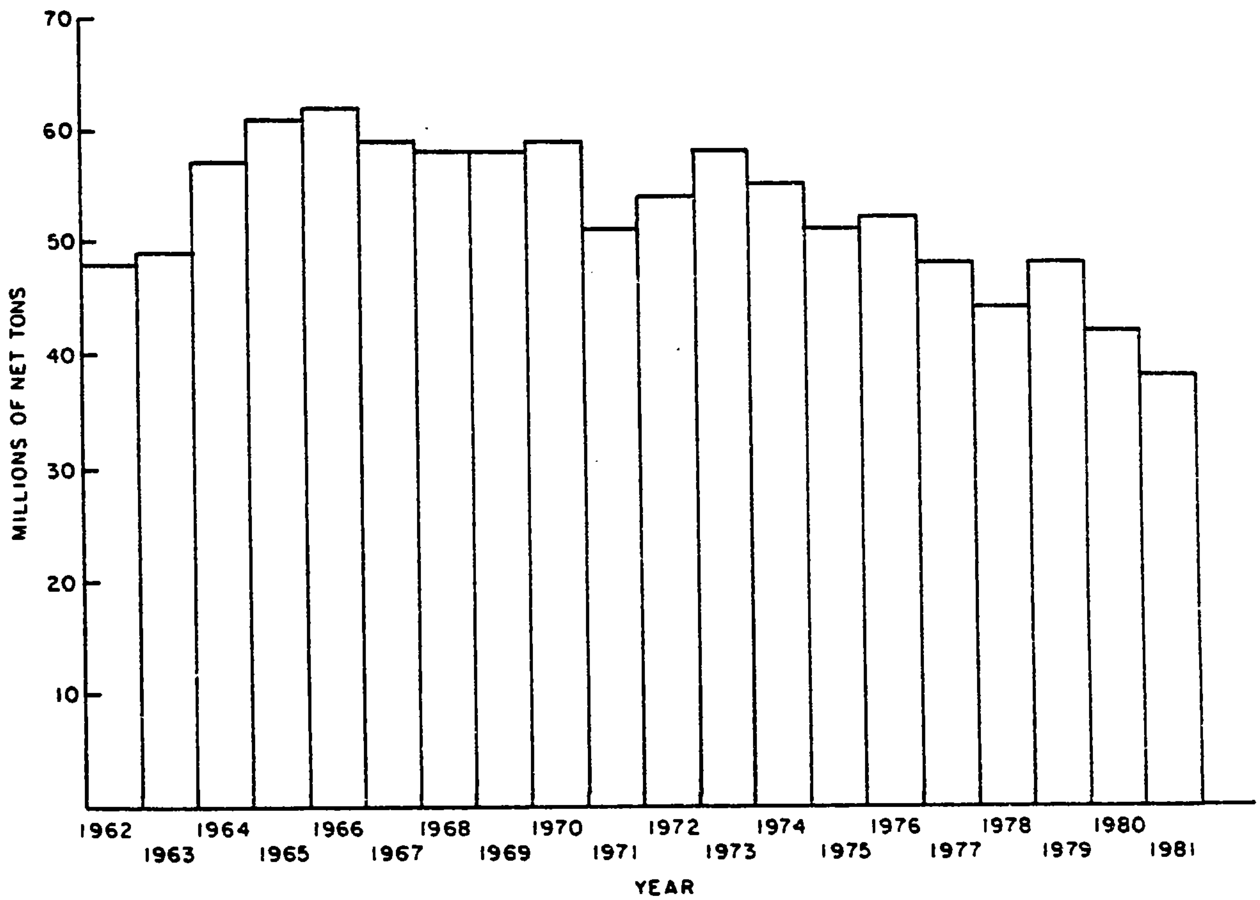


Figure 1. Metallurgical coke production in the U.S. (tons x 10^6).[1,10,11]

6. Coke Quenching

7. Coke Handling

There are specific emission problems related to each process. Each will be discussed in this section. A flow diagram representing the major and minor processes in the manufacture of coke is presented in Figure 2. A schematic showing the major emission sources from by-product coke ovens is given in Figure 3.

By-product ovens consist of three main parts, the coking chamber, heating chamber and regenerative chamber. These are all lined with refractory brick. The coking chamber dimensions vary from 30 to 43 feet long, 6 to 20 feet high, and 12 to 22 inches wide.[2] The ovens are arranged side by side. The heating chamber is located between the coking chambers; the regenerative chambers are underneath. A series of 10 to 100 ovens comprise a coke battery.

The coal is crushed, blended and charged into the hot ovens. The coal can be charged either wet or dry. Wet coal is usually charged by a larry car whereas dry or preheated coal can be charged either by a larry car, in a pipeline, or a conveyor system. The coal is heated for a predetermined time, and the resultant coke is pushed into a quench car located on rails along the battery. The quench cars carry incandescent coke to quench towers, in which water is sprayed on the coke to rapidly cool it. The quenched coke is then transferred to the coke wharf where it is sent by conveyors to be screened for removal of fines.

COAL HANDLING, CRUSHING AND BLENDING

Before coal can be converted to coke, it must first be pulverized so that 80 to 90 percent of the coal is less than an 1/8 in. in size. There is also a need to usually blend two or more types of coal (low, medium and high volatile) to produce the desired qualities in the coke. The blending of coals helps produce better by-products and extend life of coke oven walls by avoiding excessive pressure on the walls caused by expansion of the coal.

After the pulverized coal is mixed and blended, water or oil are sometimes added to control the coal's bulk density. The mixture is then transported to storage bunkers to await charging.

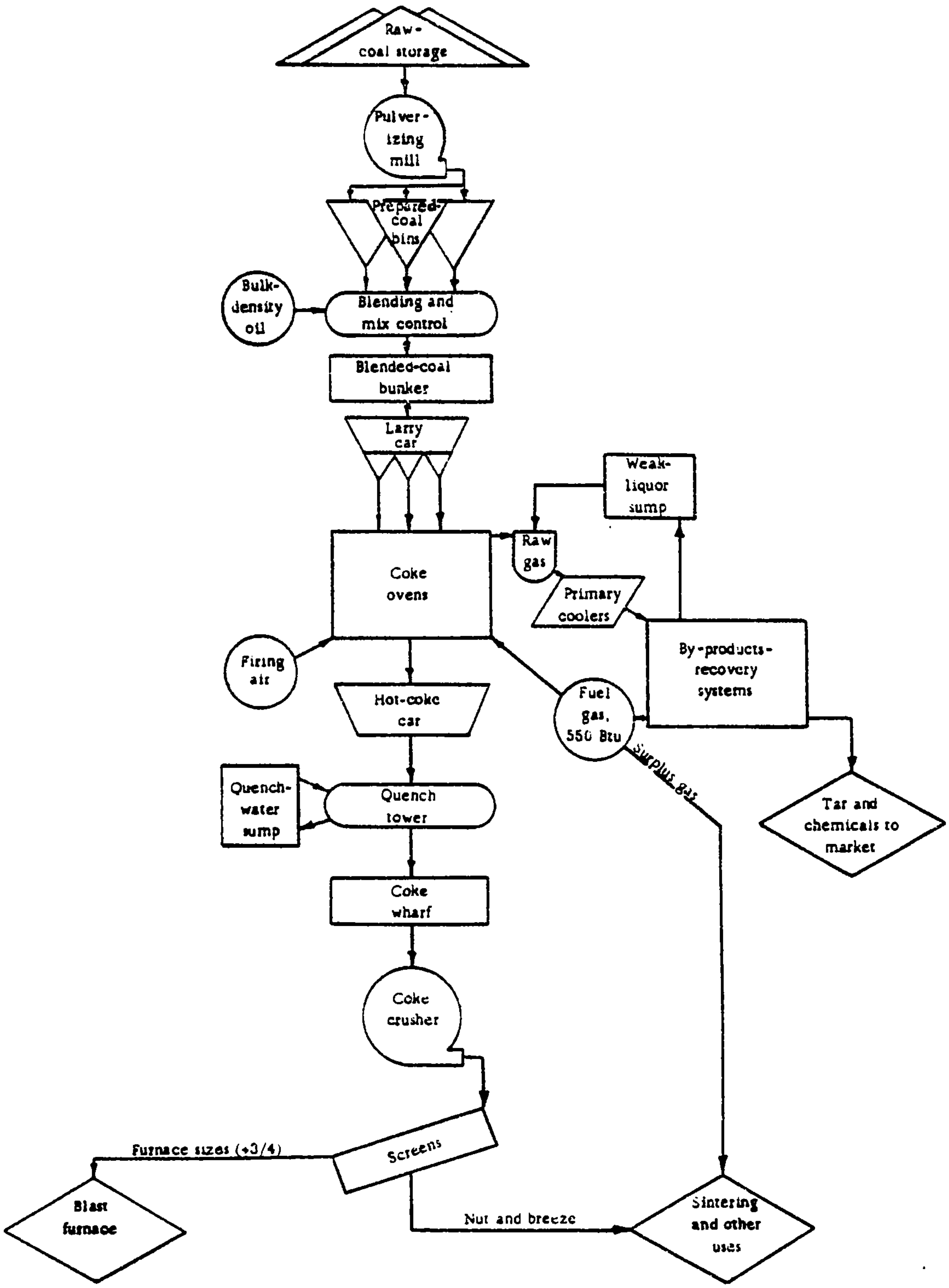


Figure 2. Flow sheet showing the major steps involved in the carbonization of coal by the by-product process.[1]

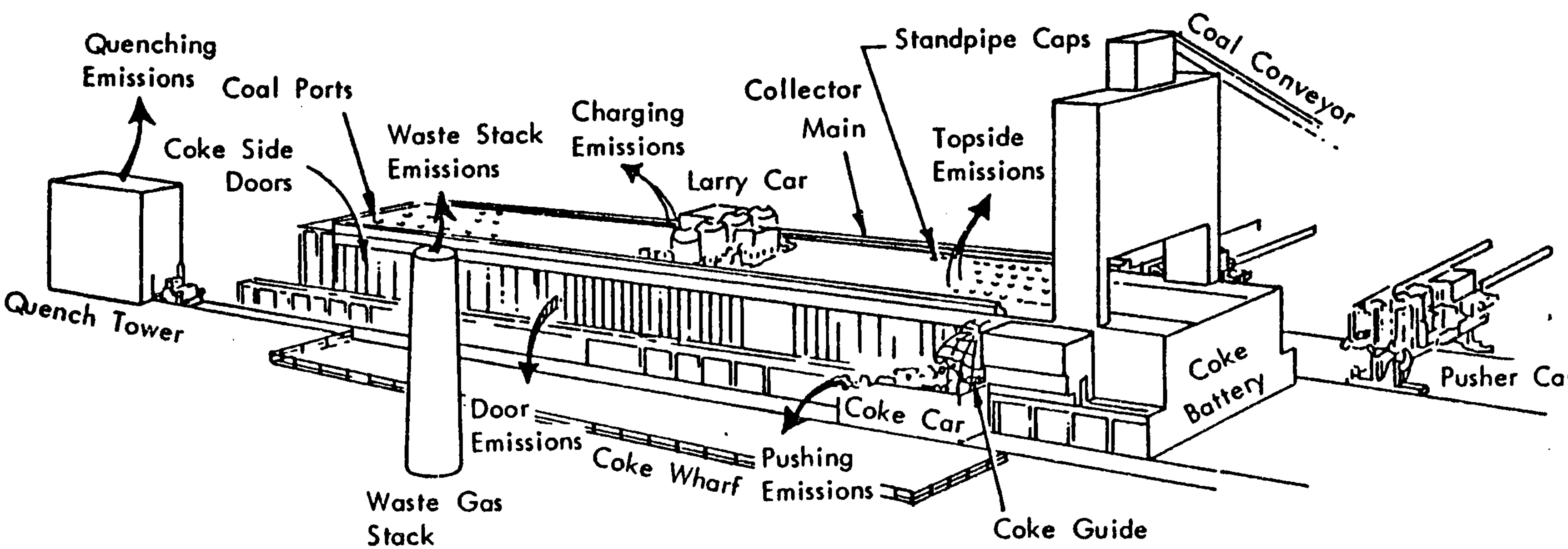


Figure 3. Schematic of a diagram of by-product coke oven showing major emission sources.[4]

The principal emissions generated during these operations occurs when crushing the coal. This, however, takes place in an enclosed area and most of the emissions are contained. There are some minor emission problems that occur when transferring material from conveyor to conveyor or conveyor to shed. A flow-diagram of a typical coal handling system in shown in Figure 4.

COAL PREHEATING

Coal preheating is a process of flash drying coal to remove moisture. The process has recently been applied to several batteries in the U.S. which represent about 10 percent of the U.S. coke production capacity. The operation consists of a two-step process. The first step is the actual heating of the coal for drying, and the second is the charging of the hot coal into the ovens.

The pulverized coal is initially heated in a fluidized preheating column to temperatures of 400 to 500°F. The flash-dried coal is carried up the column with the hot combustion gases and separated out by a series of primary and secondary cyclones. Some preheating systems use a two-stage drying process.

Three techniques are presently used to charge preheated coal in the U.S., i.e.: pipeline (Coaltek®), conveyor (Pre carbon) and hot larry car (Simcar).

The pipeline system is completely enclosed. The coal is transported via a pipeline into the ovens. The method of coal transport is usually superheated steam. The conveyor method is a two-step process. The hot coal is initially transported by a chain conveyor into a series of weigh hoppers. From the hoppers, coal travels along the battery via conveyors to a charging buggy where it is gravity fed into the ovens.

The hot larry car method of charging is somewhat similar to conventional charging. The hot coal is discharged from feed bunkers into the charge car. The car travels to the oven to be charged and is aligned over the charging ports. Due to the fluid properties of preheated coal, a leveler bar is usually unnecessary when using either of the three dry coal charging methods.

The main advantages of dry coal charging are: poor grade coals can be used for coking, oven throughput is increased, the coke produced is of better quality (when using poorer grade coal), and the coking temperature in the oven

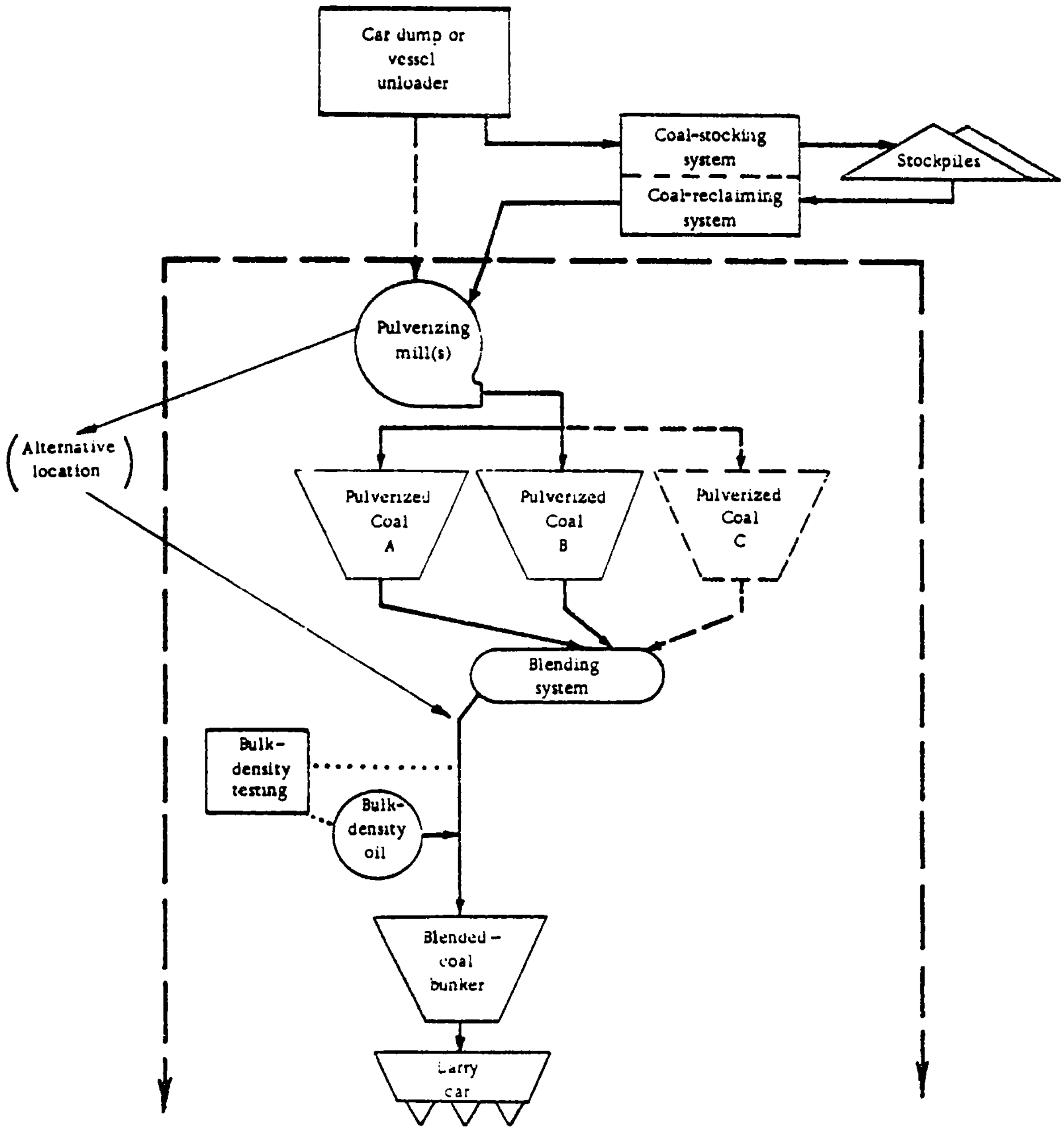


Figure 4. Generalized coal-handling system.[1]

is more uniform. The disadvantages of preheating coal are: more fines are produced in the byproduct gas, increased costs and complexity in the preheating facility, and additional facilities for solids handling and transport are required.

Preheater emissions are controlled by conventional cleaning devices, either low-energy venturi scrubbers or dry electrostatic precipitators. Leaks occassionally occur from pipeline charging systems due to the positive pressure exerted in the ovens which forces emissions out through improperly sealed lids, doors, etc. Conveyor and hot larry car charging cause emission problems similar to conventional wet coal charging. These emissions are discussed in the following section.

WET COAL CHARGING

After the coal is crushed and blended, if it is not preheated, it is charged directly into the coke ovens at ambient temperature. The blended coal is usually transported by conveyor belts to large coal bunkers situated on top of the coke oven battery. A large rail-type vehicle, called a larry car, receives a weighted or volume amount of coal from the coal bunker. The total coal amount is then distributed into three to four hoppers mounted on the larry car. The larry car then traverses the length of the coke battery until reaching the oven to be charged. Once the larry car is aligned over the ovens charging ports, moveable sleeves connect each of the hoppers with its respective port and the coal is fed in. Coal feed is accomplished by gravity, screwfeeds or turntable mechanisms. The coal tends to cone up under the charging ports requiring leveling by a leveler bar located on the push machine. The bar is inserted through the chuck door on the pusher side of the oven. The leveler bar moves back and forth leveling the coal in the oven.

Wet Coal charging is considered one of the more significant sources of emissions at a coke plant. When the coal enters the incandescent oven, a large volume of steam, gas and smoke are generated; increasing the pressure in the oven. The steam evolves from the moisture in the coal while the gasses result from the removal of volatile constituents in the coal. There are also significant amounts of particulate matter generated during the charging sequence which are emitted into the atmosphere through poorly sealed charge ports, oven doors, and/or standpipe caps.

Two different techniques for charging wet coal have been developed to alleviate some of the emissions resulting from the charging process. These techniques are referred to as stage charging and sequential charging.

Stage charging was developed in England in the 1950's and later applied in the U.S.[3] It is an operating technique where coal is charged from the larry car hoppers into an oven in a predetermined sequence. The oven is usually charged under negative pressure. The negative pressure (aspiration) is provided by using a steam injector located within the gooseneck of the ascension pipe (standpipe) which connects the oven to the collector main. The stage charging technique is shown in Figure 5.

The most important requirement for good stage charging involves adequate steam aspiration. A negative pressure must be maintained in the oven during charging to avoid any smoke or gas leakage from the charging ports or oven doors. However, too high an aspiration pressure can cause coal fines to be pulled into the collector main. Additionally, good stage charging requires clean (unobstructed) ascension pipe and gooseneck gas passages. These are areas where carbon builds-up and, therefore, must be cleaned continuously.

Sequential charging is very similar to stage charging. The EPA defines the two types of wet charging techniques as follows:[3]

Stage Charging -	a procedure where a maximum of two hoppers are discharging at the same time.
Sequential Charging -	a procedure where the first hoppers are still discharging when subsequent hoppers begin dumping.

The oven is also aspirated during sequential charging. The main objectives accomplished by sequential charging are quicker charge times and a more level charge within the oven. Usually, in an oven with four charging ports, the two outside ports are charged together, the third port is charged 20 seconds later and the last port 20 seconds after that. Figure 6 illustrates the steps in sequential charging.

A third type of system, somewhat being used to control charging emissions, is to use a scrubber system mounted on the larry car. Figure 7 shows this type of system.

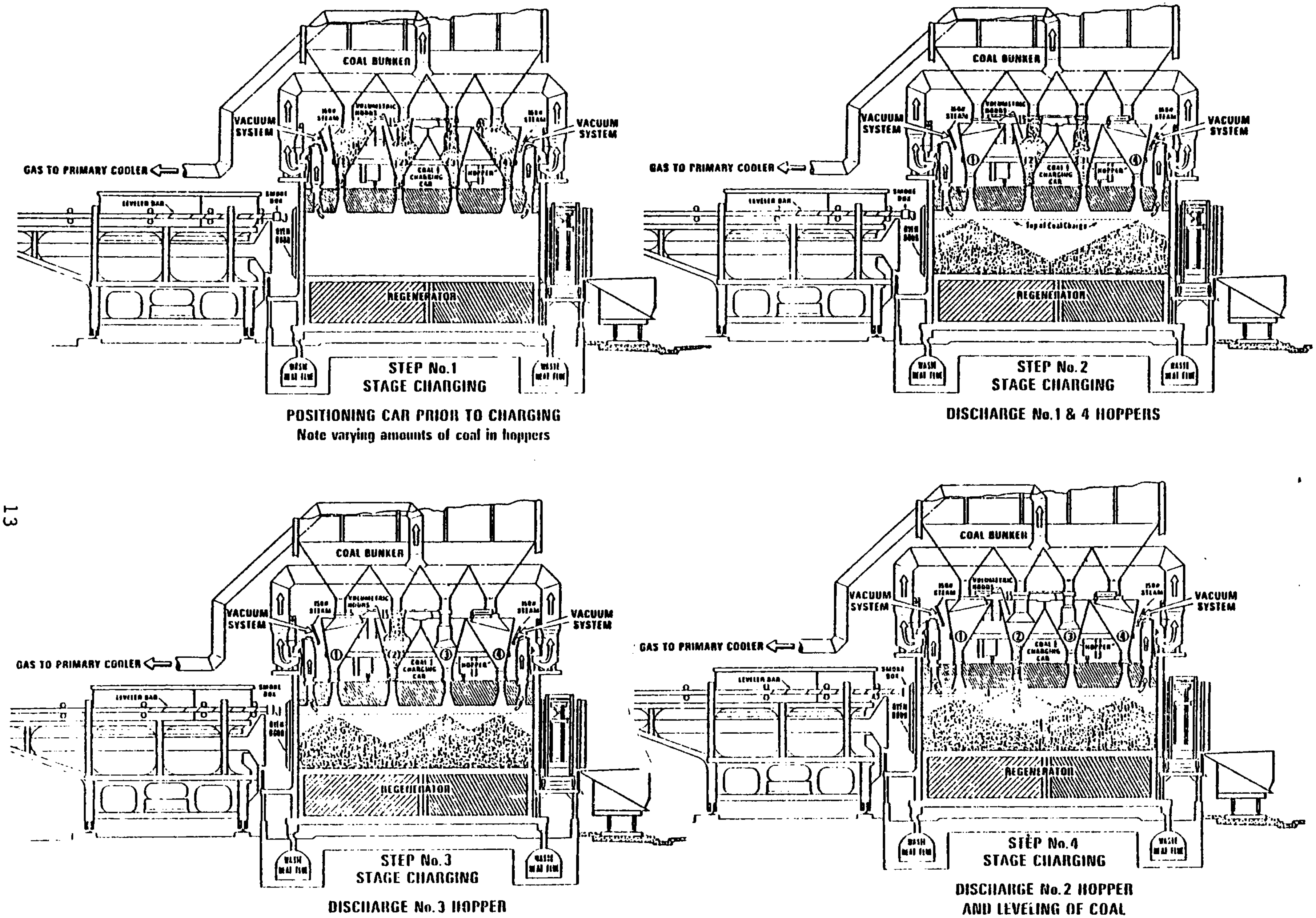


Figure 5. "Stage Charging on a Single Collector Main Battery - A Total System Concept", by F.M. Clark, U.S.S.C., Fairfield, Alabama.

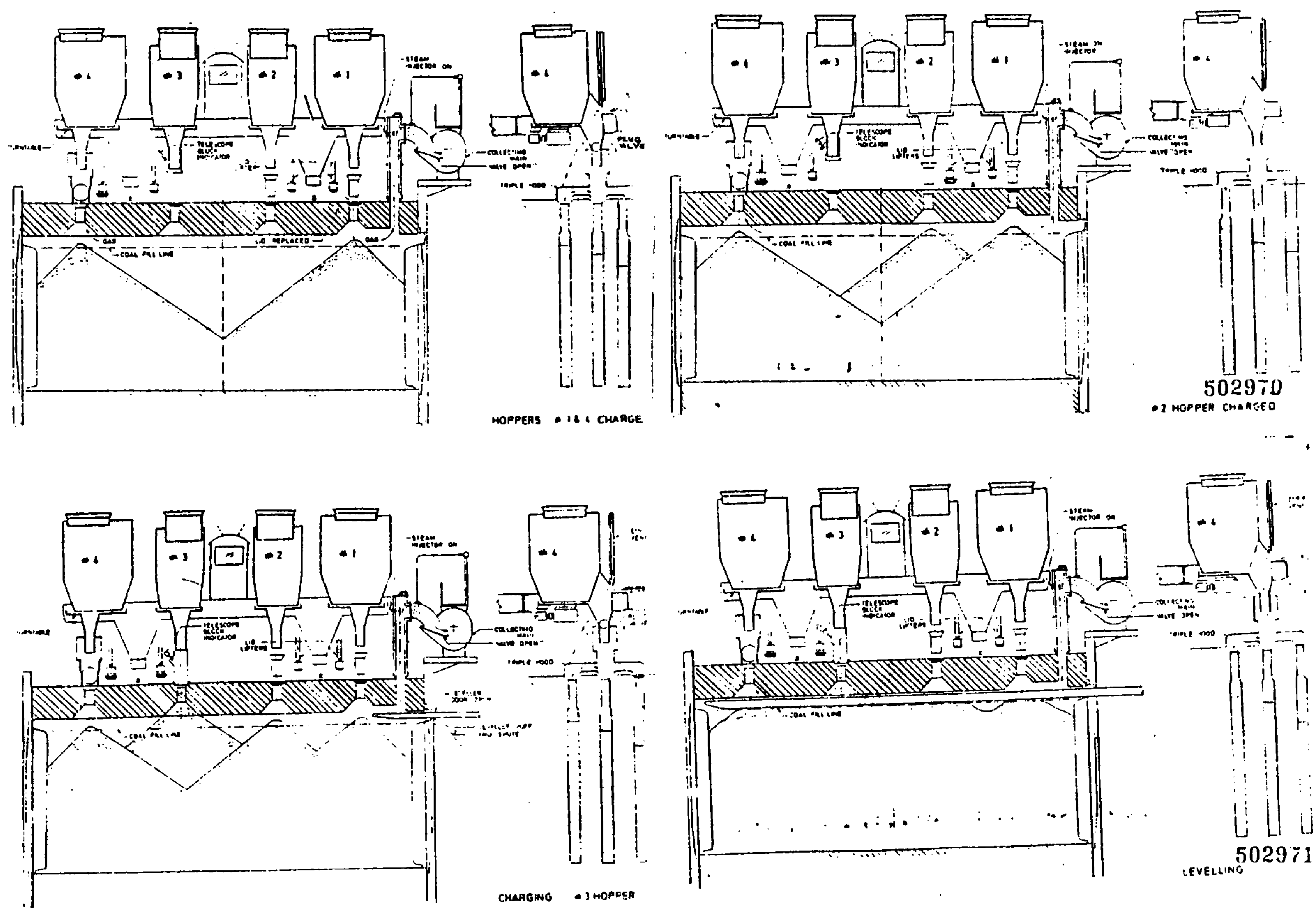


Figure 6. Sequential smokeless charging car from John M. Henderson and Co. Ltd., mechanical engineers.

