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Development Document for Interim Final Effluent Limitations, Guidelines and Proposed New Source Performance Standards for the

Carbon Black Manufacturing

Point Source Category

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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DEVELOPMENT DOCUMENT
for
INTERIM FINAL
EFFLUENT LIMITATIONS, GUIDELINES
AND PROPOSED NEW SOURCE PERFORMANCE STANDARDS

for the

CARBON BLACK MANUFACTURING
POINT SOURCE CATEGORY

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ABSTRACT

This document presents the findings of a study of the carbon black manufacturing point source category for the purpose of developing effluent limitations and guidelines for existing point sources and standards of performance for new point sources and pretreatment standards for new and existing point sources, to implement Sections 301(b), 301(c), 304(b), 304(c), 306(b), 306(c), and 307(b) of the Federal Water Pollution Control Act, as amended (33 U.S.C. 1251, 1331, 1314, and 1316, 86 Stat. 816 et. seq., P.L. 92-500 (the "Act").

Effluent limitations and guidelines contained herein set forth the degree of effluent reduction attainable through the application of the Best Practicable Control Technology Currently Available (BPCTCA) and the degree of effluent reduction attainable through the application of the Best Available Technology Economically Achievable (BATEA) which must be achieved by existing point sources by July 1, 1977, and July 1, 1983, respectively. The standards of performance and pretreatment standards for existing and new sources contained herein set forth the degree of effluent reduction which is achievable through the application of the Best Available Demonstrated Control Technology (BADCT), processes, operating methods, or other alternatives.

The development of data and recommendations in this document relate to the carbon black manufacturing point source category which is one of eight industrial segments of the miscellaneous chemicals point source category study. Effluent limitations were developed for each subcategory on the basis of the level of raw waste load as well as on the degree of treatment achievable. Appropriate technology to achieve these limitations include systems for reduction in pollutant loads by in-plant technology.

Supporting data and rationale for development of the proposed effluent limitations, guidelines and standards of performance are contained in this report.

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SECTION I

CONCLUSIONS

General

The miscellaneous chemicals point source category encompasses eight industrial segments grouped together for administrative purposes. This document provides background information for carbon black manufacturing point source category and represents a revision of a portion of the initial contractor's draft document issued in February, 1975.

In that document it was pointed out that the carbon black manufacturing point source category differs from the others in raw materials, manufacturing processes, and final products. Water usage and subsequent wastewater discharges also vary considerably from segment to segment. Consequently, for the purpose of the development of the effluent limitations, guidelines and corresponding BPT (Best Practicable Control Technology Currently Available), NSPS (Best Available Demonstrated Control Technology) for new sources, and BAT (Best Available Technology Economically Achievable) requirements, each segment is treated independently.

The carbon black manufacturing point source category is defined to include those commodities listed under the Standard Industrial Classification (SIC) 2895. Thermal and lamp black have been included for completeness of coverage of the carbon black manufacturing processes. It should be emphasized that the proposed treatment model technology will be used only as a guideline. The cost models for BPT, BAT, and NSPS were developed to facilitate the economic analysis and should not be construed as the only technology capable of meeting the effluent limitations, guidelines and standards of performance presented in this development document. There are alternative systems which, taken either singly or in combination, are capable of attaining the effluent limitations, guidelines and standards of performance recommended in this development document. These alternative choices include:

1. Various types of end-of-pipe wastewater treatment.
2. Various in-plant modifications and installation of at-source pollution control equipment.
3. Various combinations of end-of-pipe and in-plant technologies.

It is the intent of this document to identify the technology that can be used to meet the regulations. This information also will allow the individual plant to make the choice of what specific combination of pollution control measures is best suited to its situation in complying with the limitations and standards of performance presented in this development document for the carbon black point source category.

Carbon Black

For the purpose of developing recommended effluent limitations, guidelines and new source performance standards for carbon black manufacture, this point source category has been subcategorized by process as follows:

A. Furnace Process
B. Thermal Process Including Acetylene Black
C. Channel Process
D. Lamp Process

The criteria used for establishing the above subcategorization included the impact of the following factors on the above groupings:

1. Production processes.
2. Product types and yields.
3. Raw material sources.
4. Wastewater quantities, characteristics, control and treatment.

The wastewater parameters of significance in the manufacture of carbon black are total suspended solids, total dissolved solids and pH.

Based on an EPA survey of the entire carbon black segment, discussed in Section IV, Industrial Categorization, it was concluded that complete elimination of discharge of process wastewater pollutants is achievable for all subcategories of the carbon black point source category for BPT, BAT and NSPS effluent limitations, guidelines and new source performance standards. (see Tables IV-1 and IV-2).

Based on the findings of this survey, approximately twenty-nine furnace black and four thermal black plants are operating in the United States. There are also two lamp black plants and one channel black plant operating. Of these thirty-six plants surveyed, twenty-four have achieved no discharge of process wastewater pollutants. These include nineteen furnaces, three thermal, including one acetylene black plant, one channel and one lamp black plant. The thermal and furnace processes that have achieved the no discharge level manufacture a full range of carbon black grades and are found in both water surplus and water deficient areas. The channel black plant is located in an arid area. The lamp black plants surveyed are located in water surplus areas. It is concluded that all subcategories in the carbon black manufacturing should have no discharge of process wastewater pollutants allowed. The summary of the effluent limitations, guidelines and new source performance standards are presented in Table I-1.

Table 1 -1
Summary Table

Subcategories	Contaminants of Interest	Flow L/kkg Product (gal/1,000 lbs.)	Raw Waste Loads (RWL) Parameter	kg/kkg[1]	mg/L	Treatment Technology	BPCTCA (1977) Long-Term Average Daily Effluent Parameter	kg/kkg[1]	mg/L
Subcategory A Furnace Black	N/A[2]	N/A[2]	No Discharge of PWWP[3]			in-plant	No Discharge of PWWP[3]		
Subcategory B Thermal Black	N/A[2]	N/A[2]	No Discharge of PWWP[3]			in-plant	No Discharge of PWWP[3]		
Subcategory C Channel Black	N/A[2]	N/A[2]	No Discharge of PWWP[3]			in-plant	No Discharge of PWWP[3]		
Subcategory D Lamp Black	N/A[2]	N/A[2]	No Discharge of PWWP[3]			in-plant	No Discharge of PWWP[3]		

Subcategories	Contaminants of Interest	Treatment Technology	BATEA (1983) Long-Term Average Daily Effluent Parameter	kg/kkg[1]	mg/L	New Source Performance Standard (BADCT) Treatment Technology	Long-Term Average Daily Effluent Parameter	kg/kkg[1]	mg/L
Subcategory A Furnace Black	N/A[2]	in-plant	No Discharge of PWWP[3]			in-plant	No Discharge of PWWP[3]		
Subcategory B Thermal Black	N/A[2]	in-plant	No Discharge of PWWP[3]			in-plant	No Discharge of PWWP[3]		
Subcategory C Channel Black	N/A[2]	in-plant	No Discharge of PWWP[3]			in-plant	No Discharge of PWWP[3]		
Subcategory D Lamp Black	N/A[2]	in-plant	No Discharge of PWWP[3]			in-plant	No Discharge of PWWP[3]		

[1]kg/kkg = production is equivalent to lbs/1,000 lbs. production
[2]N/A = Not Applicable
[3]PWWP = Process Wastewater Pollutants

April 30, 1976

SECTION II

RECOMMENDATIONS

General

The recommendation for effluent limitations and guidelines commensurate with the BPT, BAT and NSPS for carbon black manufacturing are presented in the following text. Included are the in-plant controls technology required to achieve the recommended effluent limitations guidelines.

Carbon Black

Implicit in the recommended effluent limitations and guidelines for carbon black manufacturing is the assumption that process wastes can be isolated from uncontaminated wastes such as utility discharges and uncontaminated storm runoff. Isolation of process wastewater is generally the first recommended step in accomplishing the reductions necessary to meet the proposed effluent limitations and guidelines. Treatment of uncontaminated wastewaters in a treatment facility is not generally cost-effective. This is generally not a problem in the carbon black manufacture.

Effluent limitations guidelines commensurate with BPT are presented for each subcategory of carbon black manufacturing point source category in Table II-1. Process wastewaters subject to these limitations include all contact process water but do not include noncontact sources such as boiler and cooling water blowdown, sanitary and other similar flows, such as shower and laundry wastewater. BPT includes the maximum utilization of applicable in-plant pollution abatement technology to achieve the effluent limitations and guidelines. Equipment washout will be considered as process wastewater. It was found in the EPA survey that the equipment washout along with process area wash water could effectively be recycled as quench water for the furnace black and thermal black processes, resulting in no discharge of process wastewater. As a result of the survey of the entire point source category and based on the in-plant changes achievable as demonstrated in Section IV, it is recommended that all subcategories in carbon black manufacturing point source category have effluent limitations, guidelines and new source performance standards set at "no discharge of process wastewater pollutants" for BPT, NSPS and BAT. NSPS and BAT effluent limitations guidelines are presented in Table II-2.

TABLE II -1

BPCTCA Effluent Limitations Guidelines

Subcategory	Effluent Characteristic	Effluent Limitations: Average of Daily Values for 30 Consecutive Days Shall not Exceed		Effluent Limitations: Maximum for Any One Day	
		kg/kkg[1]	mg/L	kg/kkg	mg/L
A (Furnace Black)	N/A[2]	No Discharge of pwwp[3]		No Discharge of pwwp[3]	
B (Thermal Black)	N/A[2]	No Discharge of pwwp[3]		No Discharge of pwwp[3]	
C (Channel Black)	N/A[2]	No Discharge of pwwp[3]		No Discharge of pwwp[3]	
D (Lamp Black)	N/A[2]	No Discharge of pwwp[3]		No Discharge of pwwp[3]	

[1] kg/kkg Productions is equivalent to lbs/1,000 lbs Production.
[2] N/A = Not Applicable
[3] pwwp = Process Wastewater Pollutants

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Table 11 -2

BATEA AND BADCT Effluent Limitations Guidelines

Subcategory	Effluent Characteristic	Effluent Limitations: Average of Daily Values for 30 Consecutive Days shall not Exceed		Effluent Limitations: Maximum for Any One Day	
		kg/kkg[1]	mg/L	kg/kkg[1]	mg/L
A	NA[2]	No Discharge of PWWP[3]		No Discharge of PWWP[3]	
B	NA[2]	No Discharge of PWWP[3]		No Discharge of PWWP[3]	
C	NA[2]	No Discharge of PWWP[3]		No Discharge of PWWP[3]	
D	NA[2]	No Discharge of PWWP[3]		No Discharge of PWWP[3]	

[1] kg/kkg productions is equivalent to lbs./1,000 lbs. production
[2] NA = Not Applicable
[3] PWWP = Process Wastewater Pollutants

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SECTION III

INTRODUCTION

Purpose and Authority

The Federal Water Pollution Control Act Amendments of 1972 (the Act) made a number of fundamental changes in the approach to achieving clean water. One of the most significant changes was to shift from a reliance on effluent limitations to water quality to a direct control of effluents through the establishment of technology-based effluent limitations to form an additional basis, as a minimum, for issuance of discharge permits.

The Act requires EPA to establish guidelines for technology-based effluent limitations which must be achieved by point sources of discharges into the navigable waters of the United States. Section 301(b) of the Act requires the achievement by not later than July 1, 1977 of effluent limitations for point sources, other than publicly owned treatment works, which are based on the application of the BPT as defined by the Administrator pursuant to Section 304(b) of the Act. Section 301(b) also requires the achievement by not later than July 1, 1983 of effluent limitations for point sources, other than publicly owned treatment works, which are based on the application of the BAT, resulting in progress toward the national goal of eliminating the discharge of all pollutants, as determined in accordance with regulations issued by the Administrator pursuant to Section 304(b) of the Act. Section 306 of the Act requires the achievement by new sources of federal standards of performance providing for the control of the discharge of pollutants, which reflects the greatest degree of effluent reduction which the Administrator determines to be achievable through the application of the NSPS process, operating methods, or other alternatives, including, where practicable, a standard permitting no discharge of pollutants.

Section 304(b) of the Act requires the Administrator to publish regulations based on the degree of effluent reduction attainable through the application of the BPT and the best control measures and practices achievable, including treatment techniques, process and procedure innovations, operation methods, and other alternatives. The regulations proposed herein set forth effluent limitations and guidelines pursuant to Section 304(b) of the Act for the carbon black point source category. Section 304(c) of the

Act requires the Administrator to issue information on the processes, procedures, or operating methods which result in the elimination or reduction in the discharge of pollutants to implement standards of performance under Section 306 of the Act. Such information is to include technical and other data, including costs, as are available on alternative methods of elimination or reduction of the discharge of pollutants.

Section 306 of the Act requires the Administrator, within one year after a category of sources is included in a list published pursuant to Section 306(b) (1) (A) of the Act, to propose regulations establishing federal standards of performance for new sources within such categories. The Administrator published in the Federal Register of January 16, 1973 (38 FR 1624) a list of 27 source categories. Publication of the list constituted announcement of the Administrator's intention of establishing, under Section 306, standards of performance applicable to new sources.

Furthermore, Section 307(b) provides that:

1. The Administrator shall, from time to time, publish proposed regulations establishing pretreatment standards for introduction of pollutants into treatment works (as defined in Section 212 of this Act) which are publicly owned, for those pollutants which are determined not to be susceptible to treatment by such treatment works or which would interfere with the operation of such treatment works. Not later than ninety days after such publication, and after opportunity for public hearing, the Administrator shall promulgate such pretreatment standards. Pretreatment standards under this subsection shall specify a time for compliance not to exceed three years from the date of promulgation and shall be established to prevent the discharge of any pollutant through treatment works (as defined in Section 212 of this Act) which are publicly owned, which pollutant interferes with, passes through, or otherwise is incompatible with such works.

2. The Administrator shall, from time to time, as control technology, processes, operating methods, or other alternatives change, revise such standards, following the procedure established by this subsection for promulgation of such standards.

3. When proposing or promulgating any pretreatment standard under this section, the Administrator shall designate the category or categories of sources to which such standard shall apply.

4. Nothing in this subsection shall affect any pretreatment requirement established by any State or local law not in conflict with any pretreatment standard established under this subsection.

In order to insure that any source introducing pollutants into a publicly owned treatment works, which would be a new source subject to Section 306 if it were to discharge pollutants, will not cause a violation of the effluent limitations established for any such treatment works, the Administrator is required to promulgate pretreatment standards for the category of such sources simultaneously with the promulgation of standards of performance under Section 306 for the equivalent category of new sources. Such pretreatment standards shall prevent the discharge into such treatment works of any pollutant which may interfere with, pass through, or otherwise be incompatible with such works.

The Act defines a new source to mean any source the construction of which is commenced after the publication of proposed regulations prescribing a standard of performance. Construction means any placement, assembly, or installation of facilities or equipment (including contractual obligations to purchase such facilities or equipment) at the premises where such equipment will be used, including preparation work at such premises.

Methods Used for Development of the Effluent Limitations and Standards for Performance

The effluent limitations, guidelines and standards of performance proposed in this document were developed in the following manner. The miscellaneous chemicals point source category was first divided into industrial segments, based on type of manufacturing and products manufactured. Determination was then made as to whether further subcategorization would aid in description of the category. Such determinations were made on the basis of raw materials required, products manufactured, processes employed, and other factors.

The raw waste characteristics for each category and/or subcategory were then identified. This included an analysis of: 1) the source and volume of water used in the process employed and the sources of wastes and wastewaters in the plant; and 2) the constituents of all wastewaters (including toxic constituents) which result in taste, odor, and color in water or aquatic organisms. The constituents of wastewaters which should be subject to effluent limitations, guidelines and standards of performance were identified.

The full range of control and treatment technologies existing within each category and/or subcategory was identified. This included an identification of each distinct control and treatment technology, including both in-plant and end- of-pipe technologies, which are existent or capable of being designed for each subcategory. It also included an identification of the effluent level resulting from the application of each of the treatment and control technologies, in terms of the amount of constituents and of the chemical, physical, and biological characteristics of pollutants. The problems, limitations, and reliability of each treatment and control technology and the required implementation time were also identified. In addition, the non-water quality environmental impacts (such as the effects of the application of such technologies upon other pollution problems, including air, solid waste, radiation, and noise) were also identified. The energy requirements of each of the control and treatment technologies were identified, as well as the cost of the application of such technologies.

The information, as outlined above, was then evaluated in order to determine what levels of technology constituted the BPT, BAT, and NSPS. In identifying such technologies, factors considered included the total cost of application of technology in relation to the effluent reduction benefits to be achieved from such application, the age of equipment and facilities involved, the process employed, the engineering aspects of the application of various types of control techniques, process changes, non-water quality environmental impact (including energy requirements), and other factors.

During the initial phases of the study, an assessment was made of the availability, adequacy, and usefulness of all existing data sources. Data on the identity and performance of wastewater treatment systems were known to be included in:

1. NPDES permit applications.

2. Self-reporting discharge data from various states.

3. Surveys conducted by trade associations or by

agencies under research and development grants.

A preliminary analysis of these data indicated an obvious need for additional information.

Additional data in the following areas were required: 1) process raw waste load (RWL) related to production; 2) currently practiced or potential in-process waste control techniques; and 3) the identity and effectiveness of end-of-pipe treatment systems. The best source of information was the manufacturers themselves. New information was obtained from telephone surveys, direct interviews and sampling visits to production facilities.

Collection of the data necessary for development of RWL and effluent treatment capabilities within dependable confidence limits required analysis of both production and treatment operations. In a few cases, the plant visits were planned so that the production operations of a single plant could be studied in association with an end-of-pipe treatment system which receives only the wastes from that production. The RWL for this plant and associated treatment technology would fall within a single subcategory. However, the wide variety of products manufactured by most of the industrial plants made this situation rare.

In the majority of cases, it was necessary to visit facilities where the products manufactured fell into several subcategories. The end-of-pipe treatment facilities received combined wastewaters associated with several subcategories (several products, processes, or even unrelated manufacturing operations). It was necessary to analyze separately the production (waste-generating) facilities and the effluent (waste treatment) facilities. This approach required establishment of a common basis, the raw waste load (RWL), for common levels of treatment technology for the products within a subcategory and for the translation of treatment technology between categories and/or subcategories.

The selection of wastewater treatment plants was developed from identifying information available in the NPDES permit applications, state self-reporting discharge data, and contacts within the point source category. Every effort was made to choose facilities where meaningful information on both treatment facilities and manufacturing processes could be obtained.

Survey teams composed of project engineers and scientists conducted the actual plant visits. Information on the identity and performance of wastewater treatment systems was obtained through:

1. Interviews with plant water pollution control personnel and/or engineering personnel.

2. Examination of treatment plant design and historical operating data (flow rates and analyses of influent and effluent).

3. Treatment plant influent and effluent sampling.

Information on process plant operations and the associated RWL was obtained through:

1. Interviews with plant operating personnel.

2. Examination of plant design and operating data (design specification, flow sheets, day-to-day material balances around individual process modules or unit operations where possible).

3. Individual process wastewater sampling and analysis.

4. Historical production and wastewater treatment data.

The data base obtained in this manner was then utilized by the methodology previously described to develop recommended effluent limitations, guidelines and standards of performance for the carbon black point source category. References utilized are included in Section XV of this report. The data obtained during the field data collection program are included in Supplement B. Cost information is presented in Supplement A. These documents are available for examination by interested parties at the EPA Public Information Reference Unit, Room 2922 (EPA Library), Waterside Mall, 401 M St. S.W., Washington, D.C. 20460.

The following text describes the scope of the study, technical approach to the development of effluent limitations guidelines, and the scope of coverage of the data base for the manufacture of carbon black.

Carbon Black

Scope of the Study

The term carbon black identifies an important family of industrial carbons used principally as reinforcing agents in rubber and as black pigments in inks, coatings and plastics. Carbon black, a petrochemical derivative, is an extremely fine soot composed principally of carbon (90 - 99 percent), with some oxygen and hydrogen. Carbon blacks are differentiated from bulk commercial carbons (such as cokes and charcoals) by the fact that carbon blacks are particulate and are composed of spherical particles, quasigraphitic in structure and of colloidal dimensions. The properties of carbon black are determined primarily by the process by which it is manufactured.

All carbon blacks are produced either by partial combustion or thermal decomposition of liquid or gaseous hydrocarbons, and are classified as lamp black, channel black, furnace combustion black, and thermal black. The Standard Industrial Classification number for the carbon black manufacture is 2895. For completeness, the thermal and lamp black carbon black manufacturing processes have been included. Lamp blacks are made by the burning of petroleum or coal-tar residues in open shallow pans, channel black by impingement of under-ventilated natural gas flames, and furnace combustion blacks by partial combustion of either natural gas or liquid hydrocarbons in insulated furnaces. Thermal blacks are produced by thermal decomposition (cracking) of natural gas. Acetylene black, which is classified as a thermal black, is produced by the exothermic decomposition of acetylene.

