Appendix G

1999 PARTICULATE MATTER RISK ASSESSMENT

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MEMORANDUM

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FROM: Amy Benson and Nathan Brodeur, Abt Associates Inc.

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SUBJECT: Particulate Matter (PM) Risk Assessment for the Proposed Combustor Emissions MACT Standard

1.0 INTRODUCTION

This memorandum describes the method used to estimate changes in incidence of health effects resulting from the attainment of technical standards for PM emissions from hazardous waste combustion units. The changes in incidence are estimated using the Criteria Air Pollutant Modeling System (CAPMS), which has been used as the primary analytical tool for evaluating benefits attributable to the Clean Air Act and for evaluating proposed alternatives to the current PM and ozone national ambient air quality standards (NAAQS).

The method used in this analysis is described below. Specifically, this memorandum addresses: (1) the use of modeled PM concentrations in the analysis, (2) application of health effect concentration-response functions to the PM concentrations, (3) the method used to estimate the exposed population and baseline incidences for use with the concentration-response functions to estimate total reductions in incidence of health endpoints, and (4) the method used to sum results to present estimates aggregated over a year. Results of applying the method are aggregated for all facilities and presented separately by individual class of combustion unit. In addition, the results are presented for all health endpoints modeled in the analysis. However, because there is some overlap among health endpoints and populations modeled, suggestions are also made for how to avoid double counting of the presented effects.

2.0 USE OF PM CONCENTRATION DATA

The Research Triangle Institute (RTI) estimated ambient PM concentrations from five years of emissions data, for 1216 sectors associated with 76 sites containing hazardous waste combustion units. A "baseline" scenario was developed by RTI. The baseline reflects ambient PM conditions for the case in which no additional emissions controls (beyond those currently in place) are implemented. A "MACT control" scenario, with PM concentrations corresponding to the MACT control levels, was also developed.

Several types of modeled ambient PM concentrations were used in this analysis. Mean and median concentrations estimated using five years of data, and 24-hour average concentrations of both PM-2.5 and PM-10 measures were used[1]. The type of measure used in this analysis depends on the PM measure used in the epidemiology studies which from which the concentration-response functions were derived. The five-year mean and median concentrations were used with the concentration-response functions based on long-term PM concentrations (averaged over one or more years). The 24-hour average concentrations, in the custom distribution form described below, were used to evaluate concentration-response functions based on short-term PM concentrations averaged over one to several days.

2.1 CAPMS AIR QUALITY DATA FORMAT

For each air quality scenario, CAPMS requires that the temporal distribution of concentrations be described for each location and pollutant being examined for the entire period modeled. For efficiency, CAPMS uses a reduced form of the temporal distribution of concentrations rather than every modeled concentration in chronological order. The reduced form distribution, or concentration profile, is outlined below.

Concentration profiles can be developed for any averaging time (ranging from hourly and daily averages to annual means or medians). Averaging times are selected to match those reported by published epidemiological and/or clinical studies used to derive concentration-response relationships. Characterizing a year's worth of air quality concentrations using an annual statistic, such as the mean or median, is straightforward; a single value describes ambient conditions in a given location across the entire year. For this analysis, RTI provided Abt Associates with five-year mean and five-year median PM concentrations which were used to evaluate the concentration-response functions based on long-term PM concentrations. Developing concentration profiles of pollutant concentrations for shorter averaging times, however, requires some data processing.

A custom distribution was created for shorter averaging times. In the custom distribution, the number of values describing pollutant concentrations across the modeled time period were reduced to 20. For example, the 365 24-hour averages across a year were reduced to 20 points by ranking the concentrations chronologically, apportioning them to 20 equally-sized bins, and taking the average value for each bin. The value in each bin is a central estimate of the daily average concentration for $1/20^{th}$ of the year. A 20-point distribution must be provided for each location-pollutant-averaging time combination for both air quality scenarios (Baseline and MACT). CAPMS then uses the concentrations reported for each scenario to calculate the change in air quality (ΔQ) at each of the 20 points (MACT scenario concentrations are subtracted from corresponding Baseline concentrations).

For this analysis, RTI modeled five years of air quality data. Therefore, RTI predicted 1825 24-hour average PM concentrations across a five-year period. These 1825 24-hour average

[1]PM10 includes all air particles that are 10 μm in diameter and smaller; PM2.5 includes all particles that are 2.5 μm in diameter and smaller.

PM concentrations were then reduced to a 20-point distribution. For the purpose of benefits modeling, this 20-point distribution was then assumed to be representative of the distribution of 24-hour average PM concentrations across a single year. This 20-point custom distribution was then used to evaluate concentration-response functions which rely on short-term PM concentrations averaged over one to several days, as described below.

2.2 TRANSLATING AIR QUALITY IMPROVEMENTS INTO ANNUAL HEALTH BENEFITS USING THE CAPMS CUSTOM DISTRIBUTION

The concentrations from the custom distribution are used together with concentration-response functions to translate air quality improvements into estimates of avoided adverse health effects. For example, the number of avoided mortality cases attributable to short-term PM reductions can be estimated using the concentration-response function from Schwartz et al. (1996a). In this case, the function is evaluated using each of the 20 "daily" ΔQ values estimated as described in Section 2.1. Each of the resulting 20 estimates represents the number of mortality cases avoided each day during the period of the year associated with a given ΔQ value.

Each estimate of daily mortality cases avoided is multiplied by the number of days in the period (365 days per year/20 periods per year = 18.25 days per period) to derive a total number of cases for that period. An estimate of the annual number of avoided mortality cases is the sum of the estimates for the 20 periods. Estimates of the number of cases avoided are calculated in this manner for each modeled location. The general approach outlined for this PM mortality example applies to the evaluation of all concentration-response functions based on short-term average PM concentrations.

3.0 USE OF CONCENTRATION-RESPONSE FUNCTIONS

Epidemiological studies have estimated the relationship between PM and health endpoints in different geographic locations. The concentration-response functions estimated by these studies differ from each other in several ways. They may have different functional forms; they may have measured PM concentrations in different ways; they may have characterized the health endpoint, y, in slightly different ways; or they may have considered different types of populations. For example, some studies of the relationship between ambient PM concentrations and mortality have excluded accidental deaths from their mortality counts; others have included all deaths. One study may have measured daily (24-hour) average PM concentrations while another study may have used two-day averages. Some studies have assumed that the relationship between y and PM is best described by a linear form (i.e., the relationship between y and PM is estimated by a linear regression in which y is the dependent variable and PM is one of several independent variables). Other studies have assumed that the relationship is best described by a log-linear form (i.e., the relationship between the natural logarithm of y and PM is estimated by a linear regression).[2] Finally, some studies have considered changes in the health endpoint only

[2]The log-linear form used in the epidemiological literature on PM-related health effects is often referred to as "Poisson regression" because the error term in the regression is assumed to have a Poisson distribution rather than the usual normal distribution. The form of the regression, however, is still log-linear.

among members of a particular subgroup of the population (e.g., individuals 65 and older), while other studies have considered the entire population in the study location. Furthermore, some of the epidemiological studies measuring the relationship between PM air pollution and adverse effects quantify the relationship in terms of PM-10, while others focus exclusively on the fine fraction, PM-2.5. (Because modeled predictions of the change in ambient PM-10 and PM-2.5 concentrations are both available, this analysis evaluated each concentration-response function using the appropriate PM indicator.)