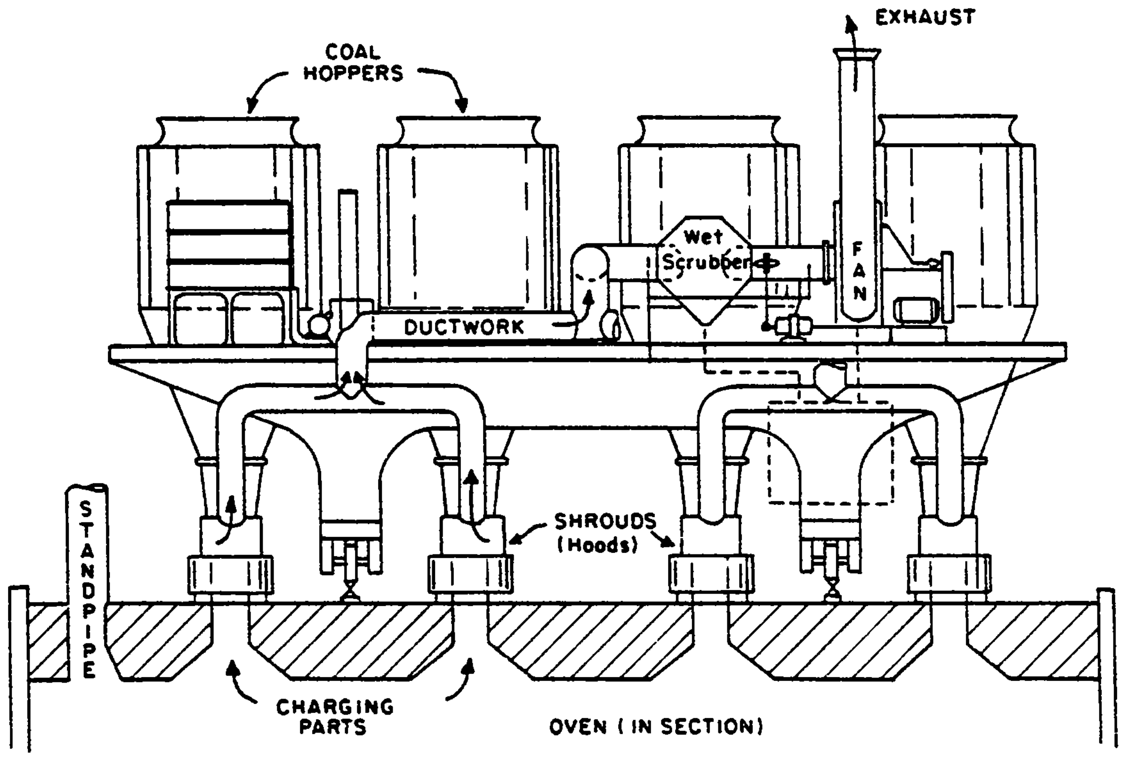


Figure 7. Representative scrubber system on a larry car.[3]

This system works by capturing emissions collected in the charging sleeves of the larry car. Some of the volatile organics are ignited at the base of the charging sleeve. The remainder of the gas and smoke enters the scrubber where the particulates are knocked out by a water spray. When the larry car returns to the coal bunker for another load of coal, it then must dump its dirty water and collect clean water for the scrubber.

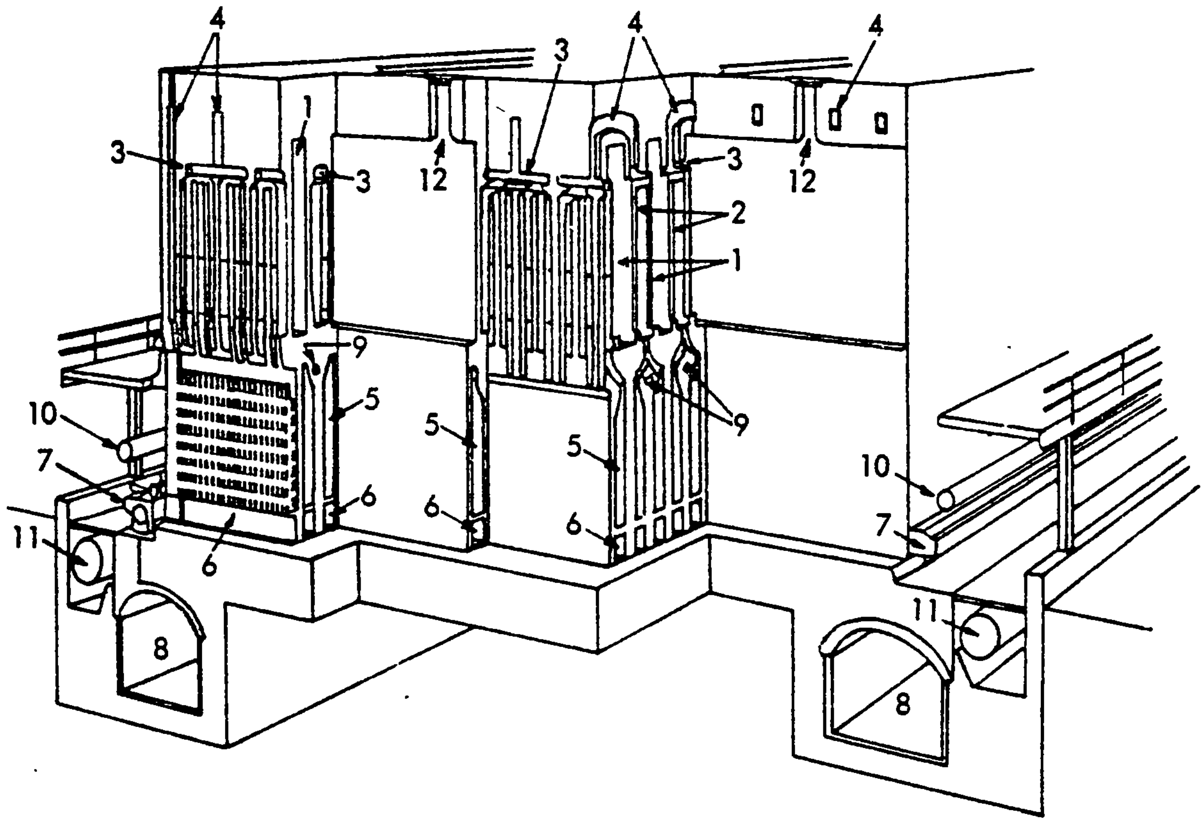
There are many problems with this type of system in comparison to stage or sequential charging including; higher cost, significant maintenance, and scrubber waste water disposal concerns. The most successful larry car mounted scrubber units are operated abroad (in Europe and Japan).

It is very difficult to assess the effectiveness of these three types of charging systems in reducing emissions. Mass emissions have not yet been measured during stage charging operations because of difficulties in collecting samples. Thus, any determination of effectiveness is currently done by visible emissions observations. Mass emission tests have been performed on a sequential charging system (the AISI/EPA Larry Car) and on larry car-mounted scrubber systems. The results of these tests are given in Section 3 of this report.

COKE OVEN UNDERFIRING

The coal that is charged into the ovens is heated to very high temperatures; temperatures that are typically in excess of 2000°F. The heat is obtained by burning fuel in long flues between the ovens. Thus, one flue is used to heat one wall of each adjacent two ovens. The main differences between by-product coke ovens is in the arrangement of the flues and other components of the underfiring system.

There are two main types of underfiring systems: underjet and gun flue. The underjet system utilizes vertical gas lines with orifices in the line to feed fuel to the flue. The gun flue system, depicted in Figure 8, utilizes a horizontal header between each set of ovens which has nozzles set into it. The fuel flows through the header to the nozzles at the bottom of the flue.



1. Oven chamber
2. Vertical combustion flues
3. Horizontal flues
4. Cross-over flues
5. Regenerators
6. Oven sole flues
7. Gas and air connections to waste-gas flue
8. Waste-gas flues
9. Gas ducts for coke-oven gas
10. Oven gas main
11. Blast-furnace gas main
12. Charging holes

Figure 8. Cut-away section showing a typical gun flue heating system.[4/2]

The underfiring of practically all batteries is dependent on the natural draft provided by the stack. There are no fans used on combustion stacks where no control device is in place. The ovens are operated, during the coking process, under a positive pressure; while the flues are operated at near or below atmospheric pressure.

The two main fuel types used for coke oven heating are blast furnace gas (BFG) and/or coke oven gas (COG). Natural gas and oil are used, but not very often. COG is used much more frequently than BFG. The coking process produces approximately 10,800 scf of COG per ton of coal charged while only 5,700 scf is required to provide the heat needed for the coking process. Raw COG is collected in collector mains, located on top of the coke battery, and sent to the byproducts plant where it is cleaned of various substances such as tars, ammonia and light oils. A process that is becoming increasingly popular is desulfurization of COG. The COG is a very energy rich gas, containing over 50 percent hydrogen and 25 percent methane. It has a heating value of 500 to 550 Btu/scf.[4] BFG is a leaner gas with a heating value of around 80 Btu/scf. The only advantage to BFG is that it has a much lower sulfur content.

There are two possible causes of particulate emissions from coke battery combustion stacks. Specifically, these are improper combustion of fuel and/or oven-to-flue leakage. Improper combustion occurs when there is excess fuel leaking into the flue or section of the regenerator causing a fuel-rich condition. Oven-to-flue leakage occurs when there are actual cracks in the brickwork between the oven and flue.

The other main cause of emissions from coke battery combustion stacks results from the high sulfur content of coke oven gas. This is usually in the form of hydrogen sulfide (H_2S) which can be stripped using existing technology. Blast furnace gas and natural gas do not pose a similar problem because of lower sulfur contents.

The control of coke battery combustion stack emissions is especially difficult because of the fine particle size, low density and low grain loading of the emissions. One of the best ways to control the emissions is by adherence to strict operation and maintenance (O&M) procedures. O&M practices typically involve scheduled oven spray patching in order to seal cracks which have developed in the walls between the flue and oven. Additionally, battery stacks are one of the few sources where conventional air pollution control devices can be installed relatively easily. Thus, there are various types of control devices that have been installed on battery stacks. These include: dry ESP, Charged Droplet Scrubber (CDS), wet ESP, and Fabric Filter. They have all operated with varying degrees of success in controlling particulate emissions from coke combustion stacks.

Dry electrostatic precipitators (ESP) have operated fairly satisfactorily, with mass efficiency ratings ranging from 24 to 90 percent.[4] The efficiency rating is a relationship that is, however, very much dependent on the inlet grain loading. There has also been good success in the control of visible emissions using this type of system. The advantages of the dry ESP is its low operating cost, low pressure drop, and good system reliability. The disadvantages are its large physical size, high initial cost, and dust disposal problems.

The Charged Droplet Scrubber System (CDS) is similar to a wet ESP. However, the CDS applies a high voltage charge directly to the water spray system rather than to a separate electrode wire. Particulate collection is accomplished by direct collision of high energy droplets with particulate greater than 1 μm and electrostatic precipitation.

A prototype CDS had been installed at Kaiser Steel and performed satisfactorily during operation. There were, however, major corrosion problems within the unit which caused extensive downtime. The use of the CDS was terminated after two years and only 360 hours of operating time. The manufacturer stated that the efficiency at higher inlet grain loading stabilizes at about 95 percent. At Kaiser, the prototype CDS was actually 60 to 80 percent efficient.[4]

The main advantages of the CDS are its minimal water utilization, safe operation, smaller physical size, lower capital cost and lower dependence on dust resisitivity and density than ESPs. The major disadvantages of the system are the loss of stack draft due to cooler temperatures which in turn requires induced draft fans, the breakdown of one or more electric fields, major corrosion problems, and sludge and wastewater disposal.

Wet electrostatic precipitators (ESP) have only operated as pilot plant demonstrations in the U.S. Their potential advantage is a higher mass removal efficiency for a given specific collection area. This is the result of reduced dust reentrainment and safe operation. Potential disadvantages would be a higher initial investment, wastewater treatment requirements, corrosion and loss of stack draft.

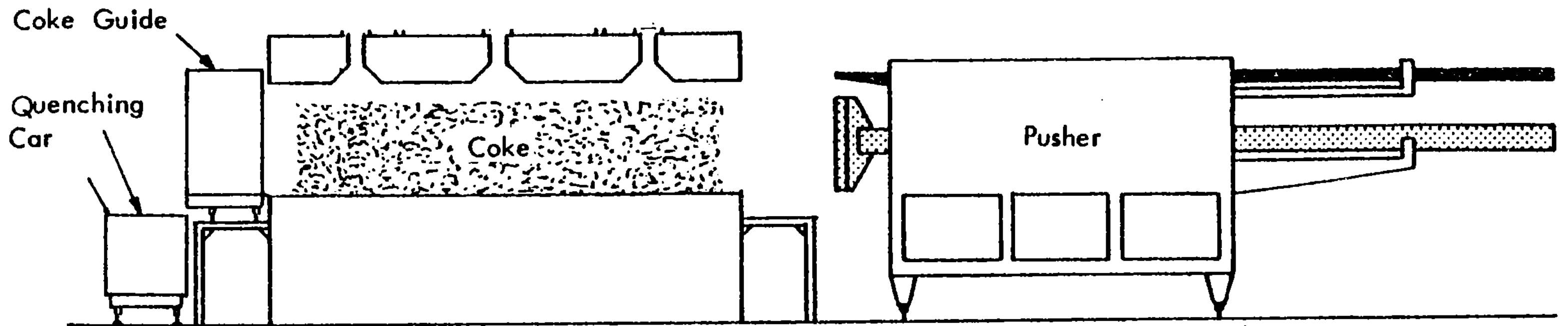
Fabric filter control or baghouses have been tested successfully at Kaiser Steel. These units replaced the prototype CDS system previously attempted for emissios control. The baghouses have shown a collection efficiency of 40 to 60 percent on condensibles and 40 to 90 percent overall.[4] The mass efficiency of front-half catches range from 40 to 99.7 percent and average around 90 percent. The primary advantages of a baghouse system are: dry dust recovery, minimal equipment corrosion, and minimal influence on stack temperature. The main disadvantages with the system are: its large size, high operating cost, the shorter fabric life due to acid particles, and potential fire hazards.

Another potential source of emissions that occur during the coking process is from doors and topside leaks. There has been no adequate method developed to sample topside emissions and so they are quantified only by visible observations. Door leaks have been estimated, however, by testing coke shed emissions during a nonpush cycle. The emissions sampled is then doubled to account for both doors. The door leakage estimate can only be considered on a order of magnitude basis at best.

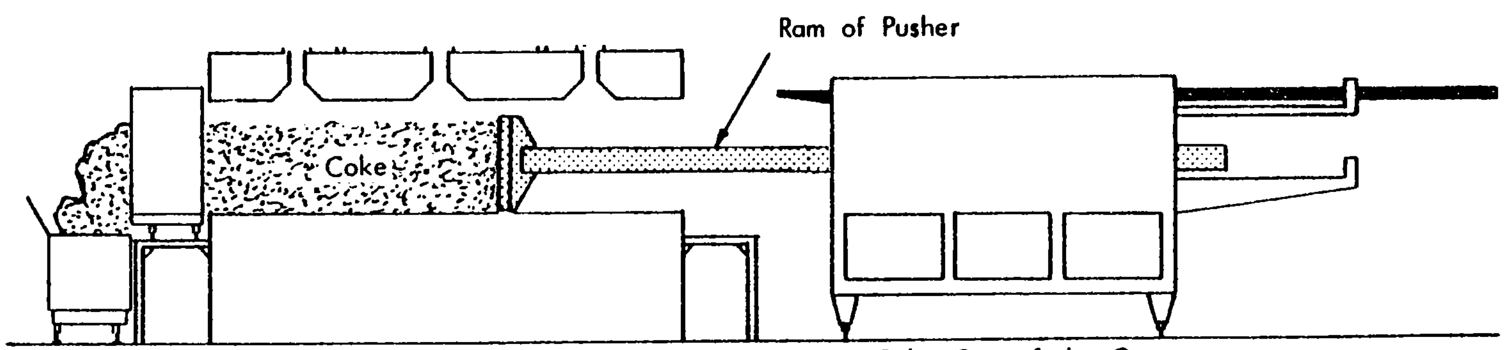
PUSHING

After the coal has been coked, the oven is ready to be pushed. This is accomplished by utilizing a moveable ram located on the push machine. The ram alignes with the pushing side door of the oven. On the opposite end, the coke side, a quench car and coke guide move into position. The doors at both ends of the oven are removed and the ram is inserted into the oven. The coke is pushed out of the oven, through the guide, and into the quench car. The pushing operation usually takes 2 to 3 minutes to complete. A schematic representing the operations involved during pushing is shown in Figure 9.

There are basically two types of emissions associated with pushing: gaseous and particulates. Due to the high porosity of the coke, most of the oven volume is filled with gas. This gas has a typical consistency as follows:[5,6]



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.



The Ram of the Pusher Advances to Push the Incandescent Coke Out of the Oven, Through the Coke Guide and into the Quenching Car

Figure 9. Schematic representation of the operations involved during pushing in one coking cycle of a by-product coke oven.[10/2]

	Percentage by Volume
H_2	83.3
CO	5.3
CH_4	5.6
N_2	5.5
CO_2 and H_2S	0.3

The gas also has a heating value of 335 Btu/cu ft.[5]

Most of these gases ignite spontaneously when in contact with air. The gases burn off completely so they are not a major pollution concern. The only component that does not burn completely is H_2S. Hence, there are sulfur emissions. In a fully coked oven, the sulfur content is very low (about 0.005 lb/ton coke).[5] The quantity of sulfur emissions depends on the original sulfur content of the charged coal. The only circumstances that sulfur emissions are a significant concern are during green pushes.

Green pushes occur when the oven is pushed prior to complete coking. There are two reasons that a green push occurs. One is when the oven is pushed too early and the coal hasn't fully coked. The other is when the oven doesn't heat evenly and cold spots occur. The first reason is usually due to operator error or an operator trying to meet a certain production rate. The latter reason occurs when the ovens are old and cracks open up between the ovens and flue. This causes uneven gas distribution in the flues. Proper maintenance can usually alleviate these problems.

Particulate emissions on the other hand pose a significant problem. The particulates are generated by the friction between the coke and oven walls during pushing and by the impaction of the coke falling into the quench car. These emissions are generally moderate during a normal push but are very heavy during a green push.

Pushing emission control techniques currently fall into three major categories:[7]

1. Hoods and a fixed duct with stationary gas cleaning equipment.
2. Enclosed quench car with mobile gas cleaning equipment.
3. Coke side shed.

The hood/fixed duct system consists of an enclosed coke guide and hood over the quench car. The hood is connected to a fixed duct which runs the entire length of the battery. The emissions are vented into the duct and subsequently cleaned via some type of stationary gas cleaning equipment, i.e. scrubber, baghouse, etc.

The advantages of this type of system are: there is a minimum amount of moveable equipment needed, there is an option of the final control device, and there are lower utility costs. The disadvantages of this system are its space restrictions and high capital costs.

The second type system is the enclosed quench car with mobile scrubber system. This system utilizes an enclosed coke guide through which coke is pushed into an enclosed quench. Mounted on a trailing locomotive car, emissions are removed by venturi scrubbers and the air is discharged to the atmosphere.

The advantages of this system are: the unit is self-contained thus no major oven modifications are required, and the processing of green pushes requires no upgrade of design or changes in operation. The disadvantages are: there is now a need to properly dispose of dirty scrubber water of which there is 20 to 50 gal/ton coke,[5] a corrosion problem exists because of the use of water, and the size of the cars requires that the quench track and quench tower be improved. In addition, the utility costs are fairly high for a mobile scrubber.

The third method of collecting pushing emissions is by using a coke side shed. This involves enclosing the entire coke side area of a battery. The shed contains the pushing emissions which are eventually drawn off via a duct situated atop the shed. The collected emissions are then conveyed into a cleaning device.

The advantages of this system are: existing machinery can be used, there is a high collection efficiency of fugitive emissions, and coke side door emissions are also collected.

The disadvantages are: fallout of large particles inside the shed, very high power costs due to the large evacuation rates required and special limitations on the coke side of the battery.

QUENCHING

After the incandescent coke has been pushed into the quench car, the coke must be cooled very quickly. This is done by quenching the coke. Quenching is currently accomplished in the United Stated by dousing the coke with water within a quench tower. In some countries, there are coke plants which use dry quenching.

In the wet quenching process, the quench car, which has been filled with hot coke, travels on tracks to the quench tower. The car enters the base of the tower and after the car has been positioned, water nozzles are opened up and the coke is quenched. This process cools the coke down from 2000°F to about 180°F[8] in 2 to 3 minutes. Figure 10 shows schematic diagram of a typical wet quench tower.

The amount of water needed to quench the coke is approximately 270 gallons per ton of coke. Approximately 180 gallons of the water evaporates.[9] This steam is laden with water droplets and air contaminants which rise up the quench tower via a natural draft. After the remaining water drains from the car, it proceeds to the coke wharf where the coke is removed for later use in the blast furnace.

There are many quench tower designs. These designs vary in shape, height, cross-sectional area, etc.; and each of these designs can affect the emissions. However, the two main factors affecting quench tower emissions seem to be the dissolved solids content of the quench water and the type of mist eliminator (baffle) system used.[10]

The dissolved solids in the water can be controlled by utilizing clean make-up water rather than dirty water. Clean water is defined as containing less than 1500 mg/l of total dissolved solids (TDS). Dirty water has greater than 5000 mg/l TDS.[10] Baffles are the method most frequently used to suppress quench tower particulate emissions. They remove some of the entrained particles and water droplets by direct impaction. A series of spray nozzles periodically cleans the baffles in order to maintain high particulate removal efficiencies.

The baffles are mainly constructed of three types of materials: stainless steel, wood or plastic. There are many types of configurations currently used.

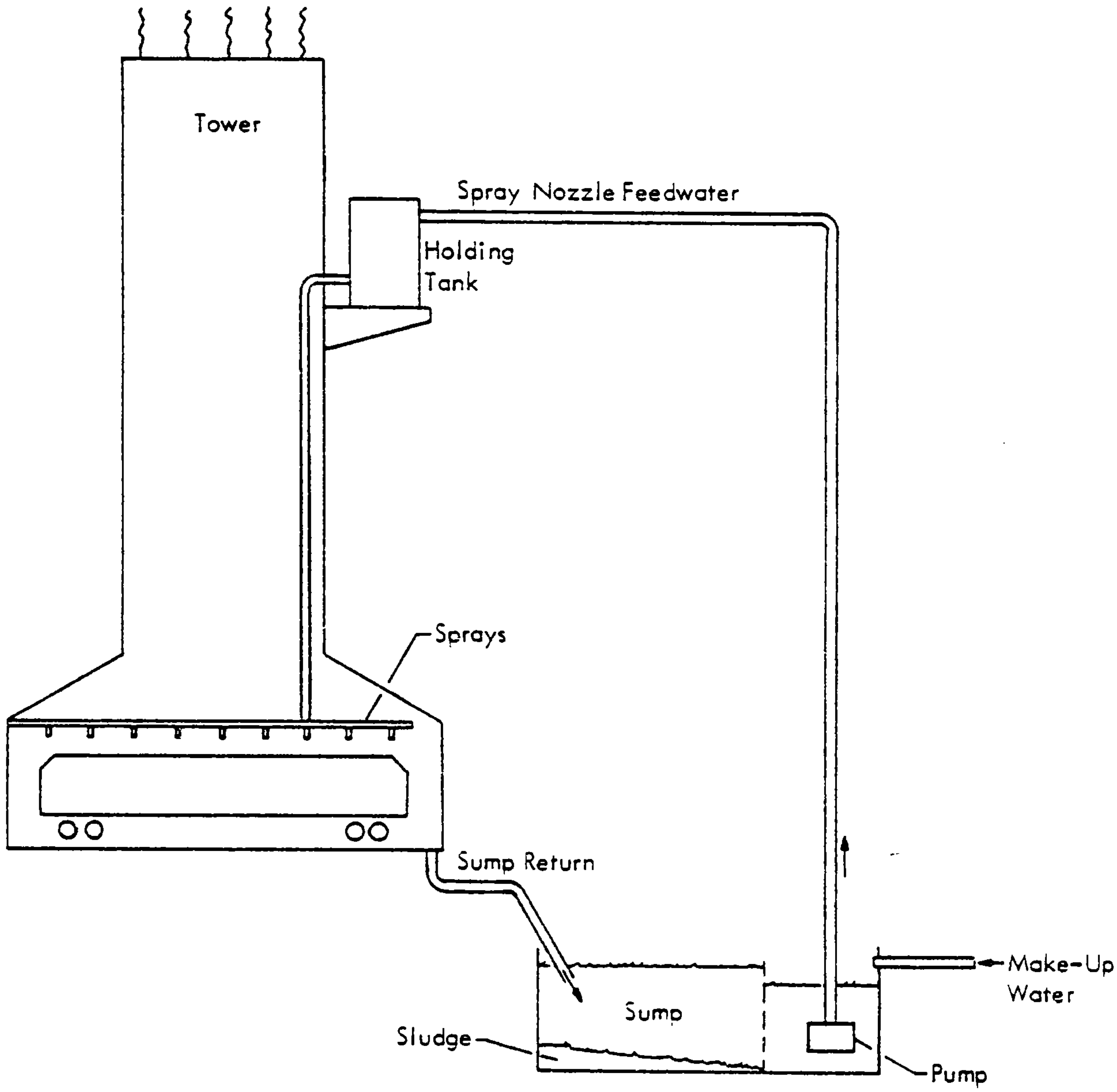


Figure 10. Schematic diagram of a wet quench tower. [10]

Dry quenching is a completely different method of quenching than wet quenching. Dry quenching utilizes inert gases to collect heat from the hot coke and transport it to waste heat boilers. The gas, which continuously circles through the system, enters from an initial intake of air. The O_2 in the air reacts with the hot coke to form CO_2. This makes the closed cycle operation fairly safe with minimal danger of explosion.

The advantages of dry vs. wet quenching are: a complete elimination of emissions conventionally associated with quenching, no water pollution problems, a better work environment, and high quality coke that is superior to wet quenched coke.

The disadvantages are: the need for new equipment and therefore a high capital cost, there is a danger of explosions, and handling dry coke is a problem because it is dustier.

There are no dry quenching plants currently operating in the U.S. and available literature indicates that there are currently no plans for constructing any new facilities.

COKE HANDLING

After the coke is quenched, it is transported in the quench car to an inclined coke wharf. The coke is dumped in the wharf, usually through the side of the quench car, and the excess water is allowed to drain. The coke is cooling to a reasonable handling temperature during this time. The gates on the wharf then open to allow the coke to fall onto a conveyer belt which carries the coke to the crushing and screening rooms. Here the coke is reduced to its desired size while the breeze that is formed is gathered and used in other plant operations.

The emissions that are generated through coke handling operations are similar to those generated during coal handling. A flow diagram showing a generalized coke-handling system is presented in Figure 11.

