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Economic Analysis and Cost-Effectiveness Analysis of Proposed Effluent Limitations Guidelines and Standards for Industrial Waste Combustors

ECONOMIC ANALYSIS AND COST-EFFECTIVENESS ANALYSIS OF PROPOSED EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS FOR INDUSTRIAL WASTE COMBUSTORS

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Chapter 1

Introduction and Overview

1.0 Overview and Definitions

The Federal Water Pollution Control Act Amendments of 1972 established a comprehensive program to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Section 101(a)). To implement these amendments, the U.S. Environmental Protection Agency (EPA) issues effluent limitations guidelines and standards for categories of industrial dischargers. By regulation, EPA establishes guidelines and standards that represent:

- **Best Practicable Control Technology Currently Available (BPT)** These regulations apply to existing industrial direct dischargers, and generally cover discharge of conventional pollutants.

- **Best Available Technology Economically Achievable (BAT)** These regulations apply to existing industrial direct dischargers and the control of priority and non-conventional pollutant discharges.

- **Best Conventional Pollutant Control Technology (BCT)** BCT regulations are an additional level of control for direct dischargers beyond BPT for conventional pollutants.

- **Pretreatment Standards for Existing Sources (PSES)** These regulations apply to existing indirect dischargers (i.e., facilities which introduce their discharges into Publicly Owned Treatment Works, or POTWs). They generally cover discharge of toxic and non-conventional pollutants that pass through the POTW or interfere with its operation. They are analogous to the BAT controls.

- **New Source Performance Standards (NSPS)** These regulations apply to new industrial direct dischargers and cover all pollutant categories.

- **Pretreatment Standards for New Sources (PSNS)** These regulations apply to new indirect dischargers and generally cover discharge of toxic and non-conventional pollutants that pass through the POTW or interfere with its operation.

This Economic Analysis (EA) assesses the economic impact of the proposed effluent limitation guidelines and standards for the Industrial Waste Combustors Industry. This rulemaking proposes limitations for Best Practicable Control Technology (BPT), Best Available Technology Economically Achievable (BAT), Best Conventional Pollutant Control Technology (BCT), Pretreatment Standards for Existing Sources (PSES), New Source Performance Standards (NSPS) and Pretreatment Standards for New Sources (PSNS).

The proposed Industrial Waste Combustors rule will apply to new and existing commercial facilities that are engaged in the combustion of industrial waste (not medical waste, sewage sludge or municipal waste) received as off-site transfers from other firms. Affected facilities include commercially-operating hazardous waste combustors regulated as “incinerators” or “boilers and industrial furnaces” (BIFs) under the Resource Conservation and Recovery Act (RCRA) as well as commercially-operating non-hazardous industrial waste combustors. The proposed rule will not apply to facilities that burn only wastes received from off-site facilities within the same corporate ownership (intracompany wastes) or facilities that only burn wastes generated on-site (captive wastes). EPA believes the wastewater generated by Industrial Waste Combustor operations at most of the captive and intracompany facilities that EPA has identified are already subject to national effluent limitations or pretreatment standards based on the manufacturing operations at the facility.

The Agency identified thirteen facilities that would meet the criteria for inclusion in the rulemaking based on responses to EPA’s 1994 Waste Treatment Industry Phase II: Incinerators Screener Survey and Questionnaire. Of these thirteen facilities, two facilities have either stopped accepting waste from off-site for combustion or have closed their combustion operations, leaving eleven in-scope facilities. The Economic Analysis addresses the eleven open facilities, including eight direct dischargers and three indirect dischargers, which employ approximately 850 people and earned over $380 million in revenue in 1992.

1.1 Summary of the Proposed Rule

The proposed rule includes BPT, BAT, BCT, PSES, NSPS and PSNS regulations. These are discussed below.

Best Practicable Control Technology (BPT)

EPA proposes to establish BPT effluent limitations guidelines to control conventional, priority, and non-conventional pollutants. The technology basis for BPT is primary precipitation, solid-liquid separation, secondary precipitation, solid-liquid separation, and sand filtration. The BPT limitations are based upon two stages of chemical precipitation, each at different pH levels, each followed by some form of separation and sludge dewatering. The first stage of chemical precipitation is preceded by chromium reduction, when necessary. The different pH levels would be selected so as to optimize the removal of metals from Industrial Waste Combustor wastewater.

Best Available Technology Economically Achievable (BAT)

EPA proposes to establish BAT effluent limitations guidelines based upon the same technologies proposed for BPT.

Best Conventional Pollutant Control Technology (BCT)

EPA proposes to establish BCT effluent limitations guidelines for Total Suspended Solids (TSS) equivalent to the proposed BPT limitations for TSS.

New Source Performance Standards (NSPS)

EPA proposes to establish NSPS limitations equivalent to the proposed BPT/BCT/BAT effluent limitations.

Pretreatment Standards for Existing Sources (PSES)

EPA proposes to establish PSES effluent limitations with a technology basis of primary precipitation, solid-liquid separation, secondary precipitation and solid-liquid separation.

Pretreatment Standards for New Sources (PSNS)

EPA proposes to establish PSNS effluent limitations equivalent to the proposed PSES effluent limitations.

1.2 Selection of the Proposed Regulatory Options

EPA evaluated two regulatory options, as follows:

- **<u>Option A</u>** Chemical Precipitation (pH=8.5 to 9)
  Liquid/Solid Separation
  Sludge Dewatering
  Second Stage Chemical Precipitation (pH=3)
  Liquid/Solid Separation
  Sludge Dewatering

- **<u>Option B</u>** Option A + Sand Filtration

To determine the technology basis and performance level for the proposed regulations, EPA developed a database consisting of daily effluent data collected from: the Detailed Monitoring Questionnaire, the 1994 Waste Treatment Industry Phase II: Incinerators Questionnaire, facility NPDES permits, facility POTW permits, and the EPA wastewater sampling program.

Selection of the Proposed BPT Option

The Industrial Waste Combustors receive for thermal treatment large quantities of hazardous and non-hazardous industrial waste that result in discharges of a significant quantity of pollutants. The EPA estimates that 291,000 pounds per year of TSS and metals are currently being discharged directly or indirectly to the nations waters.

Section 304(b)(1)(A) requires EPA to identify effluent reductions attainable through the application of "best practicable control technology currently available for classes and categories of point sources." The Senate Report for the 1972 amendments to the CWA explained how EPA must establish BPT effluent reduction levels.

Generally, EPA determines BPT effluent levels based upon the average of the best existing performances by plants of various sizes, ages, and unit processes within each industrial category or subcategory. In industrial categories where present practices are uniformly inadequate, however, EPA may determine that BPT requires higher levels of control than any currently in place if the technology to achieve those levels can be practicably applied.

In addition, CWA Section 304(b)(1)(B) requires a cost reasonableness assessment for BPT limitations. In determining BPT limitations, EPA must consider the total cost of treatment technologies in relation to the effluent benefits achieved by such technology. This inquiry does not limit EPA's broad discretion to adopt BPT limitations that are achievable with available technology unless the required additional reductions are "wholly out of proportion to the costs of achieving such marginal level of reduction." Moreover, the inquiry does not require the Agency to quantify benefits in monetary terms.

In balancing costs against the benefits of effluent reduction, EPA considers the volume and nature of expected discharges after application of BPT, the general environmental effects of pollutants, and the cost and economic impacts of the required level of pollution control. In developing guidelines, the Act does not require or permit consideration of water quality problems attributable to particular point sources, or water quality improvements in particular bodies of water. Therefore, EPA has not considered these factors in developing the proposed limitations.

EPA concluded that the wastewater treatment performance of the facilities it surveyed was, with very limited exceptions, inadequate and that only two facilities are using best practicable, currently available technology. Moreover, EPA only found a significant number of pollutants at "treatable levels" at one of the facilities. Thus, the proposed BPT effluent limitations will be based on data from this one treatment system only.

The inadequate pollutant removal performance observed generally for discharging Industrial Waste Combustor (IWC) facilities is not unexpected. As pointed out previously, these facilities are burning highly variable wastes that, in many cases, are process residuals and sludges from other point source categories. EPA's review of permit limitations for the direct dischargers shows that, in most cases, the dischargers are subject to "best professional judgment" concentration limitations which were developed from guidelines for facilities treating and discharging much more specific waste streams.

The Agency proposes BPT limitations for nine pollutants. EPA selected Option B for the Industrial Waste Combustors. These limitations were developed based on an engineering evaluation of the average level of pollutant reduction achieved through application of the best demonstrated methods to control the discharges of the regulated pollutants.

EPA's decision to base BPT limitations on Option B treatment reflects primarily an evaluation of three factors: the degree of effluent reduction attainable, the total cost of the proposed treatment technologies in relation to the effluent reductions achieved, and potential non-water quality benefits. In assessing BPT, EPA considered the age, size, process, other engineering factors, and non-water quality impacts pertinent to the facilities treating wastes in this subcategory. No basis could be found for identifying different BPT limitations based on age, size, process or other engineering factors. Neither the age nor the size of the Industrial Waste Combustor facility will significantly affect either the character or treatability of the wastes or the cost of treatment. Further, the treatment process and engineering aspects of the technologies considered have a relatively insignificant effect because in most cases they represent fine tuning or add-ons to treatment technology already in use. These factors consequently did not weigh heavily in the development of these guidelines. For a service industry whose service is thermal treatment, the most pertinent factors for establishing the limitations are costs of treatment, the level of effluent reductions obtainable, and non-water quality effects.

Generally, for purposes of defining BPT effluent limitations, EPA looks at the performance of the best operated treatment system and calculates limitations from some level of average performance of these "best" facilities. For example, in the BPT limitations for the OCPSF Category, EPA identified "best" facilities on a BOD performance criteria of achieving a 95 percent BOD removal or a BOD effluent level of 40 mg/l. (52 FR 42535, November 5, 1987). For this industry, as previously explained, EPA concluded that treatment performance is, in all but two cases, inadequate. Without two stages of precipitation at different pH levels, metal removal levels are uniformly inadequate across the industry. Also, if a substantial number of pollutants were not found in "treatable levels" for a particular facility during an EPA sampling episode, EPA obviously could not use data from that facility to develop BPT performance levels. Consequently, BPT performance levels are based on data from the one well-operated system using two stages for metals precipitation at different pH levels that was sampled by EPA.

The demonstrated effluent reductions attainable through the Option B control technology represent the BPT performance attainable through the application of demonstrated treatment measures currently in operation in this industry. The Agency selected BPT limitations based on the performance of the Option B treatment system for the following reasons. First, these removals are demonstrated by a facility and can readily be applied to all facilities. The adoption of this level of control would represent a significant reduction in pollutants discharged into the environment (from 181,000 to 54,000 pounds of TSS and metals). Second, the Agency assessed the total cost of water pollution controls likely to be incurred for Option B in relation to the effluent reduction benefits and determined these costs were economically reasonable.

The Agency proposes to reject Option A because EPA concluded that not using sand filtration as the final treatment step is not the best practicable treatment technology currently in operation for the industry. Consequently, effluent levels associated with this treatment option would not represent BPT performance levels. Also, Option A was rejected because the greater removals obtained through addition of sand filtration at Option B were obtained at a relatively insignificant increase in costs over Option A.

Selection of the Proposed BCT Option

In developing BCT limits, EPA considered whether there are technologies that achieve greater removals of conventional pollutants than proposed for BPT, and whether those technologies are cost-reasonable according to the BCT Cost Test. EPA identified no technologies that can achieve greater removals of conventional pollutants than proposed for BPT that are also cost-reasonable under the BCT Cost Test, and accordingly EPA proposes BCT effluent limitations equal to the proposed BPT effluent limitations guidelines and standards.

Selection of the Proposed BAT Option

EPA proposes BAT effluent limitations for the Industrial Waste Combustors based on the same technologies selected for BPT. The proposed BAT effluent limitations would control identified priority and non-conventional pollutants discharged from facilities.

EPA has not identified any more stringent treatment technology option which it considered to represent BAT level of control applicable to facilities in this industry.

Determination of New Source Performance Standards

Under Section 306 of the Act, new industrial direct dischargers must comply with standards which reflect the greatest degree of effluent reduction achievable through application of the best available demonstrated control technologies. Congress envisioned that new treatment systems could meet tighter controls than existing sources because of the opportunity to incorporate the most efficient processes and treatment systems into plant design. Therefore, Congress directed EPA to consider the best demonstrated process changes, in-plant controls, operating methods and end-of-pipe treatment technologies that reduce pollution to the maximum extent feasible.

EPA proposes NSPS that would control the same conventional, priority, and non-conventional pollutants proposed for control by the BPT effluent limitations. The technologies used to control pollutants at existing facilities are fully applicable to new facilities. Furthermore, EPA has not identified any technologies or combinations of technologies that are demonstrated for new sources that are different from those used to establish BPT/BCT/BAT for existing sources. Therefore, EPA proposes NSPS limitations that are identical to those proposed for BPT/BCT/BAT.

Pretreatment Standards for Existing Sources

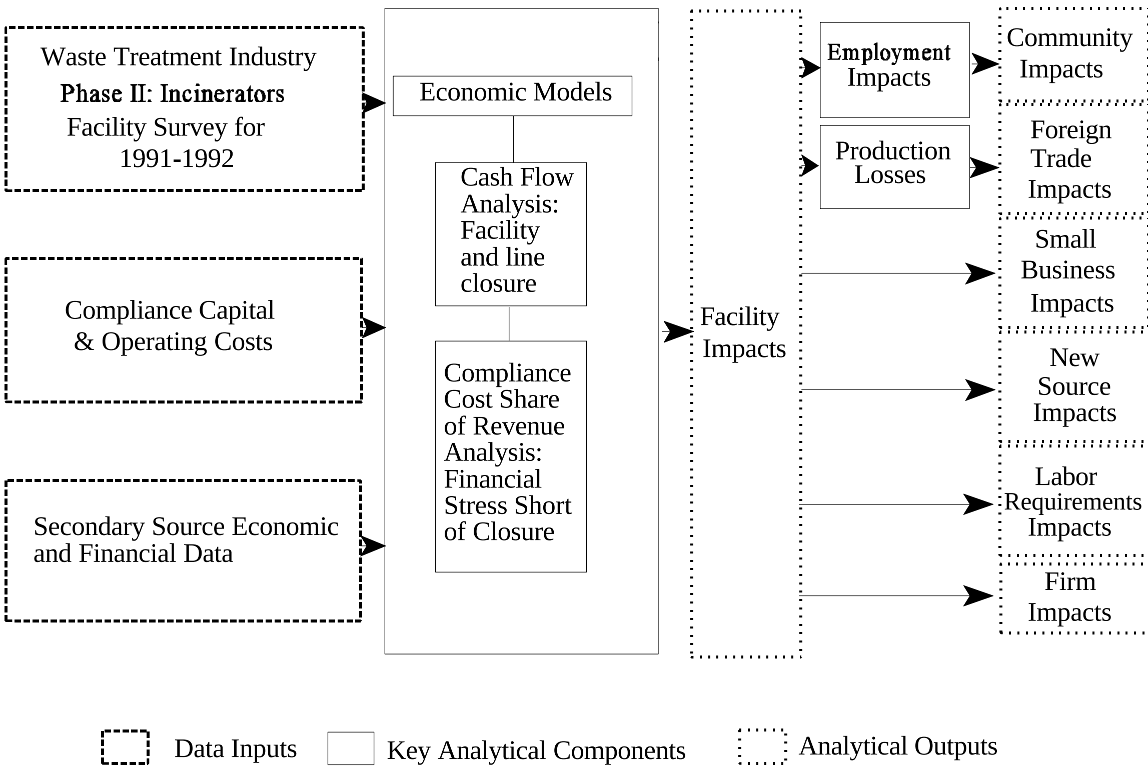
Indirect dischargers in the Industrial Waste Combustors Industry, like the direct dischargers, accept for treatment wastes containing many priority and non-conventional pollutants. As in the case of direct dischargers, indirect dischargers may be expected to discharge many of these non-combustible, low-volatility pollutants to POTWs at significant mass and concentration levels. EPA estimates that indirect dischargers annually discharge approximately 110 thousand pounds of TSS and metals to POTWs.