To estimate changes in health effects in this analysis, CAPMS applies the concentration-response functions available in epidemiological studies to changes in PM concentrations between the baseline and the control air quality scenarios investigated. Several issues related to the use of the concentration-response functions are described in the following sections. Section 3.1 describes the health effects modeled in this analysis and issues related to the overlap in these effects; Section 3.2 describes the type functional forms of the majority of concentration-response functions used in this analysis; and Section 3.3 describes how concentration-response functions are "pooled" before being used to estimate changes in health effects. Exhibit 3.1 summarizes the concentration-response functions used to quantify changes in health effects in this analysis. Much of the discussion in the following sections is taken from the Retrospective Analysis of the Clean Air Act (U.S. EPA, 1997a) and documents supporting the Regulatory Impact Analysis of the Particulate Matter and Ozone NAAQS (U.S. EPA, 1997b). Additional information is included where necessary.

3.1 Description and Overlap of Health Effects Modeled

Epidemiological studies that have estimated relationships between ambient PM concentrations and health effects are available for several health effects and several different population groups. The broad categories of health endpoints for which concentration-response functions have been estimated based on measures of PM are:

(1) mortality,
(2) hospital admissions, and
(3) respiratory symptoms and restricted activity days (not requiring hospitalization).

The health endpoints included in each of these categories and the possible overlap among health effects and populations studied are described below. Descriptions of the populations investigated in the relevant studies are important because, in most cases, the concentration-response functions from these studies are applied only to the subpopulation (e.g., asthmatic children) investigated in the epidemiological study.

Exhibit 3.1 Concentration-Response Functions Used to Estimate Health Effects Associated with Exposure to Particulate Matter

Endpoint	Concentration-Response Function		PM Averaging Time		Population[a]	Annual Baseline Incidence (per 100,000 population)[b]	Pollutant Coefficient[c]
	Source	Functional Form	Studied	Applied			
Mortality							
Mortality (Long-Term exposure), using PM2.5 indicator	Pope et al., 1995	log-linear	median of four years of data	annual median[d]	ages 30+	759 (number of nonaccidental deaths in the population ages 30 + divided by 100,000 individuals of all ages .)	0.006408
Mortality (Short-Term exposure), using PM2.5 indicator	Schwartz et al., 1996a (Boston, Knoxville, St. Louis, Steubenville, Portage & Topeka)	log-linear	2-day average	1-day average[e]	all	803 (nonaccidental deaths in general pop.)	0.001433
Mortality (Short-Term exposure), using PM10 indicator[e]	Ito & Thurston, 1996 (Chicago)	log-linear	2-day average	1-day average[f]	all	803 (nonaccidental deaths in general pop.)	0.000782
	Kinney et al., 1995 (Los Angeles)	log-linear	1-day average		all		
	Pope et al., 1992 (Utah)	log-linear	5-day average		all		
	Schwartz, 1993a (Birmingham)	log-linear	3-day average		all		
	Schwartz et al., 1996a (Boston)	log-linear	2-day average		all		
	Schwartz et al., 1996a (Knoxville)	log-linear	2-day average		all		
	Schwartz et al., 1996a (St. Louis)	log-linear	2-day average		all		
	Schwartz et al., 1996a (Steubenville)	log-linear	2-day average		all		
	Schwartz et al., 1996a (Portage)	log-linear	2-day average		all		
	Schwartz et al., 1996a (Topeka)	log-linear	2-day average		all		

(continued)

Exhibit 3.1 (continued)

Endpoint	Concentration-Response Function		PM Averaging Time		Population[a]	Annual Baseline Incidence (per 100,000 population)[b]	Pollutant Coefficient[c]
	Source	Functional Form	Studied	Applied			
Hospital Admissions							
All respiratory illnesses, using PM2.5 indicator	Thurston et al., 1994 (Toronto)	linear	1-day average	1-day average	all	n/a	3.45×10^{-8} [f]
All respiratory illnesses, using PM10 indicator	Schwartz, 1995 (Tacoma)	log-linear	1-day average	1-day average	age 65+	504 (general pop.)	0.00170
	Schwartz, 1995 (New Haven)	log-linear	1-day average		age 65+		
	Schwartz, 1996 (Spokane)	log-linear	1-day average		age 65+		
COPD, using PM10 indicator	Schwartz, 1994a (Birmingham)	log-linear	1-day average	1-day average	age 65+	103 (general pop.)	0.002533
	Schwartz, 1994b (Detroit)	log-linear	1-day average		age 65+		
	Schwartz, 1996 (Spokane)	log-linear	1-day average		age 65+		
Pneumonia, using PM10 indicator	Schwartz, 1994a (Birmingham)	log-linear	1-day average	1-day average	age 65+	229 (general pop.)	0.0013345
	Schwartz, 1994b (Detroit)	log-linear	1-day average		age 65+		
	Schwartz, 1994c (Minneapolis)	log-linear	1-day average		age 65+		
	Schwartz, 1996 (Spokane)	log-linear	1-day average		age 65+		
Congestive heart failure, using PM10 indicator	Schwartz and Morris, 1995 (Detroit)	log-linear	2-day average	1-day average	age 65+	231 (general pop.)	0.00098
Ischemic heart disease, using PM10 indicator	Schwartz & Morris, 1995 (Detroit)	log-linear	1-day average	1-day average	age 65+	450 (general pop.)	0.00056

(continued)

Exhibit 3.1 (continued)