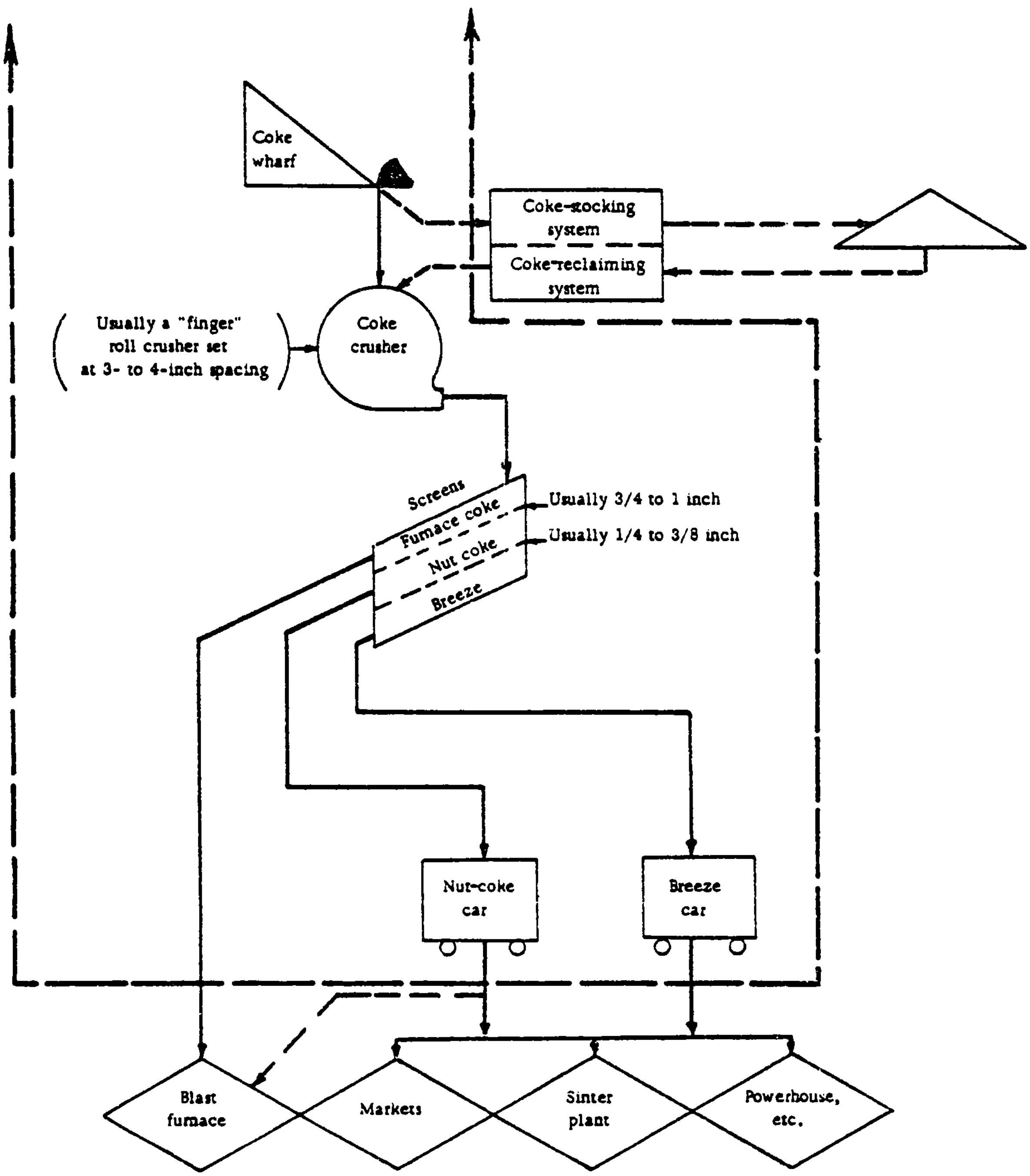


Figure 11. Generalized coke handling system.[1]

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SECTION 3

METALLURGICAL COKE EMISSION FACTORS

TOTAL AND SIZE-SPECIFIC EMISSION FACTORS

Emission factors for total particulate have been developed for the metallurgical coke industry. Size specific emission factors have also been calculated based on cascade impactor test results. These emission factors and size distributions are listed in Tables 1 and 2 and illustrated in Figures 12 to 22. The data used for this report is summarized in Tables 3 to 25 for particulate measurements, and Figures 12 to 22 for particle size measurements. All source data was presented at the beginning of the written section which describes the source category. The data used in the calculations of emission factors presented in this report include all the test reports used in the current AP-42 Metallurgical Coke section (10/80), in addition to other more recent reports.

As can be seen in Tables 1 and 2, an increased quantity of better quality data has been developed in the past 10 years. The procedures used in compiling this information, calculating the emissions factors and rating the emission factors are detailed in the following pages. This data include total particulate data, as well as particle sizing data, on controlled and uncontrolled emissions.

DATA REVIEW PROCEDURES

All available sources of data were reviewed for the compilation of emissions factors. There were limited particle size data available from FPEIS. Sources of data which reported the results of actual measurements and observations were considered primary sources. All other sources of data which referred to summarized emission data performed and reported by a different organization or author were considered secondary sources.

TABLE 1. SOURCE EMISSION FACTORS FOR COKE MANUFACTURING[a] EMISSION FACTOR RATING D (EXCEPT PARTICULATES)

Type of operation	Emission factor rating	Particulates[b]		Sulfur dioxide[c]		Carbon monoxide[c]		Volatile organics[c]		Nitrogen oxides[c]		Ammonia[c]	
		lb/ton	kg/Mt	lb/ton	kg/Mt	lb/ton	kg/Mt	lb/ton	kg/Mt	lb/ton	kg/Mt	lb/ton	kg/Mt
Coal handling													
with cyclone	D	0.11	0.055	--	--	--	--	--	--	--	--	--	--
Coal preheating													
Uncontrolled	C	3.50	1.75	--	--	--	--	--	--	--	--	--	--
With scrubber	C	0.25	0.125	--	--	--	--	--	--	--	--	--	--
With wet ESP	C	0.012	0.006	--	--	--	--	--	--	--	--	--	--
Coal charging													
Uncontrolled	E	0.48	0.24	0.02	0.01	0.6	0.3	2.5	1.25	0.03	0.015	0.02	0.01
With sequential charging	D	0.016	0.008	--	--	--	--	--	--	--	--	--	--
With scrubber on Larry Car	E	0.014	0.007	--	--	--	--	--	--	--	--	--	--
Door leaks (uncontrolled)	D	0.54	0.27	--	--	0.6	0.3	1.5	0.75	0.01	0.005	0.06	0.03
Coke pushing													
Uncontrolled	A	1.15	0.58	--	--	0.07	0.035	0.2	0.1	--	--	0.1	0.05
With ESP	C	0.45	0.225	--	--	--	--	--	--	--	--	--	--
With Venturi scrubber	E	0.17	0.08	--	--	--	--	--	--	--	--	--	--
With baghouse	E	0.068	0.003	--	--	--	--	--	--	--	--	--	--
Enclosed quench car with scrubber[d]	E	0.082	0.041	--	--	--	--	--	--	--	--	--	--
Quenching													
Uncontrolled (dirty water)[e]	D	5.24	2.62	--	--	--	--	--	--	--	--	--	--
Uncontrolled (clean water)[f]	D	1.13	0.57	--	--	--	--	--	--	--	--	--	--
With baffles (dirty water)[e]	A	1.30	0.65	--	--	--	--	--	--	--	--	--	--
With baffles (clean water)[f]	A	0.54	0.27	--	--	--	--	--	--	--	--	--	--
Combustion stacks													
Uncontrolled (COG)	A	0.47	0.234	--	--	--	--	--	--	--	--	--	--
Uncontrolled (BFG)	A	0.17	0.085	--	--	--	--	--	--	--	--	--	--
With ESP	E	0.091	0.046	--	--	--	--	--	--	--	--	--	--
With baghouse	C	0.15	0.075	--	--	--	--	--	--	--	--	--	--
Coke handling													
With rotoclone	C	0.006	0.003	--	--	--	--	--	--	--	--	--	--

[a]Emission factors expressed as units per weight of coal charged. Dash indicates no available data.

[b]Reference source category report on metallurgical coke manufacturing.

[c]From last AP-42 update 10/80.

[d]Emission factor does not take into consideration capture efficiencies of the enclosed quench car at the point of emissions origin.

[e]Dirty water >5000 mg/l TDS.

[f]Clean water <1500 mg/l TDS.

TABLE 3. SOURCE EMISSION FACTORS--COAL HANDLING--WITH CYCLONE

Source No.	Rating	lb/ton coal	Comments
1	B	0.11	1 run on Amerclone collector on coal crushing
Avg	D	0.11	

TABLE 4. SOURCE EMISSION FACTORS--PREHEATERS--UNCONTROLLED

Source No.	Rating	lb/ton coal	Comments
4	B	0.32	Avg of 12 runs at inlet to scrubber
6	A	7.04	Avg of 18 runs at inlet to scrubber (used in last AP-42 update)
8	A	3.13	1 run on inlet to scrubber[7]
Avg	C	3.50	

TABLE 5. SOURCE EMISSION FACTORS--PREHEATER--WITH SCRUBBER

Source No.	Rating	lb/ton coal	Comments
2	B	0.20	Avg of 3 runs on "B" Unit
3	B	0.14	Avg of 3 runs on "A" Unit
5	B	0.012	Avg of 12 runs with four diff. op. modes
7	A	0.65	Avg of 18 runs (used in last AP-42 update)
8	A	0.26	Avg of 3 runs
10	C	0.37	1 run on preheater No. 1 (not used in emission factors)
11	C	0.22	1 run on preheater No. 2 (not used in emission factors)
Avg	C	0.25	

TABLE 6. SOURCE EMISSION FACTORS--PREHEATERS--WITH WET ESP'S

Source No.	Rating	lb/ton coal	Comments
9	B	0.013	Avg of 3 runs on a cerchar
12a	A	0.0043	3 runs on ESP "A" } on a precarbon preheater
12b	A	0.021	3 runs on ESP "B" } on a precarbon preheater
12c	A	0.0081	3 runs on ESP "C } on a precarbon preheater
Avg	C	0.012	

TABLE 7. SOURCE EMISSION FACTORS--CHARGING--UNCONTROLLED

Source No.	Rating	lb/ton coal	Comments
14a	B	0.108	Wilputte Car (used in last AP-42 update)
17	C	0.85	EPA-450/4-79-028. Particulate emission factors applicable to the iron and steel industry (MRI).
Avg	E	0.48	

TABLE 8. SOURCE EMISSION FACTORS--CHARGING--SEQUENTIAL

Source No.	Rating	lb/ton coal	Comments
14b	B	0.016	EPA/AISI Car (used in last AP-42 update)
Avg	D	0.016	

TABLE 9. SOURCE EMISSION FACTORS--CHARGING--SCRUBBER ON LARRY CARS

Source No.	Rating	lb/ton coal	Comments
13a	C	0.021	Scrubber pilot burners on, normal operation (used in last AP-42 update)
13b	C	0.026	Normal charge - burners off (not used in Emission Factor)
13c	C	0.101	Delayed charge - burners on - not used in Emission Factor
15	D	0.012	Avg 2 tests scrubber - low energy - Krupp
16	D	0.008	Low energy centrifugal dust collector w/mist eliminators
Avg	E	0.014	

TABLE 10. SOURCE EMISSION FACTORS-UNDERFIRING-UNCONTROLLED COG ONLY

Source No.	Rating	lb/ton coal	Comments
24	A	0.49	Average of 19 runs and 5 Batteries
42	A	0.67	Average of 10 runs
44	A	0.098	Average of 4 runs
49	A	0.098	Average of 3 runs
50	A	0.73	Average of 3 runs
51	A	1.24	Average of 3 runs
52	A	0.47	Average of 3 runs
54	A	0.86	Average of 3 runs
55	A	0.79	3 runs
56	A	0.74	3 runs
59	A	0.29	3 runs
60	A	0.44	3 runs
64	A	0.53	3 runs
66	A	0.48	3 runs
67	A	0.51	3 runs
73	A	0.12	3 runs
74	A	0.33	3 runs
75	A	0.15	3 runs
76	A	0.11	3 runs
90	A	0.21	4 runs
Average	A	0.47	

TABLE 11. UNCONTROLLED--UNDERFIRING--NOT USED IN SOURCE EMISSION FACTORS

Source No.	Rating	lb/ton coal	Comments
18c	C	0.23	2 runs on inlet to ESP Stack No. 1
18d	C	0.46	1 run on inlet to ESP Stack No. 2
19c	B	0.11	3 runs on inlet to West ESP
19d	B	0.23	3 runs on inlet to East ESP
20a	B	0.23	Battery No. 2
20b	B	0.26	Battery No. 3
20c	B	0.21	Battery No. 5
20d	B	0.059	Battery "A"
21	B	0.92	2 runs on Battery No. 17
22	C	0.89	1 run on Battery No. 18
23	B	0.17	1 run on Battery No. 18
25	B	0.27	3 runs
27	B	0.099	3 runs on Battery No. 11
28	C	0.050	2 runs
29	B	0.17	2 runs without SO_4 on Battery A-5
30	B	0.45	3 runs on Battery A-1
31	B	0.13	3 runs without SO_4 on Battery No. 4
32	B	0.53	3 runs on Battery No. 9
33	B	0.13	3 runs on P4 Stack
34a	B	0.071	3 runs on P1
34b	B	0.10	3 runs on P2

(continued)

TABLE 11 (continued)

Source No.	Rating	lb/ton coal	Comments
34c	B	0.14	3 runs on P3N
34d	B	0.098	3 runs on P3S
36	C	2.33	2 runs on Battery No. 5
37	B	0.36	3 runs on Battery No. 5
38	C	0.41	5 runs on inlet to ESP C-Battery
39	B	0.20	3 runs on A Battery
40	B	0.24	3 runs on Battery No. 1
41	B	0.38	3 runs on Battery No. 8
43	B	0.15	3 runs on Battery No. 2
45	B	0.12	3 runs on Battery No. 1 (no coking)
46	B	0.23	3 runs on Battery No. 7
47	B	0.15	3 runs on Battery No. 2
48	B	0.26	3 runs on Battery No. 13
53	B	0.22	3 runs on Battery No. 3 (COG)
57	B	0.81	3 runs on Battery No. 7 (high isokinetics)
58	B	0.64	3 runs on Battery No. 15
61	B	0.10	3 runs on Battery No. 13
62	C	1.01	3 runs on Battery No. 15 (1 run is high isokinetics)
63	B	0.098	3 runs on Battery No. 1 (no coking)
65	B	0.41	3 runs on Battery No. 3 (high isokinetics)
68	B	0.18	3 runs on Battery No. 16

(continued)

TABLE 11 (continued)

Source No.	Rating	lb/ton coal	Comments
69	B	0.23	3 runs on Battery No. 5
70	B	0.11	3 runs on Battery No. 3
71	B	0.18	3 runs on Battery No. 15
72	B	0.33	3 runs on Battery No. 1
77	B	0.076	3 runs on Battery No. 1
78	B	0.093	3 runs
79	B	0.15	3 runs without sulfate
81	C	0.077	3 runs on Battery No. 1
82	C	0.069	3 runs on Battery No. 2
83	C	0.058	3 runs on Battery No. 3
84	C	0.051	3 runs on Battery No. 7
85	C	0.034	3 runs on Battery No. 8
86	C	0.044	3 runs on Battery No. 9
88	C	0.049	3 runs on Battery No. 19
89	C	0.035	3 runs on Battery No. 20
92	B	0.32	1 run
93a	C	1.65	Battery No. 3
93b	C	1.89	Battery No. 4
94a	B	0.24	3 runs Battery No. 3 without sulfates
94b	B	0.24	3 runs Battery No. 13 without sulfates
94c	B	0.42	3 runs on Battery No. 15 without sulfates

(continued)

TABLE 11 (continued)

Source No.	Rating	lb/ton coal	Comments
94d	B	0.44	3 runs on Battery No. 7 without sulfates
94e	B	0.62	3 runs on Battery No. 5 without sulfates
94f	B	0.26	3 runs on Battery No. 16 without sulfates
95	B	0.61	3 runs on Battery No. 3
96	B	0.68	19 runs on Battery Nos. 8, 9, 10, 11, and 12
Average	B	0.34	

TABLE 12. SOURCE EMISSION FACTORS-UNDERFIRING--UNCONTROLLED (BFG)

Source No.	Rating	lb/ton coal	Comments
24	A	0.27	Average of 19 runs (BFG)
44	A	0.040	3 runs with (BFG)
54	A	0.25	3 runs with (BFG)
55	A	0.13	3 runs with (BFG)
Average	A	0.17	

TABLE 13. SOURCE EMISSION FACTORS-UNDERFIRING--WITH ESP

Source No.	Rating	lb/ton coal	Comments
18a	C	0.07	One run on Stack No. 1
18b	C	0.11	One run on Stack No. 2
19a	B	0.083	3 runs ESP West
19b	B	0.034	3 runs ESP East
26	A	0.091	3 runs
38	C	0.26	5 runs
80	C	0.032	4 runs
87	C	0.048	3 runs
Average	E	0.091	

TABLE 14. SOURCE EMISSION FACTORS-UNDERFIRING--WITH BAGHOUSE

Source No.	Rating	lb/ton coal	Comments
35	A	0.47	Test on Batteries C & E
91a	B	0.19	2 runs on Battery B
91b	B	0.051	3 runs on Battery C
91c	B	0.074	3 runs on Battery D
91d	B	0.012	3 runs on Battery E
91e	B	0.18	2 runs on Battery F
91f	B	0.074	3 runs on Battery G
Average	C	0.15	

TABLE 15. SOURCE EMISSION FACTORS: PUSHING--UNCONTROLLED

Source No.	Rating	lb/ton coal	Comments
97	A	2.31	Avg of 3 runs - inlet to wet ESP
100	B	4.38	Avg of 3 runs - inlet to wet ESP (Not used in final emission factor)
103	A	0.41	Avg of 11 runs on coke side shed
107a	A	0.46	Avg of 4 runs on coke side shed during pushing cycles only
118a	A	0.69	Avg of 3 runs on coke side shed during pushing cycles only
117	A	1.90	Average of 7 runs - inlet to Venturi scrubber Minister Stein System
Average	A	1.15	

TABLE 16. SOURCE EMISSION FACTORS: PUSHING--WITH WET ESP

Source No.	Rating	lb/ton coal	Comments	
97	A	0.19	Avg of 3 runs	All shed data
98	B	1.11	Avg of 4 runs	
99	B	0.11	Avg of 2 runs	
101	B	0.31	Avg of 4 runs	
116	B	0.55	Avg of 6 runs	
Avg	C	0.45		

TABLE 17. SOURCE EMISSION FACTORS: PUSHING--WITH VENTURI SCUBBER

Source No.	Rating	lb/ton coal	Comments
102	B	0.21	1 run on A battery hood
105	A	0.13	Avg of 3 runs on "B" battery hood
106	B	0.37	3 runs on battery A and Ax battery hood
112	C	0.072	3 runs on a Minister Stein system
117	A	0.011	7 runs on a Minister Stein system
119	B	0.22	3 runs - foundry coke
Avg	E	0.17	

TABLE 18. SOURCE EMISSION FACTORS: PUSHING--WITH BAGHOUSE

Source No.	Rating	lb/ton coal	Comments
113	C	0.0003	3 runs foundry coke
120	A	0.19	3 runs No. 9 battery
121	A	0.004	3 runs
122	A	0.079	3 runs
Avg	E	0.168	

TABLE 19. SOURCE EMISSION FACTORS--PUSH CARS--SCRUBBER CONTROLLED

Source No.	Rating	lb/ton coal	Comments
123a	C	0.022	3 runs on Batteries 6 and 7; Chemico Car
123b	C	0.017	3 runs on Batteries 6 and 7; Chemico Car
124a	B	0.026	3 runs--Chemico Car 1
124b	B	0.019	3 runs--Chemico Car 2
124c	B	0.024	3 runs--Chemico Car 1
125	C	0.38	7 runs--Chemico Car (not used in Final Emission Factor)
126	B	0.012	4 runs--Chemico Car
127a	B	0.099	3 runs, Battery No. 4--Chemico Car
127b	B	0.060	6 runs, Battery No. 9--Chemico Car
128	B	0.049	3 runs, Battery No. 15, H-3 Chemico Car
129	A	0.037	3 runs, Batteries 19 and 20, H-2 Chemico Car
130	A	0.33	3 runs, No. 12 Spot Cleaning Car with Venturi
131	B	0.047	No. 11 Spot Cleaning Car with Venturi
132	B	0.10	3 runs, H-III Chemico Car, Foundry Coke
133	A	0.12	Scrubber Car No. 2
134	B	0.39	3 runs, Battery No. 5, Halcon Car
135	B	0.015	Battery No. 18 Venturi on hooded car
136	B	0.011	8 runs on Batteries 11 and 12 with Halcon Car

(continued)

TABLE 19 (continued)

Source No.	Rating	lb/ton coal	Comments
137a	B	0.034	3 runs on South Push Car
137b	B	0.033	4 runs on North Push Car
138	B	0.011	1 Spot Koppers Car with scrubber, Battery No. 11
139	A	0.025	1 Spot car Battery No. 9
140	A	0.030	1 Spot car Battery No. 2
Average	E	0.082	

TABLE 20. SOURCE EMISSION FACTORS--DOOR LEAKS--UNCONTROLLED

Source No.	Rating	lb/ton coal	Comments
141	B	0.51	Taken from EPA-450/4-79-028 (Doubled to take into account 2 doors)
142	A	(0.34) 0.68	Avg of 3 runs on coke shed during non-pushing (doubled to take into account 2 doors)
143	A	(0.22) 0.44	Avg of 3 runs on coke shed during non-pushing
Avg	D	0.54	

TABLE 21. SOURCE EMISSION FACTORS--QUENCHING--CLEAN WATER UNCONTROLLED

Source No.	Rating	lb/ton coal	Comments
148	A	1.13	Average of 5 runs performed with clean quench water
Average	D	1.13	Clean water <1500 mg/l TDS

TABLE 22. SOURCE EMISSION FACTORS--QUENCHING--DIRTY WATER UNCONTROLLED

Source No.	Rating	lb/ton coal	Comments
148	A	5.24	Average of 4 runs performed with dirty quench water
Average	D	5.24	Dirty water >5,000 mg/l TDS

TABLE 23. SOURCE EMISSION FACTORS--QUENCHING CLEAN WATER WITH BAFFLES

Source No.	Rating	lb/ton coal	Comments
144	A	1.46	Average of 13 runs performed with clean quench water
145	A	0.33	Average of 9 runs performed with clean quench water
146	A	0.32	Average of 9 runs performed with clean quench water
147	A	0.27	Average of 9 runs performed with clean quench water
148	A	0.32	Average of 5 runs performed with clean quench water
Average	A	0.54	

TABLE 24. SOURCE EMISSION FACTORS--QUENCHING--DIRTY WATER WITH BAFFLES

Source No.	Rating	lb/ton coal	Comments
144	A	2.73	Average of 11 runs performed with dirty quench water
145	A	0.43	Average of 9 runs performed with dirty quench water
146	A	0.64	Average of 9 runs performed with dirty quench water
148	A	1.39	Average of 4 runs performed with dirty quench water
Average	A	1.30	

TABLE 25. SOURCE EMISSION FACTORS--COKE HANDLING--WITH SCRUBBER

Source No.	Rating	lb/ton coal	Comments
149a	B	0.008	1 run on N type Rotoclone East Screening Station
149b	B	0.006	1 run on N type Rotoclone West Screening Station
150	B	0.004	1 run on Am. Air Filter Co. N type Rotoclone West
Avg	C	0.006	

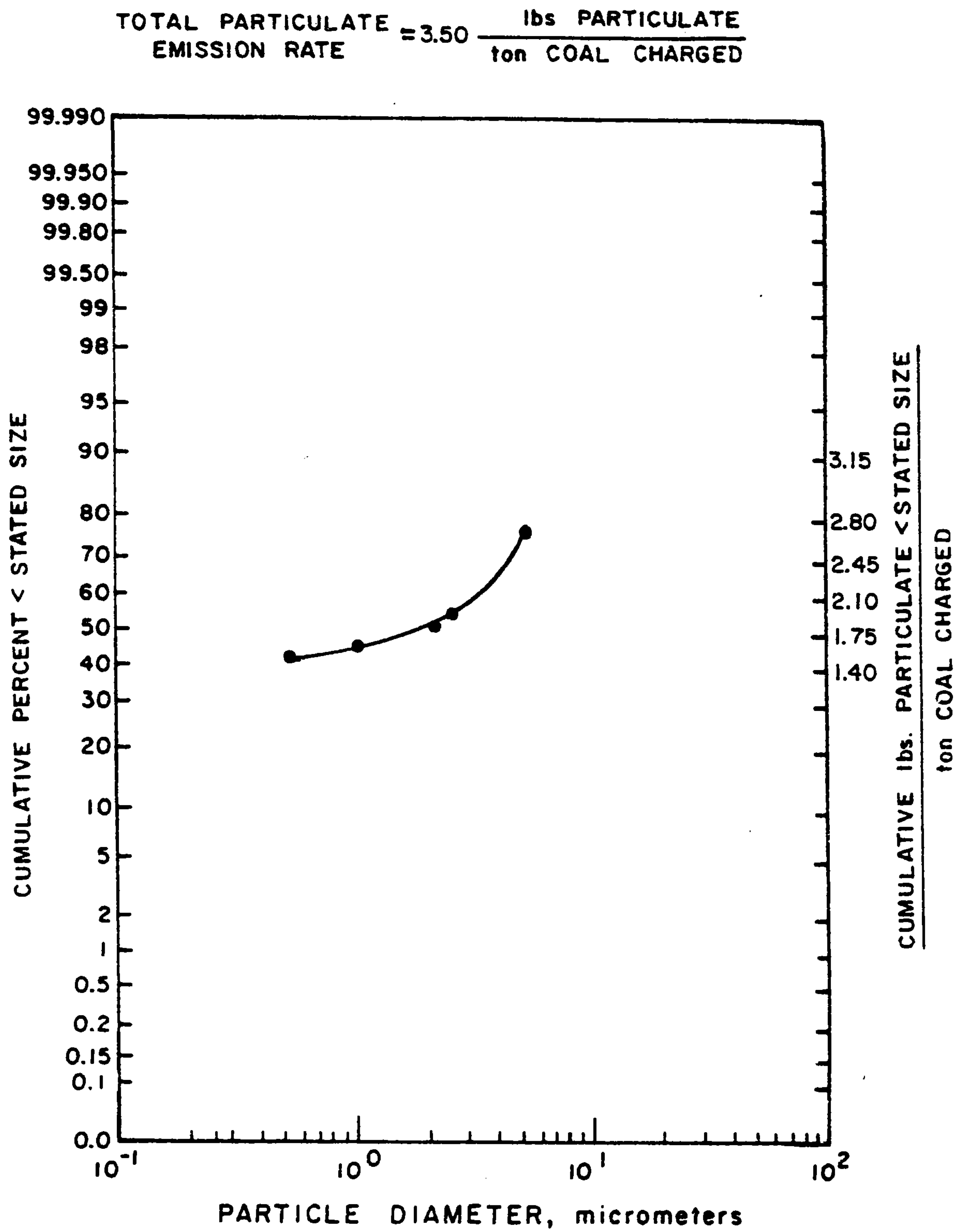

Figure 12. Coal preheating (uncontrolled).[6]

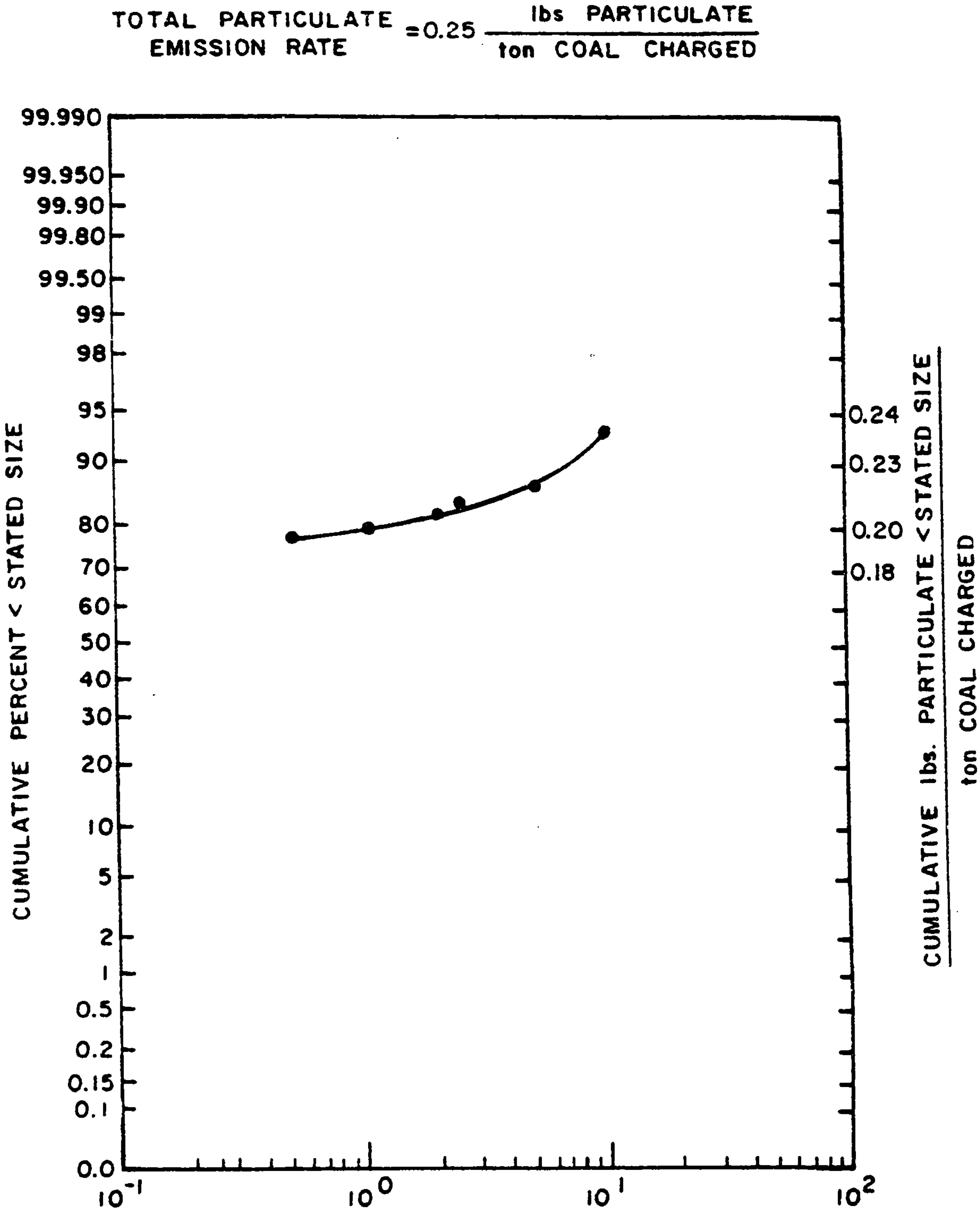

Figure 13. Coal preheating (controlled with scrubber).[7]