Section 307(b) of the Act requires EPA to promulgate pretreatment standards to prevent pass-through of pollutants from POTWs to waters of the U.S. or to prevent pollutants from interfering with the operation of POTWs. EPA is establishing PSES for this industry to prevent pass-through of the same pollutants controlled by BAT from POTWs to waters of the U.S.

1.3 Structure of the Economic Analysis

This EA describes both the methodology employed to assess impacts of the proposed rule and the results of the analyses. The overall structure of the impact analysis is summarized in Figure 1-1. The two main inputs to the analysis are: 1) data on industry baseline financial and operating conditions, and 2) projected costs of complying with the proposed rule. The industry baseline financial and operating data are based principally on the 1994 Waste Treatment Industry Phase II: Incinerators Questionnaire (hereafter referred to as the questionnaire) conducted under the authority of Section 308 of the Clean Water Act.

Figure 1-1
Economic Impact Analysis of the Incinerator Industry
Effluent Limitations Guidelines: Analytic Components



Eleven of the thirteen facilities expected to be affected by the Industrial Waste Combustors rule received and completed the detailed questionnaire, and an additional two facilities completed brief screener surveys. The questionnaire asked for balance sheet and income statement information, as well as quantitative and qualitative information regarding each facility's dependence on market sectors, types of customers and business activity. Facilities were asked to characterize the competition they faced in various markets. The questionnaire also gathered data regarding facility liquidation value, cost of capital and the facility's owning firm. EPA supplemented data obtained from the questionnaire with secondary sources, including trade literature and public filings.

In addition to baseline facility data, the second major type of data input to the analysis is the technical estimate of costs associated with compliance with the regulatory options. EPA developed these estimates based on engineering analysis of the in-scope facilities. The cost estimates were incorporated into the economic impact analysis by adding an annualized capital cost of compliance to the estimated annual operating and maintenance costs of compliance to yield a single, total annualized compliance cost.

EPA used baseline financial data and estimated annualized compliance costs to calculate baseline and post-compliance cash flows at the level of the entire facility as well as for waste treatment operations alone. Facilities that convert from non-negative to negative facility-level cash flows as a result of incurring compliance costs are considered closures associated with the regulation. EPA also calculated the ratio of compliance costs to revenue as a secondary measure of financial stress short of closure.

The Economic Analysis builds from the facility-level cash flow analysis, the results from which then drive the other components of the EA (see Figure 1-1). The firm-level impact analysis evaluates the effect of facility-level compliance costs on the parent firm. The community impact analysis examines how employment losses due to projected facility closures affect not only the people that were employed by the facility but also the communities to which these people belong. IWC closures might conceivably influence the U.S. trade balance by decreasing export-related activity and increasing imports.

EPA also examined the proposed guideline to determine if it would create barriers to entry. If existing firms were to gain a significant financial advantage over new firms in complying with the guideline, then the guideline might deter new entrants and reduce market competition.

Finally, EPA assessed the regulatory impact on small businesses, in accordance with the requirements of the Regulatory Flexibility Act. The key methodological component of this analysis was the identification of small businesses. EPA used small business thresholds provided by the Small Business Administration, which defines small businesses by firm-level employment or revenues, depending on the industry. In the Regulatory Flexibility Analysis, EPA applied these thresholds and found no small businesses among the thirteen in-scope facilities.

1.5 Organization of the Economic Analysis Report

The remaining parts of the Economic Analysis are organized as follows. Chapter 2 describes the data sources consulted for this EA. Chapter 3 profiles the Industrial Waste Combustors Industry and examines the economic and financial structure and performance of its markets. Following the background material in Chapters 2 and 3, Chapter 4 details the methodology used to estimate facility impacts and presents the results. Chapters

5 through 9 connect the results of the facility impact analysis to potential collateral effects on firms, foreign trade, communities, new entrants and small businesses. Chapter 10 presents the water quality-related benefits associated with achievement of the proposed rule.

Chapter 2

Data Sources

2.0 Introduction

This chapter describes the primary and secondary sources that provided economic and financial data used to assess the expected economic impact of the Industrial Waste Combustors rule.

2.1 Primary Source Data

EPA, under the authority of CWA Section 308, sent out the Waste Treatment Industry Phase II: Incinerators 1992 Screener Survey (OMB Approval Number: 2040-0162) and the 1994 Waste Treatment Industry Phase II: Incinerators Questionnaire (OMB Approval Number: 2040-0167). These survey efforts covered all thirteen (including the two which have either stopped accepting waste from off-site for combustion or have closed their combustion operations) of the facilities EPA currently proposes to regulate with the Industrial Waste Combustors rule. The questionnaire obtained 1991 and 1992 information on the technical and financial characteristics of facilities to estimate how facilities would be affected by an effluent guideline.

The technical data obtained by the questionnaire include information on facility operating processes that use water, the quantities of water and pollutants discharged by the various processes, the treatment systems that are currently in place for managing discharge of pollutants and other data. These data provided the basis for estimating treatment system and process change costs for complying with various rule options. The estimated technical costs for compliance in turn yielded estimates of the capital and operating costs of treatment systems and any production costs or savings that would accompany installation and operation of a treatment system. For a detailed description of the technical data obtained by the questionnaire and the related engineering and cost analyses leading to estimates of technical compliance costs, see the Technical Development Document.

The questionnaire also obtained a variety of financial data from the facilities. These data include: two years (1991-1992) of income statements and balance sheets at the facility and firm levels; selected financial data for incinerator and waste treatment operations; estimated value of facility assets and liabilities in liquidation; borrowing costs; employment at the level of the facility as well as by type of operation, and characterizations of market structure. Some respondents attached annual reports or equivalent supporting documents. The financial data obtained in the questionnaire provided the basis for assessing how facilities and product lines are likely to be affected financially by effluent guidelines.

In addition to the questionnaire, EPA obtained facility- and firm-specific data from Form 10-K submissions to the Securities and Exchange Commission and from company press releases and profiles on the internet.

EPA received detailed financial data from eleven of the thirteen in-scope facilities, including nine of the eleven currently open facilities expected to be included in the Industrial Waste Combustors rule. An earlier screener survey provided additional, less detailed data for the remaining two open, in-scope facilities.

2.2 Secondary Source Data

In addition to enabling numerous analytical tools in the economic analyses in this document, secondary source data helped to characterize and update background economic and financial conditions in the national economy and in the Industrial Waste Combustors Industry. For example, secondary source data were used to track the numerous consolidations and facility closures since administering the questionnaire. Secondary source data also contributed significantly to the firm-level analysis and to the characterization of future prospects. Secondary sources used in the analysis include:

- 1987 to 1992 *U.S. Industrial Outlooks*, published by the Department of Commerce, which supplied information for Chapter 3.
- Small business thresholds, by 4-digit industry group from the Small Business Administration, used in the Regulatory Flexibility Analysis and in the preliminary statistical analyses.
- Industry sources and trade publications (especially *EI Digest* and *The Hazardous Waste Consultant*), which contributed to the incinerators profile presented in Chapter 3 and to the facility and firm-level impact analyses.
- *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II) 2nd Edition*, published by the Bureau of Economic Analysis, provided regional multipliers.
- Financial databases, including Robert Morris Associates' *Annual Statement Studies*, Dun & Bradstreet's Million Dollar Directory and the Dun & Bradstreet company database. These sources provided diagnostic financial ratios and firm-level income statement and balance sheet values, as well as supplementary identification data.

- The FY 1997 *Economic Report of the President* provided Producer Price Index series.
- *County Business Patterns*, published by U.S. Bureau of Census
- *Canadian News Wire*
- Market Guide "Company Snapshots"

The contributions of these sources to each component of the Economic Analysis are discussed in detail within the corresponding chapters.

Chapter 3

Profile of the Industrial Waste Combustors Industry

3.1 Introduction

Though still young, the Industrial Waste Combustors[1] Industry has progressed from rapid growth in its inception to overcapacity during the early- and mid-90s to a period of increasing financial stability that appears to be emerging from recent consolidations. This chapter presents a brief economic profile of the entire commercial waste combustion industry, then focuses upon the market segment to which the proposed Industrial Waste Combustors effluent guidelines will likely apply. Because the industry continues to evolve, the profile also compares the 1991-1992 period of the questionnaire to more recent years and to the near-term future.

Since this chapter supports the economic analysis, it emphasizes economic characteristics that relate to the industry's ability to absorb or pass-through compliance costs to customers. The most important characteristics involve market risk:

1. The capital intensiveness of the production process and the long lead-times needed for facility construction and permitting make it difficult for firms to respond quickly to exogenous market shocks, such as unforeseen technological or regulatory developments.

2. Waste combustors potentially face considerable short term volatility in market demand, because they depend closely upon client industries that respond strongly to business cycles. A significant portion of waste combustor client industries also have access to close substitutes — especially waste minimization.

However, management strategies apparently exist that can deal effectively with the special challenges waste combustors face. While some members of the industry have suffered crippling financial setbacks in recent years, others have managed to grow. Consolidation of waste combustor parent firms has reduced risk from

[1] For the purposes of this economic analysis, "waste incinerators" or "waste combustors" will refer to the commercial industrial waste incinerators, boilers and industrial furnaces subject to the proposed rule.

market volatility, while an aggressive series of market entry and exit decisions by different types of waste combustor facilities has responded to the emergent regulatory and technological environment.

Industry observers foresee little growth in the aggregate size of the market, as the total quantity of hazardous wastes continues to decline in the United States. Although Canadian firms have acquired a number of U.S. hazardous waste incinerators, and some U.S. facilities treat Canadian wastes, cross-border trade shows no significant prospect of reversing the decline of hazardous waste volumes.

In response to regulatory developments and low growth prospects, cement kilns — one major component of the hazardous waste combustion industry — have largely ceased burning hazardous wastes. This development may help diminish the overcapacity and declining prices that have chronically challenged the financial health of industry participants.

In short, the industry has responded in recent years to some of the risk issues inherent to the waste treatment business and to the secular decline in aggregate market size. It remains to be seen what effect these responses will have on the financial condition of in-scope facilities, but the perennially pessimistic forecasts that have become the norm for the industry no longer seem viable. The 1996/1997 period finds commercial hazardous waste combustors in very different economic and regulatory circumstances from market participants a year or two earlier.

The following section defines relevant terms and explains the structure of the hazardous waste combustion industry[2]. An overview of the entire industry follows, based on trade publications, EPA's Biennial Reporting System, supporting documents for the proposed Industrial Waste Combustors rule and economic census data. After the overview, the profile discusses likely economic prospects for the industry in the near future and then focuses on the portion of hazardous waste combustion EPA expects will be required to comply with an Industrial Waste Combustors rule. This section will draw from the incinerators questionnaire, publicly available electronic databases and the sources previously cited. The chapter concludes by examining the time period covered by the questionnaire — 1991 and 1992.

[2] This profile concentrates on the hazardous waste portion of the Industrial Waste Combustors Industry to make use of available secondary source data and to allow comparison with other EPA data sources.

3.2 Industry Definitions

The Industrial Waste Combustors Industry includes facilities that provide a waste treatment or disposal service by burning industrial and hazardous wastes. Some facilities use the generated heat energy to produce some other commodity. Facilities that burn wastes without recovering heat energy as an input to some other industrial application are called *incinerators*. Those facilities that use the heat of combustion as an input to some other industrial production process are collectively known as *boilers and industrial furnaces*, or *BIF*s.

The industry can also be subdivided according to whether each facility provides waste combustion services to other facilities or whether it burns wastes produced by other activities at the same site. *Commercial* waste combustors offer services to off-site generators (sources) of wastes. For the purposes of this profile, commercial waste combustors also include those incinerators and BIFs that accept on-site in addition to off-site wastes. Facilities that burn only on-site wastes are *non-commercial* incinerators or BIFs. These are also known as “captive” facilities.

These distinctions create four broad categories of waste combustors:

	Facility accepts off-site wastes	*Facility accepts only on-site wastes*
Heat of combustion is an integral input used to produce another commodity	**Commercial BIF**	**Non-Commercial BIF**
Heat of combustion is not an input used to produce another commodity	**Commercial Incinerator**	**Non-Commercial Incinerator**

While the term “non-commercial” conventionally applies to combustors that receive only on-site wastes, in a more substantive, economic sense, the term can refer to facilities that receive wastes only from within the same firm. Sometimes, an incinerator can be located at a separate site from a generator, but functionally and financially the two may be integrally linked as a single business enterprise. Conversely, “commercial” should refer to facilities that receive wastes from other firms. Receiving off-site wastes is not necessarily sufficient to qualify as commercial, if the combustor does not engage in “commerce” with another business enterprise in receiving the waste for payment. For the purposes of this profile and the Economic Analysis, EPA uses the more economically meaningful definition of commercial facilities as those facilities that accept wastes from other firms.

The BIFs of particular relevance to this profile are two types of industrial furnaces — cement kilns and light-weight aggregate kilns (LWAKs) — which bake ingredients at high temperatures to produce building materials. The Industrial Waste Combustors Industry does not include facilities that only store, transport or blend wastes with other materials (fuel blending) for combustion.

Incinerators burn a wide range of wastes, including those that have low energy content and those that have a high hazardous content. BIFs can only burn a more limited range of wastes, tailored to the production process in which they are integrated, but they can do so at a lower cost. A BIF's produced energy offsets purchased energy and some of the combustion equipment is required in any case for the associated production process. Thus, incinerators are generally more versatile, while BIFs are generally less costly.

The decision to send wastes to an off-site, commercial waste combustor as opposed to an on-site facility depends largely upon the quantity of wastes generated. A manufacturer that produces a large quantity of wastes can save transportation costs, reduce combustion cost variability, address liability concerns and/or utilize existing equipment by combusting waste on-site, in a non-commercial incinerator or BIF. On the other hand, a site that produces lesser quantities of wastes may not be able to recover the capital and operating costs of an on-site incinerator or BIF, and might thus turn to a commercial waste combustor.

3.3 Overview of the Industrial Waste Combustors Market

The Industrial Waste Combustors Industry is a small and contracting industry that is becoming increasingly integrated, both vertically and horizontally. After several decades of growth, the industry found itself mired in overcapacity by the beginning of the 1990s, when the regulatory environment that had launched waste combustion as a growth industry began to yield more complex, and sometimes adverse, effects on the size and profitability of the market.

In 1984, EPA promulgated restrictions on how hazardous waste generators could dispose of their wastes. Where generators had previously sent untreated waste to landfills, they now had to find alternative methods of treating and disposing wastes.[3] Combustion proved attractive because it often met the Best Demonstrated Available Technology requirement of EPA's disposal restrictions and because combustion effectively destroyed some organic wastes that other treatment methods could not manage as well.

[3] See EPA's 1996 Hazardous Waste Combustors Rule Economic Analysis.

Over time, however, regulation of wastes has encouraged generators to reduce their output of wastes in the first place. Not only can waste minimization often cost less than alternative management methods, but some waste minimization and pollution prevention techniques improve the technical and economic efficiency of the production process. Generators found numerous ways to increase profits by reducing wastes.

At the same time, regulators and industry implemented CERCLA Superfund clean-ups more slowly than anticipated. This compounded the waste combustors' over-estimate of how quickly the market would grow. The overcapacity that followed, combined with high exit costs, set the stage for fierce price wars. Then, in 1991, promulgation of the BIF rule (discussed below) led cement kilns and LWAKs to enter the market with their low-cost combustion services.

Both incinerators and BIFs experienced severe financial stress during the resulting period of overcapacity and declining prices. Currently, many incinerators and nearly all BIFs have exited the commercial hazardous waste combustion market. However, it is not clear whether the industry's financial health will recover or continue to decline in the future.

The remainder of this section examines the history and structure of the industry in greater detail, then makes some observations about possible future directions.

Incineration Compared to Other Methods of Waste Management

Currently, a relatively small proportion of wastes generated in the U.S. is combusted. According to EPA's Biennial Reporting System (BRS),[4] incinerators and BIFs account for between 1 and 2 percent of hazardous wastes disposed or treated, in total tons. In 1993, incinerators and BIFs received 1.7 million tons of hazardous waste, out of a total of 234.9 million tons. However, incineration claims a more significant portion of off-site hazardous waste management. Table 3-1 shows that incinerators and BIFs processed 17 percent of hazardous wastes sent off-site in 1993, and that the 136 incinerators that received off-site wastes constituted nearly a third of all facilities that received off-site transfers of hazardous wastes.