Endpoint	Concentration-Response Function		PM Averaging Time		Population[a]	Annual Baseline Incidence (per 100,000 population)[b]	Pollutant Coefficient[c]
	Source	Functional Form	Studied	Applied			
Respiratory Symptoms/Illnesses not requiring hospitalization							
Chronic bronchitis, using PM10 indicator	Schwartz, 1993b		annual mean	annual mean	all	n/a	0.012
Acute bronchitis, using PM2.5 indicator	Dockery et al., 1989	logistic	annual mean	annual mean[d]	ages 10-12	n/a	0.0298
Upper respiratory symptoms (URS), using PM10 indicator	Pope et al., 1991	log-linear	1-day average	1-day average	asthmatics, ages 9-11	38,187 (applied pop.)	0.0036
Lower respiratory symptoms (LRS), using PM2.5 indicator	Schwartz et al., 1994	logistic	1-day average	1-day average	ages 8-12	n/a	0.01823
MRADs, using PM2.5 indicator	Ostro and Rothschild, 1989	log-linear	2-week average	1-day average	ages 18-65	780,000 days/year (applied pop.)	0.00741
RADs, using PM2.5 indicator	Ostro, 1987	log-linear	2-week average	1-day average	ages 18-65	400,531 days/year (applied pop.)	0.00475
Acute respiratory symptoms (any of 19), using PM10 indicator	Krupnick et al., 1990	logistic	1-day average COH	1-day average	ages 18-65 (study examined "adults")	n/a	0.00046
Shortness of breath (days), using PM10 indicator	Ostro et al., 1995	logistic	1-day average	1-day average[d]	African-American asthmatics, ages 7-12	n/a	0.00841

(continued)

Exhibit 3.1 (continued)

Endpoint	Concentration-Response Function		PM Averaging Time		Population[a]	Annual Baseline Incidence (per 100,000 population)[b]	Pollutant Coefficient[c]
	Source	Functional Form	Studied	Applied			
Work loss days (WLDs), using PM2.5 indicator	Ostro, 1987	log-linear	2-week average	1-day average	ages 18-65	150,750 days/year (applied pop.)	0.0046

NOTES:

[a] The population examined in the study and to which this analysis applies the reported concentration-response relationship. In general, epidemiological studies analyzed the concentration-response relationship for a specific age group (e.g., ages 65+) in a specific geographical area. This analysis applies the reported pollutant coefficient to all individuals in the age group nationwide.

[b] annual baseline incidence in the applied population per 100,000 individuals in the indicated population. For hospital admissions and mortality, the national baseline incidence rates are meant to provide the reader with a general perspective of the potential magnitude of the baseline incidence; for other endpoints, the annual baseline incidence estimates were taken directly from the epidemiological literature and were applied to all sectors in the analysis.

[c] a single pollutant coefficient reported for several studies indicates a pooled analysis; see text for discussion of pooling concentration-response relationships across studies.

[d] The following studies report a lowest observed pollution level:

Pope et al., 1995	Mortality (long-term exposure)	9 $\mu g/m^3$ $PM_{2.5}$
Dockery et al., 1995	Acute Bronchitis	11.8 $\mu g/m^3$ $PM_{2.5}$ (20.1 $\mu g/m^3$ PM_{10})
Ostro et al., 1995	Shortness of Breath, days	19.63 $\mu g/m^3$ PM_{10}

The remaining studies did not report lowest observed concentrations.

[e] Pooling of the ten studies used for this endpoint is described in EPA (1996).

[f] All 1-day averages are 24-hour averages, 2-day averages are 48-hour averages, etc.

* See U.S. EPA 1997 for citations

Mortality Studies

The studies that associate PM exposures with premature mortality presented in this analysis differ primarily in the type of PM exposure which is used as input to the concentration response functions (i.e., whether PM2.5 or PM10 is used and whether short-term or long-term exposure is used). The mortality studies also differ slightly in the populations studied. Brief descriptions of the mortality studies used in this analysis and the issues related to the overlap in the incidence predicted from these studies are discussed here.

One long-term exposure study is presented here. Pope et al. (1995) is a prospective cohort study which investigated the association between long-term exposure to ambient PM2.5 concentrations (measured in the study as the median of all daily concentrations measured over a four-year period) and mortality in a cohort of adults thirty years and older.[3]

Two estimates of the relationship between mortality and short-term exposure to PM are presented. One estimate is from a pooled analysis of 10 individual studies, in which PM-10 concentrations are averaged over a period of 1 to 5 days. The second estimate is taken from Schwartz et al. (1996), and uses a 2-day average PM-2.5 measure. In both cases, short-term exposure is related to daily mortality for the full population.

Long-term studies may be preferable to "short-term" (daily average) studies for estimating health effects for a couple of reasons. First, by their basic design, daily studies detect acute effects but cannot detect the effects of long-term exposures. A chronic exposure study design (a prospective cohort study) is best able to identify the long-term exposure effects, and will likely detect some of the short-term exposure effects as well.

The second reason that long-term studies may be preferable to short-term studies is that long-term study results may be less likely to be affected by deaths that are premature by only a very short amount of time. Critics of the use of short-term studies for policy analysis purposes correctly point out that an added risk factor that results in terminally ill individuals dying a few days or weeks earlier than they otherwise would have (a phenomenon referred to as "harvesting") is potentially included in the measured PM mortality "signal" detected in such a study. Because the short-term study design does not examine individual people (but instead uses daily mortality rates in large, typically city, populations), it is impossible to know anything about the overall health status of the people who die on any given day. While some of the excess deaths associated with peak PM exposures may have resulted in a substantial loss of life (measuring loss of life in terms of lost years of remaining life), others may have resulted in a relatively short amount of lifespan lost. While it is not clear that the results of prospective cohort (long-term) studies are completely unaffected by "harvesting," because they follow individuals such studies are better able to examine the health status of individuals who die during the course of the study.

[3] Dockery et al., 1993, is another study relating long-term exposures to PM to premature mortality. However, the study by Pope et al. considered a much larger population and included many more locations (52 cities versus six in the Dockery study). The Pope study is therefore considered to be preferable.

Although long-term exposure studies may be preferable, only one is presented in this analysis. Therefore, results of studies which use short-term PM exposures are also presented in this analysis for comparison. However, because a long-term exposure study may detect some of the same short-term exposure effects detected by short-term studies, including both types of study in a benefit analysis would likely result in some degree of double counting of benefits.

Hospital Admissions Studies

Several studies have investigated the association between ambient PM concentrations and increased hospital admissions for a variety of ailments and among different population groups. These studies and the issues of overlap among the endpoints and populations investigated are described below. All of these studies compare PM concentrations averaged over one to two days with daily hospital admissions.

Hospital Admissions for Respiratory Illnesses

Several studies have investigated hospital admissions specifically for respiratory ailments. Two estimates are available for hospital admissions for "all respiratory illnesses". The first study, Thurston et al. (1994), investigated respiratory admissions for individuals of all ages. The pooled analysis using information from Schwartz (1995 and 1996) estimates all respiratory hospital admissions for individuals aged 65 years and older. Studies of hospital admissions for chronic obstructive pulmonary disease (COPD) and pneumonia, which are both subsets of hospital admissions for all respiratory diseases are also presented.

Because Thurston et al. (1994) includes hospital admissions for a large group of respiratory illnesses and all age groups, this study is the most comprehensive and is therefore considered to be the most appropriate study for predicting changes in hospital admissions for respiratory illnesses related to PM exposure. Because Schwartz (1994a,b,c; 1996) estimates incidence for a subset of hospital admissions counted by Thurston et al. (1994), the incidence predicted by the Schwartz studies should not be added to the incidence predicted by Thurston et al. (1994).