Production and Uses

The United States is the largest producer of carbon black in the world, producing approximately 45 percent of the total world output (3.2 out of a total 7.1 billion pounds in 1972).

Production in the United States has increased steadily since the rubber manufacture began using carbon black in rubber in 1912. Figure III-1 illustrates the United States carbon black production by process for the period from 1952 - 1972.

The furnace process is responsible for over 90 percent of the carbon black produced in this country. At the end of 1974, there were 29 furnace black plants, four thermal black plants, including one acetylene black plant, one channel black plant and two lamp black plants in operation in the United States. At the end of 1972, the total carbon black production capacity in the U.S. was approximately 11,400,000 pounds per day. Approximately 45 percent of this total capacity was in Texas, 34 percent in Louisiana, and 22 percent in other states.

Originally, plants were established in Texas and Louisiana to be near the natural gas sources, since no cheap means of transporting this feedstock existed. As emphasis shifted from the channel process to the furnace process, it was only natural that furnace facilities would be expanded at these locations. In recent years, with the emphasis on the furnace process, specifically on liquid hydrocarbon feedstocks, the economics involved in transporting the feed-stocks and the product (carbon black) have moved the optimum sites for construction of new facilities to locations between the source of the feedstocks (the oil fields) and the major users of the carbon black specifically, the tire manufacturers).

Of the total carbon black consumed in the United States, approximately 94 percent is used in rubber manufacturing. Most of the remainder is used by the printing ink, paint, paper, and plastics industries. Table III-1 illustrates the domestic sales of carbon black in the United States by use from 1963 through 1972.

At present, only channel black is approved for direct use in foods, cosmetics, and non-rubber compounds which come into contact with foodstuff. All furnace blacks are approved up to 50 percent by weight in rubber compounds coming in contact with foods, and up to 10 percent by weight in rubber compounds coming in contact with edible oils, milk and milk products. Lamp and thermal black are not approved for use in foodstuff and related materials.

The Food and Drug Administration has set the limits based on the fact that carbon black contains solvent extractable carcinogens such as benzopyrenes. The Delaney Amendment limits carcinogens in foodstuff and material that comes in contact with foodstuffs. The smaller the carbon particle size, the purer the product as a result of the higher temperature of reaction (approximately 2800 to 3200° F). As shown in Table III-2, channel black is the smallest particle size black. Next, furnace, thermal and lamp black in that approximate order. Because the particle sizes are average figures, there is overlap for the size diameters as shown in Table III-2.

The particle size also indicates the usage. The smaller particles, channel and fine furnace black, are used in the paint and ink manufacture. The medium and larger furnace black are used in rubber and particularly in the tread

Table III -1

Domestic Sales of Carbon Black in the United States - By Use

(Thousand Pounds)

Use	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Ink	46,471	45,688	54,333	63,682	63,963	67,721	73,077	72,824	75,201	82,532
Paint	13,008	17,982	10,896	11,959	12,553	13,435	17,711	14,570	18,693	21,408
Paper	8,721	8,004	7,649	6,108	5,658	4,710	5,668	4,527	3,767	4,225
Rubber	1,629,905	1,789,432	1,945,459	2,131,169	2,072,543	2,445,550	2,616,166	2,486,146	2,678,151	2,953,779
Miscellaneous	29,315	50,388	54,163	64,677	61,428	56,986	65,327	71,454	77,715	84,764
Total	1,727,420	1,911,494	2,072,500	2,277,595	2,216,145	2,588,402	2,777,949	2,649,521	2,853,527	3,146,708

Source: The Minerals Yearbook, 1973

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TABLE III -2

CARBON BLACK GRADES MANUFACTURED

ASTM DESIGNATION*	CLASS	AVERAGE PARTICLE SIZE (MILLIMICRON)
----	HPC (Hard Processing Channel)	24 average
----	MPC (Medium Processing Channel)	26 average
----	EPC (Easy Processing Channel)	29 average
N110	SAF (Super Abrasion Furnace)	20-25
N116	SAF-HS (High Structure-SAF)	20-25
N220	ISAF-LS (Intermediate Super Abrasion Furnace-Low Structure)	24-33
N231	ISAF-LM (Low Modulus-ISAF)	24-33
N242	ISAF-HS (High Structure-ISAF)	24-33
N293	CF (Conductive Furnace)	24-33
N294	SCF (Super Conductive Furnace)	24-33
N330	HAF (High Abrasion Furnace)	28-36
N326	HAF-LS (Low Structure-HAF)	28-36
N347	HAF-HS (High Structure-HAF)	28-36
N440	FF (Fine Furnace-HAF)	40 average
N472	ECF (Extra Conductive Furnace)	31-39
N539	FEF-LS (Fast Extruding Furnace Low Structure)	39-55
N550	FEF	39-55
N568	FEF-HS (High Structure)	39-55
N650	GPF-HS (General Purpose Furnace HS)	49-73
N683	APF (All Purpose Furnace)	49-73
N761	SRF-LM (Semi-Reinforcing Furnace Low Modulus)	70-96
N762	SRF-LM-NS (Non-Stain-SRF-LM)	70-96
N765	SRF-NS	70-96
N774	SRF-NS-HM (High Modulus-SRF-NS)	70-96
N880	FT (Fine Thermal)	180-200
N990	MT (Medium Thermal)	250-350

*Generally the first number indicates the particle size range. The larger the number the larger the particle diameter.

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rubber for the tire industry. The larger particle furnace and thermal blacks are used in tire manufacture. The smaller the particle size, the harder or more abrasive the rubber product, so the tread requires smaller particles. The sidewall requires flexibility, therefore, the particle size used is larger.

Lamp black carbons are of large particle size, possess little reinforcing ability in rubber, and are lower in jetness and coloring power. They are of value as tinting pigment in certain paints and lacquers but are primarily used in the manufacture of carbon brushes for electrical equipment and carbon arcs.

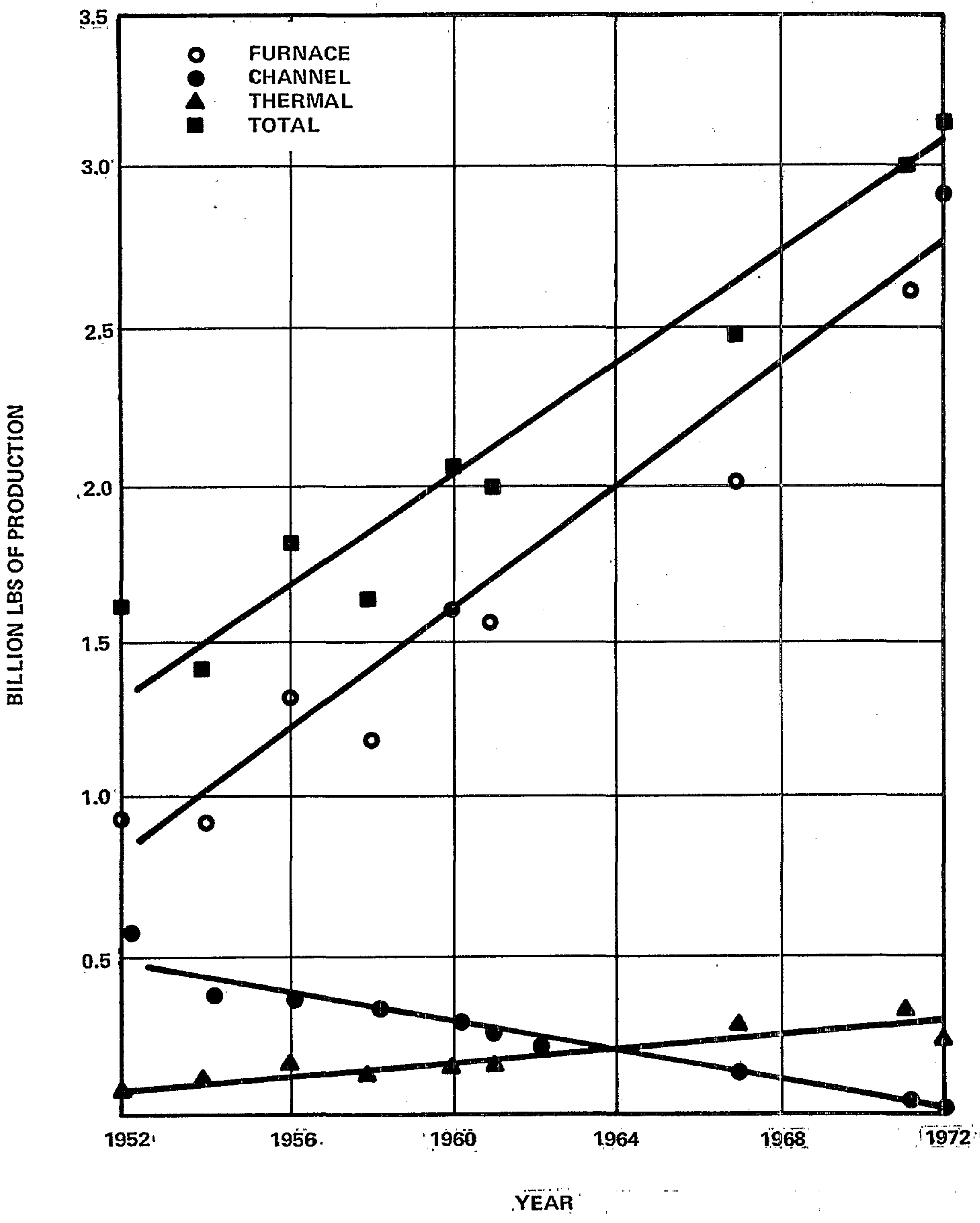
Scope of Coverage for Data Base

Of the 36 carbon black plants in operation in the U.S. twenty-nine are furnace black, four thermal black, two lamp black and one channel black. The plant visits covered four furnace plants and two thermal plants. A telephone survey covered the additional twenty-five furnace, two thermal, two lamp and the channel black plants. Effectively, the entire carbon black segment was contacted and requested to participate in this guideline study.

The results of the contractor's study combined with the telephone survey initiated the decision to issue all subcategories of the carbon black industrial effluent limitations, guidelines and new source performance standards as "no discharge of process wastewater pollutants". The details that lead to the no discharge decision are found in Section IV, Industrial Categorization.

FIGURE III -1

U.S. CARBON BLACK PRODUCTION
BY PROCESS



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SECTION IV

INDUSTRIAL CATEGORIZATION

General

The goal of this study is the development of effluent limitations, guidelines and new source performance standards for the carbon black manufacturing point source category that will be achieved with different levels of in-plant waste reduction technology. These effluent limitations guidelines and new source performance standards are to specify the quantity of pollutants which will ultimately be discharged from a specific facility and will be related to a common yardstick for the category, such as quantity of production.

Carbon Black

Discussion of the Rationale of Categorization

Manufacturing subcategories were established so as to define those sectors of carbon black manufacturing where separate effluent limitations and standards should apply. The distinctions between the subcategories have been based on the production process and product type, its quality, characteristics, and applicability of control and treatment. The following factors were considered in determining whether such subcategorizations are justified:

Manufacturing Process

The manufacturing processes used to manufacture carbon black consist of the furnace, thermal, channel, and lamp black processes. The final product from each of these processes is carbon black, differing in particle size, structure, application and trace contaminants.

Furnace black is produced by the incomplete combustion of hydrocarbons. This process is a net user of water and generally has no process contact wastewaters.

Thermal blacks are produced by cracking of natural gas to form carbon and hydrogen gas. The major wastewater source from this process is the blowdown from a recirculating dehumidifier system. Two of the three plants in operation now recycle this water as quench water resulting in no discharge of process wastewater. Acetylene black is also considered a thermal black process bringing the total thermal black plants operating in the United States to four. The single acetylene black plant operating is a dry process resulting in no discharge of process wastewater. The acetylene, like natural gas, is thermally cracked to produce hydrogen and carbon.

Channel black is produced by impingement of under-ventilated natural gas flames on moving, continuously scraped channels. This is a dry operation resulting in no discharge of process wastewater.

Lamp blacks are manufactured by the burning of petroleum or coal tar residues in open shallow pans. This is a dry operation when using the bag filter collection technique resulting in no discharge of process wastewater.

Product

The carbon black segment manufactures a single product. Therefore, subcategorization by product basis was not considered.

Raw Materials

The raw materials consumed in the manufacture of carbon black consist of hydrocarbons. Liquid hydrocarbons are used in the furnace and lamp black processes. Natural gas is used as a raw material in the furnace, thermal and channel black processes.

The most desirable feed stock oil for the furnace process comes from near the bottom of the refinery barrel and is similar in many respects to residual fuel oil. It is low in sulfur and high in aromatics and olefins. Natural gas is required to obtain and maintain the reaction temperatures. The raw materials for the lamp black process are petroleum or coal tar by-products. Based on the above, raw materials are not a basis for subcategorization.

Plant Size

Based upon process considerations, the plant size, measured in terms of production, should be directly related to the pounds of pollutants produced. As more product is produced, the greater the amount of wastewater generated. This is true for the carbon black category but the amount of quench water required to cool the process stream is also directly related to the size of that process stream. Because all process water can be consumed as quench water, plant size is not a basis for categorization.

TABLE IV -1

CARBON BLACK SEGMENT
PLANT KEY

Plant	Process	Waste Load (PWWP)*	Climate***
Ashland Oil Co. Aransas Pass, TX	furnace	no discharge	+
Ashland Oil Co. Delpre, OH	furnace	discharge	+
Ashland Oil Co. Mojave, CA	furnace	no discharge	−
Ashland Oil Co. New Iberia, LA	furnace	discharge	+
Ashland Oil Co. Shamrock, TX	furnace	no discharge	−
Cabot Corp. Big Spring, TX	furnace	no discharge	−
Cabot Corp. Franklin, LA	furnace	discharge	+
Cabot Corp. Pampa, TX	furnace	no discharge	−
Cabot Corp. Ville Platte, LA	furnace	discharge	+
Cabot Corp. Waverly, WV	furnace	discharge	+
Cities Services El Dorado, AR	furnace	no discharge	+
Cities Services Eola, LA	furnace	discharge	+
Cities Services Franklin, LA	furnace	no discharge	+

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TABLE IV-1 (continued)

-2-

Cities Services Franklin, LA	thermal	no discharge	+
Cities Services Hickok, KS	furnace	no discharge	-
Cities Services Marshall, WV	furnace	no discharge	+
Cities Services Mojave, CA	furnace	no discharge	-
Cities Services Seagraves, TX	furnace	no discharge	-
Cities Services Seagraves, TX	channel	no discharge	-
Cities Services Swartz, LA	furnace	discharge****	+
Commercial Solvent Corp. Thermatomic Carbon Sterlington, LA	thermal	discharge	+
Continental Carbon Co. Bakersfield, CA	furnace	no discharge	-
Continental Carbon Co. Dumas, TX	furnace	no discharge	-
Continental Carbon Co. Ponca City, OK	furnace	no discharge	-
Continental Carbon Co. Westlake, LA	furnace	discharge	+
J. M. Huber Baytown, TX	furnace	discharge**	+
J. M. Huber Borger, TX	thermal	no discharge	-
J. M. Huber Borger, TX	furnace	no discharge	-

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TABLE IV-1 (continued)

-3-

Monsanto Camden, NJ	lamp	no discharge	+
Phillips Borger, TX	furnace	no discharge	–
Phillips Orange, TX	furnace	no discharge	–
Sid Richardson Carbon Co. Addis, LA	furnace	discharge	+
Sid Richardson Carbon Co. Big Springs, TX	furnace	no discharge	–
Sid Richardson Carbon Co. Odessa, TX	furnace	no discharge****	–
Union Carbide Ashtabula, OH	thermal (acetylene)	no discharge	+
Union Carbide Fostoria, OH	lamp	no discharge	+

* process wastewater pollutants

** going to "no discharge" before 7/1/77

*** + : rainfall exceeds evaporation

– : evaporation exceeds rainfall

**** research and development plant that operates sporadically

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TABLE IV - 2

PLANT KEY SUMMARY

A: Summary of Carbon Black Segment Plant Key

	Process
Furnace Black	29
Thermal Black	4
Channel Black	1
Lamp Black	2
Total	36

B: Process Breakdown

	*Water +	**Water -
Furnace No Discharge	4	15
Furnace Discharge	10	-
Thermal No Discharge	2	1
Thermal Discharge	1	-
Channel No Discharge	-	1
Lamp No Discharge	2	-

*Rainfall exceeds evaporation
**Evaporation exceeds rainfall

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Plant Age

The age of a plant was found to have no significance in the characteristics of a plant's wastewater. Plants continually modify their processes to be more efficient and the plants's separation techniques can be upgraded from cyclones and wet scrubbers to bag filters. This has been done because of the higher yields obtainable with bag filters and the elimination of process wastewater. If rain runoff is controlled by diking or curbing, the dry cleaning of spills is practiced, and segregation of sanitary waste is required, the wastewater will be kept to a minimum allowing the total recycle system to be successful. Some plants have been using this scheme successfully for twenty years. Based on these operational in-plant techniques, plant age is not a basis for subcategorization.

Plant Location

Inspection of carbon black plants in various geographical areas of the country suggested that location may have some effect on the quality or quantity of the process wastewater streams, see Tables IV-1 and IV-2.

Geographical location can influence the use of ponds or cooling towers. Areas with a large net evaporation are more suitable for ponds. Storm water quantity is a significant factor in the use of ponds. In areas where rainfall is heavy, plants have successfully diverted the rainfall around the plant. The rainfall that falls directly on the plant can be used as quench water if the operating area is kept clean. Therefore, the rainfall-evaporation rate has an effect on the technique of handling the process wastewater but not on the raw waste load generated per pound of product. In the water deficient regions of the southwest, as a result of the high evaporation rate, all seventeen (17) plants have achieved the no discharge level. This amounts to about 47 percent of the point source category.

About 42 percent of the carbon black plants in water surplus regions presently operate with no discharge of process wastewater pollutants. All grades of carbon black except channel black are manufactured at these locations. The channel black process is located in the arid region.

The quality (hardness) of the water, which can influence whether process or storm water can be used as quench water, is a problem that had to be investigated. Although acceptable limits for this quench water quality have not been agreed upon by all manufacturers, plants located in both the water surplus and water deficient regions, manufacturing all grades of carbon black and either using a dry process or recycle system operate at a level of no discharge of process wastewater pollutants. The entire carbon black segment was inspected and based on the survey data, plant location was found not to be a basis for subcategorization.

Housekeeping

Plant housekeeping is a factor that was considered when comparing the various plants visited and was determined not to be a significant factor. Good housekeeping is important to the manufacture because a loss of yield can be associated with poor housekeeping. Good housekeeping generally reduces the wastewater quantities. Because of this consideration, the carbon black segment generally practices relatively good housekeeping. For example, carbon black spills were dry vacuumed rather than washed down in all of the plants visited and is the general practice throughout the category.

Air Pollution Control Equipment

In the past, air pollution control equipment had a significant impact upon wastewater quantities and characteristics. Cyclones and wet scrubbers were used to remove the carbon black from the process stream; however, at present, the carbon black manufacturers universally use bag filters for this purpose. Therefore, air pollution control equipment no longer has an adverse impact and is not a basis for subcategorization.

Because bag filtration has a significant impact on the waste abatement of the manufacture of carbon black a brief discussion of the operation of bag filters is offered to enable the reader to better understand the basis for the effluent limitations specified.

Prior to about 1965, most units recovered product from the quenched furnace effluent by means of electrostatic precipitators and several stages of cyclone collectors (usually three) with or without wet gas scrubbers. With this type of recovery system, it was possible to recover up to about 80 to 92 percent of the contained carbon black. The remaining carbon black would be vented to the atmosphere with the combustion gases. During this earlier time period, most drier vents were exhausted directly to atmosphere.

In order to improve product yield and reduce emissions, nearly all furnace type carbon black plants incorporate bag filters in the product recovery system. The bag filter has either been added on, or replaced the precipitator and/or the cyclones in existing plants. In addition, bag filters on the furnace effluent and drier vent streams are reported to obtain up to 99.95 percent carbon black recovery.

The substantial improvement in product recovery obtained by utilizing bag filters on the main process vent stream economically justifies the increased investment, utilities and maintenance cost for this equipment.

A sketch of a typical bag filter design for the main process vent stream is shown in Figure IV-1. Carbon black-laden gases enter the hopper below the bag cell plates. The hopper performs as a distribution duct for the entering production stream. The process gases and carbon black flow into the individual bags of each compartment through cell plates. The filtered gas flows through the bags and/or the bag filter stacks. The entrained carbon black collects on the inside of these bags, and during the cleaning or repressure cycle of each compartment, the black is removed and dumped into the hopper (repressuring simply means that the flow of gas through the bags is reversed, Figure IV-2). From the hoppers, the carbon black is usually either dropped through air locks into a pneumatic conveyor system or fed to screw conveyors for transportation to the product finishing area.