[4] This section draws from *EPA's Biennial RCRA Hazardous Waste Report*, *National Analysis* for 1989, 1991 and 1993 data, published in 1993, 1994 and 1995, respectively.

Table 3-1 Quantity of Hazardous Waste Managed by Off-Site Transfers

	1989	1991	1993	1989	1991	1993
Management Method	*Tons of Off-Site Haz. Wastes Per Year*			*Facilities Receiving Off-Site Haz. Wastes*		
All (excludes storage)	7,962,585	7,690,516	8,309,165	484	427	432
Landfill	2,103,280	1,228,710	1,732,070	51	28	36
Aqueous Treatment	897,037	1,067,672	801,003	97	115	99
Recovery (other than BIFs)	1,270,136	1,355,425	990,013	155	162	145
Boilers/Industrial Furnaces	443,239	533,868	920,579	28	46	53
Incineration	360,482	452,235	487,576	88	71	83
Other	2,888,411	3,052,606	3,377,924	*na*	*na*	*na*
Management Method	*Share of Off-Site Haz. Wastes*			*Share of Receiving Facilities*		
All (excludes storage)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Landfill	26.4%	16.0%	20.8%	10.5%	6.6%	8.3%
Aqueous Treatment	11.3%	13.9%	9.6%	20.0%	26.9%	22.9%
Recovery (other than BIFs)	16.0%	17.6%	11.9%	32.0%	37.9%	33.6%
Boilers/Industrial Furnaces	5.6%	6.9%	11.1%	5.8%	10.8%	12.3%
Incineration	4.5%	5.9%	5.9%	18.2%	16.6%	19.2%
Other	36.3%	39.7%	40.7%	*na*	*na*	*na*

Source: *Biennial RCRA Hazardous Waste Report, National Analyses* for 1989, 1991 and 1993 data, published in 1993 and 1994.
The total quantity of wastes received by incinerators and BIFs may be higher than the numbers above, because some combustion may also receive on-site wastes, which do not appear in this table. BRS excludes small generators.

The quantity of wastes combusted, whether off-site only or overall, has increased over the entire period for which BRS data are available, even though the total quantity of hazardous wastes declined more than 20 percent between 1991 and 1993. While off-site transfers increased 8 percent over the same biennial period, off-site transfers to waste incineration grew almost 43 percent, due mostly to BIFs entering the hazardous waste combustion market in response to the “BIF rule.”[5]

The consensus of industry observers, though, is that future data will likely show a decline in the absolute quantity of wastes combusted, especially by BIFs. Not only has the total quantity of wastes continued to decline, but the cement kilns that entered the hazardous waste market under the BIF rule have reversed their efforts in response to diminished economic and regulatory prospects. Only one cement kiln has applied for and received a final permit.[6]

How an overall decline in waste generation might affect the off-site combustor market share of the hazardous waste market is less clear. Because on-site treatment depends so much on high flow rates of wastes,

[5] See 56 F.R. 7134. The BIF rule went into effect on August 21, 1991, and led that year to 21 applications by cement kilns to burn hazardous wastes under the rule.

[6] Ash Grove Cement Company received a final permit in August 1996 (see *Hazardous Waste Consultant*, November/December 1996). The upcoming March/April edition will update the status and intentions of other cement kilns, but most or all have withdrawn plans to burn hazardous wastes.

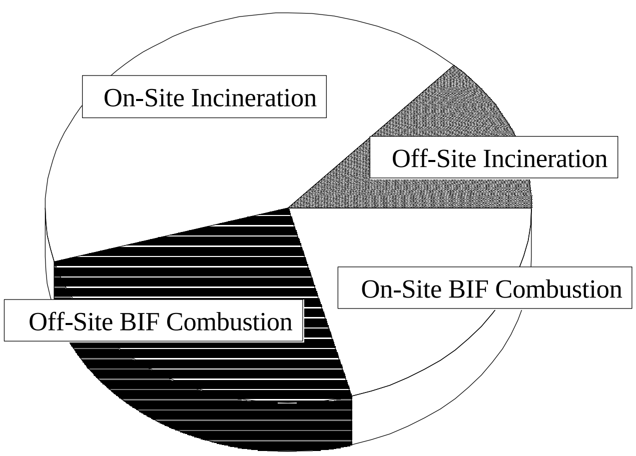
reductions in waste generation could conceivably increase off-site transfers, if on-site treatment prove less cost-effective over time.

Differential Growth Within the Industrial Waste Combustors Industry

According to 1993 BRS data, incinerators managed 55 percent of hazardous wastes entering the combustion market. However, Table 3-1 shows that, in the off-site treatment and disposal segment of the market, BIFs dominated, accounting for almost 66 percent of the 1.4 million tons of hazardous wastes combusted off-site in 1993. Figure 3-1 illustrates the distribution of hazardous wastes among the major components of the combustion market

Figure 3-1. Hazardous Waste Combustion

1993 Shares by Management Method



As noted in the previous section, BIFs made these gains after the 1991 promulgation of the BIF rule. The BIF rule allowed cement kilns and LWAKs that already combusted hazardous wastes to apply for interim status and increase their combustion of hazardous wastes pending a final permit.

Cement kilns and LWAKs immediately entered the market to take advantage of their lower costs per unit of hazardous waste combusted, compared to incinerators. These kilns enjoyed lower costs because:

- Incinerator waste was considered a hazardous waste, while, at the time, kiln dust was not. Kiln dust could either be incorporated into the cement product or disposed of at a lower cost than incinerator waste.[7]
- Cement kilns could convert some of their existing equipment and facilities to burn hazardous waste, rather than building anew.

[7] U.S. Environmental Protection Agency, *Report to Congress on Cement Kiln Dust*, 1993, p. 9-10.

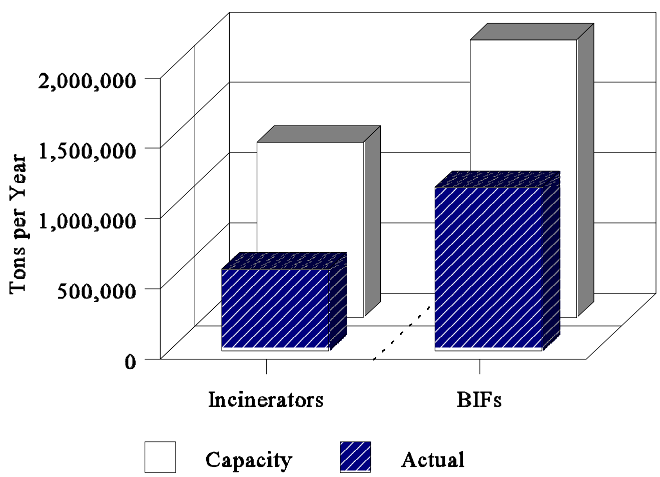
- Some capital and operating costs of waste combustion are shared with another product. In other words, the cost of waste combustion at a cement kiln is supported both by the price charged to waste generators and by the price charged to cement customers. Incinerators must recover their costs from charges to waste generators alone.

Cement kilns also have a very high capacity because their production process is highly energy intensive. Other regulatory differences may also have smaller differential effects on the incinerators and BIFs, but the net result was that, in 1992, kilns could accept hazardous wastes for combustion at about 25 percent to 50 percent of the prices charged by incinerators.[8] Since then, other regulatory developments have reduced or negated some of these advantages for BIFs. In particular:

- The proposed Hazardous Waste Identification Rule (HWIR) may allow some incinerator ash to be handled as non-hazardous waste.
- Heightened foreign competition in the cement market requires tight cost control in the production process.[9]
- Vertical integration in the incinerator industry means that incinerators are more often burning sludge from other waste treatment or disposal facilities owned by the same firm. This arrangement reduces incinerator demand volatility and shares some of the incinerators' costs with other facilities in an integrated hazardous waste treatment and disposal program.

Figure 3-2. Commercial Hazardous Wastes

Capacity and Utilization in 1993



The combination of this erosion of BIF cost advantages with a contracting market and public opposition to new permits has yielded a commercial (off-site) hazardous waste combustion market currently dominated by

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[8] *Hazardous Waste Consultant*, March 1992.

[9] *Hazardous Waste Consultant,* March 1995. Also, Southdown Inc.'s Form 10-K for fiscal year ending 12/31/95 indicated that the cement import share of U.S. consumption rose from 4 percent in 1982 to 20 percent in 1987, due partly to business cycle effects. Major low-priced sources included Mexico, Japan and Venezuela.

incinerators. Only one commercial BIF has a final permit to burn hazardous waste, and no applications are pending.

Growth and Capacity Utilization

Demand for hazardous waste combustion is unusually difficult to forecast, when compared to many other markets, because demand depends very heavily upon regulatory events and technological innovations across a wide range of industries. That is, market forecasters need not only to guess changes in environmental regulations that apply to hazardous waste combustion, but they also need to forecast environmental regulations on client industries that send wastes to combustors. Similarly, waste treatment and reduction technology in client industries has at least as much impact on waste combustors as combustion technology. Finally, while many industries that are linked to primary industries are pro-cyclical and vary with the general state of the national economy, there is no intrinsic reason to expect the demand for off-site waste treatment (as opposed to all types of waste treatment) to vary either directly or indirectly with aggregate economic output.

While chemical manufactures generated two-thirds of combusted hazardous wastes in 1991, over 97 percent of those wastes were combusted on-site.[10] Off-site wastes came from a more evenly distributed array of industries.

The serious over-capacity problems that hazardous waste combustors have experienced for most of this decade follow from the difficulties in forecasting their market. By 1993, practical capacity among incinerators exceeded the actual amount of hazardous wastes combusted by 115 percent, while BIF practical capacities exceeded combustion volumes by over 40 percent (see Figure 3-2).[11] Practical capacity measures the actual operating potential of the facility, as opposed to the permitted capacity.

The *Hazardous Waste Consultant*, a trade journal, conducts an annual survey of hazardous waste treatment, storage and disposal facilities that offers another perspective on anticipated and actual growth in the industry. This survey asks respondents to indicate the current status of their facility operations and permitting

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[10] Based on a BRS analysis in the HWCR Economic Analysis, SIC 28 accounted for at least 65 percent of routinely generated, primary wastes. The percentage of combusted hazardous wastes treated on-site is derived from the Biennial RCRA Hazardous Waste Report, National Analysis (1994), based on 1991 data.

[11] *EI Digest*, June 1994. For incinerators, 1994 practical capacity is used instead of 1993, for which the requisite value was not available. However, capacity among incinerators has not been as variable as in the BIF segment.

activities. Table 3-2 shows some selected data for the period from 1990 to 1995. Figures 3-3 and 3-4 present these data graphically for incinerators and BIFs, respectively.

Table 3-2. Status of Hazardous Waste Incinerators and Cement Kilns

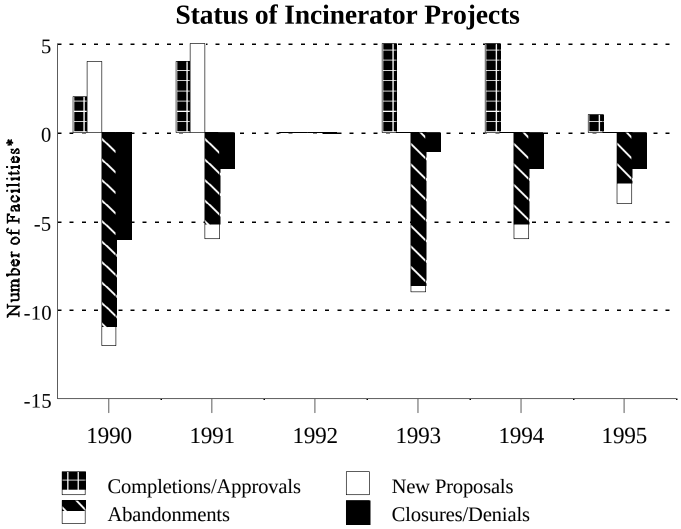
Incinerators	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
Completions or Permits Approved	2	4	na	5	5	1
New Proposals	4	5	na	0	0	0
Delays and Setbacks	20	22	na	9	9	7
Abandonments	12	6	na	9	6	4
Closures or Permit Denials	6	2	na	1	2	2
Cement and Aggregate Kilns	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
Completions or Permits Approved	2	0	na	1	0	0
New Proposals	7	21	na	0	0	0
Delays and Setbacks	7	8	na	1	0	1
Abandonments	1	5	na	8	2	3
Closures or Permit Denials	0	0	na	9	7	2

Source: *Hazardous Waste Consultant*
Mixed practice that explicitly includes an incinerator are counted as incinerators. Expansion was counted as a separate incinerator, for purposes of status.
New kiln permits in 1990 include one new Part B permit and one court decision upholding a previously issued permit.
New proposals for cement kilns in 1991 are currently combustors of toxic wastes and applied for "interim" status under the BIF rule.
The value for delays and setbacks among kilns in 1991 is the number of pending permits from prior years.
Kiln data in 1991 may include approvals and completions with current, and similarly closures and denials with abandonments. Source does not elaborate.
Three new incinerators reported in 1994 were actually projected to open prior to 1994 and appear in 1994 numbers due to delays.
The sole incinerator startup in the 1995 report will accept explosives only.

At the beginning of the decade, a large number of incinerator closures and project abandonments reflected the overcapacity problems facing the industry as a result of rapid growth in the 1980s. Industry participants cited permitting delays, rigorous state-level siting criteria, lawsuits and public opposition as major obstacles. During 1990, six incinerators closed and twelve proposed incinerators were abandoned. However, the same year saw two new cement kilns permitted and new proposals for seven more.[12]

Figure 3-3

Status of Incinerator Projects



* Negative numbers denote abandonments, closures and permit denials

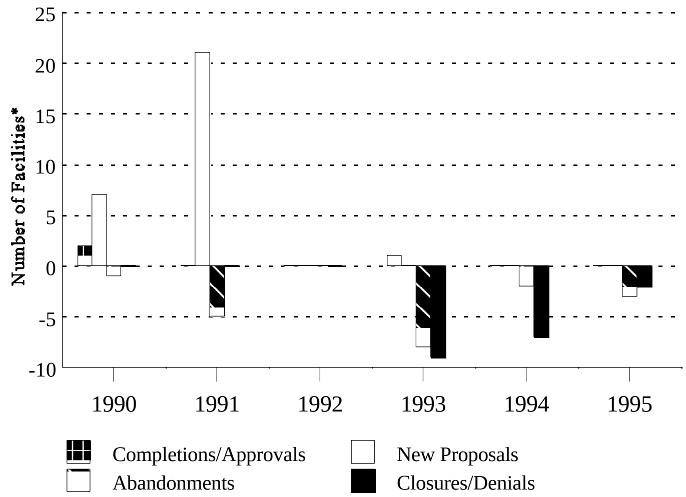
The largest surge in new kiln proposals took place in the following year, because of the BIF rule. A total of 21 cement kilns and LWAKs applied for interim status. Incinerators now faced low-priced competition from these

[12] *Hazardous Waste Consultant*, March 1992. Dixie Cement Co. received a Part B permit, while United Cement's previously issued permit was upheld in court.

BIFs, in addition to continued public opposition and permitting delays. These delays included not only slower-than-expected processing of incinerator permits, but also slower implementation of RCRA and CERCLA provisions in client industries that were expected to yield greater hazardous waste streams for off-site combustion.

Regulatory difficulties also challenged BIFs. A year after filing for interim status, cement kilns and LWAKs were required by the BIF rule to conduct a test burn and complete a "certification of compliance." Some BIFs had underestimated how difficult and time-consuming this process would be. Compounding the problem, some states would not allow the air pollution clearances the kilns needed to conduct test burns.[13]By 1993, neither incinerators nor BIFs were submitting any new proposals at all. From 1993 to 1995, 18 cement kilns and LWAKs either closed entirely, ceased accepting hazardous wastes and/or received permit denials. In most cases, BIFs gave up plans to enter the hazardous waste market because of anticipated regulatory changes, tepid growth in the market and sustained public opposition. Eleven incinerators received permits and/or completed construction during the same period, but the lack of new proposals eventually caught up to the stock of projects in process. Only one of the eleven incinerator additions occurred in 1995, and this facility processed explosives exclusively.

Figure 3-4
Status of Cement Kiln Projects



* Negative numbers denote abandonments, closures and permit denials. In 1992, 21 new proposals are applications for interim status under the BIF rule by kilns that already burn toxic waste.