Hospital Admissions for Cardiac Disease

Hospital admissions for ischemic heart disease and congestive heart failure related to PM exposure have been investigated by Schwartz and Morris (1995). These admissions are not included in the group of respiratory illness hospital admissions. In addition, there is no overlap between hospital admissions for ischemic heart disease and admissions for congestive heart failure. Therefore, they can both be counted as benefits associated with reducing exposure to PM.

Respiratory Symptoms and Restricted Activity Days

Several studies have investigated changes in a variety of respiratory symptoms not requiring admission to the hospital. These studies have investigated illnesses in both the general population and in asthmatic individuals; many of the studies have used children as the study

population. The types of symptoms investigated and issues related to potential overlap among the symptoms examined in these studies are described here. Because some of these symptoms may vary only slightly among the studies, there is considerable overlap among the health effects investigated in these studies. Exhibit 3.2 defines the symptoms and the populations investigated for each of the studies presented in this analysis.

Exhibit 3.2 Descriptions of Studies of Respiratory Symptoms not Requiring Hospitalization

Health Endpoint, PM Indicator	Definition of Health Endpoint	Population Studied	Reference
Chronic bronchitis, using PM10 indicator	Chronic bronchitis was defined as positive responses to the following questions: (1) whether a doctor had ever told the subject that he or she had chronic bronchitis, and (2) whether he or she still had bronchitis at the time of the study.	all	Schwartz, 1993
Acute bronchitis, using PM2.5 indicator	Bronchitis was defined as a doctor's diagnosis of bronchitis reported within the year prior to the study. Occurrence of bronchitis diagnosed during the year was compared with the annual mean PM concentration reported during the year.	ages 10-12	Dockery et al., 1989
Upper respiratory symptoms (URS), using PM10 indicator	URS includes runny or stuffy nose; wet cough; and burning, aching, or red eyes. Presence of symptoms on a given day were compared with the PM concentration on the same day.	asthmatics, ages 9-11	Pope et al., 1991
Lower respiratory symptoms (LRS), using PM2.5 indicator	LRS is the presence of at least two of the following symptoms: cough, chest pain, phlegm, or wheeze. Presence of symptoms on a given day was compared with PM concentrations measured on the previous day; symptoms were counted only if they were not present on the previous day.	ages 8-12	Schwartz et al., 1994

(continued)

Exhibit 3.2 (continued)

Health Endpoint, PM Indicator	Definition of Health Endpoint	Population Studied	Reference
Minor Restricted Activity Days (MRADs), using PM2.5 indicator	An MRAD is a day in which an individual restricts his or her activity due to either respiratory or nonrespiratory symptoms; an MRAD does not result in either work loss or bed disability Occurrence of MRADs was compared with PM concentrations averaged over a 2 week period.	ages 18-65	Ostro and Rothschild, 1989
Restricted Activity Days (RADs), using PM2.5 indicator	A RAD is a day in which an individual restricts his activity; RADs include both days of work loss or bed disability as well as minor restrictions. Occurrence of RADs was compared with 2-week average PM concentrations.	ages 18-65	Ostro, 1987
Acute respiratory symptoms (any of 19), using PM10 indicator	The study measured daily presence of any of 19 symptoms, including chest discomfort, coughing, wheezing, sore throat, cold, doctor-diagnosed flu, asthma, hay fever [all symptoms considered were not reported in the study]	adults	Krupnick et al., 1990
Shortness of breath, using PM10 indicator	The study measured daily presence of shortness of breath.	African-American asthmatics, ages 7-12	Ostro et al., 1995
Work loss days (WLDs), using PM2.5 indicator	Days of work loss were compared with 2-week average PM concentrations.	ages 18-65	Ostro, 1987

Respiratory Illnesses Measured in the General Population

There may be some overlap between bronchitis studied by Dockery et al. (1989) and chronic bronchitis defined by Schwartz (1993). In particular, Dockery et al. (1989) considered the effects of PM exposure on bronchitis which was diagnosed by a doctor within the previous year, which may include some of the same types of cases investigated by Schwartz (1993). Although the bronchitis measured in Dockery et al. (1989) is likely to include more cases of acute bronchitis than the bronchitis cases measured by Schwartz (1993), the measure in Dockery et al. (1989) may also include some cases of chronic bronchitis, if the cases diagnosed in the year prior to the study continue into future years. For this reason, and because the populations studied

overlap each other, the estimates of avoided incidence based on these studies are not necessarily mutually exclusive. However, both studies give valuable information regarding the incidence of bronchitis avoided in two different population groups.

Lower respiratory symptoms (LRS) as described in Schwartz et al. (1994) are distinct from doctor-diagnosed bronchitis, and therefore do not overlap with the avoided cases of bronchitis.

There are several aggregation issues related to the set of endpoints that are studied in adults. Acute respiratory symptoms (any of 19 symptoms) studied by Krupnick et al. (1990) may overlap with minor restricted activity days (MRADs) studied by Ostro and Rothschild (1989), because the age ranges of the populations studied are the same, and it is possible that an acute respiratory symptom could result in a minor respiratory restricted activity day. The degree of overlap, however, is not known, and it is possible that some of the benefit associated with each endpoint is not included within the benefit associated with the other endpoint.

MRADs and Work Loss Days (WLDs) are defined specifically as mutually exclusive endpoints (Ostro and Rothschild, 1989). Both of these estimates (MRADs and WLDs) are subsets of Restricted Activity Days (RADs). However, because the concentration-response functions for RADs and MRADs were estimated by different studies, there is no guarantee that the predicted incidence of MRADs will be less than the predicted incidence of RADs.

Respiratory Illnesses Measured in the Asthmatic Population

Three studies in Exhibit 3.2 measured respiratory illnesses exclusively in asthmatic individuals. Pope et al. (1991) studied upper respiratory symptoms (URS) in children aged 9-11. Ostro et al. (1995) measured shortness of breath among African-American asthmatics aged 7-12.[4] Estimates using Pope et al. (1991) do not appear to overlap with estimates predicted using Ostro et al. (1995).