Figure IV-1 shows a single stack for the entire bag filter. In some cases, the filters have one stack for each compartment. This makes it somewhat easier to locate leaking bags.

Normally, the main process vent bag filters contain 6 to 18 compartments and each compartment contains approximately 300 to 400 bags. Each bag is about 5 1/2 inches (14 cm.) in diameter and 126 inches (3.2 meters) long. These bags themselves are a great cost item in the bag filter. Bag filter material used by most major black producers consists of fiberglass which is coated with a graphite-silicon film. Bag life would be seriously reduced if this coating were removed, and this can easily happen if operating temperature is allowed to exceed 450° F.

The average life expectancy of the filter bags is about 12 to 18 months. However, it is usually necessary to replace a few bags in each compartment during this period. High sulfur content of the oil or impurities in the quench water may shorten this life.

FIGURE IV -1

CARBON BLACK BAG FILTER SYSTEM

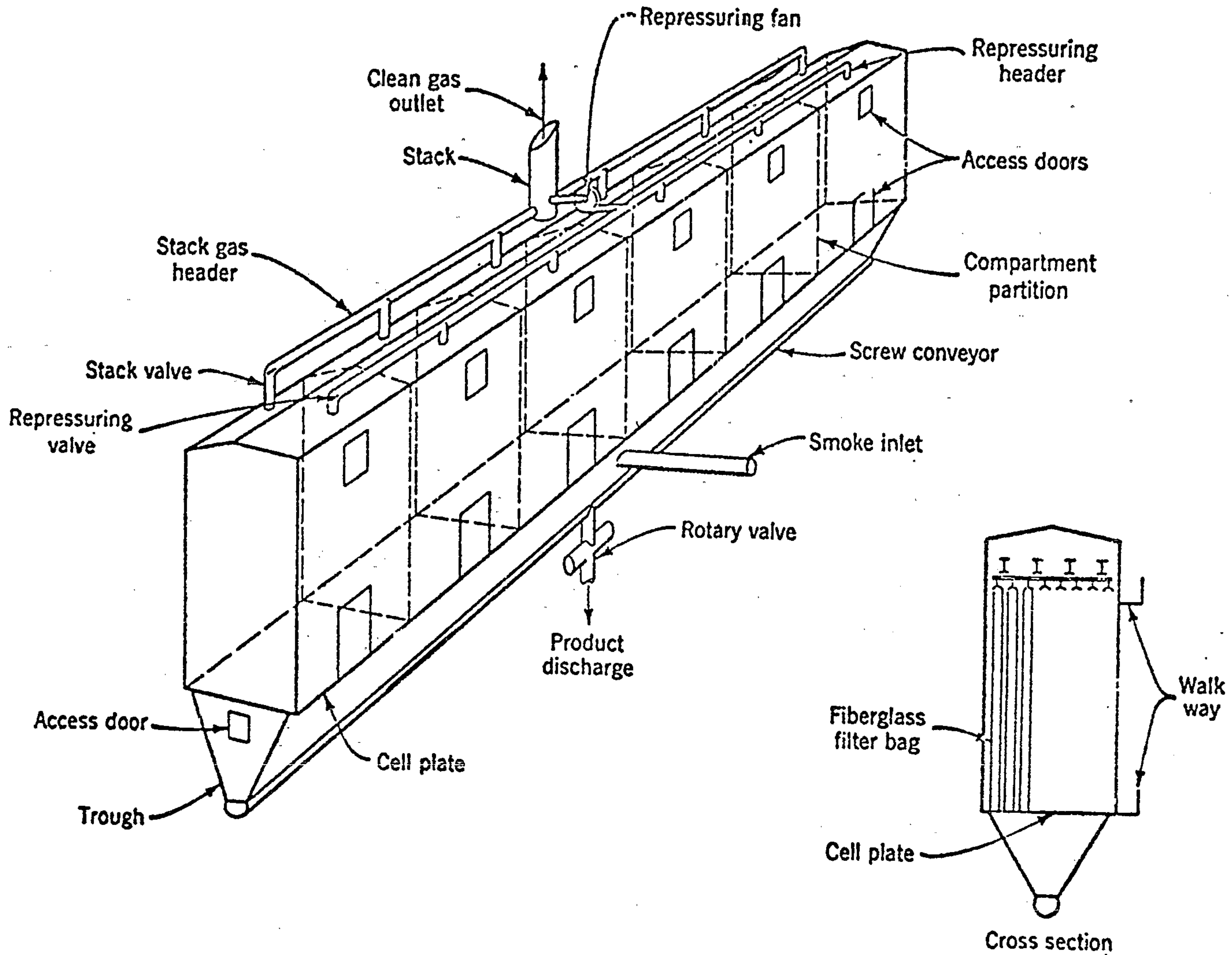

FIGURE IV -2

BAG FILTER CLEANING PROCESS

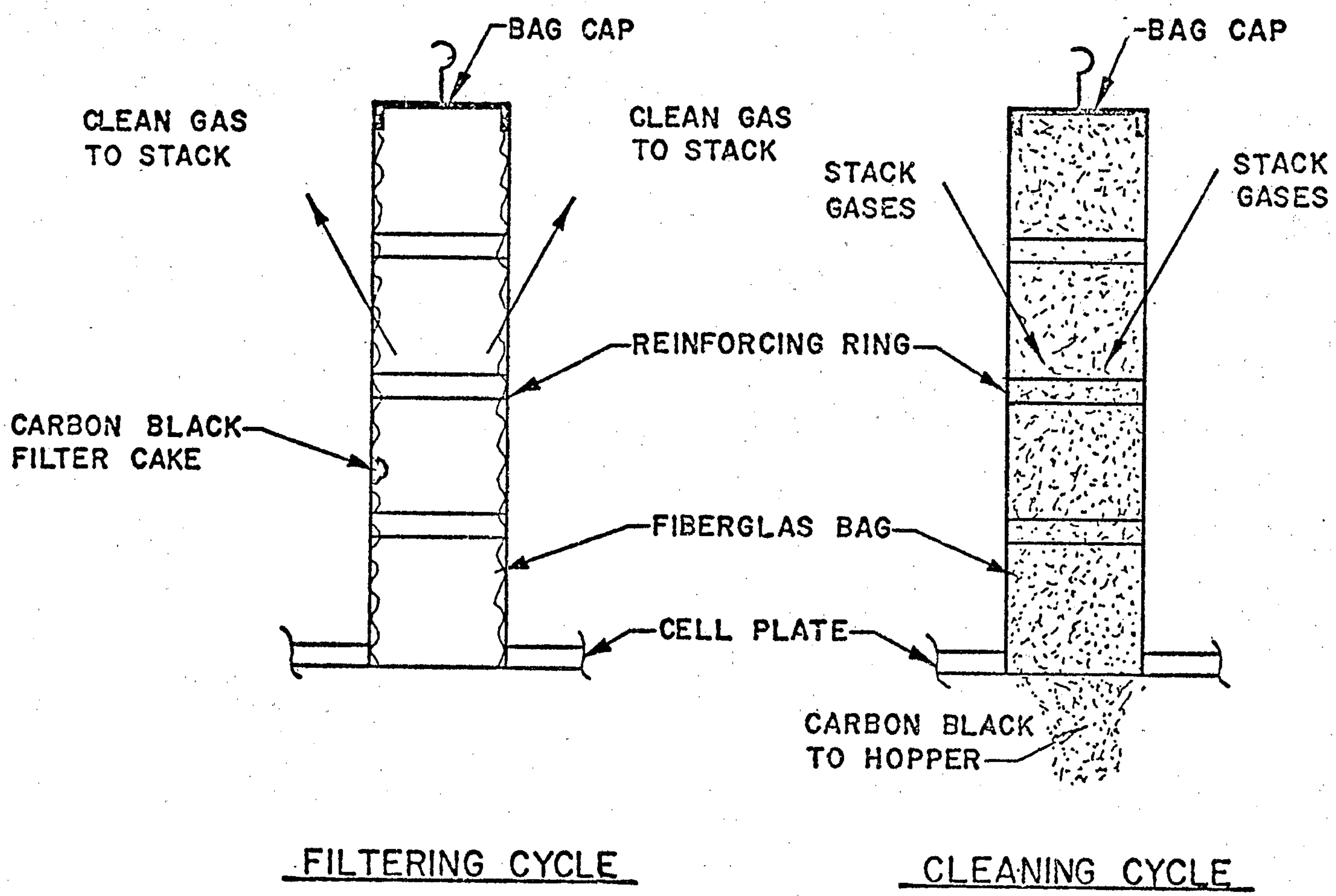

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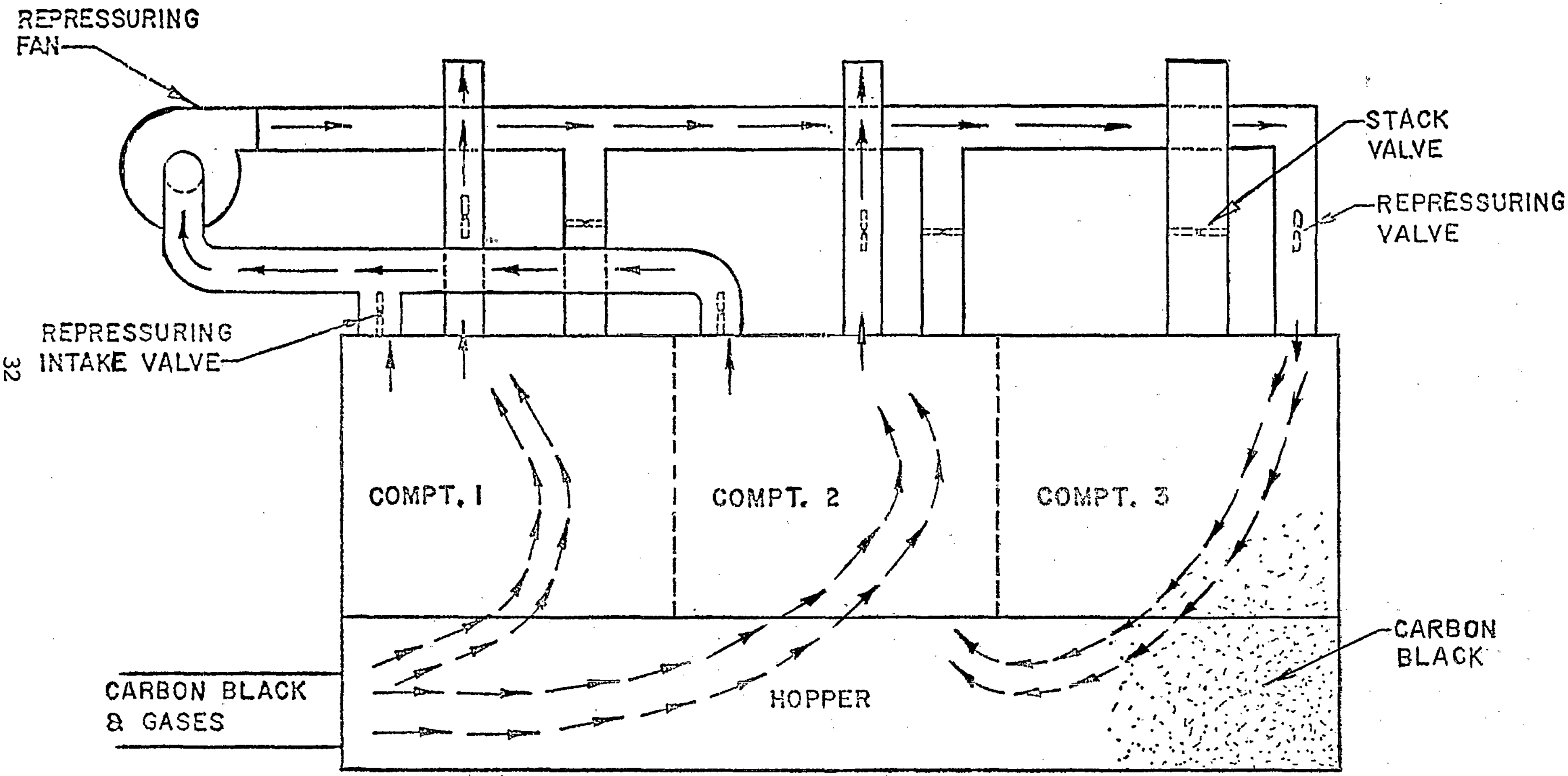
FIGURE IV -3

BAG FILTER OPERATION



*typically 8-12 compartments only 1 cut for cleaning.

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The bags are normally supported from hangers in the roof of the filter compartment with metal caps. The caps are tapered on the sides and are slightly larger in diameter than the hem around the top of the bag. The caps are inserted into the bags edgewise. When the cap is rotated and pulled outward, the bag is wedged around the perimeter of the cap. The wedging action seals the cap-bag surface and provides support for the bags. The bottom of each bag is then secured with a snap ring onto the cell plate.

The repressuring process is controlled with an electrically operated timer. Figure IV-3 illustrates the principal operations of the bag filter. As shown, the first two compartments are filtering carbon black from process gases as the No. 3 compartment is being cleaned. The next event in the operation will be cleaning of compartment No. 1 while filteration continues in the No. 2 and No. 3 compartments. This step-like rotation is continued until all compartments have been repressured. The cycle is then repeated.

The repressuring fan generates enough force to reverse the flow of gases. The gases used in the cleaning cycle are taken from compartments on the filtering cycle. In Figure IV-3, compartments No. 1 and No. 2 are supplying the repressuring gases for compartment No. 3. When compartment No. 1 is cleaned, the gases will be provided from compartment No. 2. The three-compartment filter illustrated is merely schematic. On commercial bag filters, several of the compartments are used as a source for repressuring gas.

The sequence of events which puts compartment No. 3 on-and-off the cleaning cycle is:

1. Stack valve closes.
2. Repressuring valve opens.
3. Cleaning cycle.
4. Repressuring valve closes.
5. Stack valve opens.
6. Filter cycle.

For cleaning compartment No. 1, the sequence is slightly different because of the repressuring intake valve. When the stack valve closes, so does the repressuring intake valve; and when the stack valve opens, the repressuring intake valve opens.

Similar type bag filters are used to recover carbon black from the drier purge vent gas. Fiber glass bags are used in these filters because of the normal 400° F and higher operating temperatures.

Corrosion, and its related maintenance cost, is a continuous problem in bag filters, especially in drier vent applications. This is due to both the sulfur and the water content of the exit gases.

With a system as described above, it is possible to recover up to 99.95 percent of the carbon black manufactured.

Nature of Wastes Generated

The furnace black and thermal black processes have been examined for type of contact process water usage associated with each. Contact process water is defined to be all water which comes in contact with chemicals within the process and includes:

1. Water required or produced (in stoichiometric quantities) in a chemical reaction.
2. Water used as a solvent or as an aqueous medium for reactions.
3. Water which enters the process with any reactants or which is used as dilutent (including steam).
4. Water used as an absorbent or as a scrubbing medium for separating certain chemicals from the reaction mixture.
5. Water introduced as steam to strip certain chemicals from the reaction mixture.
6. Water used to wash, remove, or separate chemicals from the reaction mixture.
7. Water associated with mechanical devices, such as steam-jet ejectors for drawing a vacuum on the process.
8. Water used as a quench or direct contact coolant such as in a barometric condenser or reaction quenching.
9. Water used to clean or purge equipment used in batch type operations.

Noncontact flows which were not considered include:

1. Sanitary wastewaters including laundry and shower wastewater.

2. Boiler and cooling tower blowdowns or once-through cooling water.
3. Chemical regenerants from boiler feed water preparation.
4. Stormwater runoff from non-process plant areas, e.g., tank farms.

These are now covered by separate regulations or may be covered at a future date by specific effluent limitations, guidelines and standards.

An evaluation of the furnace process showed that the process wastewater source is the quench water used to cool the process stream. However, all of this water is vaporized and vented to the atmosphere as steam, resulting in no process wastewater discharge. The only wastewater generated by the furnace process is from equipment washing and has been shown to be successfully recycled back to the quench water with no product contamination resulting again in no discharge of process wastewater,discharge.

The thermal black process also uses quench water to cool the product. However, in this process, this water is condensed through further water sprays in the dehumidifier and is usually recycled as quench water. Because no process wastewater is generated, this is not a basis for subcategorization.

The lamp and channel black processes are dry operations and if dry cleaning and bag filters are incorporated there will be no process wastewater discharge from these processes.

Treatability of Wastewaters

All process wastewater is to be recycled. Although it is possible to have wastewaters and require waste treatment, there are no known significant advantages with specific types of treatment systems. Therefore, wastewater generation need not occur and treatability of wastewater is not a basis for subcategorization.

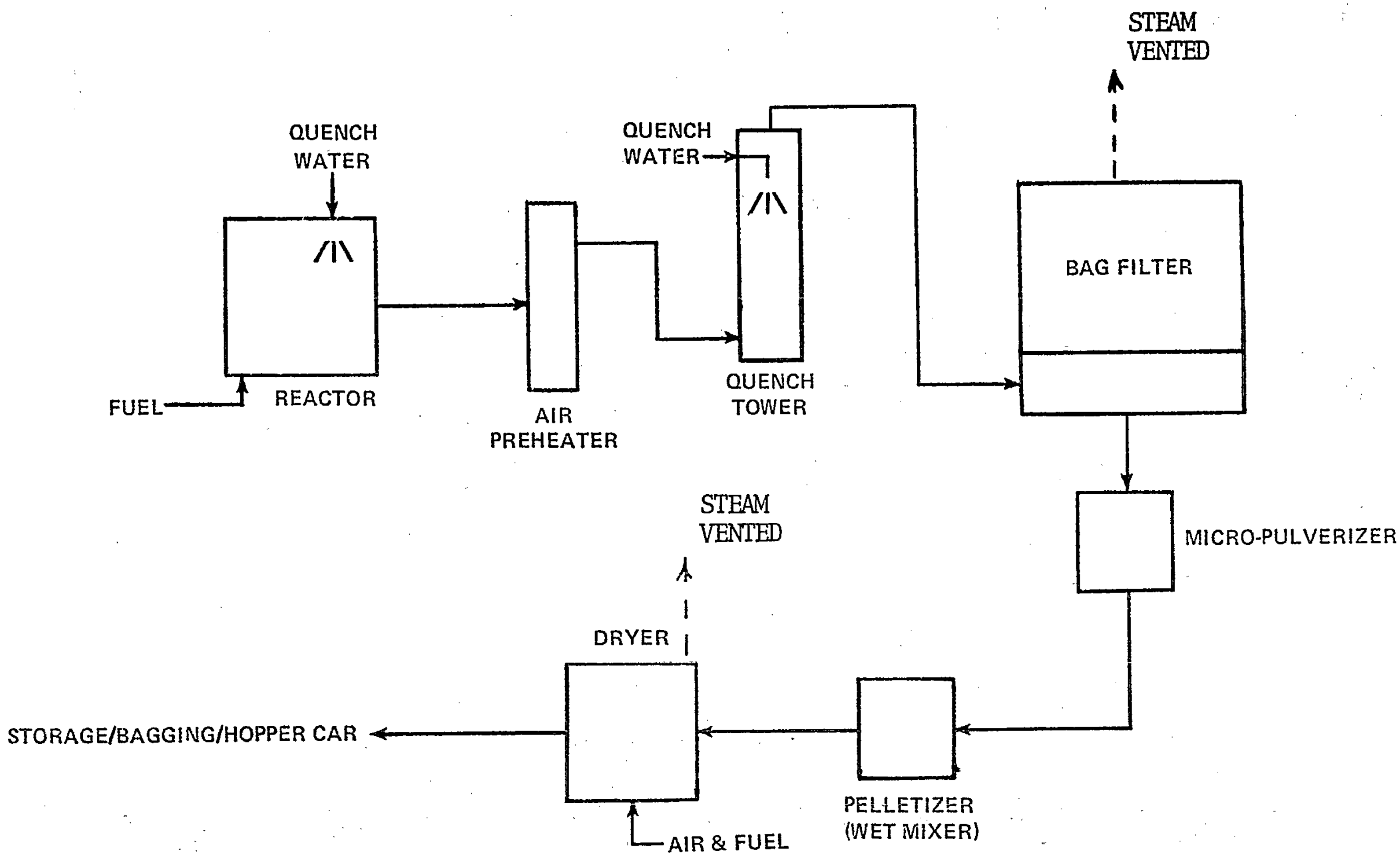
Summary of Considerations

For the purpose of establishing effluent limitations, guidelines and standards of performance carbon black manufacturing was divided into four subcategories. This subcategorization was based on distinct differences in manufacturing processes. The four selected subcategories are:

FIGURE IV -4

PROCESS FLOW SHEET

FURNACE BLACK PROCESS



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Subcategory A - Furnace Black
Subcategory B - Thermal Black, Including Acetylene Black
Subcategory C - Channel Black
Subcategory D - Lamp Black

As discussed in Section III, the furnace and thermal processes are those of significance in the United States. Subcategories C and D have been included for completeness.