Future Prospects

Despite the inherent difficulty of forecasting the commercial hazardous waste combustion market, the data show several unequivocal trends.

The first is that the recent collapse of cement kiln and LWAK activity in this market will not continue, for the simple reason that there is only one participant left. That facility — Ash Grove Cement Company — recently acquired a final BIF permit. To date, it is the only one to do so.

[13] *Hazardous Waste Consultant*, March 1992.

Second, the industry will clearly be more heavily concentrated, as major players continue to buy former competitors. Consolidation makes strategic sense, from a theoretical perspective, because of the high entry and exit costs. Uncertainty in market demand exposes individual facilities to a high risk of being unable to finance their substantial sunk costs. However, large firms that control a number of different stages in the waste treatment, storage and disposal process, employing a range of technologies, can better hedge against shifts in preferred waste management methods in response to unexpected regulatory developments or unforeseeable technological changes in client industries.

Consolidation is also the theoretically expected response to the fierce price competition that characterized the 1990s. In fact, with the exit of most BIFs from the commercial hazardous waste combustion market and with the ongoing reduction of capacity (often after an acquisition), two of the three most important reasons cited by industry participants for depressed prices are greatly ameliorated: overcapacity and competition between cement kilns and incinerators.[14] In 1994, *EI Digest* reported that commercial incinerator utilization rates had rebounded to 70 percent, and consolidations, conversions and closures have continued strongly since then.[15]

Significant obstacles clearly remain. Waste minimization continues to threaten the total size of the market. However, the previous discussion of BRS data noted that even in the face of declining aggregate volumes of hazardous waste, commercially incinerated quantities could nevertheless rise. Public opposition to new permits continues, but this is less of an issue since the industry is more interested in consolidating ownership and closing excess capacity than applying for new permits. The Hazardous Waste Identification Rule could drastically reduce the quantity of wastes designated as hazardous. On the other hand, some industry observers think that HWIR might increase the flow of hazardous wastes to commercial combustors because the rule could allow generators to close and clean up their sites that currently remain open because of high post-closure costs.[16]

While no one forecasts a financial boom, the elements appear to be in place to reverse some of the severe stresses to date. High entry and exit barriers plus horizontal and vertical integration make a recipe for economic empowerment. Major players expect market demand to stabilize or grow slightly. Finally, a growing number of states have adopted differential fees for disposing of wastes — fees that favor combustion over land disposal.

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[14] *EI Digest*, June 1994.

[15] Cited in the HWCR EIA, page 2-14.

[16] *EI Digest*, January 1996.

3.4 In-Scope Facilities

In 1994, EPA received data from thirteen Industrial Waste Combustors relevant to the rule, including detailed data from eleven. This section of the profile examines the questionnaire data as well as other, secondary source data for these facilities. The questionnaire requested data for the 1991 and 1992 fiscal years.

Three firms account for approximately 62 percent of in-scope facility revenue. The diversity of these three firms reflects the diversity of the in-scope facilities in general. They include a large, international chemical and pharmaceutical manufacturer, a cement manufacturer and a waste management firm. Nine firms, have revenue shares of between 5 and 10 percent.

Market Structure and Size

While the choice of combustion over alternative methods of managing wastes may respond sensitively to economic and regulatory events, the financial health of in-scope facilities does not share the volatility characteristic of combustion quantities. In addition to the fact that a few large firms dominate a market of relatively atomistic customers, commercial hazardous waste combustion tends to be a relatively small part of all the activities at the in-scope facilities and the firms that own them.

The 9 facilities with detailed survey data (2 facilities were not given detailed surveys) employ 1,776 persons (full-time equivalent), but the facilities report that only half of these (850) are directly related to incinerator operations. Survey respondents associate 65 percent of their total assets with hazardous waste combustion.

Including non-incineration as well as incineration-related activity, the largest facility in terms of asset size accounted for 15.1 percent of all assets at in-scope facilities, while the largest employer accounted for 15.9 percent of employment in the industry. Some sites that are relatively small in terms of assets have a high share of employment. Relative employment size does not correlate well with relative asset size.

The column titled “Self-Reported Market Share” presents responses to a question about each facility's volume of combusted wastes as a share of the total volume of wastes generated within the geographic area the respondent serves. Because the question is worded imprecisely in the questionnaire, responses should be interpreted as rough estimates of the scale of competitor activity, as perceived by respondents.

Five facilities received wastes from as far as Puerto Rico or Canada. While no facility identified Mexico as a waste source, that fact alone does not exclude the possibility of receiving wastes from a Mexican generator that is closer than some other source areas, such as the U.S. or Canada. Trade publications, however, indicate that Mexico is a fairly small source of wastes combusted in the U.S.

Since 1992, the industry has consolidated under fewer parent firms, and many of the in-scope facilities have ceased hazardous waste combustion. In the questionnaire, two respondents identified themselves as "independently owned." However, as of the beginning of 1997, every one of the in-scope respondents belonged to a multi-site firm.[17]

Most of the discussion of current conditions in the in-scope industry will be presented at the level of the firm, because of the consolidations. The ability of facilities to finance compliance costs should be seen in the context of parent corporation financial health and market strategies. Information regarding firms come from two trade journals — *EI Digest* and *Hazardous Waste Consultant* — in addition to the following sources: Form 10-Ks, attachments to questionnaire responses, facility and parent firm press releases, *Canadian News Wire* and the "Market Guide Company Snapshot."

The largest firm in the sample owns three facilities that earned approximately one-third of all revenues earned by the thirteen respondents in the period of analysis. The firm claims that it faces insignificant monopsonistic power, having several thousand customers, none of which account for more than 5 percent of revenues.

Consolidation among suppliers in the commercial hazardous waste combustion market appears to have augmented the market power of suppliers asymmetrically, compared to customers. The expectation by industry observers that prices will recover from their recent declines supports the implications of the structural developments in the market.

The largest employer in the sample accounts for more than one out of seven employees among in-scope facilities that provided detailed questionnaire responses. This firm sold its non-hazardous solid waste operations and at the same time purchased a hazardous waste incinerator from a U.S. firm that exited the industry. The new

[17] While it is probable that some of this difference may arise from the ambiguous interpretation of the question's term "independently owned," EPA has identified the pattern of consolidation on a facility-by-facility basis from secondary sources.

owner plans to cease the facility's hazardous waste combustion and use it to pre-process material for another incinerator bought in the same transaction.

One firm that represents the experience of cement kilns owns two in-scope facilities and has recently exited the hazardous waste combustion market, along with all but one of its colleagues in the cement industry. Although cement kilns have chosen to exit the hazardous waste combustion market, their ability to support compliance costs appear to be greater now than during the questionnaire period.

Questionnaire responses identify other incinerators and BIFs as the primary source of competition. Only one respondent identified a landfill as a major competitor in the respondent's market. When asked to estimate their own market shares and the market shares associated with selected other entities in the same market, these self-reported market shares ranged from 3 to 50 percent, with a revenue-weighted mean of 5 percent.

Financial Condition

The financial performance of in-scope facilities varies widely between facilities as well as over time. This instability applies to both the questionnaire and current periods, making generalizations and comparisons difficult. Revenues are currently increasing for the in-scope firms for which financial data were available from public sources, and corporate Form 10-Ks indicate less financial stress in recent years than they did in the questionnaire period. Directly comparable data are scarce, though, and so this section will present some summary facility data from 1991/92 and then select highlights from available financial news regarding the recent performance of firms that own in-scope facilities.

Return on assets is a more stable measure of profitability than return on equity, which can be and frequently is manipulated through debt-equity management. Return on assets averaged 11.57 percent in 1991 and 18.37 percent the following year. Both of these are healthy values, but they exclude two facilities that changed ownership during the period and were not able to provide complete data.

Management Strategies

Hazardous waste combustors have responded to the financial stress of the 1980's and 1990's by integrating both horizontally and vertically, resulting in the industry structure described earlier in this chapter.

These firms continue to pursue a strategy of reducing market risk by mixing asset types and closing particularly volatile facilities.

One firm that exemplifies the current strategies describes itself as a "one source service provider" with over a dozen facilities in 1996. Its acquisitions have sought to integrate vertically rather than horizontally, closing some duplicative capacity while maintaining facilities that diversified its capabilities.

However, the firm has not completely eliminated its access to the capacity it has closed. Recognizing the variability in market demand, this firm created a "ready" status where "incineration can begin quickly when market demand warrants."[18] This kind of flexible capacity is a strategy that has helped a number of industries retain market share during periods of peak demand without incurring high costs of idle capacity during periods of lower demand.

The same illustrative firm also developed an interesting strategy of accumulating wastes for periodic rather than continuous incineration. Therefore, facilities can operate at economically and technically efficient flow rates even if the total quantity of wastes varies widely from one month or year to the next.

3.5 Representativeness of the Questionnaire Period

At the time of the questionnaire, EPA selected 1991 and 1992 as the years for which respondents would report economic and financial data. These were the most recent complete data available at the time, and no other years are more representative of the industry than the selected years.

The reason for this is two-fold. First, the Industrial Waste Combustors Industry has undergone a continuous progression of changes from the 1980's to the present. The most recent data resemble the current state of the industry more than any prior year of data. This is not true of all industry questionnaires; industries that exhibit a cyclical pattern of performance may be better represented by selecting a specific segment of the business cycle rather than the most recent year.

Another consequence of the monotonic pattern of the industry's development is that a brief period is more accurate than a broad period of analysis. Unlike a cyclical industry, where gathering data over several years can

[18] From a Form 10-K filing with the Securities and Exchange Commission.

allow averaging over a business cycle, an industry undergoing continuous change in one direction over a long period of time is not expected to return to conditions present at any point in the past. Therefore averaging over a greater period of time includes increasingly irrelevant data. EPA's choice of two years rather than more provides a snapshot that is less "contaminated" by conditions at an earlier period that the industry had left behind. Choosing two years rather than one allows some accommodation of random shocks not associated with time and also allows EPA to recognize and analytically accommodate facilities that began or ceased operations immediately before or after a particular year of data.

The period selected does capture characteristics of the industry that followed some significant consolidations, though significant further acquisitions have continued in intervening years. However, even current data are not likely to reflect the impact of other management strategies described above relating to capacity control. Any trends in profitability due to increasing integration since the questionnaire years probably would not be statistically distinguishable from the profitability data gathered, because of the extremely high variability of observed data. The standard deviation of observed return on assets across the relevant facilities, for instance, is over 1.05 (105 percent) — far overwhelming any change in observed return on assets ratios one could reasonably expect between the questionnaire years and the present.[19]

In summary, the questionnaire period probably represents the current economic and financial condition of the industry better than any other period that could have been selected at the time. Current quantitative measures of financial performance are likely to be statistically indistinguishable from measures calculated on questionnaire data. However, the industry has undergone some important changes since the questionnaire. Integration has continued, with Canadian-ownership increasing its presence in the hazardous waste market. The industry has introduced some management strategies aimed at reducing the risk of demand fluctuations.

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[19] This 1.05 value is not the same as the observational standard deviation from which a confidence interval can be directly calculated. However, combined with the small number of observations, the variation in profitability presented does indicate the difficulty of determining statistically significant changes.

Chapter 4

Facility Impact Analysis

4.0 Introduction

The facility-level economic impact analysis assesses how the proposed Industrial Waste Combustors rule would affect individual facilities, as opposed to the firms that own them. While facilities are geographically contiguous entities, a firm might own more than one facility, at various locations. The next chapter assesses firm-level impacts, but this chapter provides the basis for estimating the extent of facility closures and associated production and employment losses that may result from the rule.

This analysis draws largely from facility data obtained from EPA's 1994 Waste Treatment Industry Phase II: Incinerators Questionnaire. Engineering analysis of technical questionnaire and other data generated estimates of facility costs of complying with each regulatory option. In this chapter, EPA uses economic and financial responses from the questionnaire to evaluate the impact of compliance costs on the financial condition of facilities.

Based on this analysis, EPA finds that the proposed incinerator rule is economically achievable and will not subject affected facilities to unmanageable or unreasonable financial or economic burdens.

The major sections of this chapter explain the methodology behind each component of the facility impact analysis and present the results. EPA applied two kinds of financial tests:

- **<u>After-Tax Cash Flow Test</u>**. This test examines whether a facility loses money on a cash basis. If a facility's cash flow is negative when averaged over the period of analysis, then the facility's management and ownership are determined to experience unmanageable or unreasonable financial or economic burdens.

- **<u>Compliance Cost Share of Revenue</u>**. This test examines whether a facility's estimated compliance costs amount to more than 5 percent of revenue, in which case the facility would be determined to experience unmanageable or unreasonable financial or economic burdens.

EPA applied the cash flow test to all eleven facilities that returned detailed questionnaires. Two additional facilities that are expected to incur costs under the Industrial Waste Combustors rule did not submit the detailed financial data necessary for the cash flow test, so EPA conducted only the compliance cost share of revenue test for these two facilities.

4.1 Compliance Costs

EPA technical analysis yielded estimates of how much each facility would need to spend to comply with each regulatory option.[20] The estimated expenditures were comprised of an *operating and maintenance costs* component, which recurs annually, and a one-time *capital cost of compliance* component. In order to perform the economic impact tests, EPA combined the two cost components into a single *annualized* cost. When the annualized cost is properly calculated, the facility should be indifferent between a) incurring the annualized cost every year, and b) incurring a capital cost plus operating and maintenance cost the first year and then only operating and maintenance costs each subsequent year.

EPA conducted the facility impact analysis on an after-tax basis because after-tax cash flow is the portion of cash flow that the facility can use to meet regulatory compliance costs. It is also a commonly used indicator of the ongoing viability of business enterprises. In this analysis, EPA calculated after-tax annualized costs (ATC_{Ann}) as follows:

$$ATC_{Ann} = ATC_{OM} + ATC_{C,Ann}$$

where

ATC_{Ann}	=	After-tax, annualized cost of compliance
ATC_{OM}	=	After-tax operating and maintenance cost of compliance
$ATC_{C,Ann}$	=	After-tax, annualized capital cost of compliance

The only adjustment needed to calculate ATC_{OM} from technical estimates of operating and maintenance costs is to subtract the offsetting benefit the facility would experience from reduced taxes. EPA used a marginal

[20] See Development Document for Proposed Effluent Limitations Guidelines and Standards for Industrial Waste Combustors, EPA-821-R-97-011

corporate tax rate of 34 percent, which implied that for every dollar of operating and maintenance compliance costs, before taxes, the facility would lose 66 cents in after-tax profit. Therefore,

$$ATC_{OM} = (1-\tau) \times C_{OM}$$

where

ATC_{OM}	=	After-tax operating and maintenance cost of compliance
C_{OM}	=	Operating and maintenance cost of compliance (pre-tax)
τ	=	Marginal corporate tax rate (34% in this analysis)

The technical estimates of capital costs of compliance need to be annualized as well as adjusted for taxes. EPA annualized capital costs by amortizing them over 15 years, using a discount rate of 7 percent. The 15 year time period conforms with EPA practice and reflects a technical estimate of the useful life of the relevant kinds of capital. The 7 percent discount rate — also OMB's measure of the social opportunity cost of capital (see Executive Order #12866) — represents a reasonable estimate of the real, after-tax cost of capital for a typical facility using both equity and debt financing.[21] EPA showed, in developing the Industrial Waste Combustors rule impact methodology, that annualized compliance costs are only modestly sensitive to large variations in the discount rate.

To calculate offsetting tax benefits, EPA used straight-line depreciation over 15 years — the estimated useful lifetime of the relevant capital goods. Therefore, the facility applies 1/15th of the capital cost of compliance to each year's income calculations for tax purposes. Current tax codes allow businesses to use straight-line depreciation or a Modified Accelerated Cost Recovery (MACRS) depreciation schedule.[22] EPA chose the straight-line method for this analysis because it is the simpler and more conservative method.

The annualized, after-tax capital cost of compliance is calculated as follows:

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[21] EPA performed a sensitivity test in the Metal Products and Machinery Phase 1 proposed effluent guidelines economic analysis to show that annualized costs are quite insensitive to discount rates over a reasonable range. In a review of prior economic impact analyses, the Office of Water similarly found that the use of OMB's 7% rate is probably preferable to collecting facility-specific measures of costs of capital because of the burdensome data requirements and the practically insignificant analytical benefits associated with alternatives. (See "Review of Data Gathering and Methodology Issues for Effluent Guideline Economic Impact Analyses (Draft)," August 1996.)