3.2 Functional Forms of the Concentration Response Functions Used in the Health Effects Studies

The concentration-response functions presented in the available health effects studies estimate a change in health effects associated with a change in PM. The estimated relationship between PM and a health endpoint in a study location is specific to the type of population studied, the measure of PM used, and the characterization of the health endpoint considered. When using a concentration-response function estimated in an epidemiological study to estimate changes in the incidence of a health endpoint corresponding to a particular change in PM, it is

[4]Another study, Ostro et al. (1991), measured days of moderate or worse asthma status in adults. Although this study investigated health effects in a population (asthmatics) which is important to consider, the concentration-response function from the study was not used in the current analysis because the incidence estimated using the study is very sensitive to the actual baseline and control scenario air quality data. Because this analysis uses only at the air quality contributed only by hazardous waste combustors without adding other ambient anthropogenic and natural air concentrations, the actual incidence could not be estimated.

important that the inputs be appropriate for the concentration-response function being used. For example, it is important that the measure of PM, the type of population, and the characterization of the health endpoint be the same as (or as close as possible to) those used in the study that estimated the concentration-response function.

Estimating the relationship between PM and a health endpoint, y, consists of (1) choosing a functional form of the relationship and (2) estimating the values of the parameters in the function assumed. The two most common functional forms in the epidemiological literature on PM and health effects are the log-linear and the linear relationship. The log-linear relationship is of the form

$$y = Be^{\beta PM} \quad , \tag{1}$$

or, equivalently,

$$\ln(y) = \alpha + \beta PM \quad , \tag{2}$$

where the parameter B is the incidence of y when the concentration of PM is zero, the parameter β is the coefficient of PM, ln(y) is the natural logarithm of y, and $\alpha = \ln(B)$. If the functional form of the concentration-response relationship is log-linear, the relationship between ΔPM and Δy is

$$\Delta y = y[e^{\beta * \Delta PM} - 1] \quad , \tag{3}$$

where y is the baseline incidence of the health effect (i.e., the incidence before the change in PM). For a log-linear concentration-response function, the relative risk (RR) associated with the change (ΔPM) is

$$RR_{\Delta PM} = e^{\beta * \Delta PM} \quad . \tag{4}$$

Epidemiological studies often report a relative risk for a given ΔPM, rather than the coefficient, β, in the concentration-response function. The coefficient can be derived from the reported relative risk and ΔPM by solving for β in equation (4):

$$\beta = \ln(RR)/\Delta PM \quad . \tag{5}$$

The linear relationship is of the form

$$y = \alpha + \beta PM \quad , \tag{6}$$

where α incorporates all the other independent variables in the regression (evaluated at their mean values, for example) multiplied by the respective coefficients. If the functional form of the concentration-response relationship is linear, the relationship between ΔPM and Δy is simply

$$\Delta y = \beta * \Delta PM \quad . \tag{7}$$

A few epidemiological studies have used functional forms other than linear or log-linear forms. Of these, logistic regressions were the most common. The details of the models used in these studies are given in the papers reporting the methods and results of the studies.

The input components (including PM averaging time, the applied population, and the baseline incidence) necessary to estimate incidence changes using concentration-response functions from individual studies are shown in Exhibit 3.1. In the case of PM averaging time, both the averaging time used in the epidemiological study (indicated as "Studied" in Exhibit 3.1), and the averaging time used to estimate sector-specific incidence changes in this analysis (indicated as "Applied" in Exhibit 3.1) are presented.

3.3 Pooling Several Concentration-Response Functions to Estimate one Concentration-Response Function

When there are several estimates of the relationship between PM and a given health endpoint (perhaps using estimates from different studies or different geographic locations), the results of the studies can be pooled to derive a single estimate. In this analysis, several studies were pooled to obtain a "central tendency" concentration response function if the functional forms, pollutant averaging times, and study populations were judged to be similar enough among the studies or locations.

The method in which the estimates of PM coefficients from different studies are used in a pooled analysis depends on the underlying assumption about how the different estimates are related to each other. It is reasonable that a "pooled estimate" which combines the estimates from different studies should give more weight to estimates from studies with little reported uncertainty than to estimates with a great deal of uncertainty.

The analysis presented here assumes that there is a distribution of PM coefficients (β's), rather than one estimate of the relationship between PM and a given health effect. Specifically, the coefficients reported in different studies or different geographic locations may be estimates of *different* underlying PM coefficients, rather than just different estimates of the same PM coefficient. Therefore, this analysis uses the random-effects model to pool results from different studies, because the random effects model does not assume that all studies are estimating the same parameter.[5]

Five separate pooled analyses using the random-effects model were carried out in this analysis:

(1) An analysis of PM-10 mortality, using the ten short-term exposure PM-10 studies,

[5] In studies of the effects of PM-10 on mortality, for example, if the composition of PM-10 varies among study locations, the underlying relationship between mortality and PM-10 may be different from one study location to another. For example, fine particles make up a greater fraction of PM-10 in Philadelphia County than in Southeast Los Angeles County. If fine particles are disproportionately responsible for mortality relative to coarse particles, then one would expect the true value of β for PM-10 in Philadelphia County to be greater than the true value of β for PM-10 in Southeast Los Angeles County.

(2) An analysis of PM-2.5 mortality, using six different locations at which concentration-response functions for mortality and short-term exposure to PM2.5 were estimated by Schwartz et al. (1996),

(3) An analysis of respiratory illness hospital admissions, using three "all respiratory illness" hospital admissions studies,

(4) An analysis of COPD hospital admissions, using three studies, and

(5) An analysis of pneumonia hospital admissions, using four pneumonia hospital admissions studies.

For those health-effects studies which used PM concentrations averaged over one to several days (e.g., mortality studies), PM concentrations averaged over one day were used in this analysis, because daily averages are the only short-term air quality measurements available as described in Section 2.0. The health effects studies which use multi-day averages are in effect using a smoothed data set, comparing each day's mortality to recent average exposure rather than to exposure on the same day that the health effect was observed. The more nearly linear the concentration-response function, however, the less difference it makes whether multi-day averaging functions are used with single-day PM data.[6] The concentration-response functions considered here are nearly linear.

4.0 ESTIMATES OF BASELINE INCIDENCES USED WITH LOG-LINEAR FUNCTIONS AND EXPOSED POPULATIONS

Some types of concentration-response functions used in this analysis estimate health effects in given subpopulations. To use these functions, the analysis requires an estimate of the size of such subpopulations.[7] For example, the Schwartz (1995, 1996) study of hospital admissions for all respiratory symptoms examined respiratory hospital admissions for people ages 65 and over. Therefore, in order to estimate the change in incidence of respiratory hospital admissions predicted by the Schwartz (1995, 1996) study for a given change in air quality, it is necessary to have an estimate of the number of persons aged 65 and older that are exposed to that air quality change. The general method of using available data to make baseline and sub-population estimates is described below.

Other concentration-response functions require baseline incidences because these functions estimate changes in risk as a percent change in incidence between the baseline and the control scenarios. To use these functions, the analysis requires an estimate of the baseline

[6]If the functions were perfectly linear, using one day averages rather than multi-day averages would make no difference at all.

[7]Although the concentration-response functions might be applicable to a wider segment of the population than was included in the epidemiological study of interest, this was not done in the current analysis.

incidence of the health effect being studied. "Baseline" incidences are those expected to occur under conditions where the MACT standard has not been implemented.