Description of Subcategories

Subcategory A - Furnace Black Process

This subcategory (Figure IV-4) includes carbon black manufactured by the furnace process. The process is a net user of water. Process raw waste loads should be zero, with variations caused only by intermittent equipment washdown, which can be settled, screened and recycled as quench water or evaporated. Both techniques are practiced by the manufacturers of furnace black.

Subcategory B - Thermal Black Process

This subcategory (Figure IV-5) consists of carbon black manufacture by the thermal process, including the acetylene black process. Process water in the thermal process consists of direct contact quench water. It is judged feasible to reduce process waste loads to zero through increased recycle as quench water in this subcategory as is practiced by the manufacturers of thermal black.

Subcategory C - Channel Black Process

This subcategory (Figure IV-6) covers carbon black manufactured by the channel process. Channel black is a dry process which results in no wastewater discharge.

Subcategory D - Lamp Black

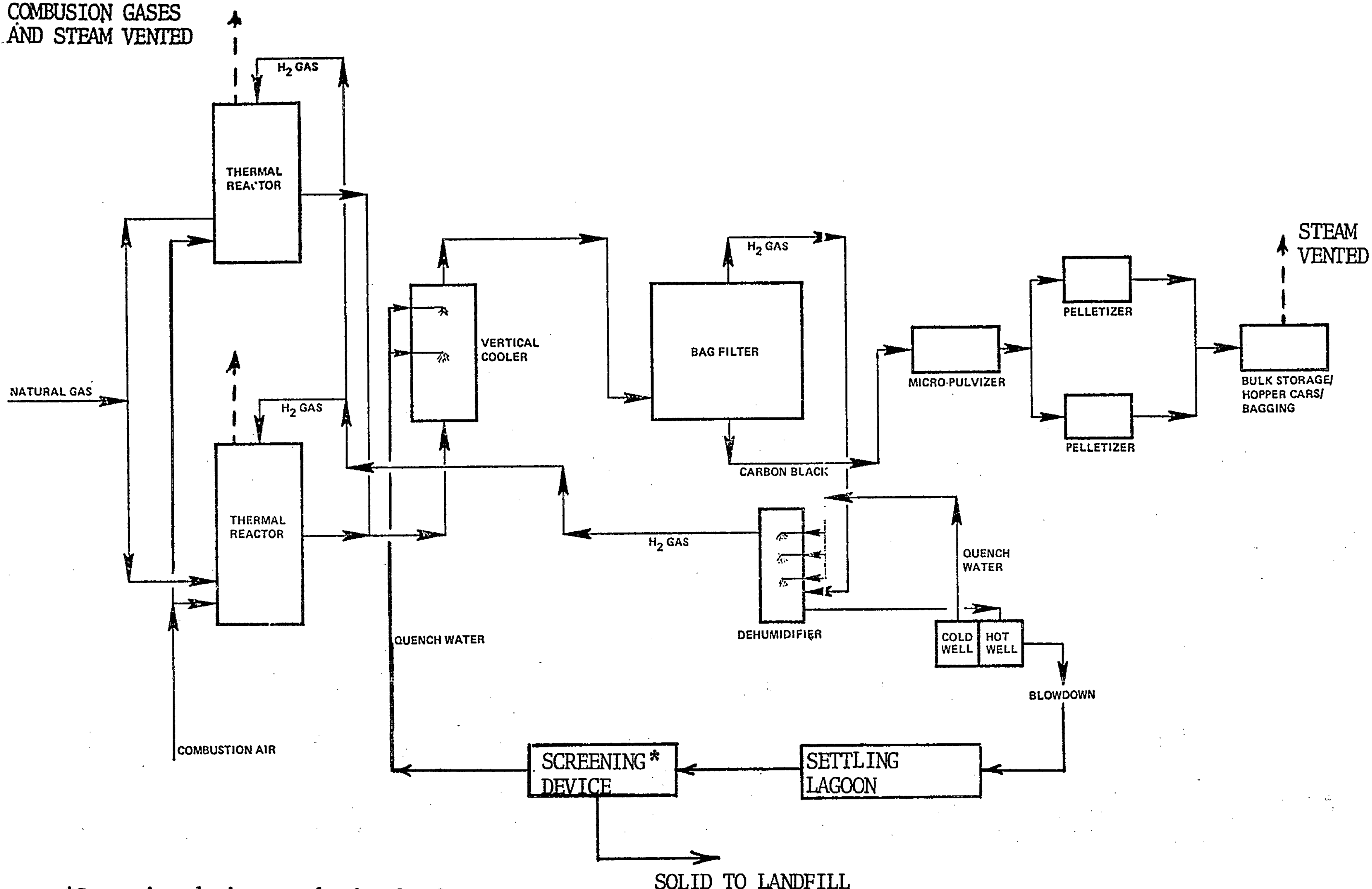
This subcategory (Figure IV-7) consists of carbon black manufactured by the lamp black process. No water is required in this process as bag filters are a tried and proven technique of collection resulting in 99+ percent recovery.

Process Descriptions

Subcategory A - Furnace Black Process

FIGURE IV -5

SIMPLIFIED FLOW SHEET
THERMAL BLACK PROCESS



*Screening device may be in the form of filtration if the water quality requires it.

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The furnace black process produces carbon black from the incomplete combustion of hydrocarbons oil or natural gas, see Figure IV-4.

In the oil furnace black process, liquid hydrocarbons are used. Yields range from 35 to 65 percent, depending on the grade of black being produced. The most desirable feedstock for furnace black is similar in many respects to residual fuel oil. It is low in sulfur and high in aromatics and olefins. The rising cost of natural gas has been a motivating factor in the shift to greater use of liquid feedstock and to the decline in the use of natural gas as a source of carbon. With this incentive, the oil furnace black process has become very flexible. Oil furnace blacks have nearly replaced channel blacks in most high-performance applications, notably passenger-car tire treads. Over the past thirty years, carbon black technology developments have centered on the oil furnace black process, and today nearly all carbon black plants use processes of this type.

The gas furnace black process is based on partial combustion of natural gas in refractory line furnaces. Yields of gas furnace blacks range from 10 to 30 percent and are lower for the smaller particle size grades. This process is similar to the oil furnace black process. Approximately 91.5 percent of all carbon black manufactured in the United States in 1972 was made by the furnace black process.

Oil is supplied from the process oil storage. The oil is usually preheated in a heat exchanger prior to firing the reactors to recover some of the waste heat from the reactor. Also, preheated air may be supplied to the reactor for partial burning of the fuel. The particle size of the carbon black is controlled by the air supply.

Carbon black particles are formed in refractory-lined reactor units designed for the incomplete burning of the fuel oil. The carbon black particle is formed in this unit. The reactor temperature is approximately 3200°F. (Reactor design configurations are generally the major area of difference between manufacturers and production processes.)

The combustion products (gases and carbon black) pass through the air preheater (at approximately 1100°F) and an oil preheater (at approximately 800°F). In-line water sprays cool the gas-carbon black stream. The combustion products then pass through a quench tower where water sprays further cool the stream to approximately 400°F. All quench water is vaporized and vented to the atmosphere.

The carbon black particles are filtered from the "quenched" gas stream by passing through baghouses. The captured carbon black is collected in hoppers below the baghouse and passed through a micro-pulverizer to a pelletizer. Water is added to the "fluff" and it is agitated and mixed to form pellets with a higher density. The "fluff" has a density of approximately 2 pounds per cu ft, whereas the pellets have a density of approximately 20 pounds per cu ft.

The wet pellets are then dried in a rotary external fired direct/indirect dryer. The indirect exhaust gases from this drier are vented to the atmosphere and the direct (contact) gases are exhausted to a bag filter. The dried carbon black pellets are then conveyed to storage and or bulk loaded. A simplified process flow diagram is shown in Figure IV-4. No contact process waste streams are generated by this process. Good housekeeping and/or roofing over and/or diking the process areas will minimize stormwater runoff contamination.

Subcategory B - Thermal Black Process

Approximately 7.8 percent of all carbon black produced in the United States in 1972 was made by the thermal black process.

The thermal black process produces carbon black by the "cracking" of hydrocarbons (i.e., separation of the carbon from the hydrogen). The feed stock is generally natural gas. Particles from the thermal black process are primarily large sizes, and yields range from 40 to 50 percent.

Each thermal black unit consists of two reactors. To make the operation continuous, one reactor is automatically switched to a heating cycle while the other is producing carbon black. The reactor refractory is heated by separating the carbon black from the hydrogen gas in a bag filter and returning and burning the hydrogen gas in the reactor that is in the "heat" cycle.

Each reactor consists of a firing zone and a cracking zone. The cracking zone contains refractory brick which stores the heat required to crack the natural gas into carbon and hydrogen. Natural gas is injected into the top of the unit. The energy supplied by the heated refractory brick cracks the natural gas to thermal black and hydrogen gas. This mixture leaves the reactor at a relatively high temperature and at an increased standard volume and enters the quench section of the reactor, where the temperature of the reaction products is decreased by adding water. Because the temperature at this point is still much higher than the boiling point of water, the quench water is converted into steam.

The cooled reaction products flow through a vertical cooler where additional quench water is added for further cooling. The temperature at this point is still in excess of the boiling point of water, and therefore the quench water is converted to steam.

From the vertical cooler, the reaction products enter the bag filter, where the thermal black is separated from the hydrogen gas. The filtered thermal black falls into a conveyor beneath the bag filter. The filtered hydrogen gas and water vapor pass through a water seal (to prevent explosions) into a dehumidifier. Water sprays in the dehumidifier cool the reformed gases below the boiling point of water, removing most of the moisture. Water collected in the dehumidifier flows to the hot well where it is cooled and transferred to the cold well. It is then used to supply the sprays in the dehumidifier. The gases leaving the dehumidifier are in excess of the amount required to heat the reactor and the excess is vented.

The loose thermal black is collected under the bag filter in a closed screw conveyor and conveyed to a micro-pulverizer. The micro-pulverizer breaks up large agglomerations of thermal black and small pieces of refractory which may be present. The loose black from the micro-pulverizer is pelletized to make it more suitable for handling. The pelletized black is directly conveyed to a hopper car for shipment or conveyed to bulk storage. The black can be loaded into hopper cars or bagged from bulk storage.

Figure IV-5 is a simplified flow diagram illustrating the thermal black process. The flow diagram shows a single unit with its two reactors.

The dehumidifier blowdown can be handled by evaporation ponds, if desired, in water deficient areas and/or can be recycled as quench water in water surplus regions resulting in no discharge of process wastewater from the process.

Good housekeeping and/or a roof over and/or diking around the process areas will minimize the stormwater runoff contamination.

Due to the high cost and lack of natural gas, large-particle furnace blacks (LPF) may soon replace many of the thermal black applications.

Figure IV - 6
Channel Black Process Flow Diagram

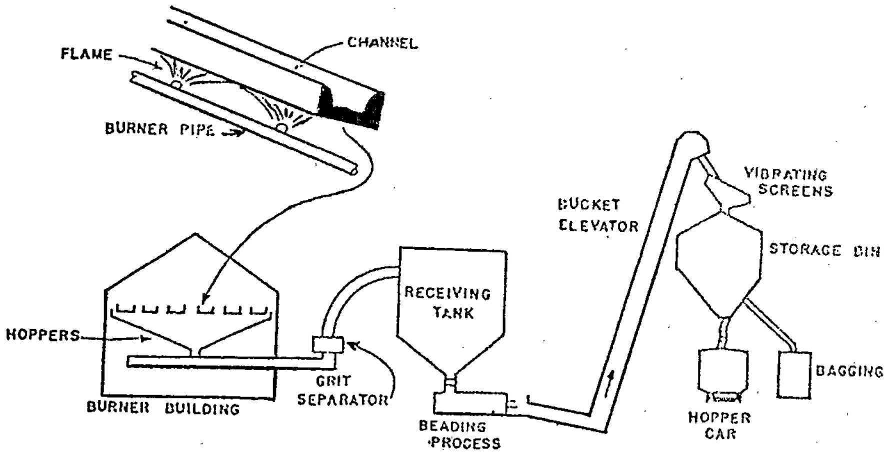
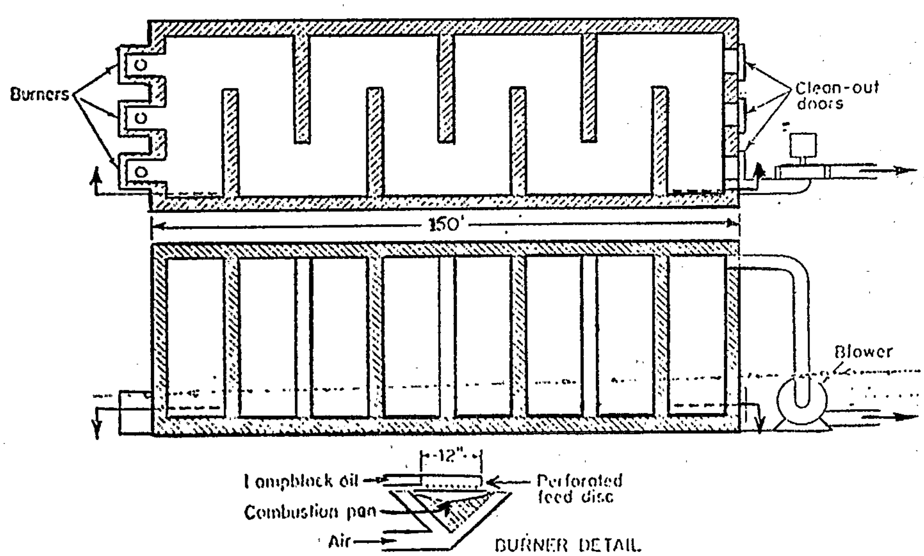


Figure IV - 7
Lamp Black Process Flow Diagram



Acetylene blacks, a type of thermal black, are produced by the thermal decomposition of acetylene. They possess a high degree of structural or chaining tendency. They provide a high elastic modulus and high conductivity in rubber stocks. At the present time, acetylene black is produced in the United States at one location and operates at a level of no discharge of process wastewater.

A typical system for achieving the no discharge of process wastewater pollutants for both the thermal and furnace black process is depicted in Figure IV-8.

Channel Black Manufacture

Channel black is a product of incomplete combustion of natural gas, (Figure IV-6). Small flames are impinged on cool surfaces, or channels, where carbon black is deposited and then scraped off as the channel moves back and forth over a scraper. The properties of channel black are varied by changes in burner tip design, distances from tip to channel, and the amount of air made available for combustion. The process is extremely inefficient chemically. For rubber-reinforcing grades, the yield is only 5 percent; for finer particle size, higher color blacks such as for use in food stuffs, the yield shrinks to 1 percent. Low yields and rapidly rising gas prices have motivated the manufacturers to develop other methods of carbon black production.

At present, there is only a single channel black plant remaining in operation in the United States, as compared to 35 plants in 1951.

Lamp Black Manufacture

Lamp black is the ancestor of all carbon blacks. Until the 1870's, it was the only carbon black available commercially, (Figure IV-7. The manufacture of lamp black was practiced by the Chinese and Egyptians during the pre-Christian era. Purified resins, fats, and oils were burned beneath inverted porcelain or pottery cones, and the soot deposited on the cool surface was carefully brushed off from time to time.

Lamp black manufacturers still follow this basic process. The principal raw materials used today, however, are petroleum and coal tar by-products, such as creosote and anthracene oils. They are burned in open, shallow pans with restricted air supply. The resulting carbon smoke is then conducted to a series of settling chambers, where the flocculated carbon deposits are periodically recovered. In a typical operation, coal-tar distillate or creosote is burned from pans four feet in diameter and six inches in depth. The smoke from each pan passes slowly through a series of settling chambers, where most of the black collects. The remainder is periodically collected by bag filters from both settling chambers and filter systems by vacuum collectors. Since the gas velocities are very low, heat is dissipated in the chambers without a need for water-spray cooling. No water is associated with this process if bag filtration collection technique is employed as is the situation with one of the two operating plants.

In recent years, this process has undergone some changes and developments, making it more similar to the oil furnace black processes. These modified lamp blacks more closely resemble oil and gas furnace blacks than traditional lamp blacks. Lamp blacks are of large particle size, possess little reinforcing ability in rubber, and are low in coloring power. They are of value as tinting pigments in certain paints and lacquers, but are primarily used in the manufacture of carbon black brushes for electrical equipment and carbon arcs. In most applications, however, they have been replaced by furnace blacks. Because two plants are in operation in the United States, this subcategory is included for completeness.

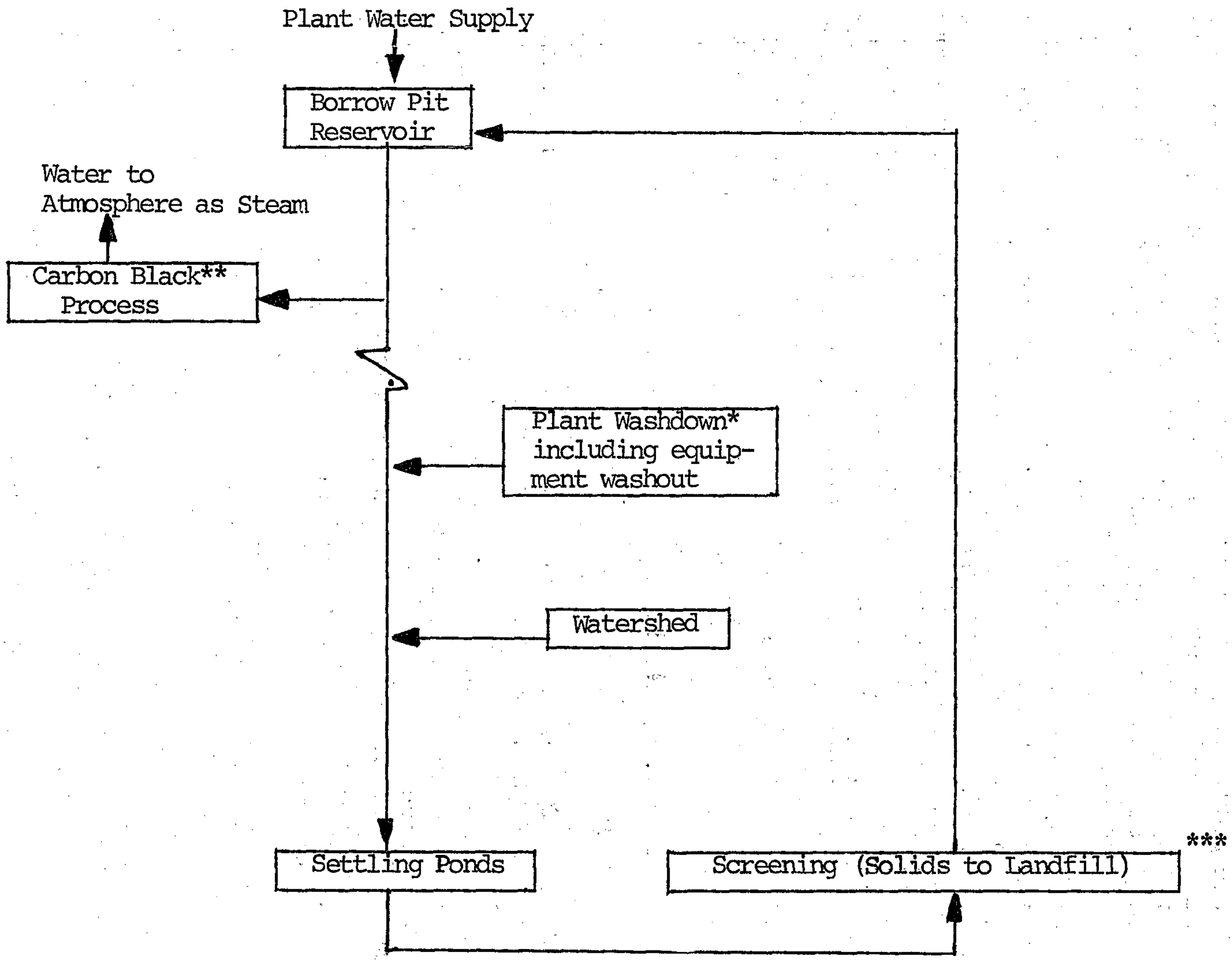
Basis for Assignment to Subcategories

This subcategorization assigns carbon black products to a subcategory by the manufacturing process by which they are produced. It should be noted that all carbon black manufacturing processes were subcategorized.