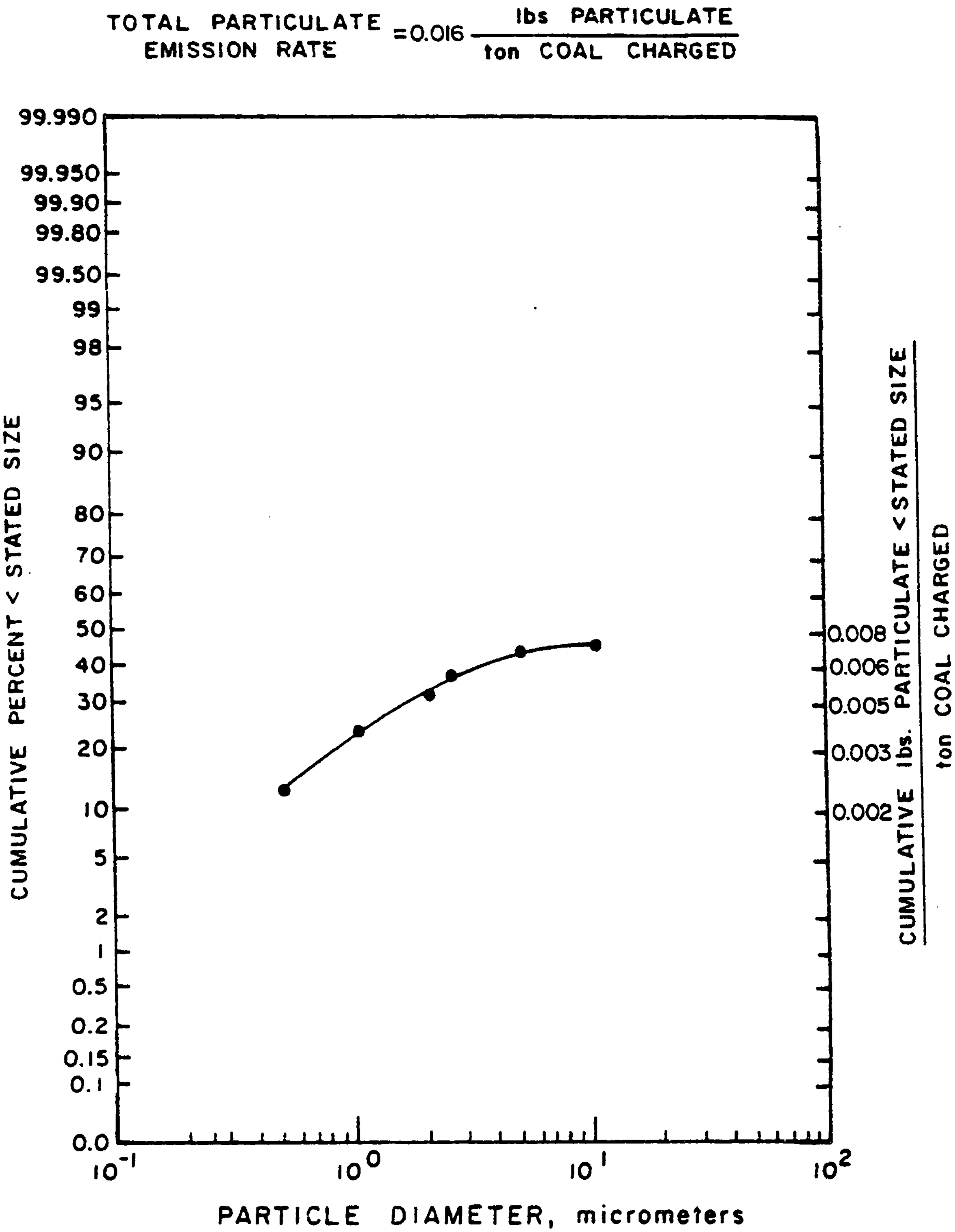

Figure 14. Coal charging (sequential) average of 2 tests.[14]

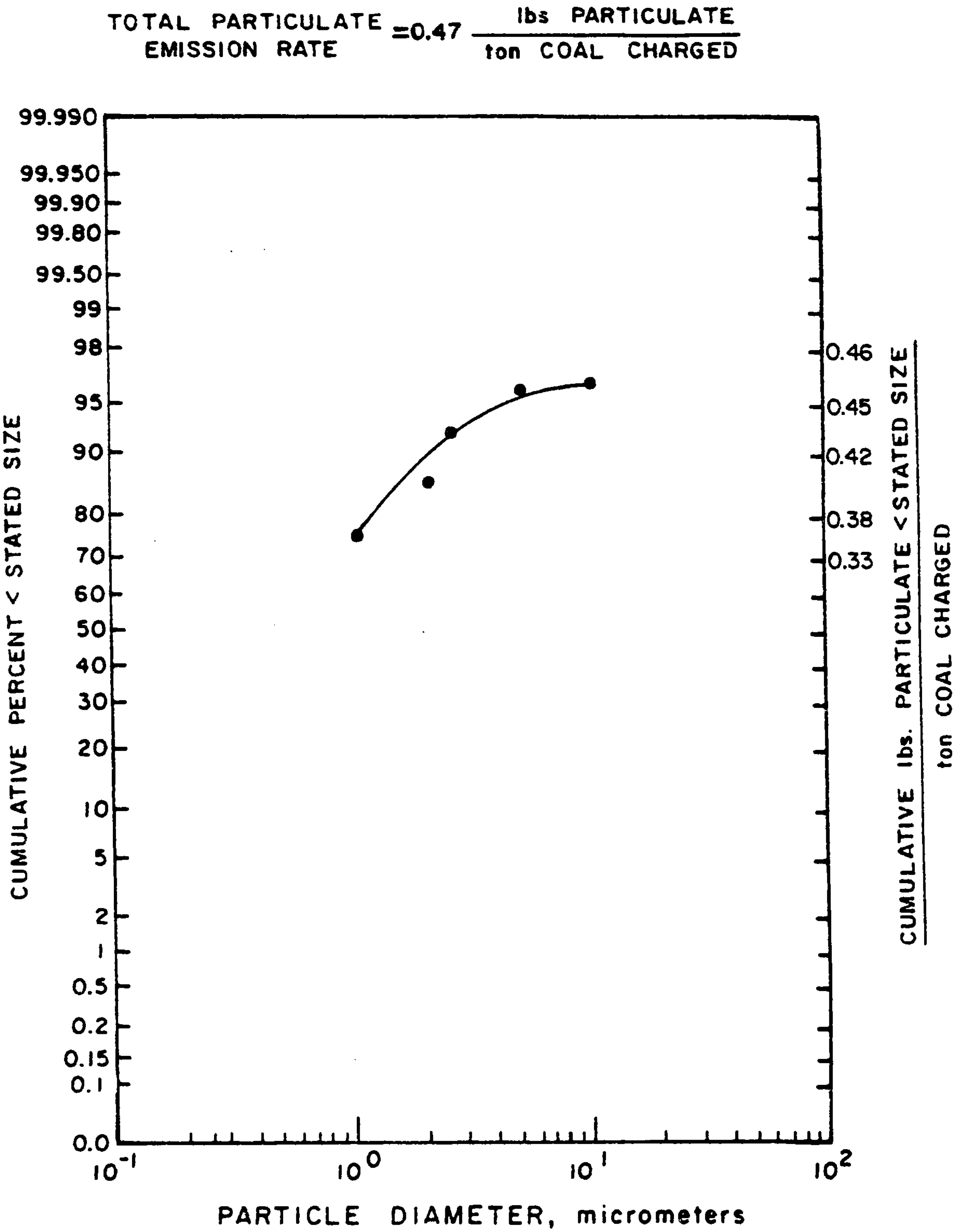

Figure 15. Combustion stacks (uncontrolled) average of 3 sites.[33,34,42]

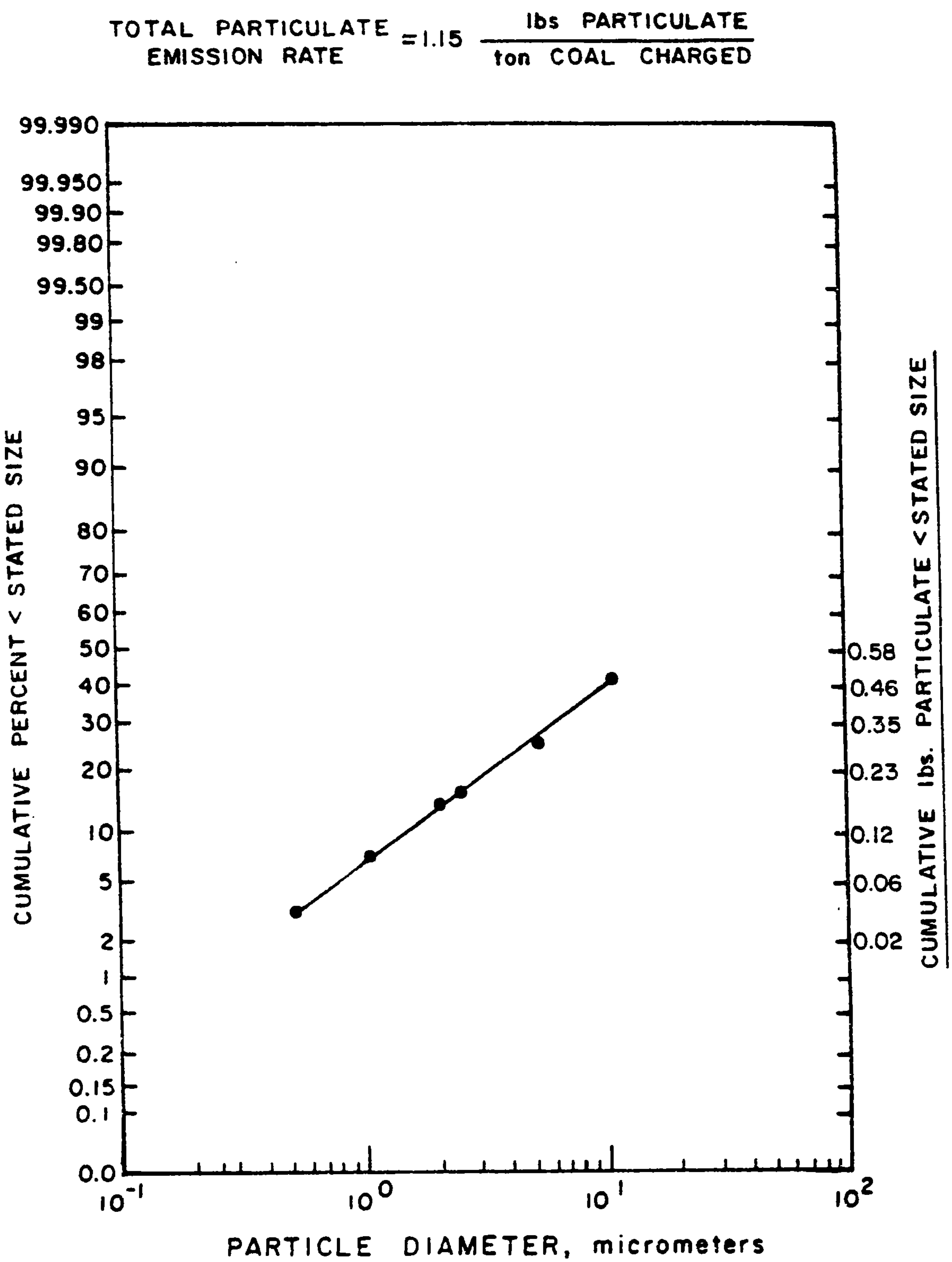

Figure 16. Pushing (uncontrolled) average of 6 sites.[103,104,107,108,117,118]

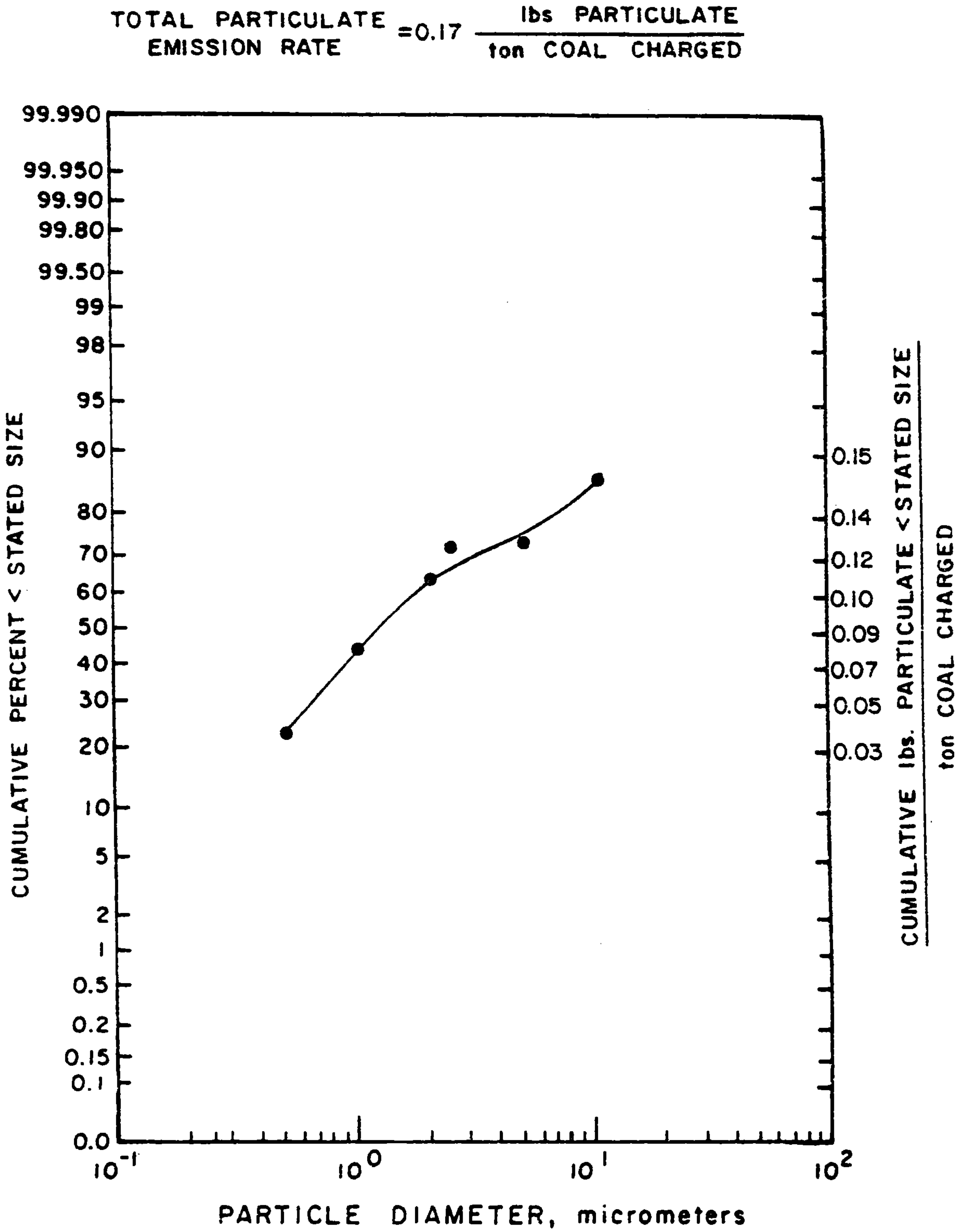

Figure 17. Pushing (controlled with scrubber) average of 2 sites.[104,108]

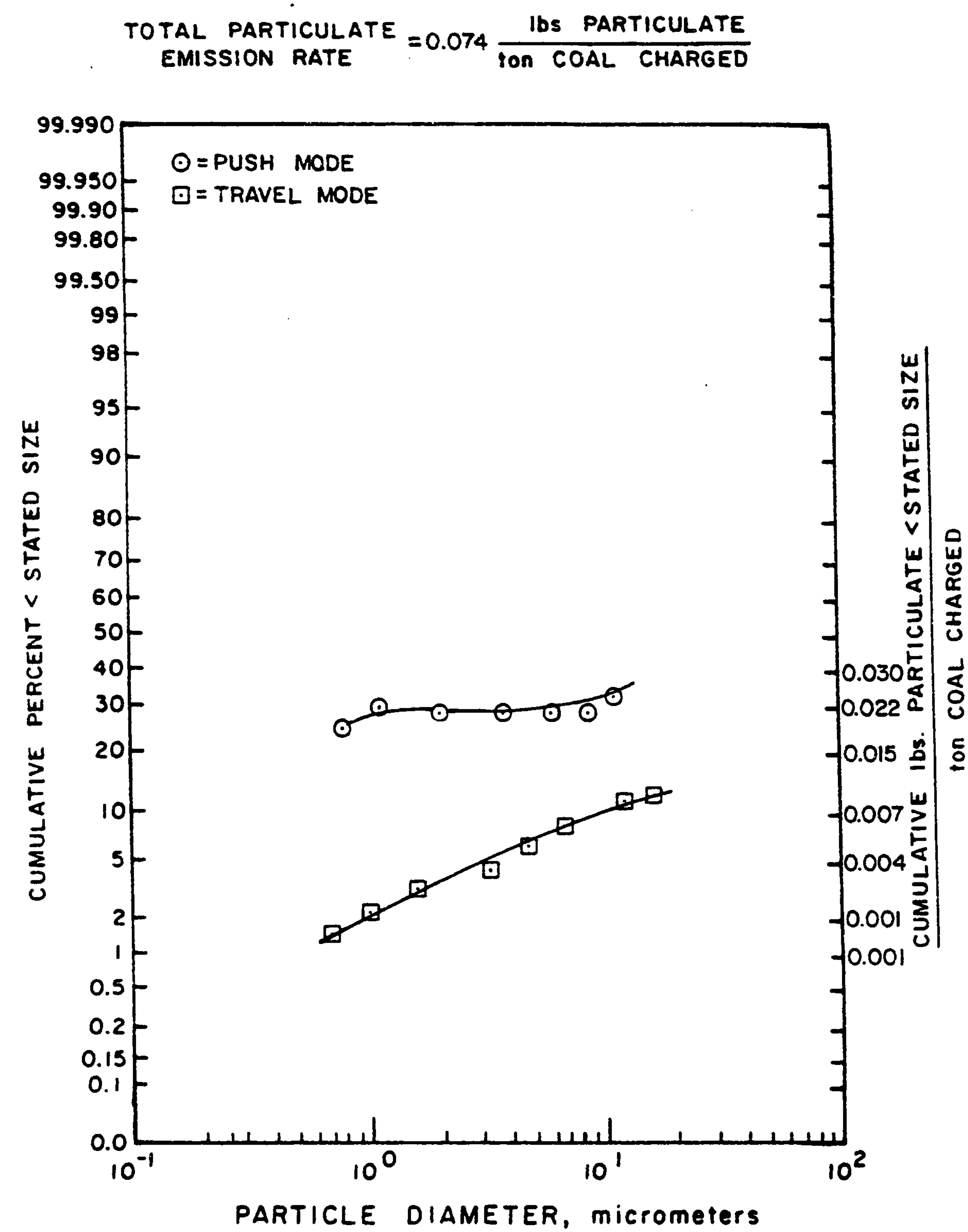

Figure 18. Push cars (with scrubber).[130]

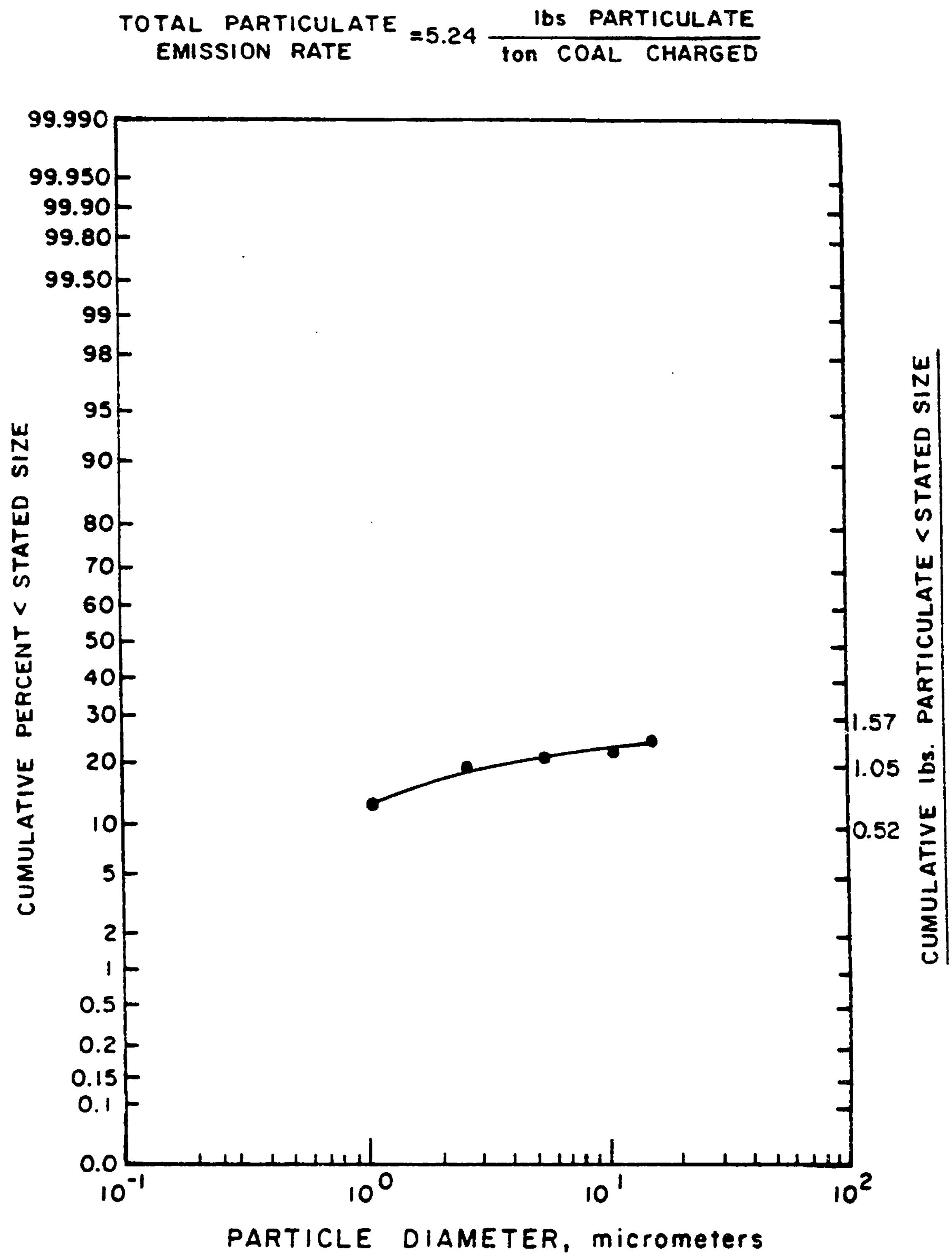

Figure 19. Quenching (uncontrolled) dirty water > 5,000 mg/1 TDS.[148]

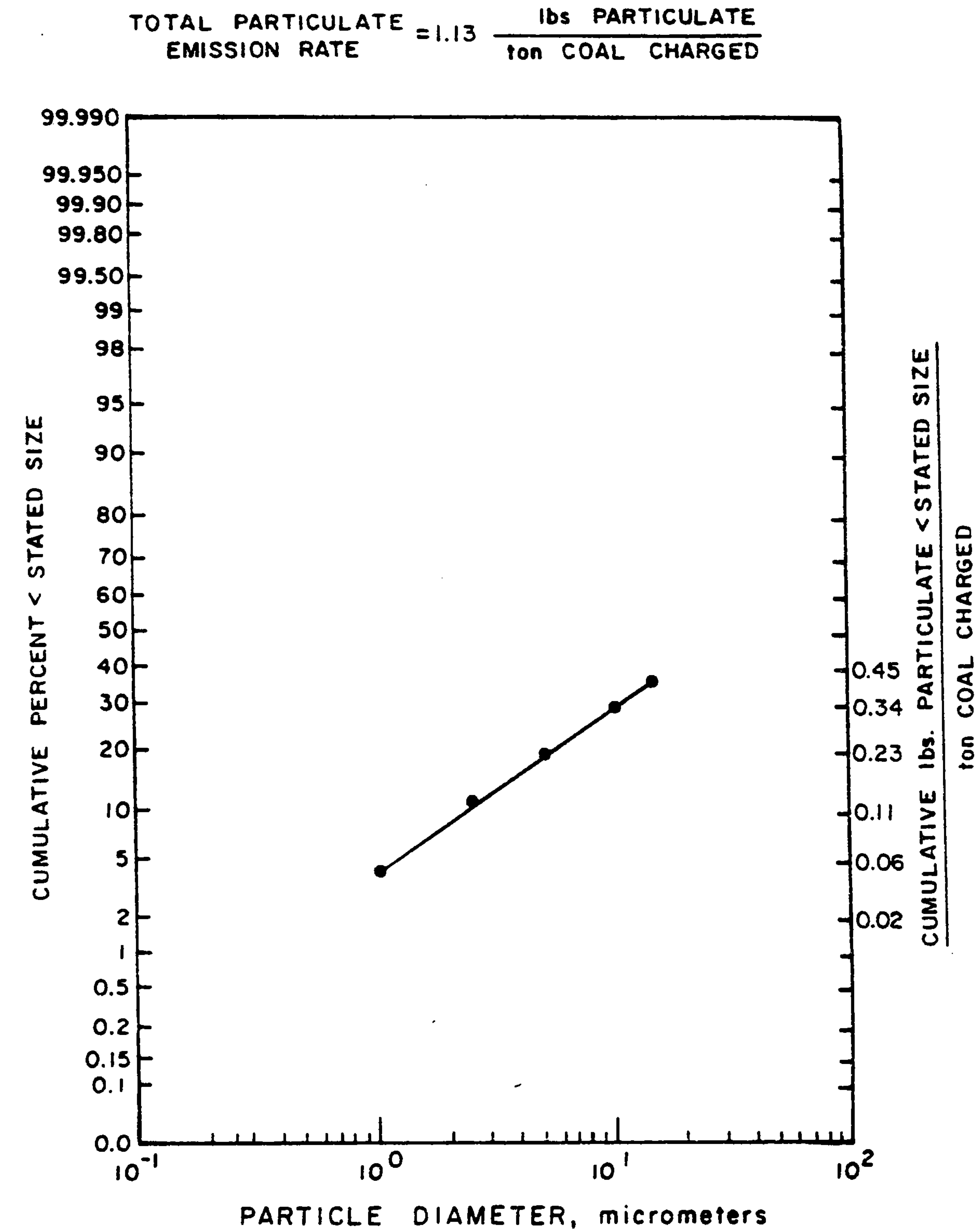

Figure 20. Quenching (uncontrolled) clean water < 1,500 mg/l TDS.[148]