4.1 EXPOSED POPULATIONS

This analysis focuses on sectors (which are geographic areas generally smaller than counties) that are associated with particular hazardous waste combustion units. Each hazardous waste facility has 16 sectors associated with it, which form concentric circles radiating out from the combustion stack. These sectors are situated at varying distances from the stack and have varying pollutant concentrations, as well as varying exposed populations. As noted above, in order to evaluate concentration-response functions which examine a specific sub-population (ages 65 and over, for example), it is necessary to have estimates of the number of people in a particular population subgroup that are exposed to given change in air quality. Therefore, for this analysis, ideally it would be possible to have sector-level population estimates for the variety of population subgroups that are examined in the concentration-response functions. However, population estimates at the sector level were available for some but not all of the pertinent sub-populations.

Sector-level population estimates were available for two age categories which were commonly examined in the concentration-response functions used in this analysis: ages 18-65, and ages 65 and over. In those cases where it was not possible to obtain sector-specific sub-population data, the percentage of persons in the subpopulation at the county level was applied to the sector level. For example, Census data is available which estimates that in Autauga County, Alabama, 5% of the population is between the ages of 8 and 12 (the examined population in Schwartz et al.'s (1994) study of Lower Respiratory Symptoms). This percentage was then multiplied by the total sector population to estimate the total number of children aged 8-12 in a sector which lies completely within Autauga County.

While the method described in the preceding paragraph works in those cases where a sector lies completely within one county, many sectors lie in multiple counties. In those cases where a sector lies in more than one county, the sector was assigned a spatially-weighted average of the county-level sub-population percentage breakdowns. This spatially-weighted average was determined by multiplying the proportion of each sector (in terms of area) located in a given county by that county's sub-population percentage. The resulting proportion-adjusted county-specific data is then summed for all the counties in which a sector lies, giving an estimate of sector-level sub-population percentages. This spatially-weighted average method assumes that county populations are uniformly distributed throughout the county.

4.2 BASELINE INCIDENCE

As mentioned above, some concentration-response functions require estimates of baseline incidence. It was necessary to estimate sector-level baseline incidence in order to evaluate those concentration-response functions at the sector-level. Sector-specific baseline incidence estimates were not available for any endpoints, so the spatially-weighted averages of county-specific data were also applied in determining sector-specific baseline incidence estimates. Unlike estimates

of the exposed population, for which all of the pertinent county-level sub-population breakdowns were available from the U.S. Census, county-level baseline incidence estimates were obtained from a variety of sources, as documented below.

County-specific mortality rates (across all ages) were obtained for each county in the United States from the National Center for Health Statistics (NCHS). Because most PM studies that estimated concentration-response functions for mortality considered only non-accidental mortality, county-specific baseline mortality rates used in the estimation of PM-related mortality were adjusted to reflect an estimate of county-specific non-accidental mortality. This estimate was determined by multiplying each county-specific mortality rate by the ratio of national non-accidental mortality to national total mortality (0.93).

Although total mortality incidences (over all ages) were available for counties, age-specific mortality incidences were not available at the county level. County-specific baseline mortality incidences among individuals aged 30 and over (necessary for PM2.5-related long-term exposure mortality, estimated by Pope et al., 1995) were therefore estimated by applying national age-specific death rates to county-specific age distributions, and adjusting the resulting estimated age-specific incidences so that the estimated total incidences (including all ages) equaled the actual county-specific total incidences. For example, if the total of the estimated age-specific incidences obtained in this way was 5% higher than the actual total incidence for a county, then each of the estimated age-specific incidences was multiplied by (1/1.05). These county-specific, age-specific mortality incidence estimates were then applied at the sector level using the spatially-weighted average method described in Section 4.1.

Each county-specific hospital admissions baseline incidence rate was obtained by multiplying the national hospital admissions rate for the relevant International Classification of Diseases (ICD) code(s) per 100,000 exposed population by the county-specific population, and then adjusting this incidence by the ratio of the county-specific proportion of the population that was aged 65 or older to the national proportion of the population aged 65 or older[8]. These county-specific hospital admissions baseline incidence rates were then used to determine spatially-weighted average baseline incidence rates at the sector level using the spatially-weighted average method described in Section 4.1.

While county-level baseline incidence estimates could be obtained for the mortality and hospital admissions endpoints, they were not available for all endpoints. Baseline incidence rates for all respiratory symptoms and illnesses included in the benefit analysis and for restricted activity days were obtained from the studies reporting concentration-response functions for those

[8] Except for Thurston et al., 1994, all hospital admissions studies used in the national benefit analysis apply only to individuals 65 and older. The Thurston study used a linear concentration-response function, which does not require a baseline incidence rate for calculation of PM-related incidence.

health endpoints. No baseline incidence rates were available from other sources for these endpoints. In these cases, the same baseline incidence was applied to all sectors in the analysis[9].

5.0 AGGREGATING INCIDENCE OVER A YEAR

This analysis presents total changes in health effects expected to occur over a one-year time period for the population exposed to PM emissions from combustors. However, several of the epidemiological studies measure changes in health effects for time periods other than one year. For example, some studies of respiratory symptoms estimate changes in the occurrence of symptoms during a single day. To present changes in health effects avoided during a given year, this analysis uses appropriate multipliers to adjust the changes in health effects predicted by studies which estimate these changes for time periods shorter than one year, as described in greater detail in Section 2.

There is one exception to presenting results as the number of cases avoided per year. Schwartz (1993) defines chronic bronchitis as positive responses to the following questions: (1) whether a doctor had ever told the subject that he or she had chronic bronchitis, and (2) whether he or she still had bronchitis at the time of the study. Therefore, the duration of an individual case of chronic bronchitis is not defined, and the results using information from this study cannot be reported as the number of cases avoided per year. Instead, the results are reported as the number of cases avoided for some time period greater than one year, but which cannot be specified given the available information.

It should be noted that this analysis estimates the avoidance of recurring health effects for a given individual. For example, if an individual avoids ten incidents of shortness of breath during a given year as a result of implementing the MACT standard, all ten incidents will be counted in the results.

6.0 BENEFITS ESTIMATES: NO-THRESHOLD ASSUMPTIONS

The current analysis assumes that health effects may occur at any PM concentration level down to zero. Even if the modeled PM concentrations in the baseline and MACT control scenarios are below the lowest observed PM concentrations seen in the available epidemiological studies or below National Ambient Air Quality Standards (NAAQS) for PM-10 or PM-2.5, health effects are assumed to result from the changes in PM concentrations between the two scenarios.