[22] The "15-Year" class of depreciable property includes "municipal wastewater treatment plants" and other property with a class life of 20 to 25 years. *1992 U.S. Master Tax Guide*, Commerce Clearing House, Inc., 1991.

$$ATC_{C,Ann} = \frac{r}{1-(1+r)^{-t}} \times C_C - \frac{C_C}{t} \times \tau$$

where

$ATC_{C,Ann}$	=	After-tax, annualized capital cost of compliance
C_C	=	Capital cost of compliance
r	=	Discount rate (7% in this analysis)
t	=	Amortization period (15 years)
τ	=	Corporate tax rate (34%)

In the above formula, the first expression on the right-hand side is the annualized equivalent of the lump sum capital cost, C_C. The second expression is the offsetting benefit in the form of reduced taxes. Each year, the taxable income is reduced by 1/15 the total capital cost of compliance. The tax associated with that depreciation is τ times the depreciation.

Substituting numeric values into the above formulas, the calculation of annualized, after-tax compliance costs becomes:

$$ATC_{Ann} = 0.66 \times C_{OM} + (0.1098 \times C_C - \frac{C_C}{15} \times 0.34)$$

ATC_{Ann}	=	After-tax, annualized cost of compliance
C_C	=	Capital cost of compliance
C_{OM}	=	Operating and maintenance cost of compliance

ATC_{Ann} is the compliance cost subtracted from baseline cash flow in the after-tax cash flow test, and it is also the value compared to total revenue in the compliance cost share of revenue test.

Offsetting Revenue Increases

While some facilities might offset a portion of compliance costs by passing them through to customers in the form of higher prices, EPA used the conservative assumption in this analysis of zero cost pass-through. Since EPA finds that no facilities would bear unmanageable impacts in the zero cost pass-through case, it follows that none would bear unmanageable impacts under any other cost pass-through assumption.

Some facilities might also substitute non-hazardous for hazardous waste or change from in-scope combustion activities to alternative waste treatment techniques. The current facility impact analysis excludes these dynamic, long-run responses that can mitigate the financial impact of effluent guidelines.

Aggregate compliance costs for the selected options are shown in Table 4-1 below.

Table 4-1. Total Costs of Proposed Regulatory Options

Proposed Options	Sites	Total Capital Costs (Mil 1992$)	Total O&M Costs (Mil 1992$)	Total Post-tax Annualized Costs (Mil 1992$)
BPT/BCT/BAT= Option B	8	6.346	1.255	1.381
PSES=Option A	3	2.090	0.529	0.531

4.2 After-Tax Cash Flow Test (Severe Impacts)

The after-tax cash flow test is conducted both in the baseline case and post-compliance case as an indicator of severe impacts. If a facility's baseline cash flow is not negative, but, after incurring estimated compliance costs, the facility's cash flow becomes negative, then EPA would determine that facility to experience unmanageable or unreasonable financial or economic burdens *as a result of the proposed rule* and the facility will likely close. If, on the other hand, a facility exhibits negative cash flow before the adoption of an Industrial Waste Combustors rule, then the negative cash flow must be attributed to some prior cause.

EPA conducted the after-tax cash flow test once using facility-wide income statement values and again using revenues, costs and expenses specifically associated with waste treatment operations. The former analysis measures the impact of alternative regulatory options on the financial health of the affected business entity. The second analysis yields additional insight into how management may perceive the impact the Industrial Waste Combustors rule has on the mix of operations within a facility.

Methodology

The after-tax cash flow test involves calculating, for each sample facility, the average after-tax cash flow (ATCF) over the years for which income statement data were obtained in the questionnaire. The calculations are as follows:

1. Express all income statement values for a sample facility as a two-year average, in 1992 constant dollars, based on the Producer Price Index for finished goods (PPI). The PPI is the appropriate deflator because waste combustion services are purchased primarily by commodity producers late in the production process. The questionnaire requested financial data for 1991 and 1992, and most facilities reported values for each of these years. However, a few facilities were not in operation in one or more of these years, or accounting procedures changed during the period in a way that precluded responding for one of the years. For these facilities, the average is the properly deflated value for the year for which the respondent reported data.

2. Compute facility-level after-tax cash flow in 1992 dollars for each year of data. *After-Tax Cash Flow* (ATCF) was computed as follows:

$$ATCF = (1-\tau)(R-C_T+D)$$

where

ATCF	=	After-tax cash flow
R	=	Total revenue (1991-1992 average)
C	=	Total costs and expenses (1991-1992 average)
D	=	Depreciation expense (1991-1992 average)
τ	=	Average tax rate, calculated by dividing average reported income taxes by average earnings before taxes

3. Repeat using revenue and costs specific to waste treatment operations.[23] In this iteration, the relevant revenue is the revenue from waste treatment, as reported in the questionnaire responses. While costs were reported specifically for waste treatment, overhead expenses — including sales, general and administrative, and depreciation expenses — were allocated to waste treatment in proportion to costs. The calculation of after-tax cash flow becomes:

$$ATCF_{wt} = (1-\tau)[R_{wt}-(C_{wt}+\omega\times C_{OH})+\omega\times D]$$

where

$ATCF_{wt}$	=	After-tax cash flow, waste treatment operations alone
R_{wt}	=	Waste treatment revenue (1991-1992 average)
C_{wt}	=	Waste treatment costs (1991-1992 average)
C_{OH}	=	Facility overhead expenses (1991-1992 average), including sales, G&A, interest and depreciation
D	=	Depreciation expense (1991-1992 average)
ω	=	Share of facility costs attributable to waste treatment, recycling/recovery, and/or disposal operations, calculated by dividing total waste treatment costs by the sum of waste treatment costs, costs of goods sold for products manufactured, and cost of other goods and services sold
τ	=	Average tax rate, calculated by dividing average reported income taxes by average earnings before taxes

4. Calculate post-compliance cash flows. The above calculations yielded baseline after-tax cash flows, based on questionnaire responses. EPA estimated post-compliance cash flows by subtracting after-tax, annualized compliance costs from baseline cash flows. Thus,

$$ATCF_{pc} = ATCF - ATC_{Ann}$$
$$ATCF_{wt,pc} = ATCF_{wt} - ATC_{Ann}$$

[23] The cash flow test can be further narrowed to target combustion operations alone, using the same methodology described here, but substituting combustion response values for waste treatment response values. EPA performed this alternative analysis and found no difference in results.

where

ATCF	=	Post-compliance after-tax cash flow
$ATCF_{wt}$	=	Post-compliance after-tax cash flow, waste treatment operations alone
ATC_{Ann}	=	After-tax, annualized cost of compliance

Results

Excluding the two closed facilities, EPA applied the after-tax cash flow test to nine facilities for which detailed data were available and usable and found none that would experience negative cash flows as a result of any of the regulatory options considered. Detailed facility data were not available for two facilities. Of the nine facilities subjected to the after-tax cash flow test, six submitted data to support an analysis of cash flow from waste treatment operations alone as well as an analysis of facility-wide cash flow. Table 4-2 presents a summary of these results.

Table 4-2 shows that EPA applied the after-tax cash flow test to six facilities based on waste treatment operations, alone. Out of these facilities, one indirect discharger exhibited negative after-tax cash flow post-compliance case but not in the baseline. Therefore, this facility's waste treatment operations are estimated to close post-compliance or otherwise experience severe impacts.

Table 4-2. Summary of After-Tax Cash Flow Test Results

	Waste Treatment Operations		All Facility Operations		No Data
Facility Type	**Baseline**	**Post-Compliance**	**Baseline**	**Post-Compliance**	
All Facilities	*6*	*6*	*9*	*9*	*2*
Cash flow < 0	0	1	0	0	—
Direct Dischargers	*5*	*5*	*7*	*7*	*1*
Cash flow < 0	0	0	0	0	—
Indirect Dischargers	*1*	*1*	*2*	*2*	*1*
Cash flow < 0	0	1	0	0	—

When the after-tax cash flow test is performed on revenues and costs from all activities at each facility, all nine open facilities with detailed financial data have positive after-tax cash flow both in the baseline and post-compliance cases. Therefore, there are no estimated facility closures due to the rule.

4.3 Compliance Cost Share of Revenue Test (Moderate Impacts)

In addition to the after-tax cash flow test, EPA also conducted a compliance cost share of revenue analysis that offers perspectives on economic impacts that cash flow analysis cannot offer. In this test, annualized compliance costs (C_{Ann}) calculated in the usual way are expressed as a ratio to revenues. Compliance costs that amount to less than 5 percent of revenues are judged to cause moderate adverse impacts short of closure, though ratios greater than 5 percent should not be interpreted as necessarily unachievable. EPA has frequently used this standard in the past to measure the financial impact of compliance costs.

EPA performed the compliance cost share of revenue test once using facility-wide revenues and again using revenues specifically associated with waste treatment operations. As in the cash flow test, the facility-level analysis provides the best assessment of economic achievability for the regulated business entity.

Since this test requires less detailed data, EPA was able to include all eleven open facilities in the share of revenue test, even though two of these facilities submitted only a screener survey. However, the two screener surveys contained only sufficient data to compare compliance costs to waste treatment revenue, and not to overall facility revenue. Compliance costs amounted to less than 2.4 percent of facility revenues in every case analyzed. Table 4-3 summarizes the results.

Table 4-3. Summary of Compliance Cost Share of Revenue Test Results

Facility Type	Waste Treatment Operations	All Facility Operations*
All Facilities	*11*	*9*
Share > 5%	2	0
Direct Dischargers	*8*	*7*
Share > 5%	0	0
Indirect Dischargers	*3*	*2*
Share > 5%	2	0

* 2 facilities submitted insufficient data for this test.

When compliance costs are expressed as a share of waste treatment revenues alone, some high ratios appear, due to exceptionally low waste treatment revenues reported by some respondents. One site, for instance, reported that revenues from waste treatment comprised only 0.02 percent of facility revenues.

Low revenue responses can occur when the waste treatment operations are not intended to generate revenue alone. The previously mentioned site, for instance, is a cement manufacturer. From an economist's perspective, the relevant revenue for a compliance costs share of revenue test would include the portion of cement manufacturing revenue attributable to waste combustion. Combustion fees measure only a small part of the financial benefit that the facility gains from waste treatment operations. In this case, the compliance cost share of revenue test could exorbitantly exaggerate the actual, economic burden of compliance costs at the waste treatment level.

Low reported waste treatment revenues may also reflect a difference in opinion between what EPA considers waste treatment operations, for the purposes of the regulation, and what the respondent to the economic and financial portion of the questionnaire considered to be waste treatment. If so, these exceptionally high ratios should be viewed as anomalous observations that do not accurately reflect the ratio of costs incurred under a regulation by a set of operations to the revenues earned by those same regulated operations.

In spite of the anomalously high values for some sites, the weighted average compliance cost share of waste treatment revenue ranges from 0.48 percent 1.07 percent. Viewed together with the facility-level results, the compliance cost share of revenue test suggests that waste treatment line operations at 4 out of 18 analyzed sites might exhibit high compliance cost to revenue ratios. However, none of the facilities are likely to experience financial stress as a consequence.

Chapter 5

Firm-Level Impact Analysis

The firm level analysis evaluates the effects of regulatory compliance on firms owning one or more affected Industrial Waste Combustor facilities. It also serves to identify impacts not captured in the facility level analysis. For example, some companies might be too weak financially to undertake the investment in the required effluent treatment, even though the investment might seem financially feasible at the facility level. Such circumstances can exist at companies owning more than one facility subject to regulation.

The firm-level analysis assesses the impacts of compliance costs at all facilities owned by the firm. These impacts are assessed using ratio analysis, which employs two indicators of financial viability: the rate of return on assets (ROA) and the interest coverage ratio (ICR). ROA is a measure of the profitability of a company's capital assets. It is computed as the earnings before interest and taxes minus taxes divided by total assets. ICR is a measure of the financial leverage of a company. It is computed as the earnings before interest and taxes divided by interest expense.

Two firms each own three affected Industrial Waste Combustor facilities and are subjected to the ratio analysis.[24] The first step is to calculate the baseline ROA and ICR for each company absent the proposed rule. The post-compliance analysis then calculates the ratios after the projected investment in wastewater treatment equipment and the associated compliance costs. One firm experiences no measurable effect as the result of compliance with the proposed rule. Neither the ROA nor the ICR changes between the baseline and postcompliance analysis. The second firm experiences an insignificant decline in ROA and a minor decline in ICR. The decline in ICR, while significant in percentage terms, is an artifact of the firm's extremely low level of debt. As a result, the two firms are found to be not significantly impacted by the proposed rule.

[24] In order to protect confidential business information, specific numbers from the ratio analyses cannot be provided.

Chapter 6

Foreign Trade Impacts

To the extent that effluent guidelines change the total production costs of domestic businesses without similarly affecting production costs for foreign competitors, regulation may affect the national balance of trade. Furthermore, if compliance costs cause facility closures, domestic and foreign facilities would compete to replace, in whole or in part, the sales associated with the closing facility.

However, based on questionnaire responses and the profile analysis, EPA finds foreign trade in the Industrial Waste Combustors Industry to be practically non-existent, due to legal and economic restrictions on the transport of wastes across national borders. Therefore, even though Canadian firms have purchased some U.S. hazardous waste incinerators recently, and some U.S. facilities receive some wastes from Canadian sources, these transactions will have no appreciable effect on the trade balance. EPA finds that the proposed rule will not have a significant adverse impact of foreign trade.

Chapter 7

Community Impacts

The community impact analysis builds from the facility impact analysis to determine if facility closures might adversely affect the general public welfare. EPA assesses community impacts by estimating the expected change in employment in communities with Industrial Waste Combustors that are affected by the proposed rule. Possible community employment effects include the employment losses in the facilities that are expected to close because of the regulation and the related employment losses in other businesses in the affected community. In addition to these estimated employment losses, employment may increase as a result of facilities' operation of treatment systems for regulatory compliance. It should be noted that job gains will mitigate community employment losses only if they occur in the same communities in which facility closures occur.

The proposed rule is estimated to result in the post-compliance closure of the waste burning operations of one facility. The post-compliance closure results in the direct loss of 27 Full-Time Equivalent (FTE) positions. Secondary employment impacts are estimated based on multipliers that relate the change in employment in a directly affected industry to aggregate employment effects in linked industries and consumer businesses whose employment is affected by changes in the earnings and expenditures of the employees in the directly and indirectly affected industries. The Bureau of Economic Analysis calculates appropriate multipliers estimated by its Regional Input-Output Modeling System (RIMS).[25] Multiplying the RIMS state-specific multiplier of 5.334 to the 27 direct FTE losses leads to an estimated community impact of 144 total FTE losses as the result of the proposed rule. The county in which the closure is projected to occur has a current employment of 173,242 FTEs dispersed among 9,922 establishments.[26] The direct and secondary job losses represent 0.08 percent of current employment in the affected county.

The FTE losses are mitigated by the job gains associated with the operation of control equipment which are estimated to be 9 FTEs nationally. The secondary and indirect effects can be estimated at the national level by using the average multiplier of 4.049, resulting in an estimate of 36 total FTE gains associated with the pollution control equipment.

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[25] The “direct-effect multiplier” measures the “total change in number of jobs in all row industries for each additional job in the industry corresponding to the entry.” Source: *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II) 2nd Edition*, Bureau of Economic Analysis, May 1992.

[26] U.S. Bureau of the Census, *County Business Patterns 1994*, U.S. Government Printing Office, Washington, DC, 1996.

Chapter 8

Impacts on New Sources

The proposed rule includes limitations that will apply to new discharging sources within the Industrial Waste Combustors Industry. EPA examined the impact of these regulations for new dischargers to determine if they would impose an undue economic and financial burden on new sources seeking to enter the industry.

In general, EPA finds that, when new and existing sources face the same discharge limitations, new sources will be able to comply with those limitations at the same or lower costs than those incurred by existing sources. Engineering analysis indicates that the cost of installing pollution control systems during new construction is generally less than the cost of retrofitting existing facilities. Thus, a finding that discharge limitations are economically achievable by existing facilities also means that those same discharge limitations will be economically achievable to new facilities.