Field sampling was not performed at plants visited because of the nature of the processes subcategorized. They either had no discharge, or the discharge was intermittent, consisting of occasional equipment washdowns or other incidental flows. Historical raw waste data from the manufacturers has been used and is presented in Section V, Waste Characteristics.

Figure IV - 8

Block Diagram for No Discharge of Process Wastewater Pollutants System



* Does not include utility blowdown, sanitary, laundry or shower, or laboratory wastewater. These may go to separate sanitary system although some may be acceptable and desirable for recycle as quench water.

** Process includes both thermal and furnace black.

*** Screening may be in the form of filtration if water quality requires it.

4/30/76

SECTION V

WASTE CHARACTERIZATION

Carbon Black

Unlike the other industries listed under miscellaneous chemicals, the carbon black manufacturers produce only a single major product type. The various production processes for manufacturing carbon black were used as a basis for subcategorization of the segment.

Because the discharges from these processes are intermittent and highly dependent upon the immediate situation, no wastewater sampling was performed for this industry. Available industrial data, however, were acquired for waste categorization.

The major wastewater discharge from subcategory A (furnace black), is from equipment and process area wash down which has been shown to be successfully recycled as quench water.

The major process wastewater stream for subcategory B (thermal process) is the recirculated dehumidifier stream. The thermal plant visited for this project had no blowdown from this source. The dehumidifier stream was ponded and recirculated as quench water in the process. Data obtained from the survey are presented in Table V-1.

Table V-1

Raw Waste Loads
Carbon Black Segment

Process	Water Usage* (L/kkg)	TSS** (kg/kkg)
Furnace Black	1,500	2.8
Thermal Black	72,100	8.9

*99+% vented as steam
**Estimated based on plant data

The furnace black process is a net user of water. The miscellaneous discharges occur on an unscheduled basis. These discharges from equipment washout and storm runoff are mixed with laboratory wastewater, utility blowdown and in some situations mixing of treated sanitary waste including shower and laundry waste. Therefore, sampling was not practical.

The thermal waste stream is probably representative of a blowdown stream that could be expected from other dehumidifier/quench systems; however, the dehumidifier blowdown would be only 1 percent (approximately) of the total 72,100 L/kkg flow and has been shown to be successfully recycled as quench water.

The raw waste load (RWL) values for the furnace black process was calculated from plant 84, indicating a three month average wastewater discharge of 97 gpm. The data did not indicate whether all of this flow was process wastewater. A range of 8 to 45 gpm with an average of 20 gpm was reported by seven other furnace plants for the equipment wash water discharge. The RWL was calculated from the TSS data of plant 84 and the 97 gpm flow, (Table V-1). However, this plant was not exemplary and the average flow of 20 gpm was used to calculate the cost for recycle equipment (Table VIII-2).

No discharge of process wastewater pollutants is still recommended for the furnace process based on the data shown in Tables IV-1 and IV-2, where 66 percent of the furnace plants currently have no discharge of process wastewater. Furthermore, based on plant data, the average wash water and other effluent flow rates represent less than 10 percent of the average quench water flow rates for those same plants.

No definable process point source waste stream is discharged from subcategory C (channel black process) and subcategory D (lamp black process). Bag filtration is the recommended collection technique for the lamp black process resulting in no discharge of process wastewater pollutants. One lamp black plant surveyed had a settling pond where the solids settled out and the liquid percolated into the ground. It is recommended that if this settling pond be lined, bag filters be installed to recover the solids and eliminate the waste stream. A second lamp black plant surveyed uses the bag filter collection technique and has no discharge of process wastewater. The channel black plant was a dry operation with no discharge of process wastewater pollutants.

Carbon black spills are generally vacuumed dry, and are therefore not a source of contamination. Dry vacuuming is used to allow recovery of uncontaminated dry carbon black and prevent wastewater contamination. This carbon can sometimes be reused but is generally incinerated and/or landfilled. Oil and grease concentrations in the process wastewater streams were not observed to be a problem for this point source category due to the high reaction temperature required to produce carbon black and the nature of all four subcategories.

It has been reported that the properties of carbon black can be changed by a variety of techniques including recirculation of off-gases and injection of additives. For example, use of potassium and sodium salts (i.e., KNO_3 and $NaNO_3$) at the rate of approximately 0.1 percent by weight have been effective in the reduction of particle size of furnace black. Also aluminum and zirconium salts have been added to the process gas stream to increase refractory life of the reactors. These alkali materials could attack the silicon-graphitized fabric and destroy the integrity of the fabric filter bags. The possible impact on process wastes due to these factors is unknown.

SECTION VI

SELECTION OF POLLUTANT PARAMETERS

General

From review of NPDES permit applications for direct discharge of wastewaters from various manufacturers, industries grouped under carbon black and examination of related published data, eight parameters (Table VI-1) were selected for all industrial wastewaters during the field data collection program. All surveyed data are summarized in Supplement B. Supplement B includes historical data from plants visited and surveyed, RWL calculations, and analysis of historical data. Supplement A has design calculations. Supplement A and B are available at the EPA Public Information Reference Unit, Room 2992 (EPA Library), Waterside Mall, Washington, D.C. 20460.

The degree of impact on the overall environment has been used as a basis for dividing the pollutants into groups as follows:

1. Pollutants of significance.
2. Pollutants of limited significance.

Particular parameters have been discussed in terms of their validity as measures of environmental impact and as sources of analytical insight.

Pollutants observed from the field data that were present in sufficient concentrations so as to interfere with, be incompatible with, or pass with inadequate treatment through publicly owned treatment works are discussed in Section XII of this document.

Pollutants of Significance

Parameters of pollution significance for the carbon black segment are TDS and TSS. Due to the intermittent flow or no discharge from the waste treatment facilities, no sampling took place on the furnace or thermal processes. No field visits were made to either the lamp or channel black manufacturing sites. These are dry operations and generate new process wastewater. The listing of parameters of significance was developed from the carbon black industrial survey.

Table VI-1

List of Parameters Examined

Total Suspended Solids

Dissolved Solids

Iron

Copper

Manganese

pH, Acidity, Alkalinity

Total Suspended Solids (TSS)

Suspended solids include both organic and inorganic materials. The inorganic compounds include sand, silt, and clay. The organic fraction includes such materials as grease, oil, tar, and animal and vegetable waste products. These solids may settle out rapidly and bottom deposits are often a mixture of both organic and inorganic solids. Solids may be suspended in water for a time, and then settle to the bed of the stream or lake. These solids discharged with man's wastes may be inert, slowly biodegradable materials, or rapidly decomposable substances. While in suspension, they increase the turbidity of the water, reduce light penetration and impair the photosynthetic activity of aquatic plants.

Suspended solids in water interfere with many industrial processes, cause foaming in boilers and incrustations on equipment exposed to such water, especially as the temperature rises. They are undesirable in process water used in the manufacture of steel, in the textile industry, in laundries, in dyeing and in cooling systems.

Solids in suspension are aesthetically displeasing. When they settle to form sludge deposits on the stream or lake bed, they are often damaging to the life in water. Solids, when transformed to sludge deposits, may do a variety of damaging things, including blanketing the stream or lake bed and thereby destroying the living spaces for those benthic organisms that would otherwise occupy the habitat. When of an organic nature, solids use a portion or all of the dissolved oxygen available in the area. Organic materials also serve as a food source for sludgeworms and associated organisms.

Disregarding any toxic effect attributable to substances leached out by water, suspended solids may kill fish and shellfish by causing abrasive injuries and by clogging the gills and respiratory passages of various aquatic fauna. Indirectly, suspended solids are inimical to aquatic life because they screen out light, and they promote and maintain the development of noxious conditions through oxygen depletion. This results in the killing of fish and fish food organisms. Suspended solids also reduce the recreational value of the water.

Dissolved Solids

In natural waters, the dissolved solids are mainly carbonates, chlorides, sulfates, phosphates, and, to a lesser extent, nitrates of calcium, magnesium, sodium, and potassium, with traces of iron, manganese and other substances. The summation of all individual dissolved solids is commonly referred to as total dissolved solids.

Many communities in the United States and in other countries use water supplies containing 2,000 to 4,000 mg/l of dissolved salts, when no better water is available. Such waters are not palatable, may not quench thirst, and may have a laxative action on new users. Waters containing more than 4,000 mg/l of total salts are generally considered unfit for human use, although in hot climates such higher salt concentrations can be tolerated. Waters containing 5,000 mg/l or more are reported to be bitter and act as a bladder and intestinal irritant. It is generally agreed that the salt concentration of good, palatable water should not exceed 500 mg/l.

Limiting concentrations of dissolved solids for fresh-water fish may range from 5,000 to 10,000 mg/l, depending on species and prior acclimatization. Some fish are adapted to living in more saline waters, and a few species of fresh-water forms have been found in natural waters with a salt concentration of 15,000 to 20,000 mg/l. Fish can slowly become acclimatized to higher salinities, but fish in waters of low salinity cannot survive sudden exposure to high salinities, such as those resulting from discharges of oil-well brines. Dissolved solids may influence the toxicity of heavy metals and organic compounds to fish and other aquatic life, primarily because of the antagonistic effect of hardness on metals.

Waters with total dissolved solids (TDS) concentrations higher than 500 mg/l have decreasing utility as irrigation water. At 5,000 mg/l, water has little or no value for irrigation.

Dissolved solids in industrial waters can cause foaming in boilers and can cause interference with cleanliness, color, or taste of many finished products. High concentrations of dissolved solids also tend to accelerate corrosion.

Specific conductance is a measure of the capacity of water to convey an electric current. This property is related to the total concentration of ionized substances in water and to the water temperature. This property is frequently used as a substitute method of quickly estimating the dissolved solids concentration.

Pollutants of Limited Significance

The following parameters, which were investigated in particular cases, have limited effects on the applicability of in-plant treatment technologies.

Iron (Fe)

Iron is an abundant metal found in the earth's crust. The most common iron ore is hematite from which iron is obtained by reduction with carbon. Other forms of commercial ores are magnetite and taconite. Pure iron is not often found in commercial use, but it is usally alloyed with other metals and minerals, the most common being carbon.

Iron is the basic element in the production of steel and steel alloys. Iron with carbon is used for casting of major parts of machines and it can be machined, cast, formed, and welded. Ferrous iron is used in paints, while powdered iron can be sintered and used in powder metallurgy. Iron compounds are also used to precipitate other metals and undesirable minerals from industrial waste water streams.

Iron is chemically reactive and corrodes rapidly in the presence of moist air and at elevated temperatures. In water and in the presence of oxygen, the resulting products of iron corrosion may be pollutants in water. Natural pollution occurs from the leaching of soluble iron salts from soil and rocks and is increased by industrial waste water from pickling baths and other solutions containing iron salts.

Corrosion products of iron in water cause staining of porcelain fixtures, and ferric iron combines with the tannin to produce a dark violet color. The presence of excessive iron in water discourages cows from drinking and, thus, reduces milk production. High concentrations of ferric and ferrous ions in water kill most fish introduced to the solution within a few hours. The killing action is attributed to coatings of iron hydroxide precipitates on the gills. Iron oxidizing bacteria are dependent on iron in water for growth. These bacteria form slimes that can affect the esthetic values of bodies of water and cause stoppage of flows in pipes.

Iron is an essential nutrient and micronutrient for all forms of growth. Drinking water standards in the U. S. have set a recommended limit of 0.3 mg/l of iron in domestic water supplies based not on the physiological considerations, but rather on aesthetic and taste considerations of iron in water.

Copper (Cu)

Copper is an elemental metal that is sometimes found free in nature and is found in many minerals such as cuprite, malachite, azurite, chalcopyrite, and bornite. Copper is obtained from these ores by smelting, leaching, and electrolysis. Significant industrial uses are in the plating, electrical, plumbing, and heating equipment industries. Copper is also commonly used with other minerals as an insecticide and fungicide.

Traces of copper are found in all forms of plant and animal life, and it is an essential trace element for nutrition. Copper is not considered to be a cumulative systemic poison for humans as it is readily excreted by the body, but it can cause symptoms of gastroenteritis, with nausea and intestinal irritations, at relatively low dosages. The limiting factor in domestic water supplies is taste. Threshold concentrations for taste have been generally reported in the range of 1.0 - 2.0 mg/l of copper while concentrations of 5 to 7.5 mg/l have made water completely undrinkable. It has been recommended that the copper in public water supply sources not exceed 1 mg/l.

Copper salts cause undesirable color reactions in the food industry and cause pitting when deposited on some other metals such as aluminum and galvanized steel. The textile industry is affected when copper salts are present in water used for processing of fabrics. Irrigation waters containing more than minute quantities of copper can be detrimental to certain crops. The toxicity of copper to aquatic organisms varies significantly, not only with the species, but also with the physical and chemical characteristics of the water, including temperature, hardness, turbidity, and carbon dioxide content. In hard water, the toxicity of copper salts may be reduced by the precipitation of copper carbonate or other insoluble compounds. The sulfates of copper and zinc, and of copper and cadmium are synergistic in their toxic effect on fish.

Copper concentrations less than 1 mg/l have been reported to be toxic, particularly in soft water, to many kinds of fish, crustaceans, mollusks, insects, phytoplankton and zooplankton. Concentrations of copper, for example, are detrimental to some oysters above .1 ppm. Oysters cultured in sea water containing 0.13-0.5 ppm of copper deposited the metal in their bodies and became unfit as a food substance.

Manganese

Manganese metal is not found pure in nature, but its ores are very common and widely distributed. The metal or its salts are used extensively in steel alloys, for dry-cell batteries, in glass and ceramics, in the manufacture of paints and varnishes, in inks and dyes, in matches and fireworks, and in agriculture to enrich manganese-deficient soils. Like iron, it occurs in the divalent and trivalent form. The chlorides, nitrates, and sulfates are highly soluble in water; but the oxides, carbonates, and hydroxides are only sparingly soluble. For this reason, manganic or manganous ions are seldom present in natural surface waters in concentrations above 1.0 mg/l. In groundwater subject to reducing conditions, manganese can be leached from the soil and occur in high concentrations. Manganese frequently accompanies iron in such ground waters and in the literature the two are often linked together.

The recommended limitation for manganese in drinking water in the U.S. is set at 0.05 mg/l and internationaly (WHO) at 0.1 mg/l. These limits appear to be based on esthetic and economic considerations rather than physiological hazards. In concentrations not causing unpleasant tastes, manganese is regarded by most investigators to be of no toxicological significance in drinking water. However, some cases of manganese poisoning have been reported in the literature. A small outbreak of an encephalitis-like disease, with early symptoms of lethargy and edema, was traced to manganese in the drinking water in a village outside of Tokyo; three persons died as a result of poisoning by well water contaminated by manganese derived from dry-cell batteries buried nearby. Excess manganese in the drinking water is also believed to be the cause of a rare disease endemic in Manchukuo.

Manganese is undesirable in domestic water supplies because it causes unpleasant tastes, deposits on food during cooking, stains and discolors laundry and plumbing fixtures, and fosters the growth of some micro-organisms in reservoirs, filters, and distribution systems.

Small concentrations of manganese - 0.2 to 0.3 mg/l may form heavy encrustations in piping while even small amounts may cause noticable black spots on white laundry items. Excessive manganese is also undesirable in water for use in many industries, including textiles; dyeing; food processing, distilling, brewing; ice; paper; and many others.

<u>Acidity and Alkalinity - pH</u>

Although not a specific pollutant, pH is related to the acidity or alkalinity of a waste water stream. It is not a linear or direct measure of either, however, it may properly be used as a surrogate to control both excess acidity and excess alkalinity in water. The term pH is used to describe the hydrogen ion - hydroxyl ion balance in water. Technically, pH is the hydrogen ion concentration or activity present in a given solution. pH numbers are the negative logarithim of the hydrogen ion concentration. A pH of 7 generally indicates neutrality or a balance between free hydrogen and free hydroxyl ions. Solutions with a pH above 7 indicate that the solution is alkaline, while a pH below 7 indicate that the solution is acid.

Knowledge of the pH of water or waste water is useful in determining necessary measures for corrosion control, pollution control, and disinfection. Waters with a pH below 6.0 are corrosive to water works structures, distribution lines, and household plumbing fixtures and such corrosion can add constituents to drinking water such as iron, copper, zinc, cadmium, and lead. Low pH waters not only tend to dissolve metals from structures and fixtures but also tend to redissolve or leach metals from sludges and bottom sediments. The hydrogen ion concentration can affect the "taste" of the water and at a low pH, water tastes "sour".

Extremes of pH or rapid pH changes can exert stress conditions or kill aquatic life outright. Even moderate changes from "acceptable" criteria limits of pH are deleterious to some species. The relative toxicity to aquatic life of many materials is increased by changes in the water pH. For example, metalocyanide complexes can increase a thousand-fold in toxicity with a drop of 1.5 pH units. Similarly, the toxicity of ammonia is a function of pH. The bactericidal effect of chlorine in most cases is less as the pH increases, and it is economically advantageous to keep the pH close to 7.

<u>Acidity</u> is defined as the quantative ability of a water to neutralize hydroxyl ions. It is usually expressed as the calcium carbonate equivalent of the hydroxyl ions neutralized. Acidity should not be confused with pH value. Acidity is the quantity of hydrogen ions which may be released to react with or neutralize hydroxyl ions while pH is a measure of the free hydrogen ions in a solution at the instant the pH measurement is made. A property of many chemicals, called buffing, may hold hydrogen ions in a solution from being in the free state and being measured as pH. The bond of most buffers is rather weak and hydrogen

ions tend to be released from the buffer as needed to maintain a fixed pH value.

Highly acid waters are corrosive to metals, concrete and living organisms, exhibiting the pollutional characteristics outlined above for low pH waters. Depending on buffering capacity, water may have a higher total acidity at pH values of 6.0 than other waters with a pH value of 4.0.

Alkalinity: Alkalinity is defined as the ability of a water to neutralize hydrogen ions. It is usually expressed as the calcium carbonate equivalent of the hydrogen ions neutralized.

Alkalinity is commonly caused by the presence of carbonates, bicarbonates, hydroxides and to a lesser extent by borates, silicates, phophates and organic substances. Because of the nature of the chemicals causing alkalinity, and the buffing capacity of carbon dioxide in water, very high pH values are seldom found in natural waters.

Excess alkalinity as exhibited in a high pH value may make water corrosive to certain metals, to most natural organic materials and toxic to living organisms.

Ammonia is more lethal with a higher pH. The lacrimal fluid of the human eye has a pH of approximately 7.0 and a deviation of 0.1 pH unit from the norm may result in eye irritation for the swimmer. Appreciable irritation will cause severe pain.

Carbon Black

As discussed in Section V, all subcategories of carbon black are no discharge of process wastewater pollutant subcategories. In the thermal subcategory, the process quench water contacts a hot process stream of carbon black and hydrogen formed by cracking natural gas. The quench water is later condensed in a dehumidifier by further cooling by active sprays. This contact water contains a relatively small amount of carbon black as TSS. Since carbon black consists of elemental carbon (which exerts minimal oxygen demand), the only pollutant of significance is TSS. TSS is measured by the organic and inorganic solids removed when filtered through a preformed glass filter mat in a Gooch crucible.

One thermal plant visited had a TSS concentration of approximately 124 mg/l in the recirculated dehumidifier system, and had no blowdown. Normally, a blowdown is taken from such a closed-loop system, but in the carbon black manufacture, this blowdown has been successfully recycled to the quench water with no product contamination resulting. The TSS concentration of the blowdown would probably be similar to the concentration measured in the closed loop that was investigated, but based on the survey this is not necessary in the manufacture of carbon black. Therefore, no process wastewater should be discharged from the plant. The parameters discussed above may affect the product as contamination if the level of pollutants are high as a result of poor settling before recycle, high concentration in the influent plant water or poor operating procedures.

The raw waste load obtained during the field survey for the furnace and thermal black plants are presented in Table V-1. Raw waste load data was collected from a process from the historical data collected from a survey of the carbon black furnace and thermal manufacturers. Channel and lamp black are total dry process resulting in no process wastewater. Raw waste data for the thermal and furnace process, historical and surveyed, are summarized in Table VII-2.

SECTION VII

CONTROL AND TREATMENT TECHNOLOGIES

General

Control and treatment technology may be divided into two major groupings: in-plant pollution abatement and end-of-pipe treatment.

Based on the ability to obtain no discharge of process wastewater pollutants in this point source category discussion of end-of-plant treatment is not applicable.

After reviewing the results of the segment-wide carbon black survey, conclusions were made commensurate with the following distinct technology levels:

I. Best Practicable Control Technology Currently Available (BPT)

II. Best Available Technology Economically Achievable (BAT)

III. Best Available Demonstrated Control Technology (NSPS)

To assess the economic impact of these proposed effluent limitations, guidelines and new source performance standards on each of the subcategories, model treatment systems have been proposed which are considered capable of attaining the recommended RWL reduction before recycle is required in order to meet the effluent limitations and guidelines. It should be noted and understood that the particular systems were chosen for use in the economic analysis only, and are not the only systems capable of attaining the specified pollutant reductions.