Consideration of thresholds may, however, be important. Systemic toxicants (chemicals and other substances that cause noncarcinogenic and nonmutagenic health effects) have often been treated as having concentration levels below which there are no observable adverse effects,

[9] For hospital admissions and mortality, the national baseline incidence rates provided in Exhibit 3.1 are meant to provide the reader with a general perspective of the potential magnitude of the baseline incidence; for other endpoints, the annual baseline incidence estimates in Exhibit 3.1 were taken directly from the epidemiological literature and were applied to all sectors in the analysis.

based on our understanding of the adaptive and homeostatic mechanisms of these types of toxicants (U.S. EPA, 1988). The lowest observed levels seen in some of the epidemiological studies in this analysis or the PM NAAQS may represent plausible estimates of such thresholds.

This project did not estimate total ambient PM concentrations; only the contribution to total PM from hazardous waste combustors was estimated. Without estimates of total PM concentrations, it is not possible to conduct any threshold analyses. Given the opportunity and additional resources, it would be appropriate to determine estimates of site-specific ambient PM concentrations, which, coupled with the change in modeled combustor emissions evaluated in this analysis, would allow for an alternate estimate of benefits using the lowest observed effect levels reported in the above three studies or the NAAQS as threshold levels below which health effects do not occur. However, given the current scope of this analysis and the available information, it was not feasible to address threshold issues at this time.

7.0 UNCERTAINTY

There are several sources of uncertainty in the health effects estimates associated with using the available concentration-response functions in this analysis. There is uncertainty about how well the studies estimated the concentration-response relationships in the study locations; there is uncertainty about how applicable these concentration-response functions are to other locations (the "assessment locations"); and there is uncertainty about extrapolating the estimated concentration-response functions beyond the range of PM concentrations that were used to estimate these functions. Finally, there are uncertainties associated with other aspects of applying concentration-response functions to estimate changes in incidence associated with changes in PM concentrations.

An obvious uncertainty in an estimated concentration-response function is the statistical uncertainty surrounding estimates of parameters in the function. The standard errors reported along with parameter estimates describe this statistical uncertainty. A less obvious uncertainty, however, is whether the functional form of the relationship being estimated is correct. The form of the relationship between PM and the health effect studied in a given epidemiological study is based on the available data, and evaluated to determine how well the data fit the relationship. It is possible that a functional form not examined in a particular study may fit the data better than the form chosen by the authors. In addition, if data are sparse, the functional form used may not be as good as a form that might be chosen if more data were available. For example, many concentration-response relationships are estimated by "Poisson regression," and assume a log-linear relationship between the expected value of the health endpoint and PM. This is a no-threshold model, which assumes that at any level of PM there will be some effect. Although good research investigates which model is most consistent with the data, there is always some degree of uncertainty about whether the model estimated is the functional form that best describes the relationship under investigation. Finally, confounding effects and modifying effects not sufficiently accounted for in the studies may contribute to error in the estimation of concentration-response functions and therefore in the estimation of incidence, based on these functions.

Uncertainties associated with other aspects of model specification contribute additional uncertainty to the estimates of PM-related incidence. One source of uncertainty is the measure of particulate matter used in concentration-response functions. Some studies use TSP (total suspended particulates) as the measure of particulate matter; others use PM10; because of a lack of monitoring data, only a few studies have used PM2.5. If only a component of particulate matter (e.g., PM2.5) is causally related to a health endpoint, other measures of particulate matter could be poor proxies for the correct measure, potentially leading to biased estimates of the concentration-response function and therefore misestimation of PM-related incidence.

Even if an estimated concentration-response function provides a good description of the relationship between a health endpoint and PM for the location in which it was estimated, it is not necessarily a good description of this relationship in a different location. The concentration-response relationship may differ from one location to another as, for example, the composition of the PM and/or the composition of the exposed populations differ.

In applying estimated concentration-response functions to estimate changes in incidence associated with changes in PM concentrations, the PM concentrations considered in the analysis may extend beyond the range of those used to estimate the concentration-response function. Extrapolation of the concentration-response function to PM concentrations that are lower than or higher than those used to estimate the function could bias the results of the analysis. For example, if there is a PM concentration threshold below which there is no association between PM and the studied health effect, extrapolation down to zero of a concentration-response function based on higher levels of PM could result in an overestimate of incidence.

There are several additional sources of uncertainty in applying estimated concentration-response functions in this analysis. In most cases, concentration-response functions are applied to the population group investigated in the study which estimated the function. Using concentration-response functions in this manner may potentially result in an underestimate of the incidence of health effects because the incidence in that portion of the population not covered in the study is implicitly zero. Health effects for which this underestimation of incidence may be most pronounced are those that were studied only in the elderly or in certain subsets of children but occur in wider age ranges in the population. For example, studies of hospital admissions were often limited to observation of effects in the population 65 years and older. The incidence of hospital admissions was then estimated for the same population of individuals. To the extent that younger individuals are also affected by PM 2.5, the number of PM-related hospital admissions may be underestimated in the current analysis. Also, several functions investigated respiratory effects in children in a limited age group (e.g., ages 10-12 years); to the extent that these respiratory symptoms may be observed in younger or older children, this analysis may underestimate the number of effects seen in the population surrounding hazardous waste combustors.

Many concentration-response functions are based on a relative risk model. In this case, the number of new cases of an effect (or the number of cases avoided, if PM levels decline) is calculated as a percent change from the baseline incidence. When such concentration-response functions are used, a measure of baseline incidence is therefore required. Ideally, location-specific baseline incidence rates would be used. However, for some health effects, the only

available information on baseline incidence is from the study that estimated the concentration-response function. Applying the incidence rate specific to the study location to other areas examined in this analysis may underestimate or overestimate the number of cases associated with a change in PM concentrations in a given area. The extent of over- or underestimation on the current analysis is not known.

8.0 RESULTS

The results generated from this analysis are contained in the attached tables. Results are presented as avoided incidence per year for each health endpoint presented. The results are aggregated by facility type (as provided by RTI). Each table contains one facility type. For example, one sheet presents the aggregated results of all LWAK sites. Each health end-point presented in the table has been modeled using the modeled PM concentrations as inputs. It should be noted, however, that although the model runs both the PM2.5 and PM10 concentration-functions for estimating changes in incidence of acute bronchitis (predicted using Dockery et al., 1989) and changes in incidence of lower respiratory functions (predicted using Schwartz et al., 1994), results are presented only for the model which uses PM2.5 as the input. A table presenting results aggregated across all incinerator categories is also provided.

8.1 Aggregation of the Health Effects

Results are presented for the health endpoints investigated in the concentration-response studies described in Section 3. However, because there are several issues related to the overlap of some of these health endpoints, the reader should refer to Section 3.1 for suggestions about how to interpret these results. For all health endpoints except mortality, total changes in incidence which cover the largest number of PM-related health effects for the largest portion of the population and which avoid double counting of effects are indicated in bold in the results file.