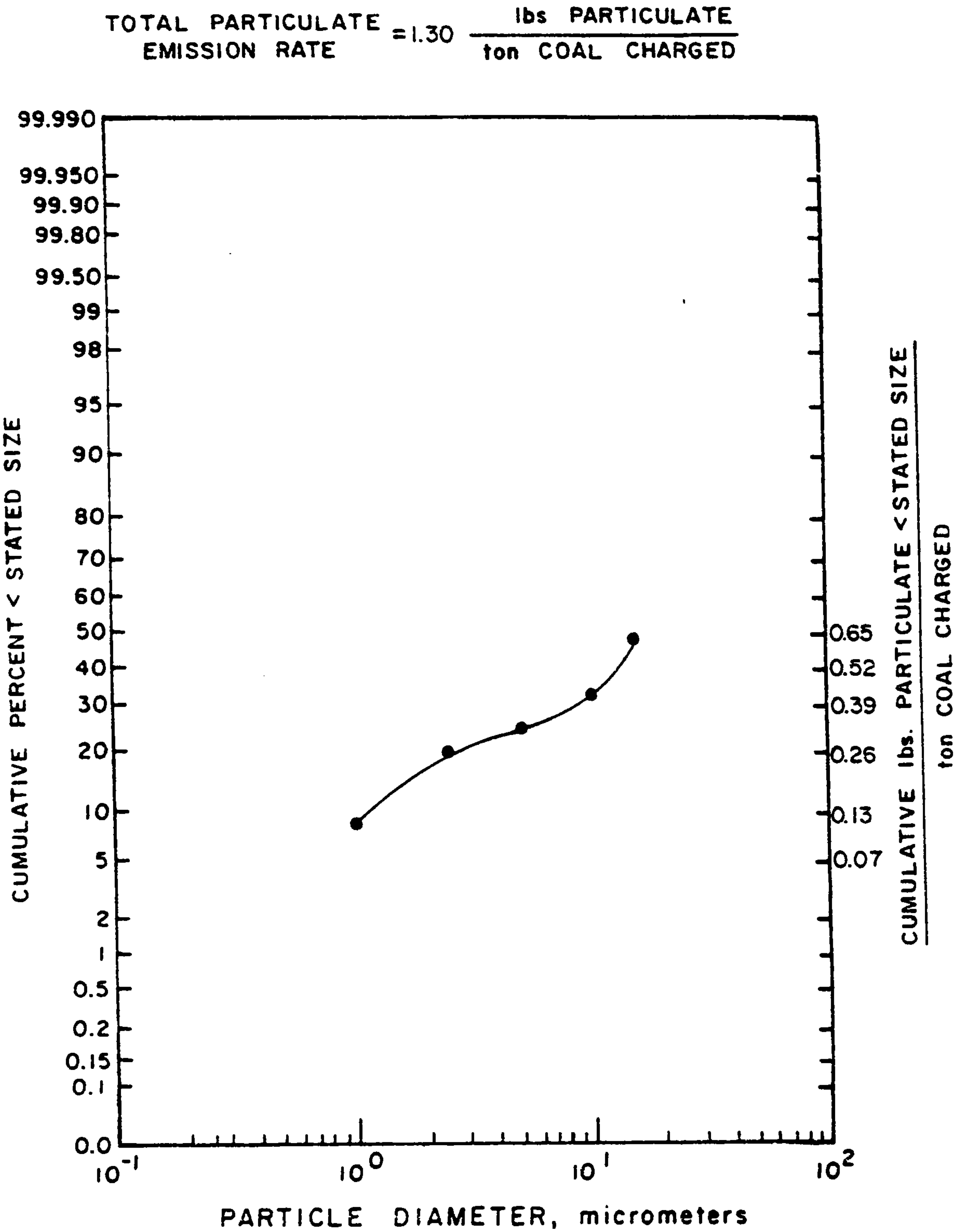

Figure 21. Quenching (controlled--with baffles) dirty water > 5,000 mg/1 TDS.[148]

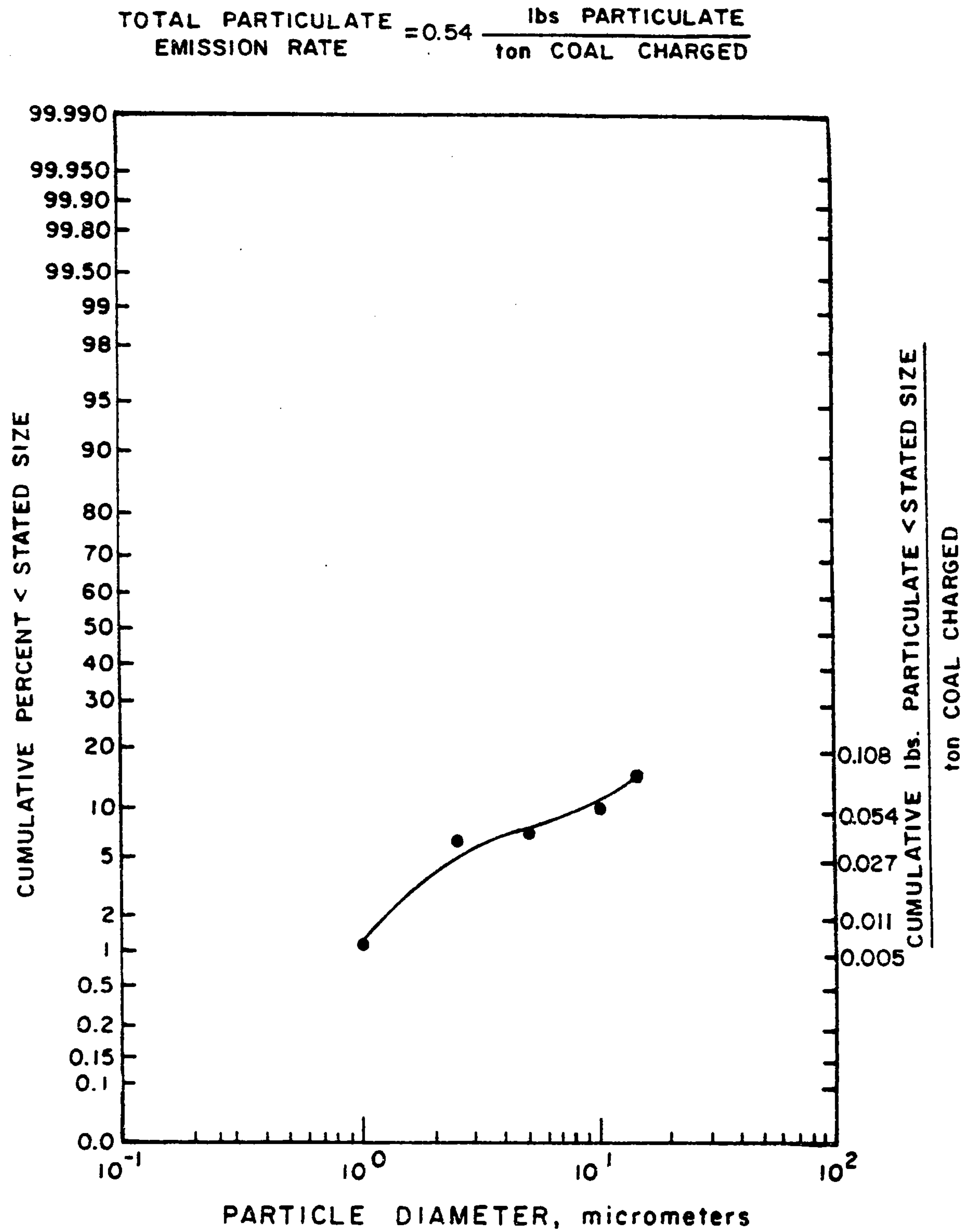

Figure 22. Quenching (controlled - with baffles) clean water < 1,500 mg/l TDS.[148]

Only primary sources were considered suitable for calculating emission factors if substantial primary sources were available. The data review process consisted of two steps. The first step consisted of obtaining sources of emission data, and judging if it should be considered a primary or secondary source. If the data was judged secondary, an attempt was made to obtain the primary sources from which it was based.

A primary source was a source that was either a report by the testing group describing the tests, or a synopsis of the testing that was prepared by any group as an effort to summarize their report file. A secondary source was a source that had taken primary or secondary data and used this data to provide reduced data.

All data sources thus collected were put in a file for more extensive review and analysis. These sources were ranked using an A through D grading system based on data quality and reliability according to the criteria described earlier and in the manual "Technical Procedures for Developing AP-42 Emission Factors and Preparing AP-42 Sections." This manual includes the definitions of A, B, C and D used in the ranking system.

The data review process was conducted on numerous data sources. The data contained in each were used to develop an emission factor specific to that source and site. The sources are grouped by metalurgical coke processes and with control device. Source category emission factors were then calculated and rated. The ranking assigned to the emission factors, reflects the rankings of the data used to develop that emission factor.

An A through E scale, as defined earlier, was used to indicated the reliability of each emission factor. A brief summary of the relevant details of each test and the basis for the assigned rank follows.

All data in the tables are presented in a lb/ton coal charged basis. In some instances, especially with the test reports on pushing, the only available data were reported on a lb/ton coke basis. To keep uniformity in the source category report and to follow the same reporting criteria in the proposed AP-42, all lb/ton coke emissions had to be converted to lb/ton coal. The present factor for determining the tonnage of coke produced per oven is 1.0 tons of dry furnace coke for each 1.43 tons of dry coal charged. This is derived from Lowry's Formula using an average volatile matter of 30.9 percent to get a yield of 73.81 percent run of oven coke. Thus dividing lb/ton coke by 0.7381 will give an approximate lb/ton coal.

Coal Handling

Source No. 1 was a report of a test conducted at Bethlehem Steel, Bethlehem, Pennsylvania by PADER. The test was an EPA method-5 test on the outlet of an Amerclone dry centrifugal dust collector, which controlled emissions from the coal crushing station. The testing was conducted on 9/26/78 and is rated a B.

Preheaters

Source 2 was a report of a test conducted at Allied Chemical Semet Solvay Division in Detroit, Michigan. Three EPA method-5 runs were conducted on the outlet of a scrubber controlling the "B" Unit Coal Preheat operation. The testing was conducted during August and September 1978 and rated a B.

Source 3 was a report of a test conducted at Allied Chemical Semet Solvay Division in Detroit, Michigan. Three EPA method-5 runs were conducted on the outlet of a scrubber controlling the "A" Unit Coal Preheat operation. The testing was conducted on 7/18 - 20/79 and was rated B.

Source 4 was a report of a test conducted at Inland Steel Co., East Chicago, Indiana. Twelve EPA method-5 runs were conducted on the northside preheater for "C" Battery at the inlet to a Venturi scrubber. The testing was conducted from 8/30 - 9/2/77 and was rated B.

Source 5 was a report of a test conducted at Inland Steel Co., East Chicago, Indiana. Twelve EPA method-5 runs were conducted on the outlet of a Venturi scrubber. This scrubber controls the northside preheater emissions at "C" Battery. The scrubber was operated in 4 different modes during the testing. The testing was conducted from 8/30 - 9/2/77 and was rated B.

Source 6 was a report of a test conducted at Jones & Laughlin Steel, Aliquippa Works. Eighteen EPA method-5 runs were conducted on the North Preheat Bleed of A-5 battery. The runs were performed on the inlet to a Venturi scrubber which controls the preheater emissions. The testing was conducted on 3/30 - 4/7/77 and this test was rated A.

Source 7 was a report of a test conducted at Jones & Laughlin Steel, Aliquippa Works. Eighteen EPA method-5 runs were conducted on the North Preheat Bleed of A-5 battery. The runs were performed on the outlet of a

Venturi scrubber which controls the preheater emissions. The unit was run with different operating conditions and the runs were performed from 3/30 - 4/7/77. This test was rated A.

Source 8 was a report of a test conducted at Jones & Laughlin Steel, Aliquippa Works. Three EPA method-5 run were performed on the inlet and outlet to a scrubber controlling the North Unit Preheater System. The test was conducted from July - August 1978 and rated A.

Source 9 was a report of a test conducted at Alabama By-Products, Torrant City, Alabama. Three runs similar to EPA Method-5 run were conducted on the outlet of a wet ESP which controls the preheater. The testing was conducted on 4/29/80 and is rated B.

Sources 10 and 11 were reports of two tests conducted at Jones & Laughlin Steel, Aliquippa Works. The tests were conducted by PADER on 11/29/77. One EPA method-5 test was performed on each of two preheaters controlled by a Venturi scrubber and a Demister. These tests were not included in the Emission Factor and were each rated C.

Source 12 was a report of a series of tests performed at U.S. Steel, Gary Indiana. The report included a series of tests conducted on three wet ESP's A, B, and C which control a preheater system. Three method-5 runs were conducted on the outlet of each of the ESP's. The testing was performed between 7/12 - 26/78 and is rated A.

Charging

Source 13 was a report of a series of tests conducted at Bethlehem Steel Co., Burns Harbor, Indiana. The runs were performed on the outlet of a scrubber system mounted on a larry car. The scrubber was tested at three different operation conditions. All the tests were performed in April 1970 and were rated C.

Source 14 was a report of a test conducted at Jones & Laughlin Steel, Pittsburgh, Pennsylvania. The testing was performed in 1973 and compared emissions from a Wilputte car vs. an EPA/AISI car. These cars were serving battery P-4 and the testing was rated B.

Source 15 was from a summary on a test conducted at Ruhrkold Zollverein in Essen, Germany. The date of the test is unknown but it was conducted on a Low Energy Krupp Scrubber mounted on a larry car. This is the average of two larry car tests and the summary is rated D.

Source 16 was from a summary on a test conducted at Osterfeld Plant in Essen, Germany. The test was performed on a larry car which had a low energy centrifugal dust collector with mist eliminators mounted on it. The method utilized was VDI 2302 and the test was conducted in August of 1974. The summary was rated D.

Source 17 was from the Publication EPA-450/4-79-028, Particulate Emission Factors Applicable to the Iron and Steel Industry (MRI). A C rating was given for uncontrolled charging emissions.

COMBUSTION STACKS

Source 18 was a report of testing at Armco Inc., Houston Works, in Houston, Texas. The report includes test data from both the No. 1 and No. 2 combustion stacks. Additionally, the data provided includes both inlet (uncontrolled) and outlet (controlled) emission data. The sources were controlled by a dry ESP. Each of the individual ESPs were comprised of three fields. The report was a file summary of the testing. The testing was performed during July 1973. The report was rated C.

Source 19 was a report of testing at Armco Inc., Houston Works, in Houston, Texas. The locations were the same as those in source 1. Three tests were performed at both the inlet and outlet of both sides of the ESP. The tests were performed during November 1976. The report was rated B.

Source 20 was a report of testing at Bethlehem Steel Corp., Bethlehem Plant in Bethlehem, Pennsylvania. Tests were performed on the No. 2, 3, 5 and A batteries. The No. 2 and 3 batteries were each comprised of 102 ovens; while the 5 & A batteries were comprised of 80 ovens each. One run was conducted on each of the batteries. The combustion stacks burn coke oven gas only. Testing was performed during May 1980. The report was rated B.

Source 21 was a report of testing at Bethlehem Steel Corp's., Franklin Plant in Johnstown, Pennsylvania. This source was uncontrolled. The No. 17 battery was comprised of 77 ovens. Two tests were performed on this source. These tests were conducted on 3 December 1975. The report was rated B.

Source 22 was a report of testing at Bethlehem Steel Corp's., Franklin Plant in Johnstown, Pennsylvania. The source was uncontrolled. The tests were performed on the No. 18 coke battery. The No. 18 coke battery was comprised of 77 ovens. The ovens were fired on coke oven gas exclusively. Three tests, only one being EPA M-5, were performed on this source during June and August 1978. The report was rated C.

Source 23 was a report of testing at Bethlehem Steel Corp's., Franklin Plant in Johnstown, Pennsylvania. The source was the No. 18 coke oven battery combustion stack. This source was described as source 22. One EPA M-5 test was performed. This report was rated B.

Source 24 was a report of tests conducted at Bethlehem Steel Corp's., Sparrow Point Plant located in Sparrows Point, Maryland. The tests were conducted on the coke oven batteries 8, 9, 10, 11, 12 combustion stacks. Each of these sources was fired on blast furnace gas and coke oven gas. Nineteen EPA M-5 tests were conducted during the firing of each individual fuel. The testing was conducted during March, June and July 1975. This report was rated A.

Source 25 was a report of testing at Donner Hanna Coke Co., in Buffalo, New York. The tests were performed on the B battery during December 1973. This coke battery is comprised of 51 ovens. Three EPA M-5 tests were performed at this location. The report was rated B.

Source 26 was a report of testing at Ford Motor Corp's. Dearborn Michigan Plant. Three EPA M-5 tests were performed on the C battery combustion stack. These tests were performed during 27-28 October 1981. The C battery is comprised of 61 coking ovens, and the emissions are controlled by an ESP. The report was rated A.

Source 27 was a report of testing at the Inland Steel Corp's. Indiana Harbor Works in East Chicago, Illinois Plant. The tests were performed on the No. 11 coke battery combustion stack. Three EPA M-5 tests were performed, in conjunction with SO_2 tests. The No. 11 battery is comprised of 69 ovens. The report was rated B.

Source 28 was a report of tests performed at Interlake, Inc., Riverdale Plant in Chicago, Illinois. The report included a description of two EPA M-5 tests. The coke oven battery was comprised of 50 ovens. The tests were performed during 4 June 1981. The report was rated C.

Source 29 was a report of tests conducted at J & L Steel Co., Aliquippa Works in Aliquippa, Pennsylvania. The tests were conducted on the A-5 coke oven battery. This battery was fired on coke oven gas. The A-5 battery was comprised of 56 ovens. Two EPA M-5 tests were conducted during 11-13 February 1980. The report was rated B.

Source 30 was a report of tests conducted at J & L Steel Co., Aliquippa Works in Aliquippa, Pennsylvania. The tests were conducted on the A-1 coke oven battery. This battery was fired on coke oven gas and was comprised of 106 ovens. Three EPA M-5 tests were conducted during 29-30 December 1980. The report was rated B.

Source 31 was a report of tests conducted at J & L Steel Co., Indiana Harbor Works in East Chicago, Illinois. The tests were conducted on the No. 4 coke oven battery. This battery was comprised of 75 ovens and fired on coke oven gas. The tests were conducted during 7-9 April 1980. The report was rated B.

Source 32 was a report of tests conducted at J & L Steel Co., Indiana Harbor Works in East Chicago, Illinois. The report detailed tests conducted on the No. 9 coke oven battery combustion stack. The No. 9 coke oven battery was comprised of 87 ovens and was fired on coke oven gas only. Three EPA M-5 tests were conducted during 22-24 October 1980. The report was rated B.

Source 33 was a report of tests conducted at J & L Steel Co., Pittsburgh Works in Pittsburgh, Pennsylvania. The report details tests conducted on the P-4 coke oven battery combustion stack. The P-4 coke oven battery was comprised of 79 ovens and was fired on coke oven gas. Three EPA M-5 tests were conducted during 16-17 April 1980. The report was rated B.

Source 34 was a report of tests conducted at J & L Pittsburgh Works in Pittsburgh, Pennsylvania coke oven combustion stacks. The testing was conducted on Batteries P1, P2, P3N, and P3S. The four batteries were of similar design and each was comprised of 59 ovens. The ovens were fired on coke oven gas. Three EPA M-5 tests were conducted on each of these combustion stacks during 19-21 June 1980. The report was rated B.

Source 35 was a report of tests conducted at Kaiser Steel Co., Fontana Works in Fontana, California. The report details testing performed on the C & E coke oven battery combustion stacks. These batteries were controlled by a baghouse. Three EPA M-5 tests were conducted on each of these during

April, 1980. Both coke oven batteries were comprised of 45 ovens; the C battery is fired on coke oven gas whereas the E battery is fired on blast furnace gas. The report was rated A.

Source 36 was a report of tests conducted at Koppers Co., Industrial Products Division in Woodward, Alabama. The tests were performed on the No. 5 coke oven battery combustion stack. The No. 5 combustion stack was comprised of 30 ovens and was fired on coke oven gas. Two EPA M-5 tests were conducted during 21-22 August 1975. The report was rated C.

Source 37 was a report of tests conducted at National Steel Co., Great Lakes Steel Division located in Ecorse, Michigan. The report detailed tests that were conducted on the No. 5 coke oven battery combustion stack. The No. 5 coke oven battery was comprised of 85 ovens and was designed to be fired on blast furnace gas and coke oven gas. Three EPA M-5 tests were conducted during 20-24 November 1980. The report was rated B.

Source 38 was a report of testing conducted at National Steel Co., Granite City, Illinois. The report details tests performed on the C-coke oven battery combustion stack. The C battery was comprised of 61 ovens. This battery's combustion stack was controlled by an ESP. Five EPA M-5 tests were performed at both the inlet and outlet of the ESP on 17-23 October 1979. The report was rated C.

Source 39 was a report of testing conducted at National Steel Co., Granite City, Illinois. The testing was conducted on the A coke oven battery combustion stack. The A battery was comprised of 45 ovens and was fired on coke oven gas. Three EPA M-5 tests were conducted during 16-17 December 1980. The report was rated B.

Source 40 was a report of tests conducted at National Steel Co., Weirton Steel Division, Weirton, West Virginia. The report detailed tests conducted on the B-1 coke oven battery combustion stack. The B-1 coke oven battery was comprised of 87 ovens. Three EPA M-5 tests were performed during 17 June 1981. The report was rated B.

Source 41 was a report of tests conducted at National Steel Co., Weirton Steel Division, Weirton, West Virginia. The report detailed tests conducted on the No. 8 coke oven battery combustion stack. The No. 8 coke oven battery was comprised of 87 ovens. Three EPA M-5 tests were conducted during 18 June 1981. The report was rated B.

Source 42 was a report of testing performed at Shenango Steel Co., Neville Island, Pennsylvania. The report described tests performed on the No. 2 and 3 coke oven battery combustion stack. The report detailed ten EPA Method 5 runs. Also included was data pertaining to particle size distributions, NO_x and SO_x. The report was rated A.

Source 43 was a report of tests conducted at U.S. Steel Co., Fairfield, Alabama. The report detailed tests conducted on the No. 2 coke oven battery combustion stack. The No. 2 coke oven battery was comprised of 57 ovens and was fired on coke oven gas. Three EPA M-5 tests conducted during 10-11 October 1979. The report was rated B.

Source 44 was a report of tests conducted at U.S. Steel Co., Gary Works in Gary, Indiana. The tests were conducted on the No. 2 coke oven battery combustion stack during the combustion of coke oven gas and blast furnace gas. The No. 2 battery was comprised of 57 ovens. Seven EPA M-5 tests were conducted during 12-26 July 1978. The report was rated A.

Source 45 was a report of tests conducted at U.S. Steel Co., Gary Works in Gary, Indiana. The tests were conducted on the No. 1 coke oven combustion stack. The No. 1 coke oven battery was comprised of 85 ovens and fired on coke oven gas. Three EPA M-5 tests were conducted during 7-9 March 1980. The report was rated B.

Source 46 is a report of tests conducted at U.S. Steel Co., Gary Works in Gary, Indiana. The tests were conducted on the No. 7 coke oven battery combustion stack. The No. 7 coke oven was comprised of 77 ovens and was fired on coke oven and blast furnace gas. Three EPA M-5 tests were conducted during 17 December 1980. The report was rated B.

Source 47 was a report of tests conducted at U.S. Steel Co., Gary Works in Gary, Indiana. The tests were conducted on the No. 2 coke oven battery combustion stack. The No. 2 coke oven battery was comprised of 57 ovens and was fired on coke oven and blast furnace gas. Three EPA M-5 tests were conducted during 27 February-2 March 1981. The report was rated B.

Source 48 was a report of tests performed at U.S. Steel Co., Gary Works in Gary, Indiana. The tests were performed on the No. 13 coke oven battery combustion stack. The No. 13 coke oven battery was comprised of 77 ovens and was fired on coke oven gas. Three EPA M-5 tests were conducted during 8-9 April 1981. The report was rated B.

Source 49 was a report of tests performed at U.S. Steel Co., Gary Works in Gary, Indiana. The tests were performed on the No. 2 coke oven battery combustion stack. The No. 2 coke oven battery was described as source 47. Three EPA M-5 tests were conducted during 23-28 April 1981. The report was rated A.

Source 50 was a report of tests performed at U.S. Steel Co., Gary Works in Gary, Indiana. The tests were performed on the No. 1 coke oven battery combustion stack. The No. 1 coke oven battery was comprised of 85 ovens and was fired on coke oven gas. Three EPA M-5 tests were performed during 3-5 November 1981. The report was rated A.

Source 51 was a report of tests performed at U.S. Steel Co., Gary Works in Gary, Indiana. The tests were performed on the No. 15 coke oven battery combustion stack. The No. 15 coke oven battery was comprised of 77 ovens and was fired on coke oven gas. Three EPA M-5 tests were performed during 7-9 March 1980. The report was rated A.

Source 52 was a report of tests performed at U.S. Steel Co., Gary Works in Gary, Indiana. The tests were performed on the No. 16 coke oven battery combustion stack. The No. 16 coke oven battery was comprised of 77 ovens and was fired on coke oven gas. Three EPA M-5 tests were performed during 9-10 April 1980. The report was rated A.

Source 53 was a report of tests performed at U.S. Steel Co., Gary Works in Gary, Indiana. The tests were performed on the No. 3 coke oven battery combustion stack. The No. 3 battery was comprised of 57 ovens and was fired on both coke oven and blast furnace gases. Six EPA M-5 tests were performed during 9-13 April 1980. The report was rated B.

Source 54 was a report of tests performed at U.S. Steel Co., Gary Works in Gary, Indiana. The tests were performed on the No. 7 coke oven battery combustion stack. The No. 7 coke oven battery was comprised of 77 ovens and was fired on both coke oven and blast furnace gas. Six EPA M-5 tests were performed during 9-13 April 1980. The tests were segregated according to the type of fuel being used. The report was rated A.

Source 55 was a report of tests performed at U.S. Steel Co., Gary Works in Gary, Indiana. The tests were performed on the No. 5 coke oven battery combustion stack. The No. 5 coke oven battery was comprised of 77 ovens and was fired on both coke oven and blast furnace gas. Six EPA M-5 tests were performed during 15-17 April 1980. These tests were segregated according to the type of fuel being used. The report was rated A.

Source 56 was a report of testing performed at U.S. Steel Co., Gary Works in Gary, Indiana. The tests were performed on the No. 5 coke oven battery combustion stack. The No. 5 coke oven battery was described as source 55. Three EPA M-5 tests were performed during the burning of coke oven gas. These tests were conducted during 30-31 May 1980. The report was rated A.

Source 57 was a report of tests conducted on the No. 7 coke oven combustion stack at U.S. Steel Co., Gary Works in Gary, Indiana. The description of the No. 7 coke oven is included as source 54. Three EPA M-5 tests were performed during the burning of coke oven gas. These tests were conducted during 30-31 May 1980. The report was rated B.

Source 58 was a report of tests performed at U.S. Steel Co., Gary Works in Gary, Indiana. The tests were conducted on the No. 15 coke oven battery combustion stack. The No. 15 coke oven battery was described as source 51. Three EPA M-5 tests were performed during the burning of coke oven gas. These tests were conducted on June 1-2, 1980. The report was rated a B.

Source 59 was a report of tests performed at U.S. Steel Co., Gary Works in Gary, Indiana. The tests were conducted on the No. 3 coke oven battery combustion stack. The No. 3 coke oven battery was described as source 53. Three EPA M-5 tests were performed during the combustion of coke oven gas. These tests were conducted during 3 June 1980. The report was rated A.

Source 60 was a report of tests conducted at U.S. Steel Co., Gary Works in Gary, Indiana. The report detailed tests performed on the No. 16 coke oven battery combustion stack. The No. 16 coke oven battery was comprised of 77 ovens and was fired on coke oven gas. Three EPA M-5 tests were conducted on the source during 3 June 1980. The report was rated A.

Source 61 was a report of testing at U.S. Steel Co., Gary Works in Gary, Indiana. The tests were conducted on the No. 13 coke oven battery. The No. 13 battery was comprised of 77 ovens and was fired on coke oven gas exclusively. Three EPA M-5 tests were conducted during 15-16 July 1980. The report was rated B.

Source 62 was a report of testing at U.S. Steel Co., Gary Works in Gary, Indiana. The report detailed testing at the No. 15 coke oven battery combustion stack. The No. 15 coke oven battery was comprised of 77 ovens and was fired on coke oven gas. The report described two EPA M-5 tests conducted during 15-17 July 1980. The report was rated C.

Source 63 was a report of testing at U.S. Steel Co., Gary Works in Gary, Indiana. The report detailed testing at the No. 1 coke oven battery combustion stack. The No. 1 coke oven battery was comprised of 85 ovens and was fired on coke oven gas. The report detailed three EPA M-5 tests conducted during 17-18 July 1980. The report was rated B.

Source 64 was a report of testing at U.S. Steel Co., Gary Works in Gary, Indiana. The report detailed testing on the No. 16 coke oven battery stack. The No. 16 coke oven battery was described as source 52. Three EPA M-5 tests were conducted during 18-19 July 1980. The report was rated A.