There are many possible combinations of in-plant systems capable of attaining the effluent limitations, guidelines and standards of performance suggested in this report. It is the intent of this study to allow the individual plant to make the final decision about what specific combination of pollution control measures is best suited to its situation in complying with the effluent limitations, guidelines and standards.

Carbon Black

In-Plant Pollution Abatement

The elimination or reduction of in-plant pollution sources depends upon any one or a combination of the following factors:

1. New plant process selection to minimize pollution. Present corporate environmental awareness requires that the new environmental impact of products and processes be evaluated.

2. The modification of process equipment to improve product recovery or to minimize pollution.

3. Maintenance and good housekeeping practices to minimize pollution. The competitive nature of the segment requires that most producers operate their plants in the most efficient manner possible. This necessitates good maintenance and housekeeping practices.

4. The age of the plant and process equipment as it affects pollution. Poorly maintained process equipment does not warrant consideration of its age. An example of the impact of new technology on carbon black manufacturing is the use of bag filters for carbon black recovery, accepted as state-of-the-art technology. In the past, cyclones and wet scrubbers were used, which generate larger quantities of wastewaters.

Based on the field visits and the telephone survey described earlier (Section III), Tables IV-1 and IV-2 were compiled. The findings of this survey shows that all subcategories of the carbon black point source category, manufacturing all grades of carbon black and regardless of geographical location are achieving a no discharge of process wastewater pollutants level. The field survey is presented in Table VII-1.

Table VII-1

Treatment Technology Survey
Carbon Black Segment

Plant	Subcategory	Treatment Technology
81	A	Settling/Evaporation
82	A[1]	Settling Basin, Gravity Filtration
83	A and B	Evaporation/Settling Ponds (no discharge)
84	A	Baffled Settling Lagoons/Coke Breez Filter Bed
85	A and B	Settling Lagoon (no discharge)
86	B	Oxidation Pond/Slurry Storage Lagoon/Clarification Lagoon
87	A	Separator Units
88	A	Surge Basin/Sand Filtration

[1]Scheduled to achieve no discharge of process wastewater pollutant by 7/1/77.

It is important to note that the treatment technology applied to subcategory A was not for process contact sources. Rather, the technology was applied to treatment of equipment washout, process area washdown, and in some instances, storm water runoff, utility water and treated sanitary wastes. Such technology, however, is applicable to process contact wastewaters to achieve pollution control and zero no discharge of process wastewater pollutants for the carbon black segment.

Plant 83 collected stormwater runoff from its property and from adjoining property for use as quench water in its process. Also, it was implementing a program to include its sanitary wastewater within this treatment system.

Plant 82 treated miscellaneous utility discharges and stormwater runoff by gravity settling followed by gravity filtration. At the time of the plant visit, little discharge was observed. This facility has plans to achieve no discharge of process wastewater by the third quarter of 1976 solely with in-plant changes. Again, this system did not treat any process contact water. Plant 83 was a combination furnace and thermal black plant. All process contact waters (from the thermal black dehumidifier system) were collected in approximately seven acres of evaporation/settling ponds. No discharge occurred from this system due to the high net evaporation for the area. The sanitary wastes (including shower water) were also collected by this system and recycled as quench water.

Plant 84 had separate treatment for the sanitary waste including shower and laundry wastewater. Laboratory wastewater, equipment washout and storm runoff went to the baffled settling lagoons then into coke breez filter beds before mixing with the plant sanitary and utility waste before leaving the plant. No treatment efficiencies were known. Low intermittent flow from the filter bed was observed. Spills were dry cleaned. Bag filters were washed several times per year. The waste load from this operation was not known.

Plant 85 had separate treatment for sanitary waste. Equipment washout, process area washdown and rain runoff from the concrete, curbed process area pads was all collected and sent to a gravity settling lagoon, mechanically screened and recycled as quench water for the process. Plant 85 is both a thermal and furnace process plant. The humidifier scrubber water is sent through the same treatment system and recycled as quench water resulting in no discharge of process wastewater pollutants for both the thermal and furnace processes. This plant is located in a water surplus region. No historical raw waste water data was immediately available, but has been requested.

Plants 83 and 85 are considered exemplary plants.

Gravity Settling and/or Gravity Filtration

During the plant survey program, historic wastewater treatment plant performance data were obtained when available. Table VII-2 is a summary of average treatment results attained by the plants surveyed. The treatment processes are identified in Table VII-1. The information in Table VII-2 indicates only the relative effectiveness of the applied treatment technology.

More data has been requested from the manufacturers in order to better define the wastewaters generated from the carbon black processes and also to better understand the potential

TABLE VII-2

Wastewater Treatment Plant Performance Data
Carbon Black Segment

Plant Number	Subcategory	Flow rate, gpm[1]		Influent TSS, mg/l[1]		Effluent TSS, mg/l[1]		% Removal[2]
		Average	Range	Average	Range	Average	Range	
81	A	18	12-26	40	9-145	22	13-32	70
84	A	97	2-200	1800	120-6300	13	3-24	99
86	B	NR[3]		247	NR[3]	51	NR[3]	79
87	A	13	34(max)	78	16-120	13	70(max)	83
88	A	45	NR[3]	38	10-85	14	7-18	63

[1] Historical data supplied from manufacturers
[2] Calculated
[3] NR = Not reported

problem of product contamination as a result of recycle as explained in section IV.

It must be emphasized that the data presented above are significant in that they illustrate the possible performance of applied treatment technology. All plants received wastewater from many different sources, including in some cases sanitary wastewater, utilities and stormwater. This data does not represent the application of these technologies to process contact streams.

SECTION VIII

COST, ENERGY, AND NON-WATER QUALITY ASPECTS

General

In order to evaluate the economic impact of treatment on a uniform basis, in-plant treatment models which will provide the desired level of treatment were proposed for the thermal and furnace black processes. In-plant control measures such as distance from treatment system to quench feed have been evaluated based on the industrial averages for the cost, energy, and non-water quality aspects of in-plant controls and are intimately related to the specific processes for which they are developed. Although there are general cost and energy requirements for equipment items, these correlations are usually expressed in terms of specific design parameters. Such parameters are related to the production rate and other specific considerations at a particular production site.

In the manufacture of a single product there is a wide variety of process plant sizes and unit operations. Many detailed designs might be required to develop a meaningful understanding of the economic impact of process modifications. Such a development is really not necessary, however, because the in-plant models are capable of attaining the recommended reduction in the RWL's within the subcategories before recycle is required. The cost associated with these systems can be divided by the production rate for the given subcategory to show the economic impact of the system in terms of dollars per 1000 pound of product.

Non-water quality aspects such as noise levels will not be perceptibly affected by the proposed wastewater treatment systems. Most carbon black plants generate fairly high noise levels. Equipment associated with in-plant control systems would not add significantly to these noise levels.

Annual and capital cost estimates have been prepared for carbon black in-plant treatment models to evaluate the economic impact of the proposed effluent limitations, guidelines and new source performance standards. In-plant costs can be estimated using this same framework of assumptions and unit values. The capital costs were generated on a unit process basis and are reported in the form of cost curves in Supplement A for all the proposed treatment systems. The following percentage figures were added on to the total unit process costs to develop the total capital cost requirements:

Item	Percent of Unit Process Capital Cost
Electrical	14
Piping	20
Instrumentation	8
Site Work	6
Engineering Design and Construction Surveillance Fees	15
Construction Contingency	15

Land costs were computed independently and added directly to the total capital costs.

Annual costs were computed using the following cost basis:

Item	Cost Allocation
Capital Recovery plus Return	10 yrs at 10 percent
Operations and Maintenance	Includes labor and supervision, chemicals, sludge hauling and disposal, insurance and taxes (computed at 2 percent of the capital cost), and maintenance (computed at 4 percent of the capital cost).
Energy and Power	Based on $0.02/kw hr for electrical power and 17¢/gal for grade 11 furnace oil.

The 10-year period used for capital recovery is that which is presently acceptable under current Internal Revenue Service regulations pertaining to industrial pollution control equipment.

The following is a qualitative as well as a quantitative discussion of the possible effects that variations in treatment technology or design criteria could have on the total capital costs and annual costs.

Technology or Design Criteria	Capital Cost Differential
1. Use earthen basins with	1. Cost reduction could

a plastic liner in place of reinforced concrete construction, and floating aerators plus permanent-access walkways.	be 20 to 30 percent of the total cost.
2. Place all treatment tankage above grade to minimize excavation, especially if a pumping station is required in any case. Use all-steel tankage to minimize capital cost.	2. Cost savings would depend on the individual situation.
3. Minimize flows and maximize concentrations through extensive in-plant recovery and water conservation, so that other treatment technologies, e.g., incineration, may be economically competitive.	3. Cost differential would depend on a number of items, e.g., age of plant, accessibility to process piping, local air pollution standards, etc.

All cost data were computed in terms of August 1972 dollars, which corresponds to an Engineering News Records index (ENR) value of 1980.

Carbon Black

This section provides quantitative cost information relative to assessing the economic impact of the proposed effluent limitations, guidelines and new source performance standards for the carbon black manufacturing point source category. Since wastewater is associated with only the furnace and thermal black processes, a treatment model was developed for only subcategories A and B (furnace and thermal black). In order to evaluate the economic impact on a uniform treatment basis, an in-plant treatment model was proposed which will provide the desired level of treatment before recycle is required. This treatment model is summarized below:

Technology Level	In-Plant Treatment Model
BPT, NSPS and BAT	Gravity Settling and/or Filtration and Recycle

The choice of which in-plant controls are required to attain no discharge of process wastewater pollutants is left up to the individual manufacturer.

FIGURE VIII -1

IN-PLANT RECYCLE
COST MODEL - STEP NO. 1

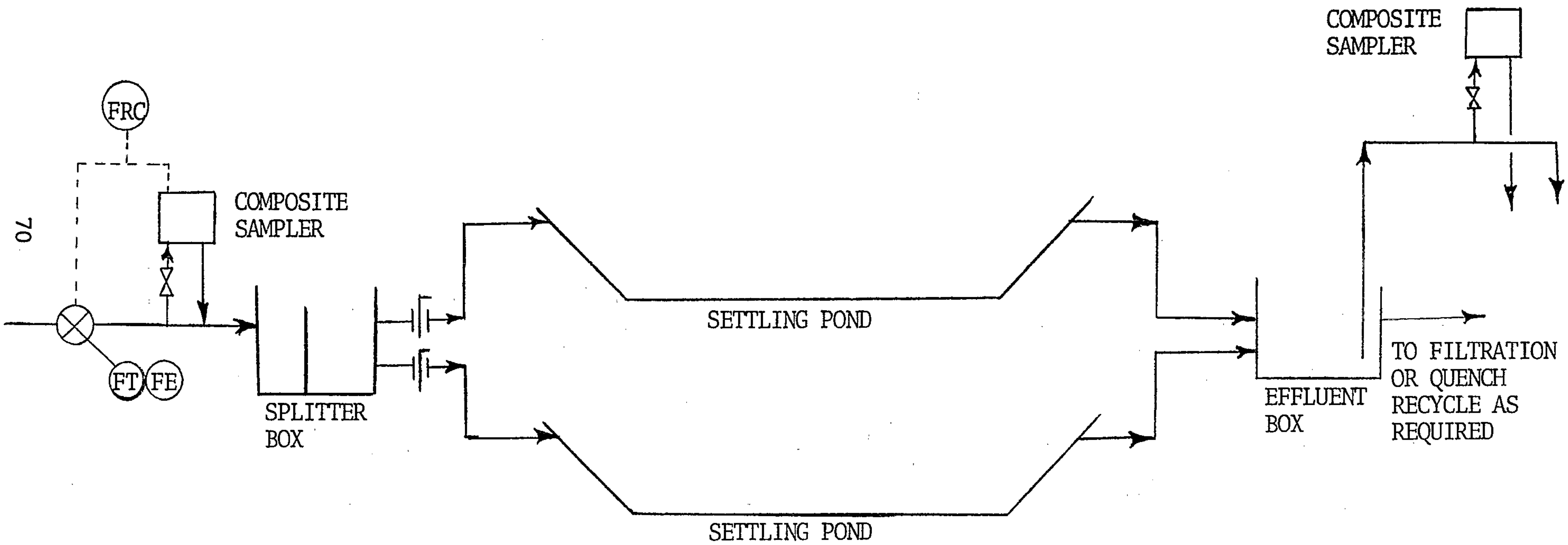


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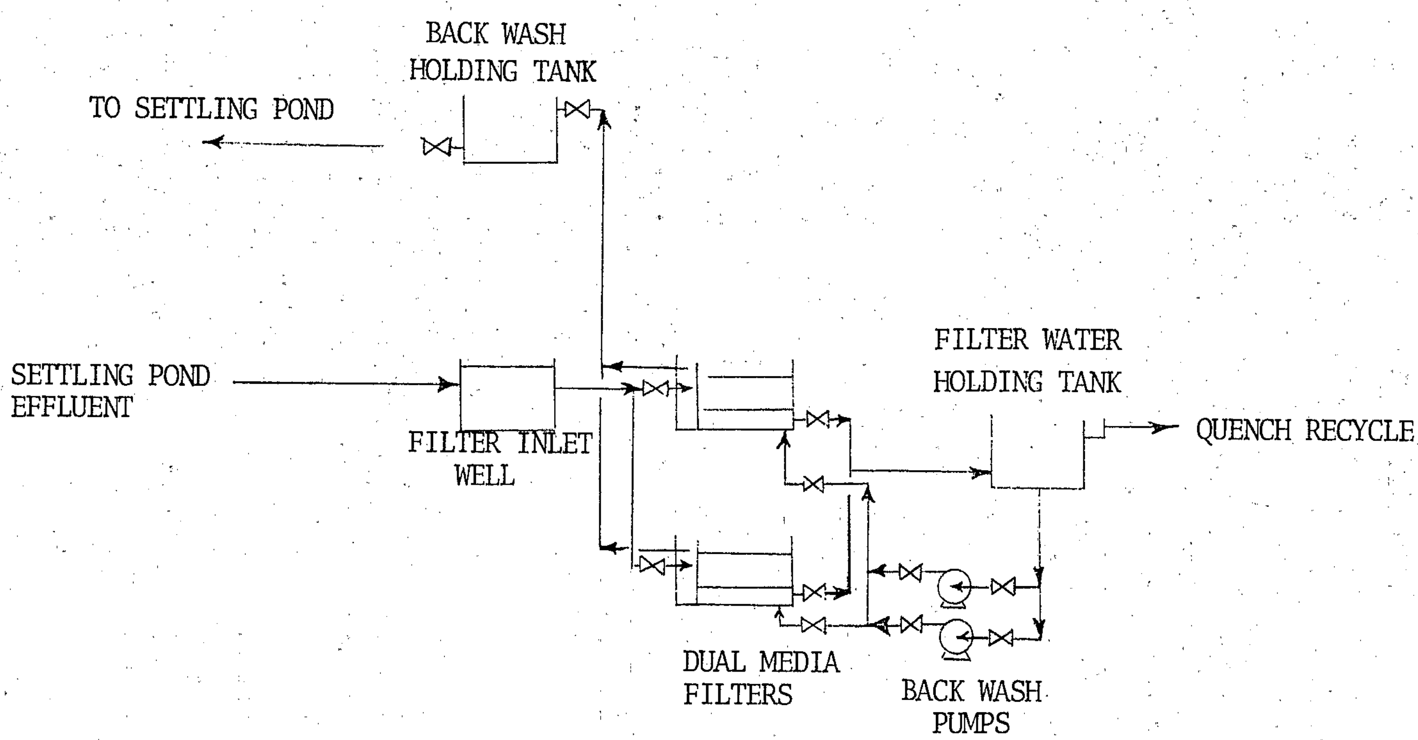
FIGURE VIII -2

IN-PLANT RECYCLE
COST MODEL - STEP NO. 2



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BPT, BAT and NSPS Cost Model

To evaluate the economic effects of the BPT, BAT and NSPS effluent limitations, guidelines and new source performance standards for carbon black manufacturing, it was necessary to formulate a treatment model. The model selected was gravity settling ponds and/or dual media filtration, as shown in Figure VIII-1 and VIII-2. The cost model is in two steps, since the plant water quality may be of a level that step No. 2 would not be required before being recycled as quench water. In order that the cost model include carbon black plants in all geographical locations, step No. 2 has been included. Again, it should be emphasized that step No. 2, the dual media filtration, may not be necessary but is included for completeness in measuring the total economic impact that the manufacturers would have to incur for the complete installation.

Cost

Annual and capital cost estimates have been prepared for the above in-plant model. These costs are presented in Table VIII-1 and VIII-2 for the furnace and thermal black processes, respectively. These costs show that the economic impact based on the current selling price of $220.00 per metric ton to be minimal. Because the majority of the plants surveyed have installed the equivalent of Step No. 1, the economic impact will generally be less then the calculated values. The detailed cost breakdown by unit processes are included in the Supplement A.

Energy

Since the BPT, BAT and NSPS treatment models were designed to use landfilling of gravity compacted sludge, energy requirements will be for low horsepower pumps and pond dredging operations. The gravity filtration would require only small horsepower pumps. Tables VIII-1 and VIII-2 presents the cost for energy and power for the treatment model for BPT, BAT, and NSPS.

Non-Water Quality Aspects

The non-water quality considerations for the carbon black segment in achieving the proposed effluent limitations guidelines are minimal. The major consideration will be disposal of the settled carbon black, which can be done primarily by landfilling or low cost incineration such as pit burning.

Other non-water quality aspects will not be perceptibly affected.

TABLE VIII-1

Wastewater Treatment Costs for BPCTCA, BADCT and BATEA Effluent Limitations (ENR 1780 - August, 1972 Costs)

Furnace Black Process

		Technology Level	
	RWL	STEP NO. 1	STEP NO. 2[2]
Average Production 214 kkg/day			
(470 x 10^3 lbs/day)			
Production Days 350			
Wastewater Flow - kL/Day	109		
(gpd)	28,800		
kL/kkg product	0.5		
(gal/1,000 lbs)	(61)		
TSS Effluent Limitations - kg TSS/kkg product[3]	0.97[5]	0.0[4]	0.0[4]
TOTAL CAPITAL COSTS		187,800	62,000
ANNUAL COSTS			
Capital Recovery plus return at 10% at 10 years		30,600	10,000
Operating + Maintenance		5,000	5,000
Energy + Power		--	--
Total Annual Cost		35,600	15,000
Cost[1] $/1,000 kg Product		0.48	0.20
($/1,000 lbs Product)		0.22	0.09

[1]Cost based on total annual cost
[2]Incremental cost over Step No. 1 cost if required
[3]kg/kkg product is equivalent to lb/1,000 lb product
[4]No discharge of process wastewater pollutants allowed
[5]RWL TSS limit shown is based on average flow rate of 20 gpm or 28,800 gpd and TSS concentration from plant 84.

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TABLE VIII-2

Wastewater Treatment Costs for BPCTCA, BADCT and BATEA Effluent Limitations (ENR 1780 - August, 1972 Costs)

Thermal Black Process

Average Production 68 kkg/day (150 x 10^3 lbs/day)

Production Days 350

	RWL	TECHNOLOGY LEVEL STEP NO. 1	STEP NO. 2[2]
Wastewater Flow - kL/Day	49		
(gpd)	(13,000)		
kL/kkg product	0.7		
(gal/1,000 lbs)	(86)		
TSS Effluent Limitations - kg TSS/kkg product[3]	0.089	0.0[4]	0.0[4]
TOTAL CAPITAL COSTS		123,800	38,500
ANNUAL COSTS			
Capital Recovery plus return at 10% at 10 years		20,200	6,300
Operating + Maintenance		5,000	5,000
Energy + Power		--	--
Total Annual Cost		25,200	11,300
Cost[1] $/1,000 kg Product)		$1.06	0.47
($/1,000 lbs Product)		0.48	0.22

[1]Cost based on total annual cost
[2]Incremental cost over Step No. 1 cost if required
[3]kg/kkg product is equivalent to lb/1,000 lb product
[4]No discharge of process wastewater pollutants allowed

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SECTION IX

BEST PRACTICABLE CONTROL TECHNOLOGY CURRENLTY AVAILABLE (BPT)

General

The effluent limitations that must be achieved by all plants by 1 July, 1977 through the application of the Best Practicable Control Technology Currently Available (BPT) are based upon an average of the best performance achievements of existing exemplary plants.

Carbon Black

The effluent limitations guidelines for all subcategories of carbon black manufacturing has been established to be no discharge of process wastewater pollutants for BPT and are presented in Table IX-1.

The development of the BPT has been based on in-plant technology for carbon black manufacturing subcategories. The effluent limitations commensurate with the BPT have been established on the basis of information in Sections III through VIII of this report, and are presented in the following sections. It has been shown that these limitations can be attained through the application of BPT pollution control technology.