Chapter 9

Regulatory Flexibility Analysis

Since none of the facilities in the analysis are owned by small businesses under the Small Business Administration (SBA) definition, EPA has concluded that the proposed rule, if adopted, would not have a significant economic impact on a substantial number of small entities.

In evaluating the small business status of each facility, EPA used SBA standards for testing the status of the parent of each facility. These standards specify a revenue or employment threshold for each SIC code, below which the firm is considered a small business.

EPA obtained SIC codes for parent firms from SEC filings of the firms themselves. When an SIC code was not cited, EPA used an SIC code of 3241 for known cement manufacturers and an SIC code of 4953 for known refuse companies. The remaining firms were associated with SIC codes through a search of EPA's Facility Index System (FINDS). Within the database, Dun & Bradstreet SIC assignments were given preference; in their absence, the analysis used the RCRA SIC assignment.

Some firms could not be assigned to a single SIC. In these cases, the threshold is a two-part value comprised of both the highest employment threshold and revenue threshold over all the SIC codes that apply to the firm. If firm-level revenues *or* employment failed to exceed the relevant threshold, the facility would be categorized as a small business.

One site is a very large conglomerate. Instead of examining all the SIC codes that actually apply to the parent firm, the thresholds used are the highest employment and revenue thresholds among all industries.

Chapter 10

Summary Environmental Assessment

10.1 Introduction

This chapter quantifies the water quality-related benefits associated with achievement of the proposed BPT/BCT/BAT and PSES effluent limitations for Industrial Waste Combustors (IWCs). Based on site-specific analyses of current conditions and changes in discharges associated with the proposal, the Agency estimated instream pollutant concentrations for 17 priority and nonconventional pollutants from direct and indirect discharges using stream dilution modeling. The potential impacts and benefits to aquatic life are projected by comparing the modeled instream pollutant concentrations to published EPA aquatic life criteria guidance or to toxic effect levels. Potential adverse human health effects and benefits are projected by: (1) comparing estimated instream concentrations to health-based water quality toxic effect levels or criteria; and (2) estimating the potential reduction of carcinogenic risk and noncarcinogenic hazard (systemic) from consuming contaminated fish or drinking water. Upper-bound individual cancer risks, population risks, and systemic hazards are estimated using modeled instream pollutant concentrations and standard EPA assumptions. Modeled pollutant concentrations in fish and drinking water are used to estimate cancer risk and systemic hazards among the general population, sport anglers and their families, and subsistence anglers and their families. EPA used the findings from the analyses of reduced occurrence of instream pollutant concentrations in excess of both aquatic life and human health criteria or toxic effect levels to assess improvements in recreational fishing habitats that are impacted by IWC wastewater discharges (ecological benefits). These improvements in aquatic habitats are then expected to improve the quality and value of recreational fishing opportunities.

Potential inhibition of operations at publicly owned treatment works (POTW) and sewage sludge contamination (here defined as a sludge concentration in excess of that permitting land application or surface disposal of sewage sludge) are also evaluated based on current and proposed pretreatment levels. Inhibition of POTW operations is estimated by comparing modeled POTW influent concentrations to available inhibition levels. Contamination of sewage sludge is estimated by comparing projected pollutant concentrations in sewage sludge to available EPA regulatory standards for land application and surface disposal of sewage sludge. Economic productivity benefits are estimated on the basis of the incremental quantity of sludge that, as a result of reduced pollutant discharges to POTWs, meets criteria for the generally less expensive disposal method, namely land application and surface disposal. In addition, the potential fate and toxicity of pollutants of concern associated with IWC wastewater are evaluated based on known characteristics of each chemical.

These analyses are performed for discharges of the eleven commercial Industrial Waste Combustors (eight direct dischargers and three indirect dischargers) identified as within the scope of this regulation. The following sections provide the results of these analyses, organized by the type of discharge (direct and indirect).

10.2 Comparison of Instream Concentrations with Ambient Water Quality Criteria (AWQC)/Impacts at POTWs

The water quality modeling results for 8 direct IWC facilities discharging 17 pollutants (metals) to 8 receiving streams indicate that at current discharge levels, instream concentrations of 3 pollutants are projected to exceed acute aquatic life criteria or toxic effect levels in one of the 8 receiving streams (12 percent). Instream concentrations of 8 pollutants are projected to exceed chronic aquatic life criteria or toxic effect levels in 50 percent (4 of the total 8) of the receiving streams. The proposed BAT regulatory option will reduce acute aquatic life excursions from three pollutants to two pollutants. The regulatory option will also reduce the chronic aquatic life excursions from eight pollutants to seven pollutants in the four receiving streams. Additionally, at current discharge levels, instream concentrations of two pollutants (using a target risk of 10^{-6} (1E-6) for carcinogens) are projected to exceed human health criteria or toxic effect levels (developed for consumption of water and organisms) in 50 percent (4 of the total 8) of the receiving streams. The instream concentration of one pollutant (using a target risk of 10^{-6} (1E-6) for carcinogens) is projected to exceed the human health criteria or toxic effect levels (developed for organisms consumption only) in 25 percent (2 of the total 8) receiving streams. The proposed BAT regulatory option will eliminate human health criteria or toxic effect level (developed for consumption of water and organisms) excursions by one pollutant, but four receiving streams are still impacted. Human health criteria or toxic effect level (developed for organisms consumption only) excursions are eliminated in one of the two impacted receiving streams at the proposed BAT regulatory option. Under the proposed BAT regulatory option, pollutant loadings are reduced 29 percent.

Modeling results for 3 indirect IWC facilities that discharge 17 pollutants (metals) to 3 POTWs located on 3 receiving streams indicate that at current discharge levels no instream pollutant concentrations are expected to exceed acute aquatic life criteria or toxic effect levels. The instream concentration of one pollutant is projected to exceed chronic aquatic life criteria or toxic effect levels in 33 percent (1 of the total 3) receiving streams. The proposed pretreatment regulatory option will eliminate this chronic aquatic life excursion. Additionally, at current discharge levels, the instream concentration of one pollutant is projected to exceed both human health criteria or toxic effect levels (developed for consumption of water and organisms) and human health criteria or toxic effect levels (developed for organisms consumption only) in one receiving stream. Projected excursions are eliminated by the proposed pretreatment regulatory option. Pollutant loadings are reduced 97 percent.

In addition, POTW inhibition problems and sludge contamination problems are projected only at current discharge levels. Inhibition problems are projected to occur at 33 percent (1 of the 3) of the POTWs from the discharge of one pollutant. The proposed pretreatment regulatory option eliminates any inhibition problem. Sludge contamination is projected to occur at 67 percent (2 of the 3) of the POTWs due to the discharge of three pollutants. The proposed pretreatment regulatory option will also eliminate sludge contamination problems.

10.3 Human Health Risks and Benefits

The excess annual cancer cases at current discharge levels and, therefore, at proposed BAT and proposed pretreatment discharge levels are projected to be far less than 0.5 for all populations evaluated from the ingestion of contaminated fish and drinking water for both direct and indirect IWC wastewater discharges. A monetary value of this benefit to society is, therefore, not projected. Systemic toxicant effects are projected from fish consumption for both direct and indirect discharges. For direct discharges, systemic effects are projected to result from the discharge of three pollutants to three receiving streams at current discharge levels. An estimated population of 705 subsistence anglers and their families are projected to be affected. At the proposed BAT regulatory option, systemic toxicity is limited to one pollutant in one receiving stream with 373 subsistence anglers and their families remaining exposed; a 47 percent reduction. For indirect discharges, systemic toxicant effects are projected at current discharge levels due to the discharge of two pollutants to one receiving stream. An estimated population of 249 subsistence anglers and their families are projected to be affected. No systemic toxicant effects are projected at proposed pretreatment discharge levels. Monetary values for the reduction of systemic toxic effects cannot currently be estimated.

10.4 Ecological Benefits

Potential ecological benefits of the proposed rule, based on improvements in recreational fishing habitats, are projected for only indirect IWC wastewater discharges, because the proposed rule is not projected to completely eliminate instream concentrations in excess of aquatic life and human health ambient water quality criteria (AWQC) in any stream receiving wastewater discharge from direct discharge IWC facilities. For indirect discharges, concentrations in excess of AWQC are projected to be eliminated at one receiving stream as a result of the proposed pretreatment regulatory option. The monetary value of improved recreational fishing opportunity is estimated by first calculating the baseline value of the receiving stream using a value per person day of recreational fishing, and the number of person-days fished on the receiving stream. The value of improving water quality in this fishery, based on the increase in value to anglers of achieving contaminant-free fishing, is then calculated. The resulting estimate of the increase in value of recreational fishing to anglers on the improved receiving stream is $78,600 to $281,000 (1992 dollars).

The estimated benefit of improved recreational fishery opportunities is only a limited measure of the value to society of the improvements in aquatic habitats expected to result from the proposed rule. Additional benefits, which could not be quantified in this assessment, include increased assimilation capacity of the receiving stream, protection of terrestrial wildlife and birds that consume aquatic organisms, maintenance of an aesthetically pleasing environment, and improvements to other recreational activities such as swimming, water skiing, boating, and wildlife observation. Such activities contribute to the support of local and State economies.

10.5 Economic Productivity Benefits

Potential economic productivity benefits, based on reduced sewage sludge contamination and sewage sludge disposal costs, are projected at one POTW that will meet land application pollutant concentration limits as a result of the proposed rule. Savings in disposal cost are estimated at $7,400 (1992 dollars). In addition, two POTWs (1 additional) are expected to accrue a modest benefit through reduced record-keeping requirements and exemption from certain sewage sludge management practices. A monetary value for these modest benefits cannot currently be estimated.

10.6 Pollutant Fate and Toxicity

EPA identified 21 pollutants of concern (10 priority pollutants, 4 conventional/classical pollutant parameters, and 7 nonconventional pollutants) in waste streams from IWC facilities. Seventeen (17) of these pollutants (all metals) are evaluated to assess their potential fate and toxicity based on known characteristics of each chemical.

Most of the 17 pollutants have at least one known toxic effect. Based on available physical-chemical properties and aquatic life and human health toxicity data for these pollutants, 10 exhibit moderate to high toxicity to aquatic life; 3 are classified as known or probable human carcinogens; 13 are human systemic toxicants; 13 have drinking water values; and 10 are designated by EPA as priority pollutants. In terms of projected partitioning, 4 have a moderate to high potential to bioaccumulate in aquatic biota, potentially accumulating in the food chain and causing increased risk to higher trophic level organisms and to exposed human populations via consumption of fish and shellfish. All of the modeled pollutants are metals, which in general are not applicable to evaluation based on volatility and adsorption to solids. It is assumed that all of the metals have a high potential to adsorb to solids.

The impacts of the four conventional/classical pollutants are not evaluated when modeling the effect of the proposed rule on receiving stream water quality and POTW operations or when evaluating the potential fate and toxicity of discharged pollutants. These pollutants are total suspended solids (TSS), chemical oxygen demand (COD), total dissolved solids (TDS), and total organic carbon (TOC). The discharge of these pollutants can have adverse effects on human health and the environment. For example, habitat degradation can result from increased suspended particulate matter that reduces light penetration, and thus primary productivity, or from accumulation of sludge particles that alter benthic spawning grounds and feeding habitats. High COD levels can deplete oxygen concentrations, which can result in mortality or other adverse effects on fish. High TOC levels may interfere with water quality by causing taste and odor problems and mortality in fish.

10.7 Documented Environmental Impacts

The Environmental Assessment[27] also summarizes documented environmental impacts on aquatic life, human health, POTW operations, and receiving stream water quality. The summaries are based on a review of published literature abstracts, State 304(l) Short Lists, State Fishing Advisories, and contact with State environmental agencies. Two direct discharging IWC facilities and two POTWs receiving the discharge from 2 IWC facilities are identified by States as being point sources causing water quality problems and are included on their 304(l) Short List. State contacts indicate that of the two direct facilities, one is no longer in operation and the other is currently in compliance with its permit limits and is no longer a source of impairment. Both of the POTWs listed are also currently in compliance for the listed pollutants. In addition, two IWC facilities are located on water bodies with State-issued fish consumption advisories. However, the advisories are based on dioxins, which are not proposed for regulation for the IWC industry.

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[27] See *Environmental Assessment of Proposed Effluent Limitations Guidelines and Standards for Industrial Waste Combustors*, EPA 821-B-97-009.

COST-EFFECTIVENESS ANALYSIS OF PROPOSED EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS FOR INDUSTRIAL WASTE COMBUSTORS

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Table of Contents

Section 1
Introduction

This cost-effectiveness analysis supports the proposed effluent limitations guidelines and standards for the Industrial Waste Combustors Industry. The report assesses the cost-reasonableness of two Best Practicable Technology (BPT) regulatory options for direct dischargers, which discharge effluent directly to navigable waters of the United States. It also assesses two regulatory options of Pretreatment Standards for Existing Sources (PSES) for indirect dischargers, which discharge effluent to publicly-owned treatment works (POTWs).

Cost-effectiveness analysis is used in the development of effluent limitation guidelines to evaluate the relative efficiency of alternative regulatory options. It is also used to compare the efficiency of a proposed regulation with the efficiency of previous regulations. Cost-effectiveness is defined as the incremental annual cost (in 1981 constant dollars) per incremental toxic-weighted pound of pollutant removed. This definition includes the following concepts:

Toxic-Weighted Removals — Because pollutants differ in their toxicity, the reductions in pollutant discharges, or pollutant removals, are adjusted for toxicity by multiplying the estimated removal quantity for each pollutant by a normalizing weight, called a *Toxic Weighting Factor (TWF)*. The TWF for each pollutant measures its toxicity relative to copper, with more toxic pollutants having higher TWFs.

Annual Costs — The cost-effectiveness analysis uses the estimated annual costs of complying with the alternative regulatory options. The annual costs include annual expenses for operating and maintaining compliance equipment and for meeting monitoring requirements, and an annual allowance for the capital outlays for pollution prevention and treatment systems needed for compliance. These costs are calculated on a pre-tax basis (i.e., without any adjustment for tax treatment of capital outlays and operating expenses). In addition, the annual allowance for capital outlays is calculated using a discount rate of 7 percent. Finally, the compliance costs are calculated in 1981 dollars to facilitate a comparison of cost-effectiveness values for regulations developed at different times for different industries.

Incremental Calculations — The incremental values that are calculated for a given option are the change in total annual compliance costs and the change in removals from the next less stringent option, or the baseline if there is no less stringent option, where regulatory options are ranked by increasing levels of toxic-weighted removals. Thus, the cost-effectiveness values for a given option are relative to another option, or, for the least stringent option, to the baseline.

The result of the cost-effectiveness calculation represents the unit cost of removing the next pound-equivalent of pollutants. Cost-effectiveness is strictly a relative measure used for comparative purposes. This analysis does not provide an absolute scale by which a particular cost-effectiveness value can be assigned a qualitative judgment. Because cost-effectiveness values are calculated using normalized pound-equivalent removed, the cost-effectiveness value for a given option may be compared with the values of other options being considered for a given regulation; because cost-effectiveness values are always expressed in constant 1981 dollars, they may be compared with values calculated for other industries or past regulations.[28]

Although not required by the Clean Water Act, cost-effectiveness analysis is a useful tool for evaluating options for the removal of toxic pollutants. It is not intended to analyze the removal of conventional pollutants, however, such as oil and grease, biochemical oxygen demand and total suspended solids. Removals of these pollutants are not included in the cost-effectiveness calculation.

In this report, EPA presents a measure referred to as cost-reasonableness in the assessment of BPT limitations as required under CWA Section 304(b)(1)(B). Cost-reasonableness is the ratio of costs to raw (non-normalized) pounds removed by each option.

The remaining parts of this report are organized as follows. Section 2 defines cost-effectiveness, discusses the cost-effectiveness methodology and describes the relevant regulatory options of the proposed rule.

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[28] For several reasons, cost-effectiveness ratios between regulations are not exactly comparable. For example, TWFs are revised over time to incorporate updated toxicological data, the costs may not be evaluated consistently on a pre-tax or after tax basis, and the opportunity cost of capital may vary. Therefore, comparisons between options of a given regulation are more reliable than comparisons between regulations.