Source 65 was a report of testing conducted at U.S. Steel Co., Gary Works in Gary, Indiana. The report detailed testing conducted at the No. 3 coke oven battery combustion stack. The No. 3 coke oven battery was described as source 53. Three EPA M-5 tests were conducted during 20-21 July 1980. The report was rated B.

Source 66 was a report of testing conducted at U.S. Steel Co., Gary Works in Gary, Indiana. The report detailed testing conducted at the No. 5 coke oven battery combustion stack. The No. 5 coke oven battery was described as source 55. Three EPA M-5 tests were conducted during 20-21 July 1980. The report was rated A.

Source 67 was a report of testing conducted at U.S. Steel Co., Gary Works in Gary, Indiana. The report detailed testing conducted at the No. 7 coke oven battery combustion stack. The No. 7 coke oven battery was described as source 57. Three EPA M-5 tests were conducted during 21-23 July 1980. The report was rated A.

Source 68 was a report of testing conducted at U.S. Steel Co., Gary Works in Gary, Indiana. The report detailed testing conducted on the No. 16 coke oven battery combustion stack. The No. 16 coke oven battery was described as source 52. Three EPA M-5 tests were conducted during 7-8 January 1981. The report was rated B.

Source 69 was a report of testing conducted at U.S. Steel Co., Gary Works in Gary, Indiana. The report detailed tests performed on the No. 5 coke oven battery combustion stack. The No. 5 coke oven battery was described as source 55. Three EPA M-5 tests were conducted during 17-18 February 1981. The report was rated B.

Source 70 was a report of testing conducted at U.S. Steel Co., Gary Works in Gary, Indiana. The report detailed tests performed on the No. 3 coke oven battery combustion stack. The No. 3 coke oven battery was described as source 53. Three EPA M-5 tests were conducted during 3-4 March 1981. The source was firing coke oven gas only. The report was rated B.

Source 71 was a report of testing conducted at U.S. Steel Co., Gary Works in Gary, Indiana. The report detailed tests conducted on the No. 15 coke oven battery combustion stack. The No. 15 coke oven combustion stack was described as source 62. Three EPA M-5 tests were conducted during 8-9 April 1981. The report was rated B.

Source 72 was a report of testing conducted at U.S. Steel Co., Gary Works in Gary, Indiana. The tests were conducted on the No. 1 coke oven battery. The No. 1 coke oven battery was described as source 45. Three EPA M-5 tests were conducted during 2-4 November 1982. The report was rated B.

Source 73 was a report of testing conducted at U.S. Steel Co., Geneva Works in Provo, Utah. The report detailed testing conducted on the No. 4 coke oven battery combustion stack. The No. 4 oven battery combustion stack was comprised of 63 ovens and was fired on coke oven gas. Three EPA M-5 tests were conducted during 24-26 February 1981. The report was rated A.

Source 74 was a report of testing conducted at U.S. Steel Co., Geneva Works in Provo, Utah. The report detailed testing conducted on the No. 3 coke oven battery combustion stack. The No. 3 coke oven battery was comprised of 63 ovens and was fired on coke oven gas. Three EPA M-5 tests were conducted during 3-5 February 1981. The report was rated A.

Source 75 was a report of testing conducted at U.S. Steel Co., Geneva Works in Provo, Utah. The report detailed tests that were conducted on the No. 2 coke oven battery combustion stack. The No. 2 coke oven battery combustion stack was comprised of 63 ovens and was fired on coke oven gas. Three EPA M-5 tests were conducted during 16-18 February 1982. The report was rated A.

Source 76 was a report of testing conducted at U.S. Steel Co., Geneva Works in Provo, Utah. The report detailed tests that were performed on the No. 1 coke oven battery combustion stack. The No. 1 coke oven battery was comprised of 63 ovens and was fired with coke oven gas. Three EPA M-5 tests were conducted during 13-16 October 1981. The report was rated A.

Source 77 was a report of tests conducted at Wheeling Pittsburgh Steel Corp., Mon Valley Plant in Monassen, Pennsylvania. The tests were conducted on the No. 1 coke oven battery combustion stack. The No. 1 coke oven battery was comprised of 74 ovens and was fired on coke oven gas. Three EPA M-5 tests were conducted during 9 September 1981. The report was rated B.

Source 78 was a report of tests conducted at Republic Steel Corp., Chicago District in Chicago, Illinois. The report described tests that were conducted on the No. 1 coke oven battery combustion stack. The No. 1 coke oven battery was comprised of 60 ovens and was fired on both coke oven gas and blast furnace gas. Three EPA M-5 tests were conducted during 10 February 1982. The report was rated B.

Source 79 was a report of tests conducted on the No. 4 coke oven battery combustion stack at Republic Steel Co., Mahoning Valley District in Warren, Ohio. The No. 4 coke oven was comprised of 85 ovens and was fired on coke oven gas. The report detailed three EPA M-5 tests conducted during 16-17 September 1981. The report was rated B.

Source 80 was a report of tests conducted on the U.S. Steel Co., Clairton Works in Clairton, Pennsylvania. The testing was conducted on the No. 21 coke oven battery combustion stack. The stack was controlled by an ESP. Four EPA M-5 tests and were conducted during 17-20 December 1979. The report was rated C.

Source 81 was a report of tests conducted at the U.S. Steel Co., Clairton Works in Clairton, Pennsylvania. The testing was conducted on the No. 1 coke oven battery combustion stack. The No. 1 coke oven battery was comprised of 64 coke oven batteries which were fired on coke oven gas. Three EPA M-5 tests were conducted during 11-12 March 1981. The report was rated C.

Source 82 was a report of tests conducted at the U.S. Steel Co., Clairton Works in Clairton, Pennsylvania. The report detailed tests that were conducted on the No. 2 coke oven battery combustion stack. The No. 2 coke oven was comprised of 64 ovens and was fired on coke oven gas. Three EPA M-5 tests were conducted during 13 and 19 March 1981. The report was rated C.

Source 83 was a report of tests conducted at the U.S. Steel Co., Clairton Works in Clairton, Pennsylvania. The report detailed tests that were conducted on the No. 3 coke oven battery combustion stack. The No. 3 coke oven combustion stack was comprised of 64 ovens that were fired on coke oven gas. Three EPA M-5 tests were conducted during 20-25 March 1981. The report was rated C.

Source 84 was a report of tests conducted at the U.S. Steel Co., Clairton Works in Clairton, Pennsylvania. The report detailed tests that were conducted on the No. 7 coke oven battery combustion stack. The No. 7 coke oven battery was comprised of 64 ovens that were fired on coke oven gas. Three EPA M-5 tests were conducted during 6-7 April 1981. The report was rated C.

Source 85 was a report of tests conducted at the U.S. Steel Co., Clairton Works in Clairton, Pennsylvania. The report detailed tests that were conducted on the No. 8 coke oven battery combustion stack. The No. 8 coke oven battery was comprised of 64 ovens that were fired on coke oven gas. Three EPA M-5 tests were conducted during 10 and 13 April 1981. The report was rated C.

Source 86 was a report of tests conducted at the U.S. Steel Co., Clairton Works in Clairton, Pennsylvania. The tests were conducted on the No. 9 coke oven battery combustion stack. The No. 9 coke oven battery was comprised of 64 ovens and was fired on coke oven gas. Three EPA M-5 tests were conducted during 15-16 April 1981. The report was rated C.

Source 87 was a report of tests conducted at the U.S. Steel Co., Clairton Works in Clairton, Pennsylvania. The testing was conducted on the No. 21 coke oven battery combustion stack. This source was described as source 80. Three EPA M-5 tests were performed during 1-2 September 1981 on the outlet of the ESP. The report was rated C.

Source 88 was a report of tests conducted at the U.S. Steel Co., Clairton Works in Clairton, Pennsylvania. The testing was conducted on the No. 19 coke oven battery combustion stack. The No. 19 coke oven battery was comprised of 87 ovens which were fired on coke oven gas. Three EPA M-5 tests were conducted during 16-17 September 1981. The report was rated C.

Source 89 was a report of tests conducted at the U.S. Steel Co., Clairton Works in Clairton, Pennsylvania. The tests were conducted on the No. 20 coke oven battery combustion stack. The No. 20 coke oven battery was comprised of 87 ovens and was fired with coke oven gas. Three EPA M-5 tests were conducted during 5-6 October 1981. The report was rated C.

Source 90 was a report of tests performed at Republic Steel Co., Cleveland District Plant in Cleveland, Ohio on the No. 1 coke battery. Four EPA M-5 tests were performed during 16-17 July 1979. The No. 1 coke battery was comprised of 51 ovens. The ovens were fired with coke oven gas. The report was rated A.

Source 91a was a report of tests performed at Kaiser Steel Co., Fontana Works in Fontana, California. Two EPA M-5 tests were performed on the coke oven battery B during 26-27 July 1979. The B battery was fired on coke oven gas. The source was controlled by a reverse air baghouse. The battery was comprised of 45 ovens. The report was rated B.

Source 91b was a report of tests performed at Kaiser Steel Co., Fontana Works in Fontana, California. Three EPA M-5 tests were performed on the coke oven battery C during 26-27 March 1979. The C battery was fired on coke oven gas. The source was controlled by a reverse air baghouse. This baghouse utilized silicon-graphite bags. The battery was comprised of 45 ovens. The report was rated B.

Source 91c was a report of tests performed at Kaiser Steel Co., Fontana Works in Fontana, California. Three EPA M-5 tests were performed on the coke oven battery D during 27-28 November 1978. The D battery was fired on coke oven gas. The emissions were controlled by a reverse air baghouse. This baghouse was fit with silicon graphite bags. The test report was rated B.

Source 91d was a report of tests performed at Kaiser Steel Co., Fontana Works in Fontana, California. Three EPA M-5 tests were performed on the E coke oven battery during 12-13 February 1979. The battery was heated by blast furnace gas. The emissions were controlled by a reverse air baghouse. The report was rated B.

Source 91e and f was a report of tests performed at Kaiser Steel Co., Fontana Works in Fontana, California. Three EPA M-5 tests were performed on the G coke oven battery and 2 EPA M-5 tests were performed on the F battery. The tests were conducted during 7-8 January 1980 (G battery) and 9-10 January

1980 (F battery). Both batteries were heated by coke oven gas and blast furnace gas. Each battery was controlled by an independent reverse air baghouse fitted with silicon-graphite bags. The report was rated B.

Source 92 was a report of testing at Jones & Laughlin Steel Co., Aliquippa Works in Aliquippa, Pennsylvania. One EPA M-5 tests were performed on 1 June 1978. These tests were performed on the A-5 battery. The battery was comprised of 56 ovens. The report was rated B.

Source 93 was a report of testing at Keystone Coke Co., at Conshohocken, Pennsylvania. The tests were conducted on the No. 3 and No. 4 coke oven battery combustion stacks in July 1979. One test was performed on each of these stacks. The report was rated C.

Source 94a was a report of testing at U.S. Steel, Gary Works in Gary, Indiana. The tests were performed on the No. 3 coke oven battery combustion stack during 1-6 February 1980. Three EPA M-5 tests were conducted on the stack while the ovens were independently firing blast furnace gas and coke oven gas. The battery was comprised of 57 ovens. The report was rated B.

Source 94b was a report of testing at U.S. Steel, Gary Works in Gary, Indiana. The tests were performed on the No. 13 coke oven battery combustion stack during 24-25 January 1980. Three EPA M-5 tests were performed while the ovens were heated by coke oven gas. The No. 13 battery was comprised of 77 ovens. The report was rated B.

Source 94c was a report of testing at U.S. Steel, Gary Works in Gary, Indiana. The tests were conducted on the No. 15 coke oven battery combustion stack. Three EPA M-5 tests were performed during the independent burning of coke oven and blast furnace gases. The report was rated B.

Source 94d was a report of testing at U.S. Steel, Gary Works in Gary, Indiana. The tests were conducted on the No. 7 coke oven combustion stack. Three EPA M-5 tests were performed during the independent burning of coke oven and blast furnace gases. The report was rated B.

Source 94e was a report of testing at U.S. Steel, Gary Works in Gary, Indiana. The report described testing performed on the No. 5 coke oven battery stack during 13-16 November 1979. The coke oven battery was comprised of 77 ovens. Three EPA M-5 tests were performed during the independent burning of coke oven gas and blast furnace gas. The report was rated B.

Source 94f was a report of testing at U.S. Steel, Gary Works in Gary, Indiana. The report described tests that were performed on the No. 16 coke oven battery stack during 17-18 November 1979. The coke oven battery was comprised of 77 ovens. Three EPA M-5 tests were performed during the burning of coke oven gas. The report was rated B.

Source 95 was a report of testing at U.S. Steel, Fairfield Works in Fairfield, Alabama. The report described testing performed on the No. 3 coke oven battery combustion stack during 19-21 August 1975. Three EPA M-5 tests were performed at this location while the ovens were heated by coke oven gas. The No. 3 coke oven battery was comprised of 57 ovens. The report was rated B.

Source 96 was a report of testing performed at Bethlehem Steel Co., Sparrows Point Plant in Sparrows Point, Maryland. Nineteen EPA M-5 tests were conducted on the No. 8, 9, 10, 11 and 12 coke oven battery stacks. The tests were performed during the use of various combinations of blast furnace gas and coke oven gas. The tests were performed during March-November 1975. SO_2 was also measured. The test was rated B.

PUSHING

Source 97 was a report of testing performed at Armco Steel Co., Houston, Texas. The report included testing at the inlet and outlet of a wet ESP. This ESP services the oven shed from two batteries. The shed was designed for 201,400 scfm. The battery ovens were sized for 12.7 ton/push. Three EPA M-5 tests were performed at each location. The testing was performed on 26-28 October 1976. The report was rated A.

Source 98 was a report of testing performed at Armco Steel Co., Houston, Texas. The testing was performed at the same location as source 97 although only outlet testing was performed. There were four EPA M-5 tests performed on 29 July-1 August 1977. The report was rated B.

Source 99 was a report of testing at Armco Steel Co., Houston, Texas. The location was the outlet of the ESP described as source 97. Two EPA M-5 tests were performed on 1 May 1979. The report was rated B.

Source 100 was a report of testing at Armco Steel Co., Houston, Texas. The location was the inlet to the ESP described as source 97. Three EPA M-5 tests were performed during 2-3 May 1979. The report was rated B.

Source 101 was a report of testing at Armco Steel Co., Houston, Texas. The location was the outlet of the ESP described as source 97. Four EPA M-5 tests were performed during 3-5 August 1979. The report was rated B.

Source 102 was a report of testing performed at Bethlehem Steel, Bethlehem, Pennsylvania. The report detailed one EPA M-5 test on the outlet of the A battery hood. This hood was controlled by a venturi scrubber. The test was performed on 19 December 1980. The report was rated B.

Source 103 was a report of testing performed at Bethlehem Steel, Burns Harbor, Indiana. The report detailed eleven EPA M-5 tests that were conducted on the No. 1 battery shed. The No. 1 battery was comprised of 82 6-meter ovens. Each oven was designed to produce 23.5 ton coke/push. The shed enclosure was designed for 300,000 acfm of air on a continuous basis. The testing was performed during July-September 1974. The report was rated A.

Source 104 was a report of testing performed on the Coke Guide Fume Hood high energy wet scrubber at Ford Motor, Dearborn, Michigan. The tests were performed on the pushside hood ducting A and Ax batteries. The tests were conducted during 1975. The report included extensive emissions information. This information was presented in many cases as both inlet (uncontrolled) and outlet data on many pollutants. The Ax battery was comprised of 13 ovens; whereas the A battery was comprised of 45 ovens. The report was rated A.

Source 105 was a report of testing at Ford Motor Co., Dearborn, Michigan. The testing was performed on the B battery. Three EPA M-5 tests were performed during the period 23-25 February 1982. The report was rated A.

Source 106 was a report of testing at Ford Motor Co., Dearborn, Michigan. Three EPA M-5 tests were performed on the pushside hood ducting the A and Ax batteries. The tests were performed during 25-27 July 1979. The Ax battery was comprised of 13 ovens whereas the A battery was comprised of 45 ovens. The report was rated B.

Source 107 was a report of testing performed at Great Lakes Carbon Corp., St. Louis, Missouri. The report detailed tests performed during pushing and non pushing cycles on an uncontrolled pushside shed. The tests were performed during April 1975. The report was rated A.

Source 108 was a report of testing at Inland Steel, East Chicago, Indiana. The report detailed tests performed during 7-11 November 1976. The report was rated B.

Source 109 was a report of testing at Inland Steel, East Chicago, Indiana. The report detailed tests performed during 17 November 1978 on the No. 11 coke oven battery. Three EPA M-5 tests were performed. The report was rated B.

Source 110 was a report of testing performed at Inland Steel Corp., East Chicago, Indiana. The report detailed three EPA M-5 tests performed on Battery No. 9. The tests were performed on 28 December 1979. The report was rated B.

Source 111 was a report of testing performed at Interlake Inc., Chicago, Illinois. The report detailed three EPA M-5 tests performed on the No. 2 coke battery. The No. 2 coke oven battery is comprised of 50 ovens. The emissions were controlled by a Minister Stein system with a venturi scrubber. These tests were performed during 18-19 June 1980. The report was rated B.

Source 112 was a report of testing performed at Interlake Inc., Chicago, Illinois. The report was a summary of three tests conducted on the outlet of a Minister Stein system with a venturi scrubber. The report was rated C.

Source 113 was a report of testing performed at Ironton Coke Corp., Ironton, Ohio. Three EPA M-5 tests performed on coke batteries 1 and 2. The report was rated C.

Source 114 was a report of testing at Keystone, Coke Co., Conshohocken, Pennsylvania. The report included one EPA M-5 test on the outlet of a baghouse. The test was performed on 23 October 1980. The report was rated C.

Source 115 was a report of testing at Keystone, Coke Co., Conshohocken, Pennsylvania. The report detailed one EPA M-5 test on the outlet of a baghouse. The test was performed on 15 January 1981. The report was rated C.

Source 116 was a report of testing performed at Dofasco's Southside Coke Evacuation shed. Tests were performed under various operating loads including push and nonpush cycle emissions. The tests were performed at both the inlet and outlet of the wet ESP which had been installed to control shed emissions. The tests were performed during December 1976. The report was rated B.

Source 117 was a report of tests performed at the Allied Chemical Corp.'s Minister Stein coke oven emission control system on coke battery No. 3. The tests were performed during April 1979. Seven EPA M-5 tests were conducted at both the inlet and outlet to the control system. The report was rated A.

Source 118 was a report of testing performed at the Bethlehem Steel, Burns Harbor Plant. The tests were performed during March 1975. These tests were conducted during various operational phases of the coke battery operation. Three EPA M-5 runs were conducted. The report was rated A.

Source 119 was a report of testing at Indiana Gas & Chemical Co. Three EPA M-5 runs were performed at the outlet of a venturi rod scrubber. These tests were conducted during 8-10 October 1979. The scrubber controlled the emissions from two coke oven batteries. At the time of testing 48 ovens were operating. The report was rated B.

Source 120 was a report of testing performed at U.S. Steel Gary Works, Gary, Indiana. The report detailed three tests conducted during October 1981. The tests were performed on the outlet of a baghouse servicing battery 9. The data was rated A.

Source 121 was a report of testing performed at U.S. Steel Gary Works, Gary, Indiana. Three EPA Method 5 tests were performed on the outlet of the east baghouse. This baghouse controlled the emissions from the No.s 13, 15, 16 batteries. The system includes a hooded coke guide, a single spot quench car and baghouse. The testing was conducted during 6-8 October 1981. The data was rated A.

Source 122 was a report of testing at Wheeling-Pittsburgh Steel Co. at Monassen, PA. Three EPA Method 5 tests were conducted during August 1981. The tests were conducted on the outlet of a baghouse servicing both batteries 1 and 2. The report was rated A.

QUENCH CARS

Source 123 was a report of testing at Republic Steel Co., Cleveland, Ohio. The report included tests performed on the No. 21 and No. 22 quench cars. These cars were Chemico H-111 cars. Each of these cars was equipped with a scrubber. The No. 6 and 8 batteries each have 63 ovens. The individual ovens are 13.7 ft high. Three tests were performed on each car emissions. These tests were conducted during April 1981. The report was rated C.

Source No. 124 was a report of testing at Republic Steel, Mahoning Valley District, Warren, Ohio and Youngstown, Ohio Plants. The tests were performed during October 1981. The Warren plant testing was performed on two Chemico H-111 cars, each equipped with scrubbers. These cars had been installed for battery 4. This battery was composed of 85 ovens. The Youngstown Plant had one Chemico H-111 which,services batteries B and C. The B and C batteries were comprised of 65 and 59 ovens, respectively. The report was rated B.

Source 125 was a report of testing at J & L Steel Co., Pittsburgh, Pennsylvania. The tests were conducted on the P-4 coke oven battery. This battery was served by a Chemico H-111 car. This service was changed in 1981 by putting the P4 emissions through the Minister-Stein baghouse control system. The P4 battery was comprised of 79 ovens. These tests were conducted during August-September 1979. Seven tests were performed during this period. The report was rated C.

Source 126 was a report of testing at Bethlehem Steel Co., Sparrows Point, Maryland. The testing was performed on the batteries 11 and 12. Four EPA M-5 tests were conducted during October 1980. The report was rated B.

Source 127 was a report of testing at J & L Steel Indiana Harbor Work, East Chicago, Illinois. Tests were conducted on battery Nos. 4 and 9. Three tests were performed during May 1981 on the battery 4. This battery emissions were controlled by a Chemico H-111 one spot car, fit with a scrubber. The battery No. 4 had 75 ovens. Four tests were performed during March 1981 on the battery 9. This battery was serviced by a Chemico H-111 one spot car with a scrubber. The report was rated B.

Source 128 was a report of testing at U.S. Steel, Clairton Works. This report detailed three tests conducted on the battery 15. This battery was controlled by a Chemico H-111 one spot car. The battery No. 15 was comprised of 61 ovens. The report was rated B.

Source 129 was a report of testing performed at U.S. Steel Corp., Clairton Works. Three tests were conducted during March-April 1981 on the Chemico H-111 car that serviced batteries 19 and 20. These batteries were both comprised of 87 ovens. The report was rated A.

Source 130 was a report of testing performed at Republic Steel, Cleveland, Ohio on the No. 12 Koppers/Rosedale one spot car. This car services all four batteries at the No. 1 coke plant. Three EPA M-5 tests were performed during 19-21 June 1979. This car was controlled by a Venturi scrubber. The report was rated A.

Source 131 was a report of testing performed at Republic Steel, Cleveland, Ohio. Three tests were performed at both the inlet and outlet of the No. 11 one spot car equipped with a Venturi scrubber. The testing was performed during 28-29 November 1979. The report was rated B.

Source 132 was a report of testing performed at Shenango Steel Co., Pittsburgh, Pennsylvania. Three EPA M-5 tests were performed on the Chemico H-111 car. The tests were performed during 10-13 February 1981. The report was rated B.

Source 133 was a report of testing performed at U.S. Steel, Fairfield, Alabama. Three tests were performed on the push control scrubber car No. 2. The report was rated A.

Source 134 was a report of testing at Bethlehem Steel Co., Sparrows Point, Maryland. The testing was performed during 13-17 October 1980. The tests were performed on a Halcon car. Three EPA M-5 tests were performed. The data were rated B.

Source 135 was a report of testing at Bethlehem Steel Co., Johnstown, Pennsylvania. The testing was performed during May 1979. The tests were conducted on emissions from the No. 18 battery Koppers/Rosedale one spot car. The data were rated B.

Source 136 was a report of testing performed at Bethlehem Steel Co., Sparrows Point, Maryland. Eight EPA M-5 runs were performed on a Halcon car. This car services batteries 11 and 12. The data were rated B.

Source 137 was a report of testing at CF&I, Pueblo, Colorado. EPA M-5 runs were conducted on both the north and south Granite City one spot cars. Three and four EPA M-5 tests were performed on these cars, respectively. These tests were performed during 3-20 March 1980. The data were rated B.

Source 138 was a report of testing conducted at Inland Steel Co., E. Chicago, Illinois. The tests were performed during November 1978. The tests were performed on the Koppers one spot car. The data were rated B.

Source 139 was a report of testing conducted at Inland Steel Co., E. Chicago, Illinois. The tests were performed during December 1979. The tests were conducted on the Granite City one spot car. The data were rated A.

Source 140 was a report of testing conducted at Inland Steel Co., E. Chicago, Illinois. The tests were performed during June 1980. The data were rated A.

Door Leaks

Source 141 was from the Publication EPA-450/4-79-028. This was used to determine the Emission Factor for door leaks. This was rated B.

Source 142 was a report of a test from Great Lakes Carbon, in St. Louis, Missouri. The test consisted of three method-5 runs performed on a coke shed during the nonpush cycle, thus any emissions collected were considered to be leaks from the doors. The actual emission rate was doubled to account for two doors. The testing was conducted in April of 1975 and rated A.

Source 143 was a report from a test conducted at Bethlehem Steel, in Burns Harbor, Indiana. The test consisted of three method-5 runs performed on a coke shed during nonpush cycles. The emissions generated were considered to come from leaky doors and the emission rate was doubled to account for two doors. The test was conducted in March of 1975 and the report was rated A.

Quenching

Source 144 was a report on tests conducted at U.S. Steel, Lorain Works. The tests were conducted on a quench tower controlled by single row baffles set at 45°. Thirteen EPA method-5 runs were conducted using clean quench water which has a total dissolved solids (TDS) content of less than 1500 mg/l. Eleven method-5 runs were conducted using dirty quench water which has a TDS of greater than 5000 mg/l The testing was conducted in September and October 1976 and was rated A.

Source 145 was a report of tests conducted at U.S. Steel, Gary, Indiana on Quench tower No. 3. The tests were conducted on the tower which was controlled by Carlstill Plastic Baffles. Eighteen EPA method-5 runs were conducted, nine when clean quench water was used and nine when dirty quench water was used. The testing was conducted in January 1980 and rated A.

Source 146 was a report of tests conducted at U.S. Steel, Gary, Indiana on Quench tower No. 5. The tests were conducted on the tower which was controlled by Single Row Baffles set at 45°. Eighteen EPA method-5 runs were performed on the tower, nine when clean quench water was used and nine when dirty quench water was used. The testing was conducted in November 1979 and the report was rated A.

Source 147 was a report of tests conducted at DOFASCO in Hamilton, Ontario. The testing was conducted on tower No. 2 which was controlled by a Double Row Baffle system set at 20°. Nine EPA method-5 runs were conducted using clean quench water. The test was conducted in August of 1977 and the report is rated A.

Source 148 was a report of tests conducted at DOFASCO in Hamilton, Ontario. The testing was performed below (uncontrolled) and above (controlled) the baffle system installed on Tower No. 1. The baffles were Plastic Munters T-271 mist eliminator baffles. Five EPA method-5 runs were performed above and below the baffles using clean quench water and four controlled and uncontrolled runs were performed using dirty quench water. The test was done in October 1981 and the report was rated A.

Coke Handling

Source No. 149 was a report of a test conducted at Bethlehem Steel, Bethlehem, Pennsylvania. EPA method-5 tests were conducted on the East and West Screening Station controlled by an N-Type Rotoclone. The testing was conducted on 3/12 - 13/75 and was rated B.

Source No. 150 was a report of a test conducted at Bethlehem Steel, Bethlehem, Pennsylvania by PADER. One EPA method-5 test was conducted on the outlet of the Rotoclone on the West Screening Station. The testing was conducted on 9/26/78 and is rated B.

AP-42 SECTION

METALLURGICAL COKE MANUFACTURE

7.2 COKE MANUFACTURING

7.2.1 Process Description

Coking is the process of destructive distillation, or the heating of coal in an atmosphere of low oxygen content. Coke is the carbonaceous residue of this process. The process also releases many gases, together with liquid and solid compounds, by reduction of complex organic constituents in the coal. Metallurgical coke is produced primarily from bituminous coals, and in by-product coke ovens. By-product coke ovens are designed to collect all the volatile products liberated during the coking process, and recover the gas and coal chemicals produced.

The by-product oven consists of three main parts: the coking chamber, heating chamber and regenerative chamber. Each of these is lined with refractory brick. Coking chambers are narrow rectangular chambers with interior dimensions ranging from 30 to 43 feet long, 6 to 20 feet high and 12 to 22 inches wide. The coal is contained within this chamber during coking. A series of 10 to 100 ovens, positioned side by side, with a heating chamber between each coking chamber and the regenerative chamber underneath constitutes a coke battery.