Survey findings (Table IV-2) indicate that the furnace process is a net user of water, i.e., no process contact wastewater is discharged from the process. Based on this fact, no discharge of process wastewater pollutants is recommended for subcategory A.

Survey findings also indicate that the thermal process (Subcategory B), as a result of in-process changes, can achieve a level of no discharge of process wastewater pollutants. The single acetylene black plant has attained no discharge of process wastewater pollutants and is included for completeness.

The only channel black process (Subcategory C) operating in the United States has achieved the level of no discharge of wastewater pollutants.

One lamp black plant (Subcategory D) in the United States have achieved the level of no discharge of process wastewater pollutants. The other lamp black plant has no point source discharge due to the type of treatment used.

Based on these facts, no discharge of process wastewater pollutants is recommended for subcategories A, B, C and D.

The objective of these effluent limitations guidelines is to induce in-plant reduction of both flow and contaminant loadings. However, it is not the intent of these effluent limitations and guidelines to specify the in-plant practices which must be employed at the individual carbon black plants.

The actual effluent limitations and guidelines would be applied directly only to a plant whose manufacturing processes fall within a single subcategory. In the case of multi-subcategory plants the effluent limitations guidelines to be placed upon a plant would represent the sum of the individual effluent limitations and guidelines applied to each of its subcategory operations. This building-block approach allows the system to be applied to any facility regardless of its unique set of processes.

Table IX -1

BPCTCA Effluent Limitations Guidelines

Subcategories	Flow L/kkg Product (gal/1,000 lbs)	Raw Waste Load (RWL) Parameter	kg/kkg[1]	mg/L	BPCTCA Long-Term Average Daily Effluent Parameter	kg/kkg[1]	mg/L
Subcategory A Furnace Black	NA[2]	No discharge of PWWP[3]			No discharge of PWWP[3]		
Subcategory B Thermal Black	NA[2]	No discharge of PWWP[3]			No discharge of PWWP[3]		
Subcategory C Channel Black	NA[2]	No discharge of PWWP[3]			No discharge of PWWP[3]		
Subcategory D Lamp Black	NA[2]	No discharge of PWWP[3]			No discharge of PWWP[3]		

	Effluent Limitations					
	Average of Daily Value for Thirty Consecutive Days Shall Not Exceed			Maximum Value for Any One Day		
	Parameter	kg/kkg[1]	mg/L	Parameter	kg/kkg[1]	mg/L
Subcategory A Furnace Black	No discharge of PWWP[3]			No discharge of PWWP[3]		
Subcategory B Thermal Black	No discharge of PWWP[3]			No discharge of PWWP[3]		
Subcategory C Channel Black	No discharge of PWWP[3]			No discharge of PWWP[3]		
Subcategory D Lamp Black	No discharge of PWWP[3]			No discharge of PWWP[3]		

[1]kg/kkg = Productions is equivalent to lb/1,000 lbs Production
[2]NA = Not Applicable
[3]PWWP = Process Wastewater Pollutants

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SECTION X

BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE (BAT)

General

The effluent limitations guidelines to be achieved by all plants by July 1, 1983 through the application of the Best Available Technology Economically Achievable (BAT) are based upon the very best control and treatment technology employed by the existing exemplary plants in each industrial subcategory.

Carbon Black

Effluent limitations guidelines commensurate with the BAT are presented in Table X-1. BAT effluent limitations, guidelines and new source performance standards are recommended to be no discharge of process wastewater pollutants for all subcategories of carbon black manufacturing. These standards are attainable by in-plant changes as explained in Sections III to VII and Section IX.

Table X -1

BATEA Effluent Limitations Guidelines

Subcategories	Flow L/kkg Product (gal/1,000 lbs)	BPCTCA Long-Term Daily Effluent			BATEA Long-Term Average Daily Effluent		
		Parameter	kg/kkg[1]	mg/L	Parameter	kg/kkg[1]	mg/L
Subcategory A Furnace Black	N/A[2]	No Discharge of pwwp[3]			No Discharge of pwwp[3]		
Subcategory B Thermal Black	N/A[2]	No Discharge of pwwp[3]			No Discharge of pwwp[3]		
Subcategory C Channel Black	N/A[2]	No Discharge of pwwp[3]			No Discharge of pwwp[3]		
Subcategory D Lamp Black	N/A[2]	No Discharge of pwwp[3]			No Discharge of pwwp[3]		

	BATEA Effluent Limitations					
	Average of Daily Value for Thirty Consecutive Days Shall Not Exceed			Maximum Value for Any One Day		
	Parameter	kg/kkg[1]	mg/L	Parameter	kg/kkg[1]	mg/L
Subcategory A Furnace Black	No Discharge of pwwp[3]			No Discharge of pwwp[3]		
Subcategory B Thermal Black	No Discharge of pwwp[3]			No Discharge of pwwp[3]		
Subcategory C Channel Black	No Discharge of pwwp[3]			No Discharge of pwwp[3]		
Subcategory D Lamp Black	No Discharge of pwwp[3]			No Discharge of pwwp[3]		

[1] kg/kkg = Production is equivalent to lb/1,000 lbs production
[2] N/A = Not Applicable
[3] pwwp = Process Wastewater Pollutants

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SECTION XI

NEW SOURCE PERFORMANCE STANDARDS (NSPS)

General

The term "new source" is defined in the "Federal Water Pollution Control Act Amendments of 1972" to mean "any source, the construction of which is commenced after the publication of proposed regulations prescribing a standard of performance". Technology applicable to new sources shall be the Best Available Demonstrated Control Technology (NSPS), defined by a determination of what higher levels of pollution control can be attained through the use of improved production process and/or wastewater treatment techniques. Thus, in addition to considering the best in-plant and end-of-pipe control technology, NSPS technology is to be based upon an analysis of how the level of effluent may be reduced by changing the production process itself.

Carbon Black

New source performance standards commensurate with NSPS for carbon black manufacture point source category are presented in Table XI-1. The standards are attainable by in-plant changes as explained in Sections III to VII and Section IX. No discharge of process wastewater pollutants are recommended for "new source" carbon black plants.

Table XI -1

BADCT Effluent Limitations Guidelines

Subcategories	Flow L/kkg Product (gal/1,000 lbs)	BPCTCA Long-Term Daily Effluent Parameter	kg/kkg[1]	mg/L	BADCT Long-Term Average Daily Effluent Parameter	kg/kkg[1]	mg/L
Subcategory A Furnace Black	NA[2]	No discharge of PWWP[3]			No discharge of PWWP[3]		
Subcategory B Thermal Black	NA[2]	No discharge of PWWP[3]			No discharge of PWWP[3]		
Subcategory C Channel Black	NA[2]	No discharge of PWWP[3]			No discharge of PWWP[3]		
Subcategory D Lamp Black	NA[2]	No discharge of PWWP[3]			No discharge of PWWP[3]		

	BADCT Effluent Limitations					
	Average of Daily Value for Thirty Consecutive Days Shall Not Exceed			Maximum Value for Any One Day		
Subcategories	Parameter	kg/kkg[1]	mg/L	Parameter	kg/kkg1	mg/L
Subcategory A Furnace Black	No discharge of PWWP[3]			No discharge of PWWP[3]		
Subcategory B Thermal Black	No discharge of PWWP[3]			No discharge of PWWP[3]		
Subcategory C Channel Black	No discharge of PWWP[3]			No discharge of PWWP[3]		
Subcategory D Lamp Black	No discharge of PWWP[3]			No discharge of PWWP[3]		

[1] kg/kkg = production is equivalent to lb/1,000 lbs production
[2] N/A = Not Applicable
[3] PWWP = Process Wastewater Pollutants

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SECTION XII

PRETREATMENT STANDARDS

General

Pollutants from specific processes within the carbon black point source category may interfere with, pass through, or otherwise be incompatible with publicly owned treatment works (municipal system). The following section examines the general wastewater characteristics of this category and the pretreatment unit operations which may be applicable to carbon black manufacturing.

Carbon Black

Subcategories A, B, C and D should have no process wastewater discharges. Presently no carbon black plant is known to discharge process wastewater to a municipal treatment system. The only wastewater from this subcategory would be sanitary wastewater and utility blowdowns. If an existing source, as a result of these regulations, determines that a discharge should be made to a POTW rather than recycling the water to quench systems some pretreatment would be required. This pretreatment would be of a type to prevent excessive oil and grease discharges to POTW's. A simple weir skimmer should suffice and essentially no cost is involved since existing collection systems can be fitted with skimmer weirs and the oil periodically removed. Proper operation and employee instruction should prevent any significant problem.

The need for pretreatment of any industrial waste is related to the ability of a publicly owned treatment works to remove pollutant parameters in the waste. Pretreatment standards are intended to prevent introduction of pollutants into publicly owned treatment works which interfere with, pass through, or are otherwise incompatible with such works. It has been shown in the literature that oil and grease levels of 100 mg/l from petroleum, mineral or unknown origin could interfere with the normal operations of POTW's. For this reason a pretreatment level of 100 mg/l oil and grease for new sources is recommended.

SECTION XIII

PERFORMANCE FACTORS FOR TREATMENT PLANT OPERATIONS

Carbon Black

Because all subcategories of the carbon black manufacturing point source category are designated no discharge of process wastewater pollutants, performance factors for treatment plants are not applicable.

SECTION XIV

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SECTION XV

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SECTION XVI

GLOSSARY

Carbon Black

Acetylene Black. Carbon black produced by the thermal decomposition of acetylene, possess a high degree of structural, or chaining, tendency. They provide high elastic modulus and high conductivity in rubber stocks.

Amorphous. Without shape.

Blowdown. Water intentionally discharged from a cooling or heating system to maintain the dissolved solids concentration of the circulating water below a specific critical level.

Carbon Black. A family of industrial carbons primarily carbon (90 to 99%) contains some sulfur, oxygen and hydrogen; a petrochemical used principally as reinforcing agents in rubber and as black pigments in inks, coatings, and plastics.

Channel Black. Carbon black manufactured by the channel process. It is produced by the incomplete combustion of natural gas, and is deposited on, then scraped off, a moving channel.

Colloid. A solid, liquid, or gaseous substance made up of very small, insoluble, nondiffusible particles (as single large molecules or masses of smaller molecules) that remain in suspension in a surrounding solid, liquid, or gaseous medium. All living matter contains collodial material, and a colloid has only a negligible effect on the freezing point, or vapor tension of the surrounding medium.

Furnace Black. Carbon black manufactured by the furnace process, produced by partial combustion of hydrocarbons in insulated furnaces.

Impingement. To strike with a sharp collision.

Lamp Black. Carbon black manufactured by the burning of petroleum or coal tar residues in open shallow pans.

Quasigraphitic. Having graphite-like qualities.

Quench. To cool a material suddenly or halt a process or reaction abruptly.

Thermal Black. Carbon black manufactured by the thermal process, produced by thermal decomposition (cracking) of natural gas.

General Definitions

Abatement. The measures taken to reduce or eliminate pollution.

Absorption. A process in which one material (the absorbent) takes up and retains another (the absorbate) with the formation of a homogeneous mixture having the attributes of a solution. Chemical reaction may accompany or follow absorption.

Acclimation. The ability of an organism to adapt to changes in its immediate environment.

Acid. A substance which dissolves in water with the formation of hydrogen ions.

Acid Solution. A solution with a pH of less than 7.00 in which the activity of the hydrogen ion is greater than the activity of the hydroxyl ion.

Acidity. The capacity of a wastewater for neutralizing a base. It is normally associated with the presence of carbon dioxide, mineral and organic acids and salts of strong acids or weak bases. It is reported as equivalent of $CaCO_3$ because many times it is not known just what acids are present.

Act. The Federal Water Pollution Control Act Amendments of 1972, Public Law 92-500.

Activated Carbon. Carbon which is treated by high-temperature heating with steam or carbon dioxide producing an internal porous particle structure.

Adsorption. An advanced method of treating wastes in which a material removes organic matter not necessarily responsive to clarification or biological treatment by adherence on the surface of solid bodies.

Aerobic. Ability to live, grow, or take place only where free oxygen is present.

Algae. One-celled or many-celled plants which grow in sunlit waters and which are capable of photosynthesis. They are a food for fish and small aquatic animals and, like all plants, put oxygen in the water.

Algal Bloom. Large masses of microscopic and macroscopic plant life, such as green algae, occuring in bodies of water.

Algicide. Chemical agent used to destroy or control algae.

Alkali. A water-soluble metallic hydroxide that ionizes strongly.

Alkalinity. The presence of salts of alkali metals. The hydroxides, carbonates and bicarbonates of calcium, sodium and magnesium are common impurities that cause alkalinity. A quantitative measure of the capacity of liquids or suspensions to neutralize strong acids or to resist the establishment of acidic conditions. Alkalinity results from the presence of bicarbonates, carbonates, hydroxides, alkaline salts and occasionally borates and is usually expressed in terms of the amount of calcium carbonate that would have an equivalent capacity to neutralize strong acids.

Alum. A hydrated aluminum sulfate or potassium aluminum sulfate or ammonium aluminum sulfate which is used as a settling agent. A coagulant.

Anaerobic. Ability to live, grow, or take place where there is no air or free oxygen present.

Anion. Ion with a negative charge.

Antagonistic Effects. The simultaneous action of separate agents mutually opposing each other.

Backwashing. The process of cleaning a rapid sand or mechanical filter by reversing the flow of water.

Bacteria. Unicellular, plant-like microorganisms, lacking chlorophyll. Any water supply contaminated by sewage is certain to contain a bacterial group called "coliform".

Bacterial Growth. All bacteria require food for their continued life and growth and all are affected by the conditions of their environment. Like human beings, they consume food, they respire, they need moisture, they require heat, and they give off waste products. Their food requirements are very definite and have been, in general, already outlined. Without an adequate food supply of the type the specific organism requires, bacteria will not grow and multiply at their maximum rate and they will therefore, not perform their full and complete functions.

(BADCT) NSPS Effluent Limitations. Limitations for new sources which are based on the application of the Best Available Demonstrated Control Technology. See NSPS.

Bag Filter. Apparatus used to attain a more complete purification of air than is attained by a baffle chamber.

Bag House. Large chamber for holding bags (usually synthetic) used in the filtration of gases for the recovery of solids suspended in gases.

Base. A substance that in aqueous solution turns red litmus blue, furnishes hydroxyl ions and reacts with an acid to form a salt and water only.

Batch Process. A process which has an intermittent flow of raw materials into the process and a resultant intermittent flow of product from the process.

BAT (BATEA) Effluent Limitations. Limitations for point sources, other than publicly owned treatment works, which are based on the application of the Best Available Technology Economically Achievable. These limitations must be achieved by July 1, 1983.

Benthic. Attached to the bottom of a body of water.

Benthos. Organisms (fauna and flora) that live on the bottoms of bodies of water.

Biochemical Oxygen Demand (BOD). A measure of the oxygen required to oxidize the organic material in a sample of wastewater by natural biological process under standard conditions. This test is presently universally accepted as the yardstick of pollution and is utilized as a means to determine the degree of treatment in a waste treatment process. Usually given in mg/l (or ppm units), meaning milligrams of oxygen required per liter of wastewater, it can also be expressed in pounds of total oxygen required per wastewater or sludge batch. The standard BOD is five days at 20 degrees C.

Biota. The flora and fauna (plant and animal life) of a stream or other water body.

Biological Treatment System. A system that uses microorganisms to remove organic pollutant material from a wastewater.

Blowdown. Water intentionally discharged from a cooling or heating system to maintain the dissolved solids concentration of the circulating water below a specific critical level. The removal of a portion of any process flow to maintain the constituents of the flow within desired levels. Process may be intermittent or continuous. 2) The water discharged from a boiler or cooling tower to dispose of accumulated salts.

BOD5. Biochemical Oxygen Demand (BOD) is the amount of oxygen required by bacteria while stabilizing decomposable organic matter under aerobic conditions. The BOD test has been developed on the basis of a 5-day incubation period (i.e. BOD_5).

Boiler Blowdown. Wastewater resulting from purging of solid and waste materials from the boiler system. A solids build up in concentration as a result of water evaporation (steam generation) in the boiler.

BPT (BPCTCA) Effluent Limitations. Limitations for point sources, other than publicly owned treatment works, which are based on the application of the Best Practicable Control Technology Currently Available. These limitations must be achieved by July 1, 1977.

Break Point. The point at which impurities first appear in the effluent of an adsorption filter bed, (e.g. granular carbon).

Brine. Water saturated with a salt.

Carbonaceous. Containing or composed of carbon.

Carbonates. Dibasic salts of carbonic acid, H_2CO_3, e.g., potassium carbonate, K_2CO_3; the radical, CO_3^{-}.

Cation. The ion in an electrolyte which carries the positive charge and which migrates toward the cathode under the influence of a potential difference.

Caustic Soda. In its hydrated form it is called sodium hydroxide. Soda ash is sodium carbonate.

Chemical Oxygen Demand (COD). A measure of oxygen-consuming capacity of organic and inorganic matter present in water or wastewater. It is expressed as the amount of oxygen consumed from a chemical oxidant in a specific test. It does not differentiate between stable and unstable organic matter and thus does not correlate with biochemical oxygen demand.

Chlorides. Chloride ion exist as salts of hydrochloric acid, e.g. potassium chloride, KCl.

Chlorination. The application of chlorine to water, sewage or industrial wastes, generally for the purpose of disinfection but frequently for accomplishing other biological or chemical results.

Clarification. Process of removing turbidity and suspended solids by settling. Chemicals can be added to improve and speed up the settling process through coagulation.

Clarifier. A basin or tank in which a portion of the material suspended in a wastewater is settled.

Clays. Aluminum silicates less than 0.002mm (2.0 um) in size. Therefore, most clay types can go into colloidal suspension.

Coagulation. The clumping together of solids to make them settle out of the sewage faster. Coagulation of solids is brought about with the use of certain chemicals, such as lime, alum or polyelectrolytes.

Coagulation and Flocculation. Processes which follow sequentially.

Coagulation Chemicals. Hydrolyzable divalent and trivalent metallic ions of aluminum, magnesium, and iron salts. They include alum (aluminum sulfate), quicklime (calcium oxide), hydrated lime (calcium hydroxide), sulfuric acid, anhydrous ferric chloride. Lime and acid affect only the solution pH which in turn causes coagulant precipitation, such as that of magnesium.

Coliform Organisms. A group of bacteria recognized as indicators of fecal pollution.

Colloid. A finely divided dispersion of one material (0.01-10 micron-sized particles), called the "dispersed phase" (solid), in another material, called the "dispersion medium" (liquid).

Color Bodies. Those complex molecules which impart color to a solution.

Color Units. A solution with the color of unity contains a mg/l of metallic platinum (added as potassium chloroplatinate to distilled water). Color units are defined against a platinum-cobalt standard and are based, as are all the other water quality criteria, upon those analytical methods described in Standard Methods for the Examination of Water and Wastewater, 12 ed., Amer. Public Health Assoc., N.Y., 1967.

Combined Sewer. One which carries both sewage and storm water run-off.

Composite Sample. A combination of individual samples of wastes taken at selected intervals, generally hourly for 24 hours, to minimize the effect of the variations in individual samples. Individual samples making up the composite may be of equal volume or be roughly apportioned to the volume of flow of liquid at the time of sampling.

Concentration. The total mass of the suspended or dissolved particles contained in a unit volume at a given temperature and pressure.

Conductivity. A reliable measurement of electrolyte concentration in a water sample. The conductivity measurement can be related to the concentration of dissolved solids and is almost directly proportional to the ionic concentration of the total electrolytes.

Contact Process Wastewaters. These are process-generated wastewaters which have come in direct or indirect contact with the reactants used in the process. These include such streams as contact cooling water, filtrates, centrates, wash waters, etc.

Continuous Process. A process which has a constant flow of raw materials into the process and resultant constant flow of product from the process.

Contract Disposal. Disposal of waste products through an outside party for a fee.

Crustaceae. These are small animals ranging in size from 0.2 to 0.3 millimeter long which move very rapidly through the water in search of food. They have recognizable head and posterior sections. They form a principal source of food for small fish and are found largely in relatively fresh natural water.

Cyclone. A conical shaped vessel for separating either entrained solids or liquid materials from the carrying air or vapor. The vessel has a tangential entry nozzle at or near the largest diameter, with an overhead exit for air or vapor and a lower exit for the more dense materials.

Desorption. The opposite of adsorption. A phenomenon where an adsorbed molecule leaves the surface of the adsorbent.

Demineralization. The total removal of all ions.

Disinfection. The process of killing the larger portion (but not necessarily all) of the harmful and objectionable microorganisms in or on a medium.

Dissolved Oxygen (DO). The oxygen dissolved in sewage, water or other liquids, usually expressed either in milligrams per liter or percent of saturation. It is the test used in BOD determination.