Section 3 presents the findings of the separate analyses for direct dischargers and indirect dischargers. Section 4 compares the cost-effectiveness of the proposed regulation with the cost-effectiveness values calculated for previously promulgated rules. In addition, the report includes six appendices. Appendix A lists the pollutants of concern and their CAS numbers. Appendix B gives the Toxic Weighting Factor (TWF) for each pollutant. Appendix C contains the Publicly Owned Treatment Work (POTW) removal efficiencies used in this analysis. POTW removal efficiencies are the percentage of each pollutant that a typical POTW is expected to remove from indirect facility discharges. Appendix D presents a supporting cost-effectiveness analysis in dollars per pound-equivalent of the BPT options. Appendix E contains an alternative set of weighting factors, Pollutant Weighting Factors (PWFs), for normalizing pollutant removals according to toxicity. The PWFs are based on a different analytical convention than TWFs. The results of the cost-effectiveness analysis using the PWFs are contained in Appendix F.

Section 2
Methodology

2.1 Overview

Section 2 defines cost-effectiveness, describes the steps taken in the cost-effectiveness analysis, and characterizes the regulatory options considered in this analysis.

In developing effluent limitations guidelines, EPA uses cost-effectiveness calculations to compare the efficiency of alternative regulatory options in removing pollutants. Cost-effectiveness is defined as the incremental annual cost of a pollution control option in an industry or industry subcategory per incremental pollutant removal. The increments are calculated relative to another option or, for the least stringent option, to existing treatment. Pollutant removals are measured in copper-based "pounds-equivalent." The cost-effectiveness value, therefore, represents the unit cost of removing the next pound-equivalent of pollutant.

Three factors are of particular importance in cost-effectiveness calculations: (1) the normalization of pounds of pollutant removed to copper-based pounds-equivalent; (2) the incremental nature of cost-effectiveness; and (3) the fact that cost-effectiveness results are used for comparison purposes rather than on an absolute basis. First, the analysis is based on removals of pounds-equivalent — a term used to describe a pound of pollutant weighted by its toxicity relative to copper. These weights are known as toxic weighting factors. Copper is used as the standard pollutant for developing toxic weighting factors because it is a toxic metal commonly released in and removed from industrial effluent. The use of pounds-equivalent reflects the fact that some pollutants are more toxic than others. By expressing pollutant removals in common terms, the removals can be summed across pollutants to give a meaningful basis for comparing cost-effectiveness results among alternative regulatory options or different regulations.

Second, cost-effectiveness analysis is done on an incremental basis to compare the incremental, or marginal, cost and removals of one control option to another control option or to existing treatment. To determine incremental cost-effectiveness, the regulatory options are ranked in increasing order of stringency, where stringency is the aggregate pollutant removals, measured in pounds-equivalent. If two or more options remove equal amounts of pollutants, these options are then ranked in increasing order of cost. After the options are ranked, incremental costs and removals are calculated between each option and the next less stringent option. Incremental values for the least stringent option are calculated relative to existing treatment.

Third, no absolute scales exist for judging cost-effectiveness values. The values are considered high or low only within a given context, for example when compared to other regulatory options or when compared to effluent limitations guidelines for other industries.

Cost-effectiveness analysis involves a number of steps, which may be summarized as follows:

- Determine the relevant wastewater pollutants;
- Estimate the relative toxic weights of priority and other pollutants;
- Define the pollution control approaches;
- Calculate pollutant removals for each control option;
- Determine the annualized cost of each control option;
- Rank the control options by increasing stringency and cost;
- Calculate incremental cost-effectiveness values; and
- Compare cost-effectiveness values.

These steps are discussed below.

Pollutant Discharges Considered in the Cost-Effectiveness Analysis

Some of the factors considered in selecting pollutants for regulation include toxicity, frequency of occurrence, and the amount of a pollutant in the waste stream. Twenty-one pollutants were identified as pollutants of concern. These pollutants were detected at treatable levels in the untreated wastewater stream (see Appendix A). Of the twenty-one identified pollutants, ten are proposed for regulation under BPT/BCT/BAT and nine are proposed for regulation under PSES. The eleven pollutants not proposed for regulation will nevertheless be considered in this analysis because they serve as indicators for the regulated pollutants and are removed by the proposed control options without imposing additional costs. The cost-effectiveness analysis of the proposed Industrial Waste Combustors effluent limitations guidelines is therefore based on all twenty-one pollutants of concern.

Relative Toxic Weights of Pollutants

Cost-effectiveness analyses account for differences in toxicity among the regulated pollutants by using toxic weighting factors (TWFs). Relatively more toxic pollutants have higher TWFs. These factors are necessary because different pollutants have different potential effects on human and aquatic life. For example, a pound of nickel (TWF=0.036) in an effluent stream has significantly less potential effects than a pound of cadmium (TWF=5.16). The toxic weighting factors are used to calculate the *toxic pound-equivalent* unit — a standardized measure of toxicity.

In the majority of cases, toxic weighting factors are derived from both chronic freshwater aquatic criteria (or toxic effect levels) and human health criteria (or toxic effect levels) established for the consumption of fish. These factors are then standardized by relating them to copper. The resulting toxic weighting factors for each pollutant of concern are provided in Appendix B. Table 2-1 shows some examples of the effects of different aquatic and human health criteria on weighting factors.

Table 2-1. Weighting Factors Based on Copper Freshwater Chronic Criteria

Pollutant	Human Health Criteria* (g/l)	Aquatic Chronic Criteria (g/l)	Weighting Calculation	Toxic Weighting Factor
Copper**	--	12.0	5.6/12.0	0.467
Hexavalent Chromium	3,400	11.0	5.6/3,400 + 5.6/11	0.511
Nickel	4,600	160.0	5.6/4,600 + 5.6/160	0.036
Cadmium	170	1.1	5.6/170 + 5.6/1.1	5.120
Benzene	12	265.0	5.6/12 + 5.6/265	0.488

Criteria are maximum contamination thresholds. Using the above calculation, the greater the values for the criteria used, the lower the toxic weighting factor. Units for criteria are micrograms of pollutant per liter of water.

* Based on ingestion of 6.5 grams of fish per day.

** While the water quality criterion for copper has been revised (to 12.0 g/l), the cost-effectiveness analysis uses the old criterion (5.6 g/l) to facilitate comparisons with cost-effectiveness values for other effluent limitations guidelines. The revised higher criteria for copper results in a toxic weighting factor for copper not equal to 1.0 but equal to 0.467.

Source: Environmental Protection Agency

As indicated in Table 2-1, the toxic weighting factor is the sum of two criteria-weighted ratios: the “old” copper criterion divided by the human health criterion for the particular pollutant, and the “old” copper criterion divided by the aquatic chronic criterion. For example, using the values reported in Table 2-1, 10.96 pounds of copper pose the same relative hazard in surface waters as one pound of cadmium, since cadmium has a toxic weight 10.96 times (5.12/0.467 = 10.96) as large as the toxic weight of copper.

2.2 Pollution Control Options

This section summarizes two BPT, two BAT, and two PSES options that EPA considered. The BPT and BAT options would apply to direct dischargers, while the PSES options would apply to indirect dischargers.

2.2.1 BPT Technology Options

The two currently available treatment systems for which the EPA assessed performance for BPT are:

Option A: Primary Precipitation, Solid-Liquid Separation, Secondary Precipitation, and Solid-Liquid Separation. Under Option A, BPT limitations would be based upon two stages of chemical precipitation, each followed by some form of separation and sludge dewatering. The pH's used for chemical precipitation would vary to promote optimal removal of metals because different metals are preferentially removed at different pH levels. In addition, the first stage of chemical precipitation is preceded by chromium reduction, when necessary. In some cases, BPT limitations would require the current treatment technologies in place to be improved by use of increased quantities of treatment chemicals and additional chemical precipitation/sludge dewatering systems.

Option B: Primary Precipitation, Solid-Liquid Separation, Secondary Precipitation, Solid-Liquid Separation, and Sand Filtration. The second option evaluated for BPT for Industrial Waste Combustor facilities would be based on the same technology as Option A with the addition of sand filtration at the end of the treatment train.

2.2.2 BAT Technology Options

The evaluated BAT options for the Industrial Waste Combustors are based on the same technologies selected for BPT.

2.2.3 PSES Technology Options

Indirectly discharging Industrial Waste Combustors generate wastewaters with similar pollutant characteristics to direct discharging facilities. Hence, the same treatment technologies and regulatory options — Option A and Option B — discussed previously for BPT and BAT were considered applicable to PSES.

2.3 Calculation of Pollutant Removals

EPA calculated the reduction in *at-stream* pollutant loadings to the receiving water body for each control option. *End-of-pipe* and *at-stream* pollutant removals may differ because a portion of the end-of-pipe loadings for indirect dischargers may be removed by a POTW before entering the receiving water body. As a result, the at-stream removal of pollutants due to PSES regulations are generally less than end-of-pipe removals.

The following example may help to clarify how at-stream pollutant removals are calculated for indirect dischargers: If a facility discharges 100 pounds of cadmium in its waste water to a POTW and the POTW has a removal efficiency for cadmium of 40 percent, then the POTW removes 40 pounds of cadmium. The cadmium discharged to surface waters is only 60 pounds. If a regulation results in a reduction of cadmium in the facility's waste water to 30 pounds, then the POTW removes 12 of the 30 pounds it receives from the facility, and the amount discharged to surface waters is 18 pounds. As a result, the reduction in discharges to surface waters is 42 pounds, although the reduction in facility discharges to the POTW is 70 pounds. In general, at-stream loadings for facilities that discharge to a POTW are calculated by multiplying end-of-pipe loadings by (1 - POTW removal efficiency). The cost-effectiveness calculations in this analysis reflect the fact that the actual reduction of pollutant discharge to surface waters is not 70 pounds (the change in the amount discharged to the POTW), but 42 pounds (= 60 - 18), the change in the amount ultimately discharged to surface waters.

2.4 Annualized Costs for Each Control Option

Full details of the methods used to estimate the costs of complying with the regulatory options can be found in the Technical Development Document and the Economic Analysis Report. A brief summary of the compliance cost analysis is provided below.

Two categories of compliance costs are included in the cost-effectiveness analysis: (1) capital costs, including costs for equipment, retrofitting and upgrading control technology, permit modification, and land; and (2) operating, maintenance, and monitoring costs. Although operating, maintenance, and monitoring costs occur annually, capital costs are a one-time “lump sum” cost. To express the capital costs on a annual basis, capital costs were annualized over the expected useful life of the capital equipment, 15 years, at a discount rate of 7 percent. Total annualized costs are the sum of annualized capital costs and the annual operating, maintenance and monitoring costs. The cost-effectiveness analysis presented in the main body of this report uses pre-tax costs as the basis for its calculations.

The engineering analysis yielded compliance costs estimates in 1992 dollars, the base year of the Industrial Waste Combustors Industry regulatory analysis. To increase the consistency of these cost-effectiveness values with those of other promulgated rules, the compliance costs used in the cost-effectiveness analysis were deflated from 1992 to 1981 dollars using Engineering News Record's Construction Cost Index (CCI). This adjustment factor is:

$$Adjustment\ \ factor \ = \ \frac{1981\ \ CCI}{1992\ \ CCI} \ = \ \frac{3535}{4985} \ = \ 0.709$$

BPT compliance costs are presented in 1996 dollars in addition to the 1992 base year dollars. Compliance costs used in the cost-effectiveness analysis were inflated from 1992 to 1996 dollars using the *Engineering News Record's* Construction Cost Index (CCI). This adjustment factor is:

$$Adjustment\ \ factor \ = \ \frac{1996\ \ CCI}{1992\ \ CCI} \ = \ \frac{5620}{4985} \ = \ 1.127$$

2.5 Calculation of Incremental Cost-Effectiveness Values

Options were ranked in order of increased stringency, measured in aggregate removals of pounds-equivalent of pollutants. After the options had been ranked, incremental cost-effectiveness values were calculated. Cost-effectiveness values were calculated separately for indirect and direct dischargers. For each discharger category, the cost-effectiveness value of a particular option was calculated as the incremental annual cost of that option divided by the incremental pounds-equivalent removed by that option. Algebraically, this equation is:

$$CE_k \ = \ \frac{ATC_k \ - \ ATC_{k-1}}{PE_k \ - \ PE_{k-1}}$$

where:

CE_k = Cost-effectiveness of Option k;

ATC_k = Total annualized compliance cost under Option k; and

PE_k = Removals in pounds-equivalent under Option k.

The numerator of the equation is the incremental cost in moving from Option k-1 to Option k. Similarly, the denominator is the incremental removals associated with the move from Option k-1 to Option k. Thus, cost-effectiveness values are measured in dollars per pound-equivalent of pollutant removed. When k corresponds to the least stringent option (k = 1), the incremental costs and removals are the increments in moving from the baseline case to Option k.

2.6 Comparisons of Cost-Effectiveness Values

Two types of comparisons are typically done using cost-effectiveness values. First, the cost-effectiveness values for the alternative regulatory options and technologies under consideration may be compared among themselves to identify which options offer relatively higher or lower cost-effectiveness in achieving pollutant reductions. Second, the average cost-effectiveness of regulatory options can be used to assess the cost-effectiveness of controls relative to previously promulgated effluent limitations guidelines for other industries.

Section 3

Cost-Effectiveness Results

3.1 Cost-Reasonableness Analysis for Direct Dischargers

CWA Section 304(b)(1)(B) requires a cost-reasonableness assessment for BPT limitations. In determining BPT limitations, EPA must consider the total cost of treatment technologies in relation to the effluent reduction benefits achieved by such technology. This inquiry does not limit EPA's broad discretion to adopt BPT limitations that are achievable with available technology unless the required additional reductions are wholly out of proportion to the costs of achieving such marginal level of reduction.

Tables 3-1 summarizes the BPT regulatory options applicable to direct dischargers. The regulatory options are listed in order of increasing stringency on the basis of estimated pollutant removals. Annualized compliance costs are shown in 1992 and 1996 dollars. Pollutant removals include total suspended solids and metals removals, and are reported on an unweighted basis. Since BPT options consider the removal of conventional pollutants in addition to toxics, no pound-equivalent removals are calculated. As a result, the cost-measure of an option is expressed in dollars per *pound* for BPT options, not dollars per *pound-equivalent*, and the resulting value is referred to as *cost-reasonableness*, not *cost-effectiveness*. In addition, costs are conventionally presented in nominal dollars, not in 1981 dollars. BPT options are also not considered incrementally to each other. Therefore, the cost-reasonableness value presented in Table 3-1 is an average, not an incremental, value.

Table 3-1 shows that Option A achieves 93,441 pounds of removals, at an annual cost of $1.74 million (1992 dollars). The average cost-reasonableness of Option A in 1996 dollars is estimated to be approximately $21 per pound removed.

Table 3-1. National Estimates of Industrial Waste Combustors Costs and Pollutant Removals, Direct Dischargers (BPT)

Regulatory Option	Annualized Cost, $millions		Pollutant Removals	Average Cost-Reasonableness
	1992 Dollars	*1996 Dollars*	*Raw Pounds*	*($1996/lb)**
Option A	1.74	1.96	93,441	21
Option B	1.95	2.20	126,434	17

Source: Environmental Protection Agency
*Rounded to the nearest dollar.

Option B, the proposed option, achieves 126,434 pounds of removals, at an annual cost of $1.95 million (1992 dollars). The estimated average cost-reasonableness of Option B in 1996 dollars is approximately $17 per pound removed.

EPA considers the cost-reasonableness values of Option B to be acceptable; it has the lower cost-reasonableness of the two options. Stepping from Option A to Option B increases total removals by more than 35 percent while increasing annual compliance costs by only 13 percent.

On the basis of this analysis, EPA determines that the proposed Option B is cost-reasonable, and that the cost-reasonableness of the two considered regulatory options supports the choice of Option B as the proposed BPT option for direct dischargers.

3.2 Cost-Effectiveness Analysis for Indirect Dischargers

Tables 3-4 and 3-5 summarize the cost-effectiveness analysis results for the PSES regulatory options applicable to indirect dischargers. Annual compliance costs are shown in both 1992 and 1981 dollars, and pollutant removals are reported in both unweighted and toxic-weighted pounds. The regulatory options are listed in order of increasing stringency, measured by toxic-weighed pollutant removals.