The structural design of a coke oven battery is depicted in Figure 7.2.1. Typically, a larry car runs along the top of the coke battery. The larry car delivers a coal charge to each individual oven through ports situated on top of the oven. These ports are sealed after each charge. Other methods used to deliver coal into the ovens are by pipeline or conveyor. These charge methods are associated with the use of preheated coal. After coal charging, heat is supplied to the ovens by combustion of gases passing through the heating flues (chambers). The fuel used for this combustion are natural gas, coke oven gas, blast furnace gas, or a mixture of coke oven and blast furnace gas. Coke oven gas is the most common fuel used. In the ovens, coke is formed first near the brick walls and then toward the center, where the temperatures are 2000° - 2100°F (1100° - 1150°C). The coal is coked for a time period between 12 - 30 hrs. The specific time is determined by production schedules, coke quality and presence of a preheater unit. The coke is then pushed into a quench car. These cars carry incandescent coke to quench towers, in which water is

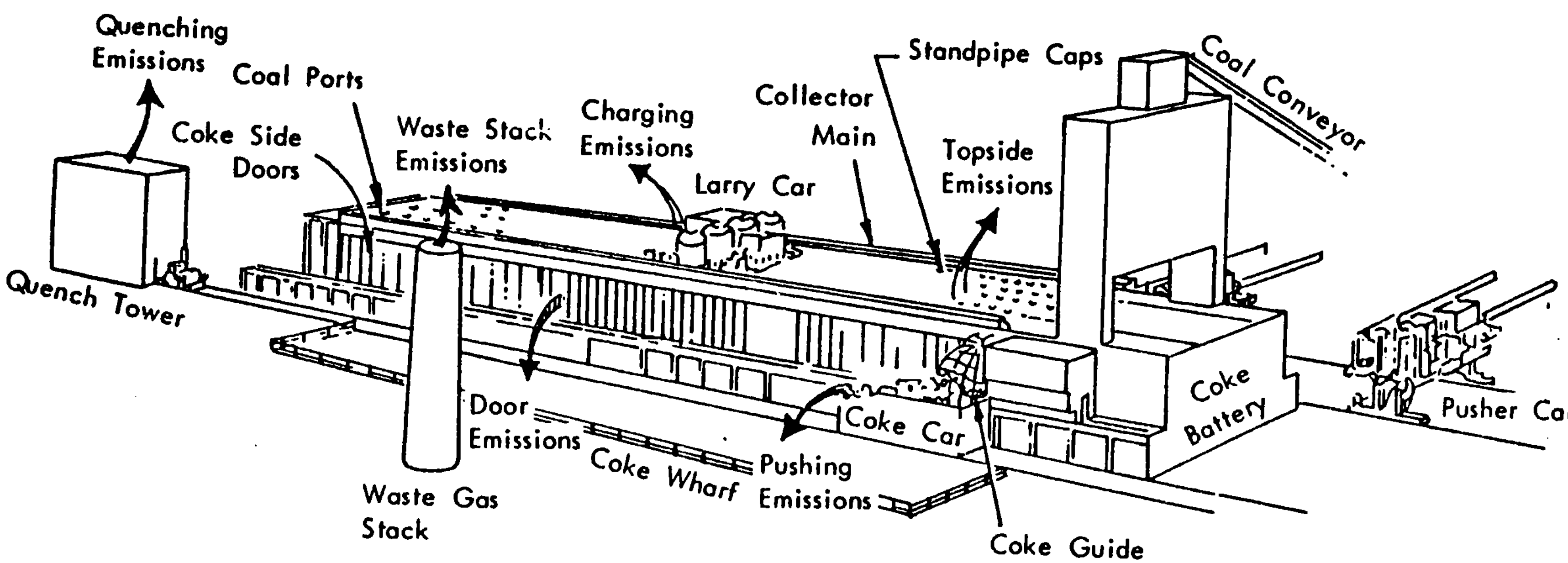

Figure 7.2.1. Schematic of a diagram of byproduct coke oven showing major emission sources.[4]

sprayed on the coke to rapidly cool it. The quenched coke is transferred to the coke wharf and transferred by conveyors to be screened for size. Figure 7.5.1 of this document depicts a flow diagram of an integrated iron and steel plant which contains coking operations.

7.2.2 Emissions and Controls

Particulates, volatile organic compounds, carbon monoxide and other emissions are generated during the following by-product coking operations: (1) coal handling, (2) coal preheating (if used), (3) charging of coal into the incandescent ovens, (4) combustion stacks, (5) coke oven doors are topside leaks, (6) pushing the coke out of the ovens, (7) quenching the hot coke and (8) coke handling. Gaseous emissions from the by-product ovens, during the coking process, are drawn off into a collecting main(s). The collected gases are then subjected to various operations, within the by-product recovery plant, for separating ammonia, coke oven gas, tar, phenol, light oil (benzene, toluene, xylene) and pyridine. These unit operations are potential sources of volatile organic compounds.

Before coal can be converted to coke, it must first be pulverized so that 80 to 90 percent of the coal is less than an 1/8" in size. There is also a need to usually blend two or more types of coal (low, medium and high-volatile) to produce the desired qualities in the coke. The blending of coals will also help produce better by-products and extend life of coke oven walls by avoiding excessive pressure on the walls caused by expansion of the coal.

After the pulverized coal is mixed and blended, water and/or oil are sometimes added to control (decrease or increase, respectively) the coal's bulk density. Finally, the mixture is transported to storage bunkers to await charging.

The primary emission source during these operations occurs when crushing the coal. However, typical coal crushing operations take place in an enclosed area and most of the emissions are contained. Minor emission problems occur while transferring material from conveyor to conveyor, or conveyor to shed.

Coal preheating emissions consist of particulates, hydrocarbons and sulfur species. Some of the hydrocarbons and sulfur species generated are from the coke oven gas fired heaters; although the sulfur concentration is also associated with the type of coal heated. Hydrocarbon emissions are largely determined by operating temperatures, coal residence time in the preheater unit, coal particle size and the oxygen content of the carrier gas. Particulate and gas emissions are usually controlled by scrubbers or ESPs.

The most significant source of emissions at a coke plant are associated with charging. The emissions generated are mostly particulate and volatile constituents of the coal. Most of the emissions are associated with the initial charging of coal from the larry car. Control techniques used to reduce charging emissions include specified operating practices such as stage or sequential charging and control devices mounted on the larry cars. Typical larry car mounted control systems use scrubbers.

Coke oven underfiring (heating) produces varied emissions. The emissions are contingent on the type of fuel used and the type of coal. The emissions are vented from the combustion stack. These emissions are controlled by any number of different control devices including: dry ESP, charged droplet scrubber, wet ESP and fabric filters.

Emissions are also generated from improperly sealed doors, and topside leaks. Proper door maintenance and port cover sealing techniques should eliminate most of these emissions.

Pushing emissons include both gaseous and particulate emissions. The gaseous composition of pushing emissions includes H_2, CO, CH_4, N_2, CO_2 and H_2S. Whereas these emissions have a heating value of about 335 Btu/ft^3, the gas is almost completely burned off when it contacts air. The only residual of concern is the H_2S content. Particulate emissions from pushing operations tend to be significant; especially when "green" coke is pushed. Green coke results from incomplete coking of the entire coal mass within the ovens.

Pushing emissions are usually controlled by a containment method followed by a cleaning method. Examples of these systems include; fixed duct systems with stationary gas cleaning equipment, enclosed quench car with mobile gas cleaning equipment, and a coke-side shed with stationary control device.

Quenching emissions tend to vary with the quench water quality and the quench tower design. Baffle systems are commonly used as a control technique. Baffles are effective as impingement devices due to the high water content of the quench tower emissions.

After the coke is quenched, it is transported by the quench car to an inclined "coke wharf". The coke is dumped in the wharf, usually through the side of the car, and excess water is allowed to drain. Gates on the wharf then open to allow the coke to fall onto a conveyer belt which carries the coke to the screening operation. Here the coke is screened to its desired size, and the coke breeze is gathered for use in other plant operations. Emissions generated through coke handling operations are generally controlled by the use of scrubbers.

The emission factors for coking operations are summarized in Table 7.2-1, and particle size emission factors are summarized in Table 7.2-2. Typical particle size distributions for various operations in a coking facility are presented in Figures 7.2-2 to 7.2-12.

TABLE 7.2.1. SOURCE EMISSION FACTORS FOR COKE MANUFACTURING[a] EMISSION FACTOR RATING D (EXCEPT PARTICULATES)

Type of operation	Emission factor rating	Particulates[b]		Sulfur dioxide[c]		Carbon monoxide[c]		Volatile organics[c]		Nitrogen oxides[c]		Ammonia[c]	
		lb/ton	kg/Mt	lb/ton	kg/Mt	lb/ton	kg/Mt	lb/ton	kg/Mt	lb/ton	kg/Mt	lb/ton	kg/Mt
Coal handling													
with cyclone	D	0.11	0.055	--	--	--	--	--	--	--	--	--	--
Coal preheating													
Uncontrolled	C	3.50	1.75	--	--	--	--	--	--	--	--	--	--
With scrubber	C	0.25	0.125	--	--	--	--	--	--	--	--	--	--
With wet ESP	C	0.012	0.006	--	--	--	--	--	--	--	--	--	--
Coal charging													
Uncontrolled	E	0.48	0.24	0.02	0.01	0.6	0.3	2.5	1.25	0.03	0.015	0.02	0.01
With sequential charging	D	0.016	0.008	--	--	--	--	--	--	--	--	--	--
With scrubber on Larry Car	E	0.014	0.007	--	--	--	--	--	--	--	--	--	--
Door leaks (uncontrolled)	D	0.54	0.27	--	--	0.6	0.3	1.5	0.75	0.01	0.005	0.06	0.03
Coke pushing													
Uncontrolled	A	1.15	0.58	--	--	0.07	0.035	0.2	0.1	--	--	0.1	0.05
With ESP	C	0.45	0.225	--	--	--	--	--	--	--	--	--	--
With Venturi scrubber	E	0.17	0.08	--	--	--	--	--	--	--	--	--	--
With baghouse	E	0.068	0.003	--	--	--	--	--	--	--	--	--	--
Enclosed quench car with scrubber[d]	E	0.082	0.041	--	--	--	--	--	--	--	--	--	--
Quenching													
Uncontrolled (dirty water)[e]	D	5.24	2.62	--	--	--	--	--	--	--	--	--	--
Uncontrolled (clean water)[f]	D	1.13	0.57	--	--	--	--	--	--	--	--	--	--
With baffles (dirty water)[e]	A	1.30	0.65	--	--	--	--	--	--	--	--	--	--
With baffles (clean water)[f]	A	0.54	0.27	--	--	--	--	--	--	--	--	--	--
Combustion stacks													
Uncontrolled (COG)	A	0.47	0.234	--	--	--	--	--	--	--	--	--	--
Uncontrolled (BFG)	A	0.17	0.085	--	--	--	--	--	--	--	--	--	--
With ESP	E	0.091	0.046	--	--	--	--	--	--	--	--	--	--
With baghouse	C	0.15	0.075	--	--	--	--	--	--	--	--	--	--
Coke handling													
With rotoclone	C	0.006	0.003	--	--	--	--	--	--	--	--	--	--

[a]Emission factors expressed as units per weight of coal charged. Dash indicates no available data.

[b]Reference source category report on metallurgical coke manufacturing.

[c]From last AP-42 update 10/80.

[d]Emission factor does not take into consideration capture efficiencies of the enclosed quench car at the point of emissions origin.

[e]Dirty water >5000 mg/l TDS.

[f]Clean water <1500 mg/l TDS.

TABLE 7.2.2. SIZE SPECIFIC EMISSION FACTORS

Source No.	Process	Emission factor rating	Particle size (μm)	Cumulative mass percent less than stated size (%)	Cumulative mass emission factors lb/ton	Cumulative mass emission factors kg/mg
6	COAL PREHEATING Uncontrolled	C	0.5	44	1.5	0.8
			1.0	48.5	1.7	0.8
			2.0	55	1.9	1.0
			2.5	59.5	2.1	1.0
			5.0	79.5	2.8	1.4
7	Controlled with Venturi Scrubber	C	0.5	78	0.20	0.10
			1.0	80	0.20	0.10
			2.0	83	0.21	0.10
			2.5	84	0.21	0.11
			5.0	88	0.22	0.11
			10.0	94	0.24	0.12
14	COAL CHARGING Sequential	D	0.5	13.5	0.002	0.001
			1.0	25.2	0.004	0.002
			2.0	33.6	0.005	0.003
			2.5	39.[illegible]	[illegible]	0.003
			5.0	45.8	0.007	0.004
			10.0	48.9	0.008	0.004
Avg of 103, 104, 107, 108, 117, 118	COKE PUSHING Uncontrolled	A	0.5	3.1	0.04	0.02
			1.0	7.7	0.09	0.04
			2.0	14.8	0.17	0.09
			2.5	16.7	0.19	0.10
			5.0	26.6	0.30	0.15
			10.0	43.3	0.50	0.25
Avg of 104 and 108	Controlled with Venturi Scrubber	C	0.5	24	0.04	0.02
			1.0	47	0.08	0.04
			2.0	66.5	0.11	0.05
			2.5	73.5	0.12	0.06
			5.0	75	0.13	0.06
			10.0	87	0.15	0.07
130	PUSH CARS Scrubber-- travel mode	C	1.0	2.0	0.001	0.0007
			2.0	3.2	0.002	0.001
			2.5	3.5	0.003	0.001
			5.0	6.5	0.005	0.002
			10.0	10.0	0.007	0.004

Source No.	Process	Emission factor rating	Particle size (μm)	Cumulative mass percent less than stated size (%)	Cumulative mass emission factors lb/ton	Cumulative mass emission factors kg/mg
130	PUSH CARS Scrubber-- push mode	C	1.0	28.0	0.021	0.010
			2.0	29.5	0.022	0.011
			2.5	30.0	0.022	0.011
			5.0	30.0	0.022	0.011
			10.0	32.0	0.024	0.012
148	QUENCHING Uncontrolled (dirty water)	D	1.0	13.8	0.72	0.36
			2.5	19.3	1.01	0.51
			5.0	21.4	1.12	0.56
			10.0	22.8	1.19	0.60
			15.0	26.4	1.38	0.69
148	Uncontrolled (clean water)	D	1.0	4.0	0.05	0.02
			2.5	11.1	0.13	0.06
			5.0	19.1	0.22	0.11
			10.0	30.1	0.34	0.17
			15.0	37.4	0.42	0.21
148	With Baffles (dirty water)	A	1.0	8.5	0.11	0.06
			2.5	20.4	0.27	0.13
			5.0	24.8	0.32	0.16
			10.0	32.3	0.42	0.21
			15.0	49.8	0.65	0.32
148	With Baffles (clean water)	A	1.0	1.2	0.006	0.003
			2.5	6.0	0.03	0.02
			5.0	7.0	0.04	0.02
			10.0	9.8	0.05	0.03
			15.0	15.1	0.08	0.04
Avg of 33, 34, 42	COMBUSTION STACKS Uncontrolled	A	1.0	77.4	0.36	0.18
			2.0	85.7	0.40	0.20
			2.5	93.5	0.44	0.22
			5.0	95.8	0.45	0.22
			10.0	95.9	0.45	0.22

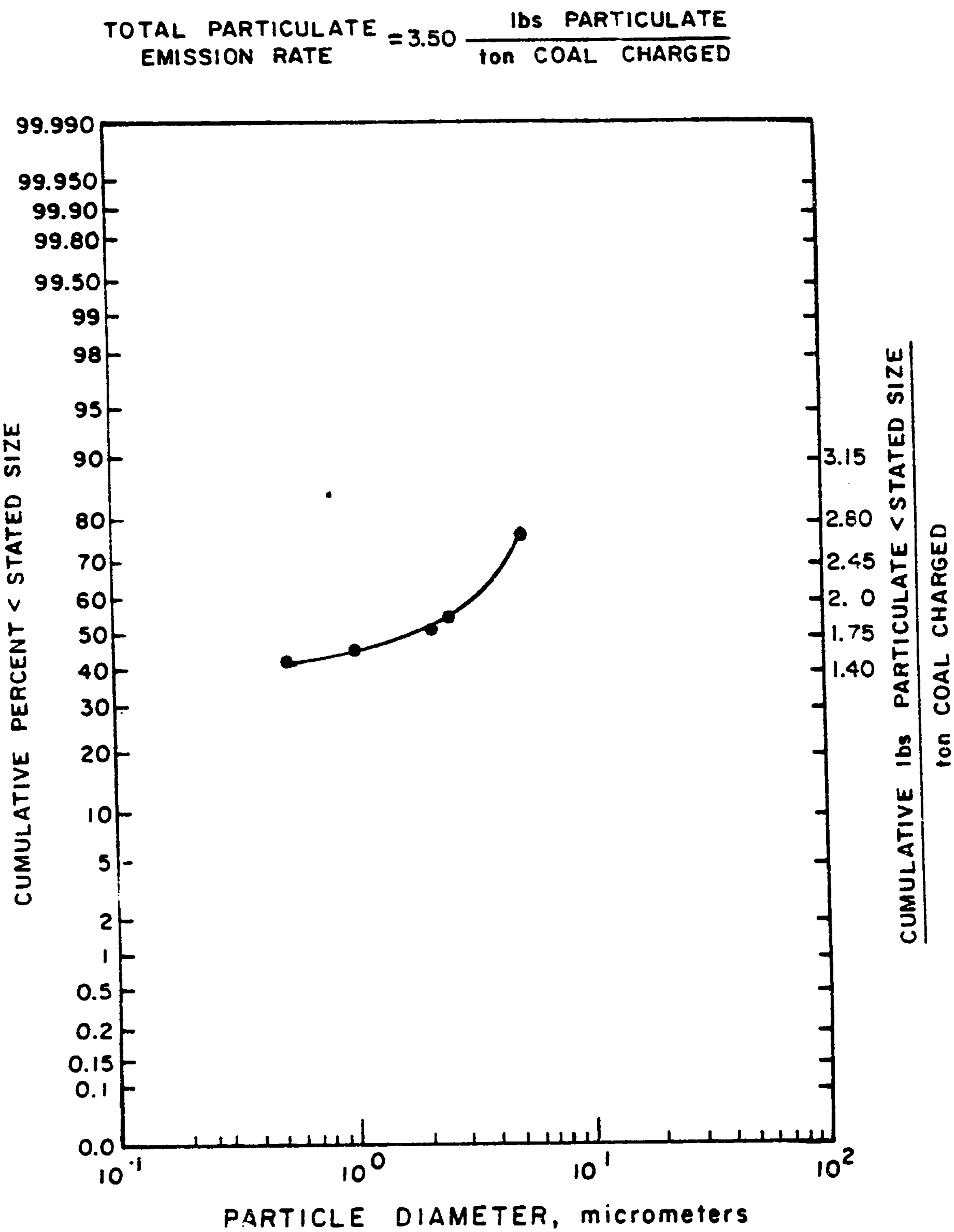

Figure 7.2.2 Coal preheating (uncontrolled).[6]

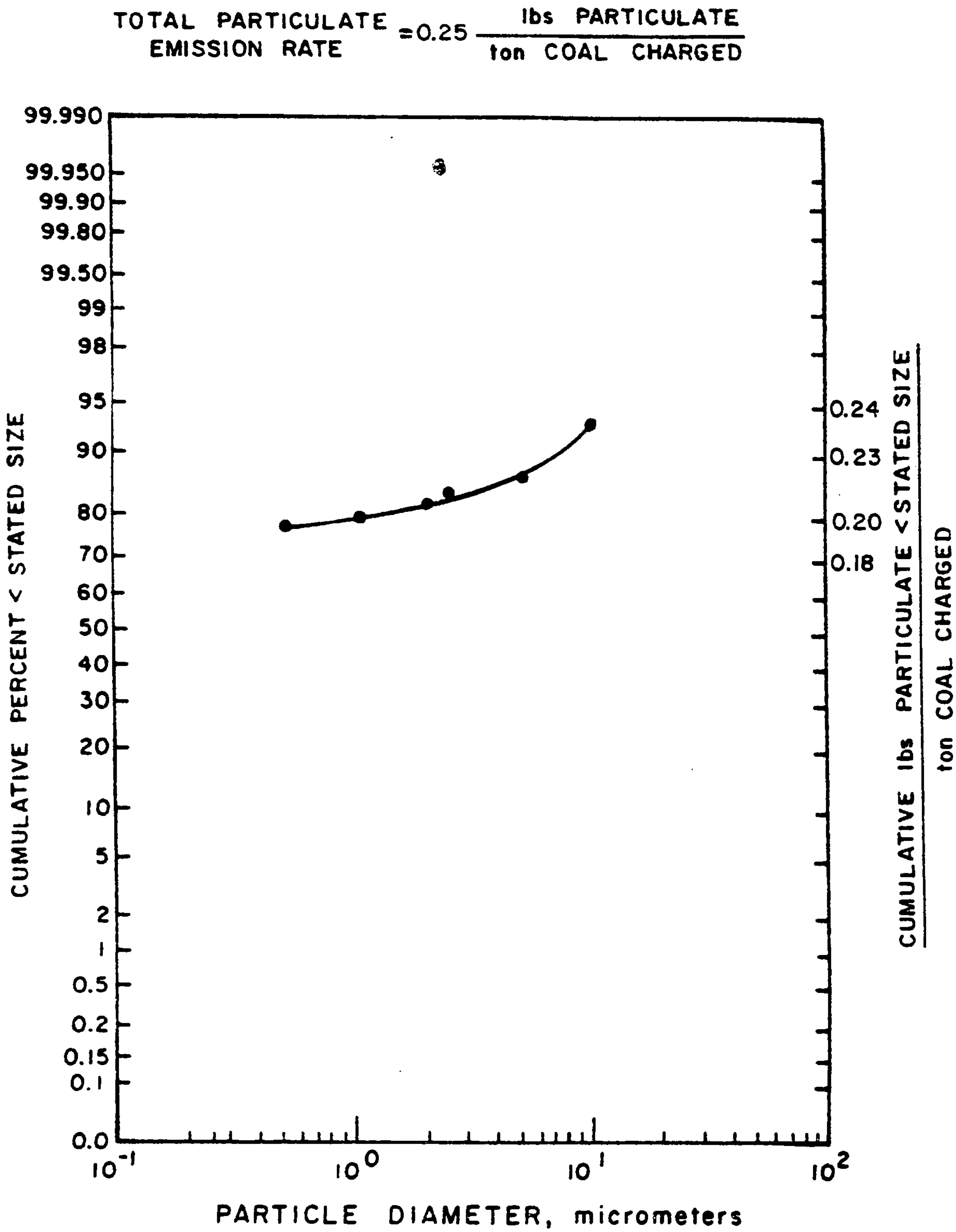

Figure 7.2.3. Coal preheating (controlled with scrubber) [7]

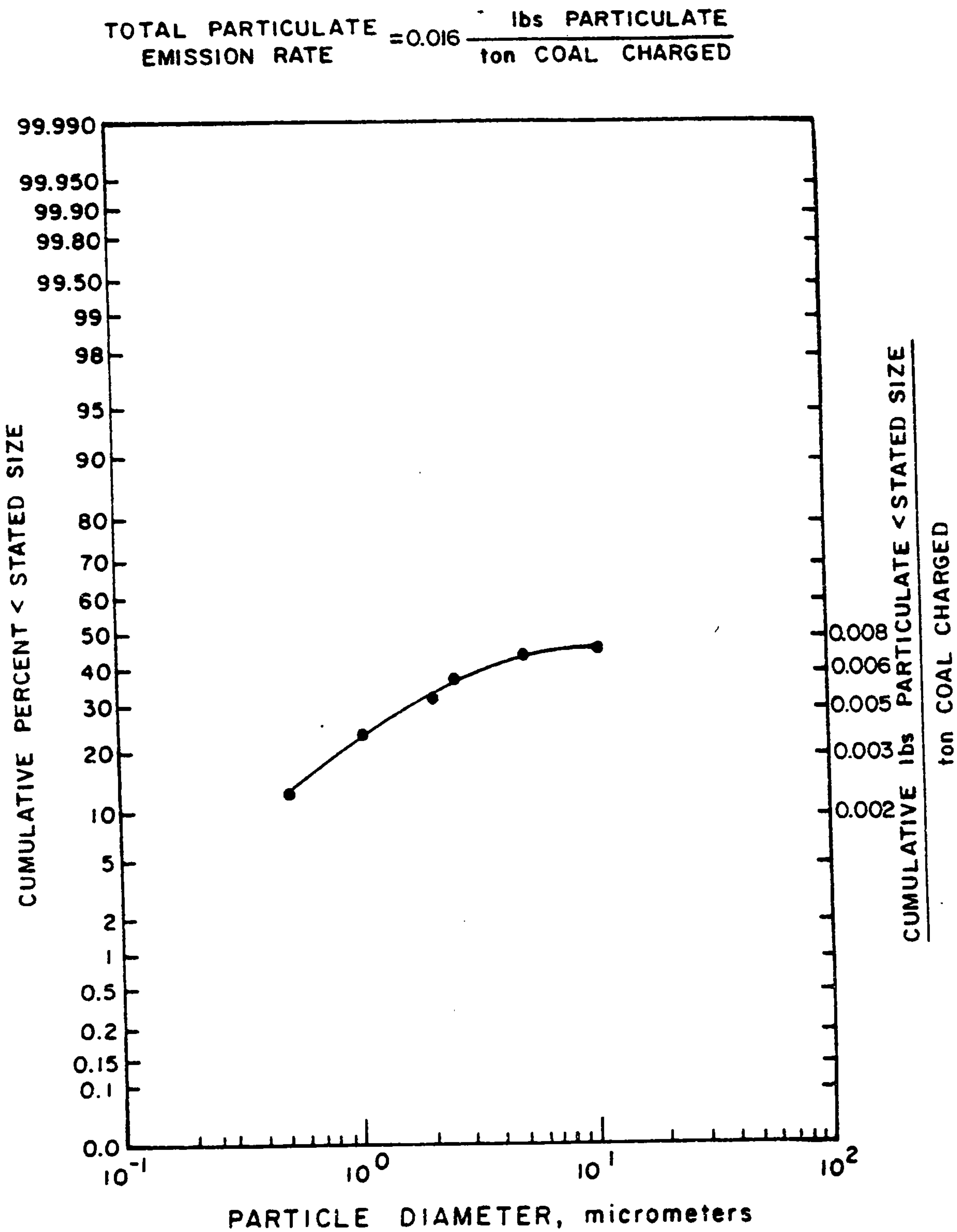

Figure 7.2.4. Coal charging (sequential) average of 2 tests.[14]

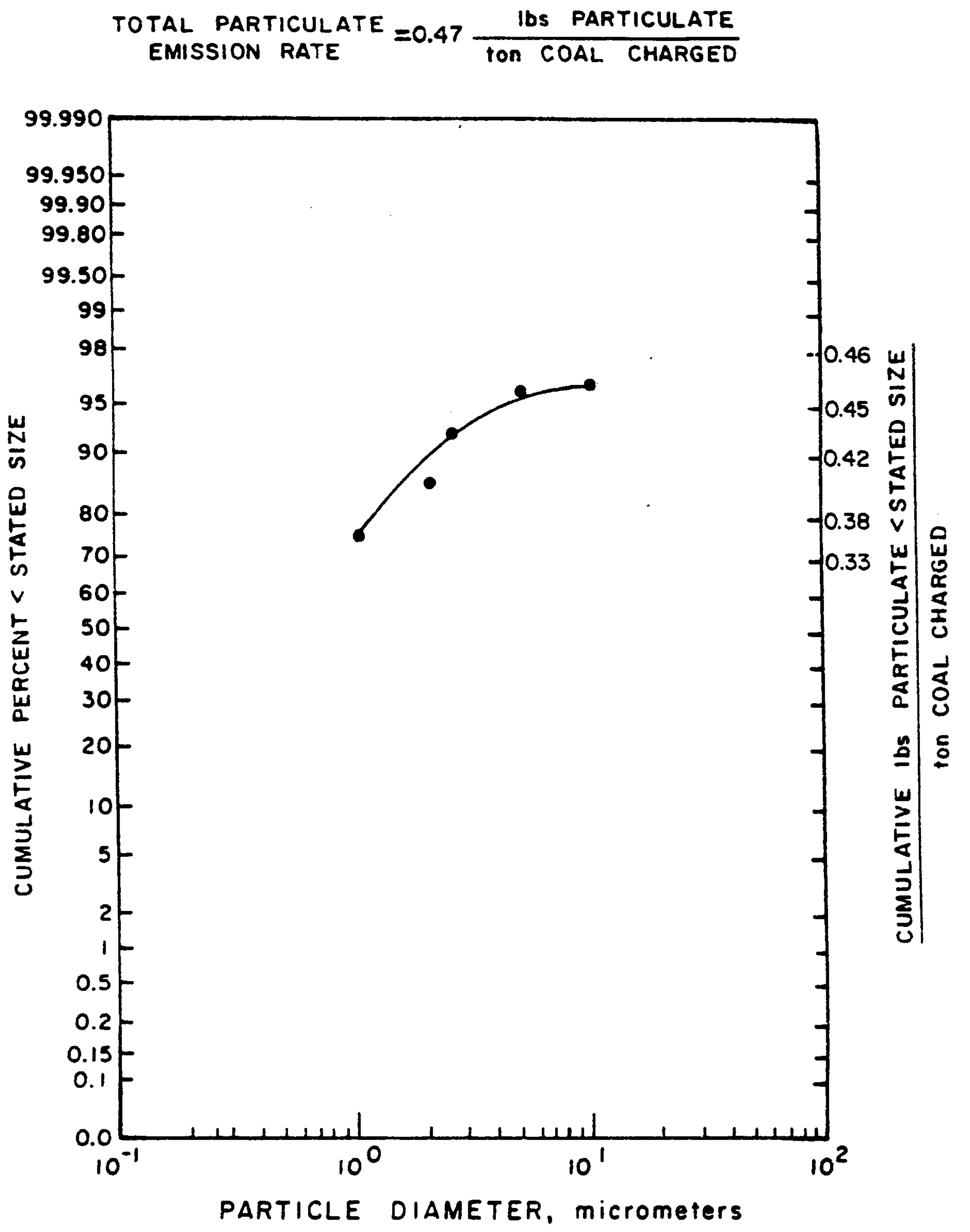

Figure 7.2.5. Combustion stacks (uncontrolled) average of 3 sites.[33,34,42]