DO Units. The units of measurement used are milligrams per liter (mg/l) and parts per million (ppm), where mg/l is defined as the actual weight of oxygen per liter of water and ppm is defined as the parts actual weight of oxygen dissolved in a million parts weight of water, i.e., a pound of oxygen in a million pounds of water is 1 ppm. For practical purposes in pollution control work, these two are used interchangeably; the density of water is so close to 1 g/cm^3 that the error is negligible. Similarly, the changes in volume of oxygen with changes in temperature are insignificant. This, however, is not true if sensors are calibrated in percent saturation rather than in mg/l or ppm. In that case, both temperature and barometric pressure must be taken into consideration.

Dual Media. A deep-bed filtration system utilizing two separate and discrete layers of dissimilar media (e.g., anthracite and sand) placed one on top of the other to perform the filtration function.

Ecology. The science of the interrelations between living organisms and their environment.

Effluent. A liquid which leaves a unit operation or process. Sewage, water or other liquids, partially or completely treated or in their natural states, flowing out of a reservoir basin, treatment plant or any other unit operation. An influent is the incoming stream.

Entrainment Separator. A device to remove liquid and/or solids from a gas stream. Energy source is usually derived from pressure drop to create centrifugal force.

Environment. The sum of all external influences and conditions affecting the life and the development of an organism.

Equalization Basin. A holding basin in which variations in flow and composition of a liquid are averaged. Such basins are used to provide a flow of reasonably uniform volume and composition to a treatment unit.

Eutrophication. The process in which the life-sustaining quality of a body of water is lost or diminished (e.g., aging or filling in of lakes). A eutrophic condition is one in which the water is rich in nutrients but has a seasonal oxygen deficiency.

Fauna. The animal life adapted for living in a specified environment.

Filtrate. The liquid fraction that is separated from the solids fraction of a slurry through filtration.

Flocculants. Those water-soluble organic polyelectrolytes that are used alone or in conjunction with inorganic coagulants such as lime, alum or ferric chloride or coagulant aids to agglomerate solids suspended in aqueous systems or both, The large dense flocs resulting from this process permit more rapid and more efficient solids-liquid separations.

Flocculation. The formation of flocs. The process step following the coagulation-precipitation reactions which consists of bringing together the colloidal particles. It is the agglomeration by organic polyelectroytes of the small, slowly settling flocs formed during coagulation into large flocs which settle rapidly.

Flora. The plant life characteristic of a region.

Flotation. A method of raising suspended matter to the surface of the liquid in a tank as scum-by aeration, vacuum, evolution of gas, chemicals, electrolysis, heat or bacterial decomposition and the subsequent removal of the scum by skimming.

Grab Sample. (1) Instantaneous sampling. (2) A sample taken at a random place in space and time.

Grease. In sewage, grease includes fats, waxes, free fatty acids, calcium and magnesium soaps, mineral oils and other nonfatty materials. The type of solvent to be used for its extraction should be stated.

Grit Chamber. A small detention chamber or an enlargement of a sewer designed to reduce the velocity of flow of the liquid and permit the separation of mineral from organic solids by differential sedimentation.

Groundwater. The body of water that is retained in the saturated zone which tends to move by hydraulic gradient to lower levels.

Hardness. A measure of the capacity of water for precipitating soap. It is reported as the hardness that would be produced if a certain amount of $CaCO_3$ were dissolved in water. More than one ion contributes to water hardness. The "Glossary of Water and Wastewater Control Engineering" defines hardness as: A characteristic of water, imparted by salts of calcium, magnesium, and ion, such as bicarbonates, carbonates, sulfates, chlorides, and nitrates, that causes curdling of soap, deposition of scale in boilers, damage in some industrial processes, and sometimes objectionable taste. Calcium and magnesium are the most significant constituents.

Heavy Metals. A general name given for the ions of metallic elements, such as copper, zinc, iron, chromium, and aluminum. They are normally removed from a wastewater by the formation of an insoluble precipitate (usually a metallic hydroxide).

Hydrocarbon. A compound containing only carbon and hydrogen.

Incineration. The combustion (by burning) of matter, (e.g. carbon spills).

Influent. Any sewage, water or other liquid, either raw or partly treated, flowing into a reservoir, basin, treatment plant, or any part thereof. The influent is the stream entering a unit operation; the effluent is the stream leaving it.

In-Plant Measures. Technology applied within the manufacturing process to reduce or eliminate pollutants in the raw waste water. Sometimes called "internal measures" or "internal controls".

Ion. An atom or group of atoms possessing an electrical charge.

Lacrimal. Tear forming fluid.

Lagoons. An oxidation pond that received sewage which is not settled or biologically treated.

Leach. To dissolve out by the action of a percolating liquid, such as water, seeping through a sanitary landfill.

Lime. Limestone is an accumulation of organic remains consisting mostly of calcium carbonate. When burned, it yields lime which is a solid. The hydrated form of a chemical lime is calcium hydroxide.

Maximum Day Limitation. The effluent limitation value equal to the maximum for one day and is the value to be published by the EPA in the Federal Register.

Maximum Thirty Day Limitation. The effluent limitation value for which the average of daily values for thirty consecutive days shall not exceed and is the value to be published by the EPA in the Federal Register.

Microbial. Of or pertaining to a bacterium.

Molecular Weight. The relative weight of a molecule compared to the weight of an atom of carbon taken as exactly 12.00; the sum of the atomic weights of the atom in a molecule.

Mollusk (mollusca). A large animal group including those forms popularly called shellfish (but not including crustaceans). All have a soft unsegmented body protected in most instances by a calcareous shell. Examples are snails, mussels, clams, and oysters.

Navigable Waters. Includes all navigable waters of the United States; tributaries of navigable waters; interstate waters; intrastate lakes, rivers and streams which are utilized by interstate travellers for recreational or other purposes; intrastate lakes, rivers and streams from which fish or shellfish are taken and sold in interstate commerce; and intrastate lakes, rivers and streams which are utilized for industrial purposes by industries in interstate commerce.

Neutralization. The restoration of the hydrogen or hydroxyl ion balance in a solution so that the ionic concentration of each are equal. Conventionally, the notation "pH" (puissance d'hydrogen) is used to describe the hydrogen ion concentration or activity present in a given solution. For dilute solutions of strong acids, i.e., acids which are considered to be completely dissociate (ionized in solution), activity equals concentration.

New Source. Any facility from which there is or may be a discharge of pollutants, the construction of which is commenced after the publication of proposed regulations prescribing a standard of performance under section 306 of the Act.

Nitrate. Salt of nitric acid, e.g., sodium nitrate, $NaNO_3$.

Non-contact Cooling Water. Water used for cooling that does not come into direct contact with any raw material, intermediate product, waste product or finished product.

Non-contact Process Wastewaters. Wastewaters generated by a manufacturing process which have not come in direct contact with the reactants used in the process. These include such streams as non-contact cooling water, cooling tower blowdown, boiler blowdown, etc.

NPDES. National Pollution Discharge Elimination System. A federal program requiring manufacturers to obtain permits to discharge plant effluents to the nation's water courses.

NSPS. New source performance standards. See BADCT effluent limitations.

Nutrient. Any substance assimilated by an organism which promotes growth and replacement of cellular constituents.

Operations and Maintenance. Costs required to operate and maintain pollution abatement equipment including labor, material, insurance, taxes, solid waste disposal, etc.

Oxidation. A process in which an atom or group of atoms loses electrons; the combination of a substance with oxygen, accompanied with the release of energy. The oxidized atom usually becomes a positive ion while the oxidizing agent becomes a negative ion in (chlorination for example).

Oxygen, Available. The quantity of dissolved oxygen available for the oxidation of organic matter.

Oxygen, Dissolved. The oxygen (usually designated as DO) dissolved in sewage, water or another liquid and usually expressed in parts per million or percent of saturation.

Parameter. A variable whose measurement aids in characterizing the sample.

Parts Per Million (ppm). Parts by weight in sewage analysis; ppm by weight is equal to milligrams per liter divided by the specific gravity. It should be noted that in water analysis ppm is always understood to imply a weight/weight ratio, even though in practice a volume may be measured instead of a weight.

Percolation. The movement of water beneath the ground surface both vertically and horizontally, but above the groundwater table.

Permeability. The ability of a substance (soil) to allow appreciable movement of water through it when saturated and actuated by a hydrostatic pressure.

pH. The negative logarithm of the hydrogen ion concentration or activity in a solution. The number 7 indicates neutrality, numbers less than 7 indicate increasing acidity, and numbers greater than 7 indicate increasing alkalinity.

Phosphate. Phosphate ions exist as an ester or salt of phosphoric acid, such as calcium phosphate rock. In municipal wastewater, it is most frequently present as orthophosphate.

Photosynthesis. The mechanism by which chlorophyll-bearing plant utilize light energy to produce carbohydrate and oxygen from carbon dioxide and water (the reverse of respiration).

Physical/Chemical Treatment System. A system that utilizes physical (i.e., sedimentation, filtration, centrifugation, activated carbon, reverse osmosis, etc.) and/or chemical means (i.e., coagulation, oxidation, precipitation, etc.) to treat wastewaters.

Phytoplankton. (1) Collective term for the plants and plantlike organisms present in plankton; contrasts with zooplankton. (2) The plant portion of the plankton.

Plankton. Collective term for the passively flating or drifting flora and fauna of a body of water; consists largely of microscopic organisms.

Point Source. Any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged.

Pollutional Load. A measure of the strength of a wastewater in terms of its solids or oxygen-demanding characteristics or other objectionable physical and chemical characteristics or both or in terms of harm done to receiving waters. The pollutional load imposed on sewage treatment works is expressed as equivalent population.

Polyelectrolytes. Synthetic chemicals (polymers) used to speed up the removal of solids from sewage. These chemicals cause solids to coagulate or clump together more rapidly than do chemicals such as alum or lime. They can be anionic (-charge), nonionic (+ and -charge) or cationic (+charge--the most popular). They are linear or branched organic polymers. They have high molecular weights and are water-soluble. Compounds similar to the polyelectrolyte flocculants include surface-active agents and ion exchange resins. The former are low molecular weight, water soluble compounds used to disperse solids in aqueous systems. The latter are high molecular weight, water-insoluble compounds used to selectively replace certain ions already present in water with more desirable or less noxious ions.

Potable Water. Drinking water sufficiently pure for human use.

Preaeration. A preparatory treatment of sewage consisting of aeration to remove gas and add oxygen or to promote the flotation of grease and aid coagulation.

Precipitation. The phenomenon which occurs when a substance held in solution passes out of that solution into solid form. The adjustment of pH can reduce solubility and cause precipitation. Alum and lime are frequently used chemicals in such operations as water softening or alkalinity reduction.

Pretreatment. Any wastewater treatment process used to partially reduce the pollution load before the wastewater is introduced into a main sewer system or delivered to a treatment plant for substantial reduction of the pollution load.

Primary Clarifier. The settling tank into which the wastewater (sewage) first enters and from which the solids are removed as raw sludge.

Primary Sludge. Sludge from primary clarifiers.

Primary Treatment. The removal of material that floats or will settle in sewage by using screens to catch the floating objects and tanks for the heavy matter to settle in. The first major treatment and sometimes the only treatment in a waste-treatment works, usually sedimentation and/or flocculation and digestion. The removal of a moderate percentage of suspended matter but little or no colloidal or dissolved matter. May effect the removal of 30 to 35 percent or more BOD.

Process Wastewater. Any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, by-product, or waste product.

Process Water. Any water (solid, liquid or vapor) which, during the manufacturing process, comes into direct contact with any raw material, intermediate product, by-product, waste product, or finished product.

Quiesance. Quiet, still, inactive.

Raw Waste Load (RWL). The quantity (kg) of pollutant being discharged in a plant's wastewater. measured in terms of some common denominator (i.e., kkg of production or m^2 of floor area).

Receiving Waters. Rivers, lakes, oceans or other courses that receive treated or untreated wastewaters.

Recirculation. The return of effluent to the incoming flow.

Reduction. A process in which an atom (or group of atoms) gain electrons. Such a process always requires the input of energy.

Retention Time. Volume of the vessel divided by the flow rate through the vessel.

Saline Water. Water containing dissolved salts, usually from 10,000 to 33,000 mg/l.

Salt. A compound made up of the positive ion of a base and the negative ion of an acid.

Sanitary Landfill. A sanitary landfill is a land disposal site employing an engineered method of disposing of solid wastes on land in a manner that minimizes environmental hazards by spreading the wastes in thin layers, compacting the solid wastes to the smallest practical volume, and applying cover material at the end of each operating day. There are two basic sanitary landfill methods; trench fill and area or ramp fill. The method chosen is dependent on many factors such as drainage and type of soil at the proposed landfill site.

Sanitary Sewers. In a separate system, pipes in a city that carry only domestic wastewater. The storm water runoff is handled by a separate system of pipes.

Screening. The removal of relatively coarse, floating and suspended solids by straining through racks or screens.

Scrubber. A type of apparatus used in sampling and in gas cleaning in which the gas is passed through a space containing wetted "packing" or spray.

Sedimentation, Final. The settling of partly settled, flocculated or oxidized sewage in a final tank. (The term settling is preferred).

Sedimentation, Plain. The sedimentation of suspended matter in a liquid unaided by chemicals or other special means and without any provision for the decomposition of the deposited solids in contact with the sewage. (The term plain settling is preferred).

Settleable Solids. Suspended solids which will settle out of a liquid waste in a given period of time.

Sewage, Raw. Untreated sewage.

Sewage, Storm. The liquid flowing in sewers during or following a period of heavy rainfall and resulting therefrom.

Sewerage. A comprehensive term which includes facilities for collecting, pumping, treating, and disposing of sewage; the sewerage system and the sewage treatment works.

Silt. Particles with a size distribution of 0.05mm-0.002mm (2.0mm). Silt is high in quartz and feldspar.

Skimming. Removing floating solids (scum).

Solution. A homogeneous mixture of two or more substances of dissimilar molecular structure. In a solution, there is a dissolving medium-solvent and a dissolved substance-solute.

Solvent. A liquid which reacts with a material, bringing it into solution.

Standard Raw Waste Load (SRWL). The raw waste load which characterizes a specific subcategory. This is generally computed by averaging the plant raw waste loads within a subcategory.

Stoichiometric. Characterized by being a proportion of substances exactly right for a specific chemical reaction with no excess of any reactant or product.

Sulfate. The final decomposition product of organic sulfur compounds.

Surge tank. A tank for absorbing and dampening the wavelike motion of a volume of liquid; an in-process storage tank that acts as a flow buffer between process tanks.

Suspended Solids. The wastes that will not sink or settle in sewage. The quantity of material deposited on a filter when a liquid is drawn through a Gooch crucible.

Synergistic. An effect which is more than the sum of the individual contributors.

Synergistic Effect. The simultaneous action of separate agents which, together, have greater total effect than the sum of their individual effects.

Total Organic Carbon (TOC). A measure of the amount of carbon in a sample originating from organic matter only. The test is run by burning the sample and measuring the carbon dioxide produced.

Total Solids. The total amount of solids in a wastewater both in solution and suspension.

Turbidity. A measure of the amount of solids in suspension. The units of measurement are parts per million (ppm) of suspended solids or Jackson Candle Units. The Jackson Candle Unit (JCU) is defined as the turbidity resulting from 1 ppm of fuller's earth (and inert mineral) suspended in water. The relationship between ppm and JCU depends on particle size, color, index of refraction; the correlation between the two is generally not possible. Turbidity instruments utilize a light beam projected into the sample fluid to effect a measurement. The light beam is scattered by solids in suspension, and the degree of light attenuation or the amount of scattered light can be related to turbidity. The light scattered is called the Tyndall effect and the scattered light the Tyndall light. An expression of the optical property of a sample which causes light to be scattered and absorbed rather than transmitted in straight lines through the sample.

Volatile Suspended Solids (VSS). The quantity of suspended solids lost after the ignition of total suspended solids.

Waste Treatment Plant. A series of tanks, screens, filters, pumps and other equipment by which pollutants are removed from water.

Water Quality Criteria. Those specific values of water quality associated with an identified beneficial use of the water under consideration.

Weir. A flow measuring device consisting of a barrier across an open channel, causing the liquid to flow over its crest. The height of the liquid above the crest varies with the volume of liquid flow.

Wet Air Pollution Control. The technique of air pollution abatement utilizing water as an absorptive media.

Zeolite. Various natural or synthesized silicates used in water softening and as absorbents.

Zooplankton. (1) The animal portion of the plankton. (2) Collective term for the nonphotosynthetic organisms present in plankton; contrasts with phytoplankton.

SECTION XVII

ABBREVIATIONS AND SYMBOLS

A.C.	activated
ac ft	acre-foot
Ag.	silver
atm	atmosphere
ave	average
B.	boron
Ba.	barium
bbl	barrel
BOD_5	biochemical oxygen demand, five day
Btu	British thermal unit
C	centigrade degrees
C.A.	carbon adsorption
cal	calorie
cc	cubic centimeter
cfm	cubic foot per minute
cfs	cubic foot per second
Cl.	chloride
cm	centimeter
CN	cyanide
COD	chemical oxygen demand
conc.	concentration
cu	cubic
db	decibels
deg	degree
DO	dissolved oxygen
E. Coli	Escherichia coliform bacteria
Eq.	equation
F	Fahrenheit degrees
Fig.	figure
F/M	BOD_5 (Wastewater flow)/ MLSS (contractor volume)
fpm	foot per minute
fps	foot per second
ft	foot
g	gram
gal	gallon
gpd	gallon per day
gpm	gallon per minute
Hg	mercury
hp	horsepower
hp-hr	horsepower-hour
hr	hour
in.	inch
kg	kilogram
kw	kilowatt
kwhr	kilowatt-hour

L(l)	liter
L/kkg	liters per 1000 kilograms
lb	pound
m	meter
M	thousand
me	milliequivalent
mg	milligram
mgd	million gallons daily
min	minute
ml	milliliter
MLSS	mixed-liquor suspended solids
MLVSS	mixed-liquor volatile suspended solids
MM	million
mm	millimeter
mole	gram-molecular weight
mph	mile per hour
MPN	most probable number
mu	millimicron
NO_3	nitrate
NH_3-N	ammonium nitrogen
O_2	oxygen
PO_4	phosphate
p.	page
pH	potential hydrogen or hydrogen-ion index (negative logarithm of the hydrogen-ion concentration)
pp.	pages
ppb	parts per billion
ppm	parts per million
psf	pound per square foot
psi	pound per square inch
R.O.	reverse osmosis
rpm	revolution per minute
RWL	raw waste load
sec	second
Sec.	Section
S.I.C.	Standard Industrial Classification
SO_x	sulfates
sq	square
sq ft	square foot
SS	suspended solids
stp	standard temperature and pressure
SRWL	standard raw waste load
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TLm	median tolerance limit
TOC	total organic carbon
TOD	total oxygen demand
TSS	total suspended solids
u	micron
ug	microgram

vol	volume
wt	weight
yd	yard

TABLE XVIII

METRIC TABLE

CONVERSION TABLE

MULTIPLY (ENGLISH UNITS)		by	TO OBTAIN (METRIC UNITS)	
ENGLISH UNIT	ABBREVIATION	CONVERSION	ABBREVIATION	METRIC UNIT
acre	ac	0.405	ha	hectares
acre-feet	ac ft	1233.5	cu m	cubic meters
British Thermal Unit	BTU	0.252	kg cal	kilogram-calories
British Thermal Unit/Pound	BTU/lb	0.555	kg cal/kg	kilogram calories/kilogram
cubic feet/minute	cfm	0.028	cu m/min	cubic meters/minute
cubic feet/second	cfs	1.7	cu m/min	cubic meters/minute
cubic feet	cu ft	0.028	cu m	cubic meters
cubic feet	cu ft	28.32	l	liters
cubic inches	cu in	16.39	cu cm	cubic centimeters
degree Fahrenheit	°F	0.555 (°F-32)*	°C	degree Centigrade
feet	ft	0.3048	m	meters
gallon	gal	3.785	l	liters
gallon/minute	gpm	0.0631	l/sec	liters/second
horsepower	hp	0.7457	kw	killowatts
inches	in	2.54	cm	centimeters
inches of mercury	in Hg	0.03342	atm	atmospheres
pounds	lb	0.454	kg	kilograms
million gallons/day	mgd	3,785	cu m/day	cubic meters/day
mile	mi	1.609	km	kilometer
pound/square inch (gauge)	psig	(0.06805 psig +1)*	atm	atmospheres (absolute)
square feet	sq ft	0.0929	sq m	square meters
square inches	sq in	6.452	sq cm	square centimeters
ton (short)	ton	0.907	kkg	metric ton (1000 kilograms)
yard	yd	0.9144	m	meter

*Actual conversion, not a multiplier

4/30/76