Table 3-4. National Estimates of Industrial Waste Combustors Annualized Costs and Pollutant Removals, Indirect Dischargers (PSES)

Regulatory Option	Annualized Cost, $millions		Pollutant Removals	
	1992 dollars	*1981 dollars*	*Raw Pounds*	*Pounds-Equivalent*
Option A	0.76	0.54	10,650	6,349
Option B	0.80	0.57	10,726	6,405

Source: US Environmental Protection Agency

Table 3-5. National Estimates of Industrial Waste Combustors Incremental Costs, Removals and Cost-Effectiveness, Indirect Dischargers (PSES)

Regulatory Option	Incremental Cost *($ millions, 1981)*	Incremental Removals *(lbs-eq)*	Cost-Effectiveness *($/lb-eq)*
Option A	0.54	6,349	85
Option B	0.03	56	509

Source: US Environmental Protection Agency
*Rounded to the nearest dollar.

As shown in Tables 3-4 and 3-5, Option A achieves 10,650 pounds of toxic pollutant removals on an unweighted basis and 6,349 pounds-equivalent on a toxic-weighted basis, at a cost of $0.54 million (1981 dollars). Since Option A is the least stringent option, in terms of pollutant removals, the cost-effectiveness of this option is the same as its average cost per pound-equivalent removed, $85.

The next more stringent option, Option B, is estimated to achieve 10,726 pounds of toxic pollutant removals on an unweighted basis and 6,405 pounds-equivalent on a toxic-weighted basis, which is a 56 pounds-equivalent increment over Option A. With an estimated annual compliance cost of $0.57 million ($1981), or $30,000 more than Option A, Option B's cost effectiveness is estimated to be $509 per pound-equivalent of pollutant removed.

EPA considers the cost-effectiveness value of Option A to be adequate in the context of regulatory alternatives. However, stepping beyond Option A to Option B is deemed not cost-effective for indirect dischargers. On the basis of this analysis, EPA determined that the proposed option, Option A, is cost-effective. The cost-effectiveness analysis supports the choice of Option A as the proposed PSES regulatory option for indirect dischargers.

Section 4

Cost-Effectiveness Values for Previous Effluent Guidelines and Standards

Tables 4-1 and 4-2 present, for indirect and direct dischargers, respectively, the baseline and post-compliance pollutant loadings and resulting cost-effectiveness values that were calculated for previous regulations. The values for the proposed Industrial Waste Combustors regulatory options are also listed in these tables. All cost-effectiveness values are presented in 1981 dollars and are based on Toxic Weighting Factors normalized to copper.

Table 4-1. Industry Comparison of Cost-Effectiveness Values for Indirect Dischargers
Toxic and Nonconventional Pollutants Only, Copper Based Weights (1981 Dollars)*

Industry	Pounds Equivalent Currently Discharged (To Surface Waters) (000's)	Pounds Equivalent Remaining at Selected Option (To Surface Waters) (000's)	Cost Effectiveness of Selected Option Beyond BPT ($/lb-eq. removed)
Aluminum Forming	1,602	18	155
Battery Manufacturing	1,152	5	15
Can Making	252	5	38
Coal Mining***	N/A	N/A	N/A**
Coil Coating	2,503	10	10
Copper Forming	934	4	10
Centralized Waste Treatment † (co-proposal) - Regulatory Option 1 - Regulatory Option 2	 689 689	 330 328	 70 110
Electronics I	75	35	14
Electronics II	260	24	14
Foundries	2,136	18	116
Industrial Waste Combustors	**6.5**	**0.2**	**85**
Inorganic Chemicals I	3,971	3,004	9
Inorganic Chemicals II	4,760	6	< 1
Iron & Steel	5,599	1,404	6
Leather Tanning	16,830	1,899	111
Metal Finishing	11,680	755	10
Metal Products & Machinery I †	1,115	234	127
Nonferrous Metals Forming	189	5	90
Nonferrous Metals Mfg I	3,187	19	15
Nonferrous Metals Mfg II	38	0.41	12
Organic Chemicals, Plastics...	5,210	72	34
Pesticide Manufacturing (1993)	257	19	18
Pesticide Formulating, Packaging.. †	33,748	< 1	1
Pharmaceuticals †	340	63	1
Plastic. Molding & Forming	N/A	N/A	N/A
Porcelain Enameling	1,565	96	14
Pulp & Paper	9,539	103	65

* Although toxic weighting factors for priority pollutants varied across these rules, this table reflects the cost-effectiveness at the time of regulation.
** N/A: Pretreatment Standards not promulgated, or no incremental costs will be incurred.
*** Reflects costs and removals of both air and water pollutants
† Proposed rule.

Table 4-2. Industry Comparison of Cost-Effectiveness Values for Direct Dischargers
Toxic and Nonconventional Pollutants Only, Copper Based Weights (1981 Dollars)*

Industry	Pounds Equivalent Currently Discharged (To Surface Waters) (000's)	Pounds Equivalent Remaining at Selected Option (To Surface Waters) (000's)	Cost Effectiveness of Selected Option Beyond BPT ($/lb-eq. removed)
Aluminum Forming	1,340	90	121
Battery Manufacturing	4,126	5	2
Can Making	12	0.2	10
Coal Mining	BAT=BPT	BAT=BPT	BAT=BPT
Coastal Oil and Gas † - Produced Water - Drilling Waste - TWC‡	 5,998 7 2	 506 0 0	 3 292 200
Coil Coating	2,289	9	49
Copper Forming	70	8	27
Centralized Waste Treatment † (co-proposal) - Regulatory Option 1 - Regulatory Option 2	 3,372 3,372	 1,267 1,271	 5 7
Electronics I	9	3	404
Electronics II	NA	NA	NA
Foundries	2,308	39	84
Industrial Waste Combustors	**BAT=BPT**	**BAT=BPT**	**BAT=BPT**
Inorganic Chemicals I	32,503	1,290	< 1
Inorganic Chemicals II	605	27	6
Iron & Steel	40,746	1,040	2
Leather Tanning	259	112	BAT=BPT
Metal Finishing	3,305	3,268	12
Metal Products & Machinery I †	140	70	50
Nonferrous Metals Forming	34	2	69
Nonferrous Metals Mfg I	6,653	313	4
Nonferrous Metals Mfg II	1,004	12	6
Offshore Oil and Gas**†	3,808	2,328	33
Organic Chemicals, Plastics...	54,225	9,735	5
Pesticide Manufacturing (1993)	2,461	371	15
Pharmaceuticals †	208	4	1
Plastics Molding & Forming	44	41	BAT=BPT
Porcelain Enameling	1,086	63	6
Petroleum Refining	BAT=BPT	BAT=BPT	BAT=BPT
Pulp & Paper	61,713	2,628	39
Textile Mills	BAT=BPT	BAT=BPT	BAT=BPT

* Although toxic weighting factors for priority pollutants varied across these rules, this table reflects the cost-effectiveness at the time of regulation.
** Produced water only, for produced sand and drilling fluids and drill cuttings, BAT=BPT.
† Proposed rule.
‡ Treatment, workover, and completion fluids.

Appendix A

Industrial Waste Combustors Pollutants of Concern

Name	CAS Number
CONVENTIONAL AND NONCONVENTIONAL POLLUTANTS	
Chemical Oxygen Demand (COD)	None
Total Dissolved Solids	None
Total Organic Carbon	None
Total Suspended Solids*	None
METALS	
Aluminum	7429905
Antimony	7440360
Arsenic*	7440382
Boron	7440428
Cadmium*	7440439
Chromium*	7440473
Copper*	7440508
Iron	7439896
Lead*	7439921
Manganese	7439965
Mercury*	7439976
Molybdenum	7439987
Selenium	7782492
Silver*	7440224
Tin	7440315
Titanium*	7440326
Zinc	7440666

*Regulated Pollutants (TSS under BPT/BCT only)

Appendix B

Toxic Weighting Factors

Name	**Toxic Weighting Factor**
CONVENTIONAL AND NONCONVENTIONAL POLLUTANTS	
Chemical Oxygen Demand (COD)	0.00000
Total Dissolved Solids	0.00000
Total Organic Carbon	0.00000
Total Suspended Solids*	0.00000
METALS	
Aluminum	0.06400
Antimony	0.19000
Arsenic*	4.00000
Boron	0.18000
Cadmium*	5.20000
Chromium*	0.02700
Copper*	0.47000
Iron	0.00560
Lead*	1.80000
Manganese	0.01400
Mercury*	500.00000
Molybdenum	0.20000
Selenium	1.10000
Silver*	47.00000
Tin	0.30000
Titanium*	0.02900
Zinc	0.05100

*Regulated Pollutants (TSS under BPT/BCT only)

Appendix C

POTW Pollutant Removal Efficiencies

Name	POTW Removal Efficiency %
CONVENTIONAL AND NONCONVENTIONAL POLLUTANTS	
Chemical Oxygen Demand (COD)	0.00
Total Dissolved Solids	0.00
Total Organic Carbon	0.00
Total Suspended Solids*	0.00
METALS	
Aluminum	17.00
Antimony	67.00
Arsenic*	66.00
Boron	70.00
Cadmium*	90.00
Chromium*	82.00
Copper*	90.00
Iron	84.00
Lead*	85.00
Manganese	41.00
Mercury*	90.00
Molybdenum	38.00
Selenium	36.00
Silver*	59.00
Tin	44.00
Titanium*	79.00
Zinc	81.00

*Regulated Pollutants (TSS under BPT/BCT only)

Appendix D
Results of Cost-Effectiveness Analysis Evaluating
BPT Options as BAT Options

In addition to estimating the cost-reasonableness of the BPT regulatory options under consideration, EPA also evaluated the BPT options under BAT criteria and estimated their incidental toxic removals and cost-effectiveness. Tables D-1 and D-2 summarize the results of this analysis. Annual compliance costs are shown in 1992 dollars, as reported in the Economic Analysis, and in 1981 dollars. Pollutant removals are reported on both an unweighted and toxic-weighted basis. The regulatory options are listed in order of increasing stringency on the basis of the estimated toxic-weighted pollutant removals. Table D-1 shows absolute costs and removals, while Table D-2 presents incremental costs, removals and cost-effectiveness.

As shown in Table D-1, Option A achieves 5,752 pounds of removals on an unweighted basis and 18,581 pounds-equivalent of removals on a toxic-weighted basis. Annual costs are $1.23 million (1981 dollars). Since Option A is the least stringent option, it is compared to the baseline, and the incremental costs and removals shown in Table 3-3 for this option are the same as the total costs and removals. The resulting cost-effectiveness is $66 per pound-equivalent.

Table D-1. National Estimates of Industrial Waste Combustors Annualized Costs and Pollutant Removals, Direct Dischargers (BAT)

	Annualized Cost, $millions		**Pollutant Removals**	
Regulatory Option	*1992 dollars*	*1981 dollars*	*Raw Pounds*	*Pounds-Equivalent*
Option A	1.74	1.23	5,752	18,581
Option B	1.95	1.38	6,767	21,265

Source: Environmental Protection Agency

Table D-2. National Estimates of Industrial Waste Combustors Incremental Costs, Removals and Cost-Effectiveness, Direct Dischargers (BAT)

Regulatory Option	**Incremental Cost** *($ millions, 1981)*	**Incremental Removals** *(lbs-eq)*	**Cost-Effectiveness** *($/lb-eq)**
Option A	1.23	18,581	66
Option B	0.15	2,684	57

Source: Environmental Protection Agency
*Rounded to the nearest dollar.

The more stringent option, Option B, achieves 21,265 pounds-equivalent of toxic-weighted removals — an increment of 2,684 pounds-equivalent over Option A — at an annual cost of $1.38 million (1981 dollars) — an increment of $0.15 million. Thus, the cost-effectiveness of Option B is estimated to be $57 per pound-equivalent.

The results presented above show that even though Option B is a BPT regulatory option its cost-effectiveness of $57 also meets BAT criteria. The significant incidental toxic removals achieved by BPT Option B and its cost-effectiveness when evaluated under BAT criteria further support the choice of Option B as the proposed regulatory option.

Appendix E

Pollutant Weighting Factors

Name	Pollutant Weighting Factor
CONVENTIONAL AND NONCONVENTIONAL POLLUTANTS	
Chemical Oxygen Demand (COD)	0.00000
Total Dissolved Solids	0.00000
Total Organic Carbon	0.00000
Total Suspended Solids*	0.00000
METALS	
Aluminum	0.01100
Antimony	0.07200
Arsenic*	57.00000
Boron	0.03200
Cadmium*	0.91000
Chromium*	0.00480
Copper*	0.08300
Iron	0.00100
Lead*	0.31000
Manganese	0.01000
Mercury*	83.00000
Molybdenum	0.03600
Selenium	0.20000
Silver*	8.30000
Tin	0.05400
Titanium*	0.00520
Zinc	0.00910

*Regulated Pollutants (TSS under BPT/BCT only)

Appendix F

Results of Cost-Effectiveness Analysis Using Pollutant Weighting Factors

F.1 Alternative Toxic Weighting Factors

EPA also performed the cost-effectiveness analysis with an alternative set of toxic weighting factors called *Pollutant Weighting Factors (PWFs).* Appendix E listed these weighting factors; this appendix presents the results of the additional analysis.

PWFs are derived from either chronic aquatic life criteria (or toxic effect levels) or human health criteria (or toxic effect levels) established for the consumption of water and fish. For carcinogenic substances, the human health risk level is 10^{6}, rather than 10^{5} in the case of TWFs. In contrast to TWFs, PWFs are not related to a benchmark pollutant. PWFs are derived by taking the reciprocal of the more stringent (smaller value) of the aquatic life or human health criteria or toxic effect levels.

While the cost-effectiveness values calculated with PWFs cannot be compared to cost-effectiveness values calculated with TWFs for previous regulations, they do permit comparisons between options in the current effluent guideline analysis. In this regard, the PWF-based cost-effectiveness analysis supports the findings described in Section 3.

F.2 Cost-Effectiveness Analysis for Direct Dischargers

Since pollutant removals for BPT regulatory options are reported on an *unweighted* basis, cost-reasonableness results for BPT options using PWFs will be identical to those using TWFs (presented in Section 3).

F.3 Cost-Effectiveness Analysis for Indirect Dischargers

Tables F-1 and F-2 summarize the cost-effectiveness analysis results for the PSES regulatory options applicable to indirect dischargers. Annual compliance costs are shown in both 1992 and 1981 dollars, and pollutant removals are reported in both unweighted and toxic-weighted pounds. The regulatory options are listed in order of increasing stringency, measured by toxic-weighed pollutant removals.

Table F-1. National Estimates of Industrial Waste Combustors Annualized Costs and Pollutant Removals, Indirect Dischargers (PSES)

Regulatory Option	Annualized Cost, $millions		Pollutant Removals	
	1992 dollars	*1981 dollars*	*Raw Pounds*	*Pounds-Equivalent*
Option A	0.76	0.54	10,650	23,844
Option B	0.80	0.57	10,726	23,862

Source: US Environmental Protection Agency

Table F-2. National Estimates of Industrial Waste Combustors Incremental Costs, Removals and Cost-Effectiveness, Indirect Dischargers (PSES)

Regulatory Option	Incremental Cost *($ millions, 1981)*	Incremental Removals *(lbs-eq)*	Cost-Effectiveness *($/lb-eq)*Option 2
Option A	0.54	23,844	23
Option B	0.03	18	1,584

Source: US Environmental Protection Agency
*Rounded to the nearest dollar.

As shown in Tables F-1 and F-2, Option A achieves 10,650 pounds of toxic pollutant removals on an unweighted basis and 23,844 pounds-equivalent on a toxic-weighted basis, at a cost of $0.54 million (1981 dollars). Since Option A is the least stringent option, in terms of pollutant removals, the cost-effectiveness of this option is the same as its average cost per pound-equivalent removed, $23.

The next more stringent option, Option B, is estimated to achieve 10,726 pounds of toxic pollutant removals on an unweighted basis and 23,862 pounds-equivalent on a toxic-weighted basis, which is an 18 pounds-equivalent increment over Option A. With an estimated annual compliance cost of $0.57 million ($1981), or $30,000 more than Option A, Option B's cost effectiveness is estimated to be $1,584 per pound-equivalent of pollutant removed.

As in the PSES analysis using TWFs, EPA considers the cost-effectiveness value of Option A to be adequate in the context of regulatory alternatives.