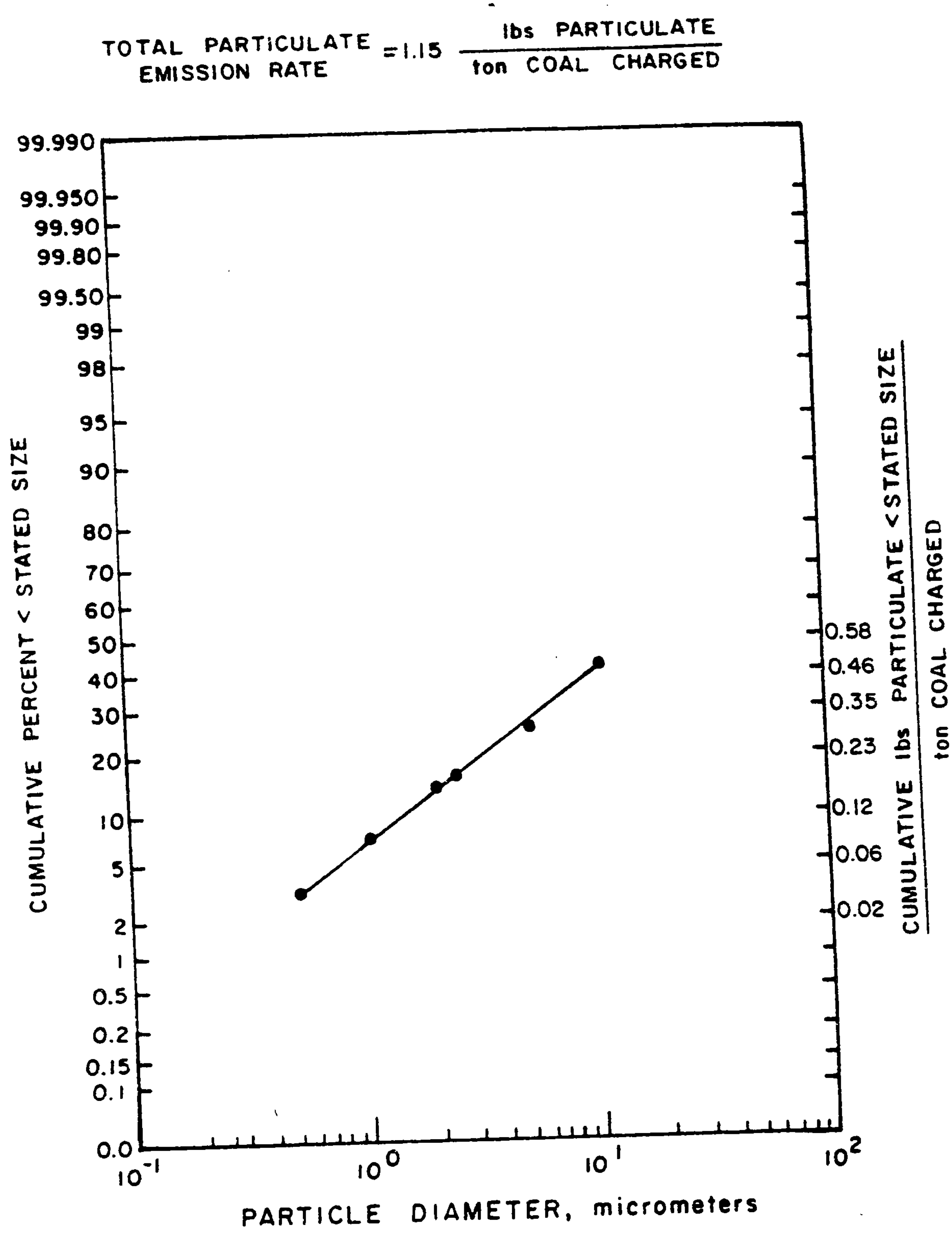

Figure 7.2.6. Pushing (uncontrolled) average of 6 sites.[103,104,107,108,117,118]

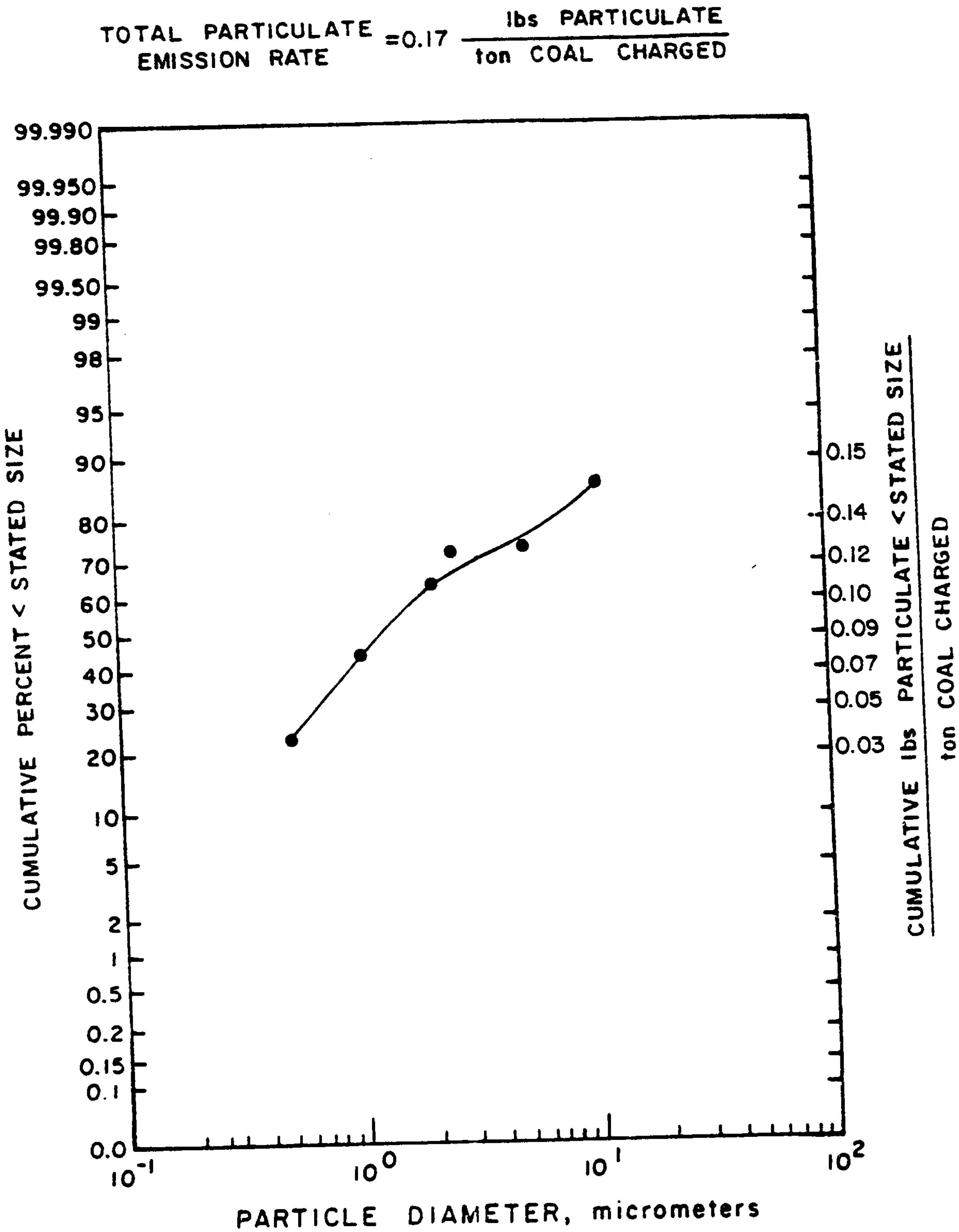

Figure 7.2.7. Pushing (controlled with scrubber) average of 2 sites.[104,108]

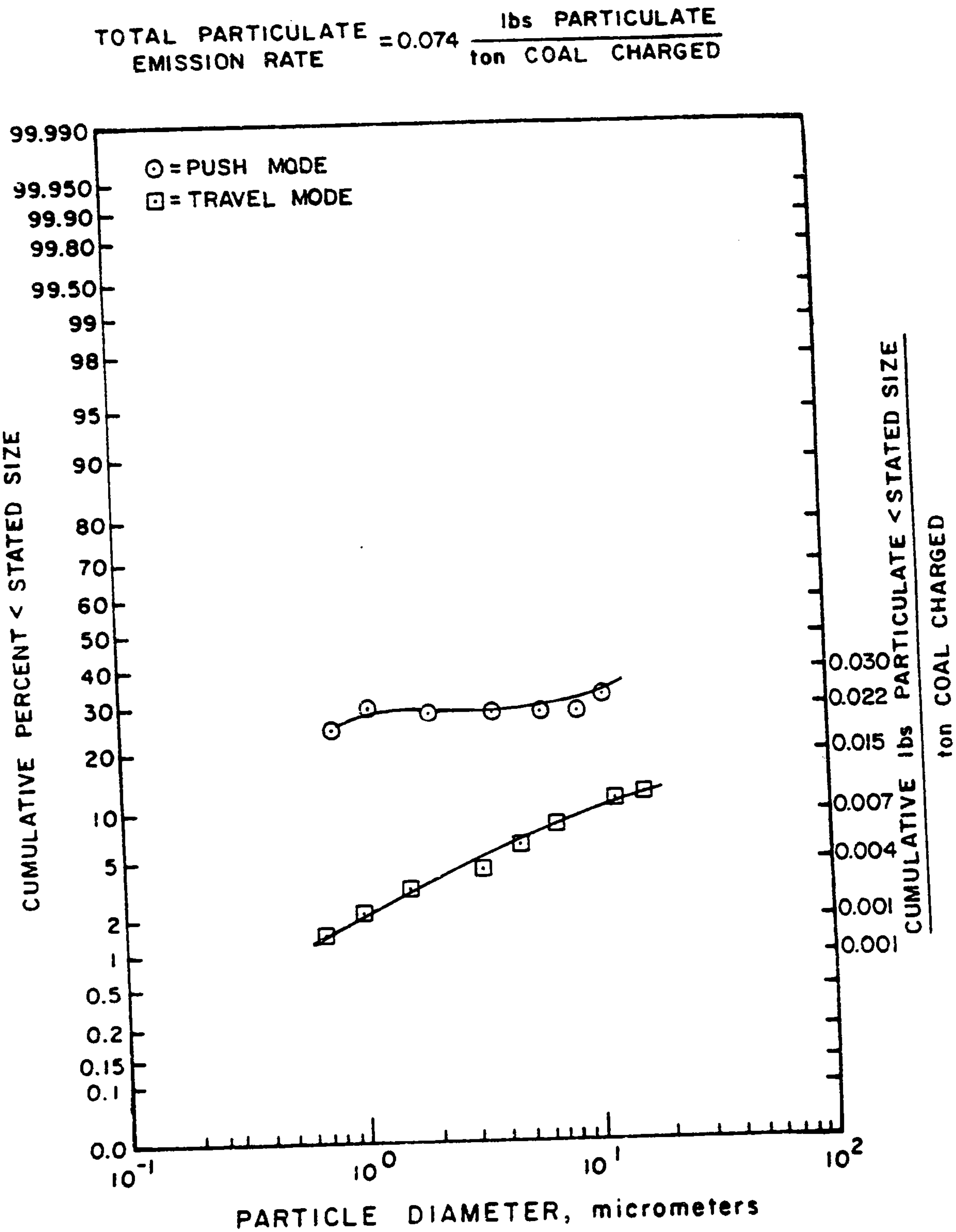

Figure 7.2.8. Push cars (with scrubber).[130]

TOTAL PARTICULATE EMISSION RATE = 5.24 $\frac{\text{lbs PARTICULATE}}{\text{ton COAL CHARGED}}$

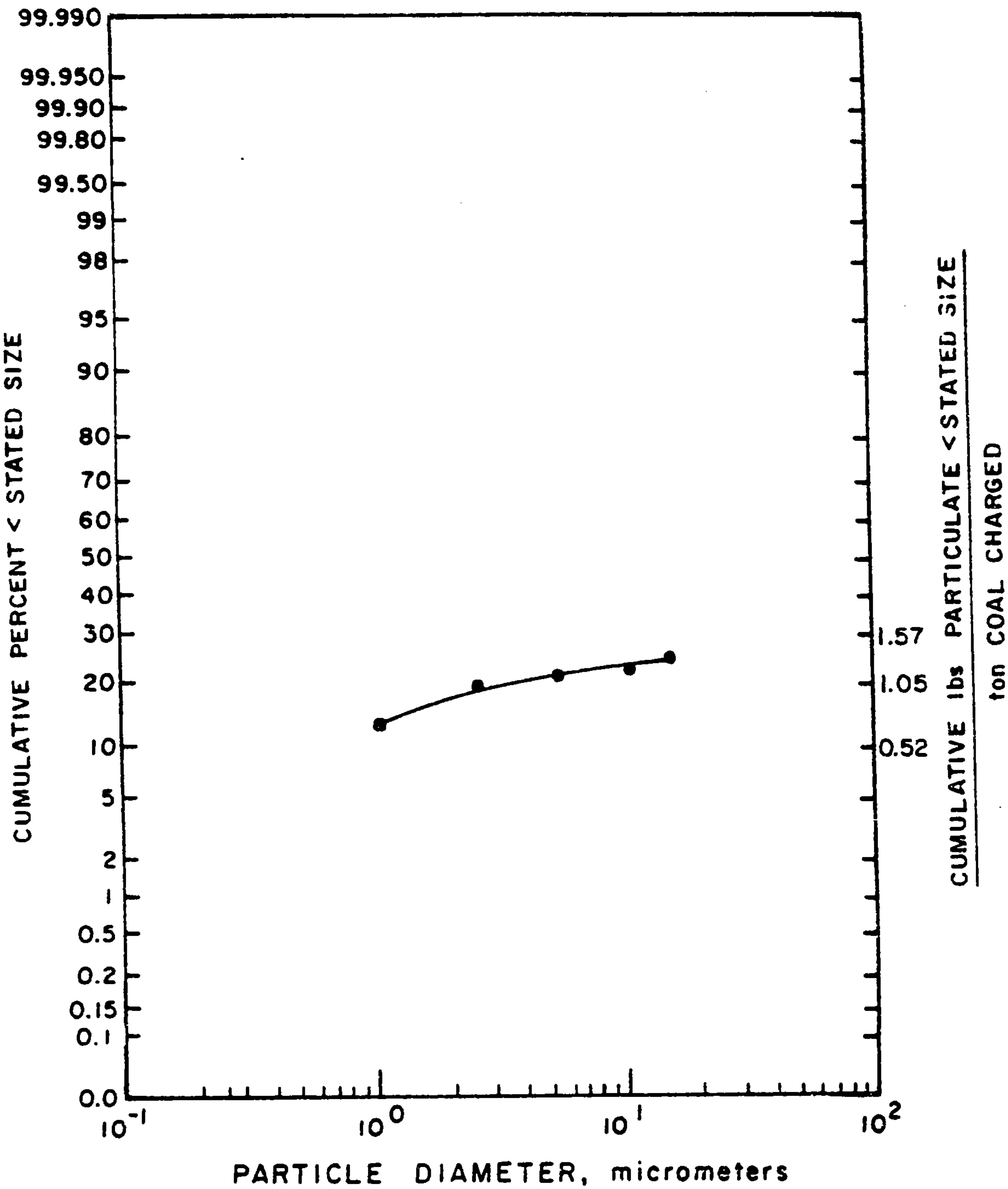

Figure 7.2.9. Quenching (uncontrolled) dirty water >5,000 mg/l TDS.[148]

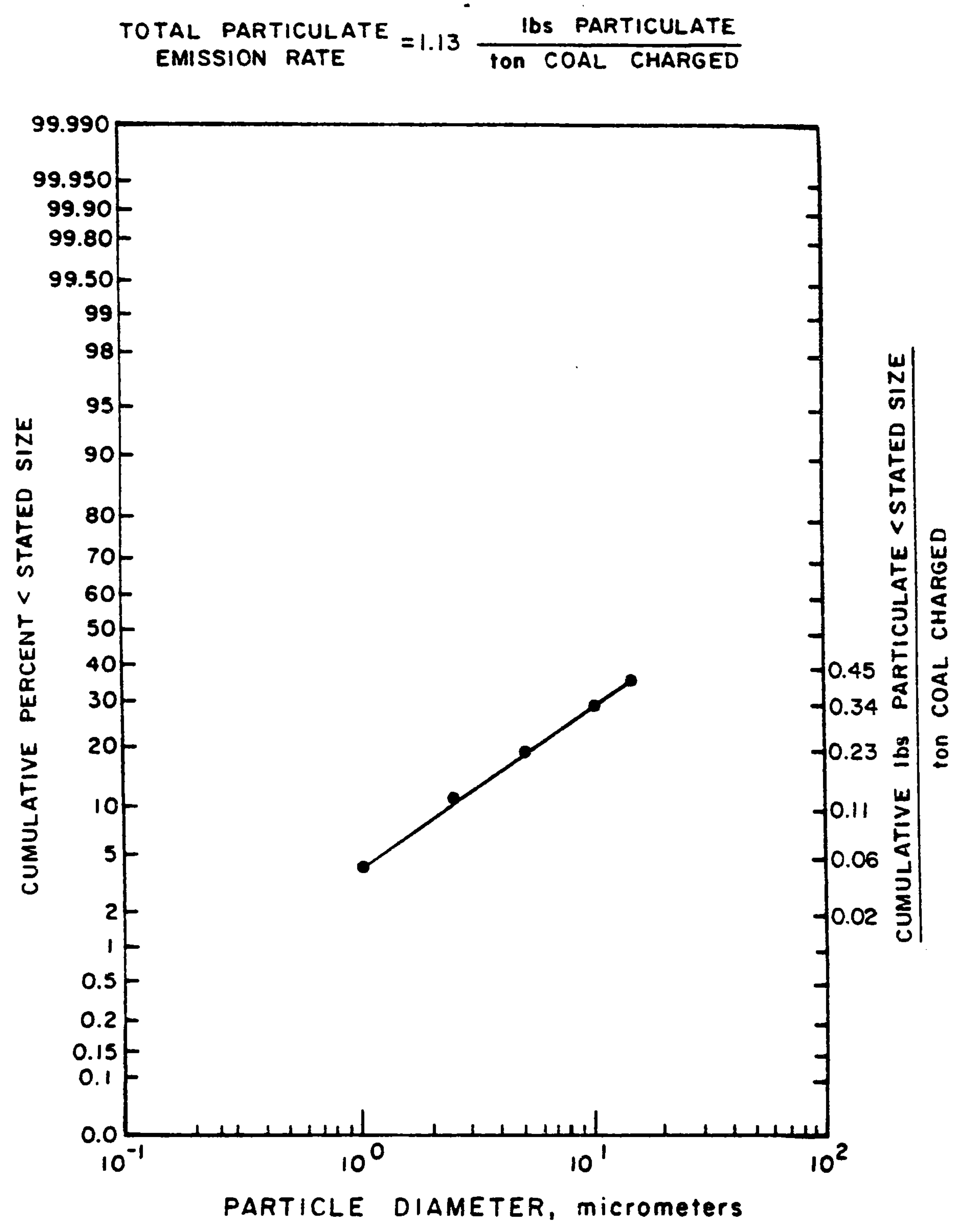

Figure 7.2.10. Quenching (uncontrolled) clean water <1,500 mg/l TDS.[148]

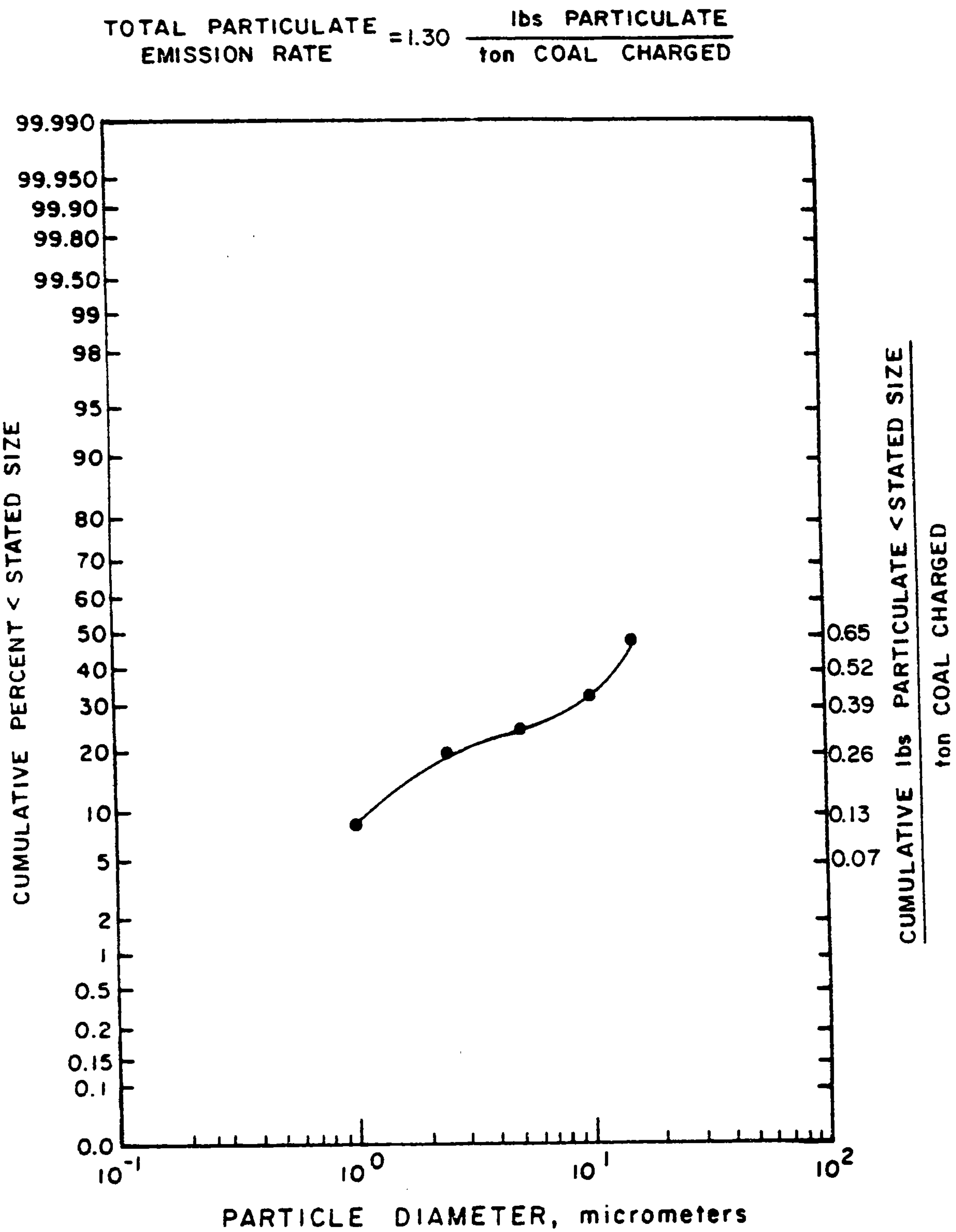

Figure 7.2.11. Quenching (controlled--with baffles) dirty water >5,000 mg/l TDS.[148]

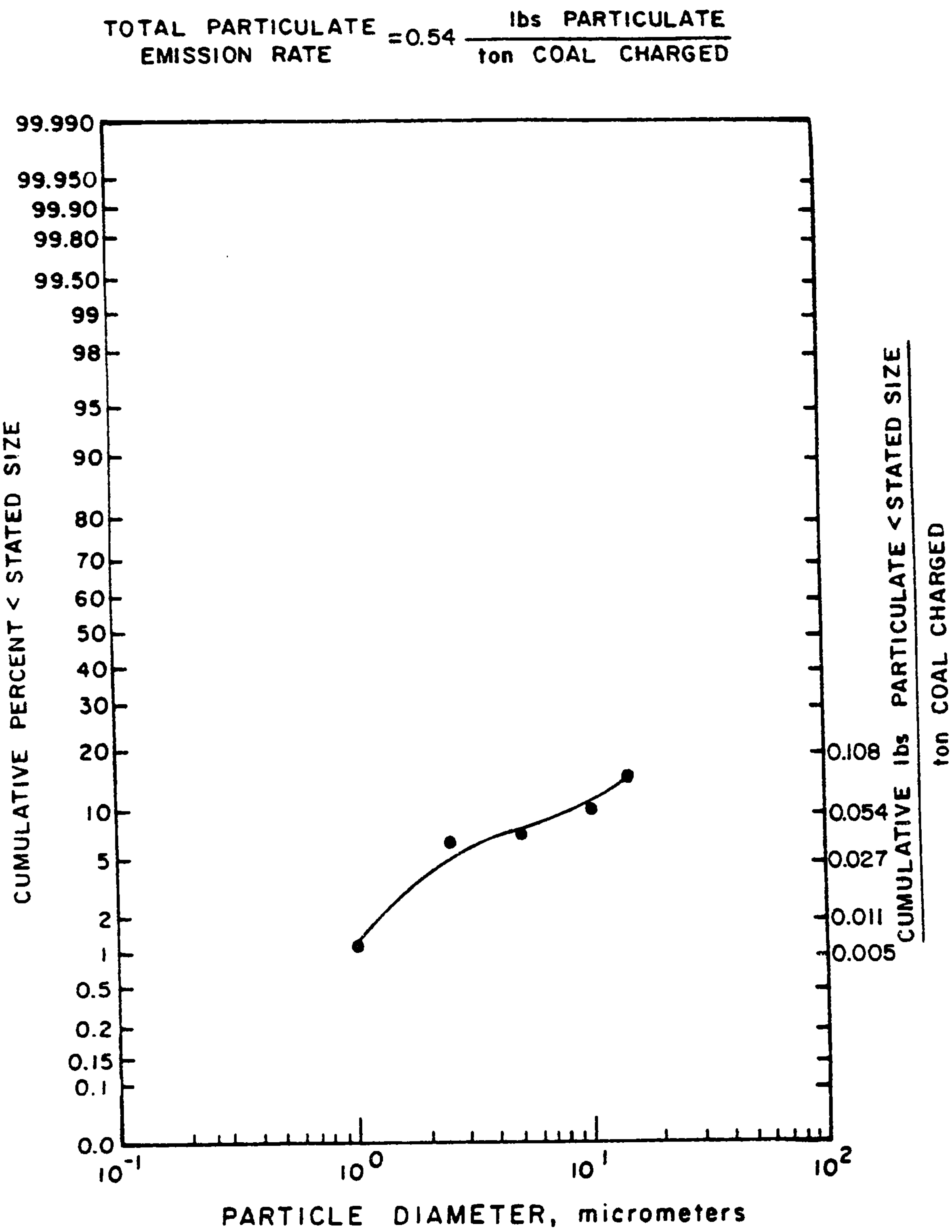

Figure 7.2.12. Quenching (controlled--with baffles) clean water <1,500 mg/l TDS.[148]

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