Special note should be given to one study (Krupnick et al., 1990) which estimates fairly large changes in incidence, but which is not included in the aggregated (i.e. bolded) set of results. The estimates of avoiding incidence of any of 19 acute symptoms predicted using Krupnick et al. (1990) may overlap with the estimates of avoided MRADs predicted using Ostro and Rothschild (1989). Therefore, it is possible that many of the avoided health effects which would be predicted using the Krupnick et al. (1990) study are included in the suggested aggregation of results.

In the case of mortality, Pope et al. (1995) is bolded because it investigates long-term exposure, which may be preferable to studies that use short-term estimates (as discussed in Section 3). However, because Pope et al. (1995) is the only long-term study used in this analysis and is applied only to the population of individuals 30 years and older, the results of using the short-term studies are also presented. The short-term studies are applied to the full population.

8.2 Magnitude of Benefits Estimates

The avoided incidence estimates are relatively small in magnitude for the majority of endpoints, even when estimates are aggregated across all of the facilities of a particular combustion unit type. This is consistent with the small changes in 24-hour average PM concentrations between the baseline and MACT air quality scenarios.

Because Pope et al. (1995) is a long-term study, it may be expected that the results of applying the Pope et al. (1995) mortality study to the full population would result in higher estimates of incidence than applying the results of Schwartz et al. (1996a). However, it is possible that the change in air quality is greater using the data required by the Schwartz function than the data required by the Pope function because the studies use different measures of air quality data. Specifically, estimates of annual avoided mortality incidence are calculated by the CAPMS computer model for the Pope study based on the change in the annual median PM 2.5 air quality concentration. In contrast, CAPMS calculates mortality incidence estimates for the Schwartz study based on the change in 20 separate daily average PM 2.5 concentrations which are representative of the distribution of daily average PM 2.5 concentrations across a year. Each of these 20 daily average concentrations represents 1/20th of a year, or 18.25 days. CAPMS then sums the incidence estimates for each of these 20 daily average concentrations to calculate an annual avoided mortality incidence for the Schwartz study.

Point Estimate Benefits - Avoided Incidence
Air Quality Scenario- PMMactJuly Incremental to PMBaseJuly
Facility Type-CINC
Modeled Population= 5355230.65

Endpoint	Reference	Avoided Incidence for No-Threshold Analysis (cases/year)
Mortality (long-term exp. - ages 30+)	**Pope et al., 1995**	**0.01**
Mortality (short-term exp.) - PM10	pooled analysis (10 functions)	0.05
Mortality (short-term exp.) - PM2.5	Schwartz et al., 1996a	0.07
Chronic Bronchitis	**Schwartz, 1993b**	**0.51**
Hosp. Admissions - All Respiratory (all ages)	**Thurston et al., 1994**	**0.07**
All Respiratory (ages 65+)	Schwartz, 1995, 1996 (pooled analysis)	0.06
Pneumonia (ages 65+)	Schwartz, 1994a,b,c, 1996 (pooled analysis)	0.02
COPD (ages 65+)	Schwartz, 1994a,b,c, 1996 (pooled analysis)	0.02
Hosp. Admissions - Congestive Heart Failure	**Schwartz and Morris, 1995**	**0.02**
Hosp. Admissions - Ischemic Heart Disease	**Schwartz and Morris, 1995**	**0.02**
Acute Bronchitis	**Dockery et al., 1989**	**0.46**
Lower Respiratory Symptoms	**Schwartz et al., 1994**	**4.09**
Upper Respiratory Symptoms	**Pope et al., 1991**	**0.47**
Any of 19 Acute Symptoms	Krupnick et al., 1990	116.20
Shortness of breath	Ostro et al., 1995	1.97
Work Loss Days	**Ostro, 1987**	**37.33**
MRAD	**Ostro and Rothschild, 1989**	**311.08**
RAD	Ostro, 1987	102.41

*The method of measuring chronic bronchitis in Schwartz (1993) does not necessarily result in the number of cases avoided/year. Instead, this value may represent number of cases avoided over a period of years.

Point Estimate Benefits - Avoided Incidence
Air Quality Scenario- PMMactJuly Incremental to PMBaseJuly
Facility Type-CK
Modeled Population= 1088193.9

Endpoint	Reference	Avoided Incidence for No-Threshold Analysis (cases/year)
Mortality (long-term exp. - ages 30+)	Pope et al., 1995	0.00
Mortality (short-term exp.) - PM10	pooled analysis (10 functions)	0.02
Mortality (short-term exp.) - PM2.5	Schwartz et al., 1996a	0.02
Chronic Bronchitis	**Schwartz, 1993b**	**0.15**
Hosp. Admissions - All Respiratory (all ages)	**Thurston et al., 1994**	**0.02**
All Respiratory (ages 65+)	Schwartz, 1995, 1996 (pooled analysis)	0.02
Pneumonia (ages 65+)	Schwartz, 1994a,b,c, 1996 (pooled analysis)	0.01
COPD (ages 65+)	Schwartz, 1994a,b,c, 1996 (pooled analysis)	0.01
Hosp. Admissions - Congestive Heart Failure	**Schwartz and Morris, 1995**	**0.01**
Hosp. Admissions - Ischemic Heart Disease	**Schwartz and Morris, 1995**	**0.01**
Acute Bronchitis	**Dockery et al., 1989**	**0.13**
Lower Respiratory Symptoms	**Schwartz et al., 1994**	**1.18**
Upper Respiratory Symptoms	**Pope et al., 1991**	**0.14**
Any of 19 Acute Symptoms	Krupnick et al., 1990	31.36
Shortness of breath	Ostro et al., 1995	0.22
Work Loss Days	**Ostro, 1987**	**7.62**
MRAD	**Ostro and Rothschild, 1989**	**63.50**
RAD	Ostro, 1987	20.90

*The method of measuring chronic bronchitis in Schwartz (1993) does not necessarily result in the number of cases avoided/year. Instead, this value may represent number of cases avoided over a period of years.

Point Estimate Benefits - Avoided Incidence
Air Quality Scenario- PMMactJuly Incremental to PMBaseJuly
Facility Type-LWAK
Modeled Population= 944791.62

Endpoint	Reference	Avoided Incidence for No-Threshold Analysis (cases/year)
Mortality (long-term exp. - ages 30+)	**Pope et al., 1995**	**0.00**
Mortality (short-term exp.) - PM10	pooled analysis (10 functions)	0.01
Mortality (short-term exp.) - PM2.5	Schwartz et al., 1996a	0.01
Chronic Bronchitis	**Schwartz, 1993b**	**0.07**
Hosp. Admissions - All Respiratory (all ages)	**Thurston et al., 1994**	**0.01**
All Respiratory (ages 65+)	Schwartz, 1995, 1996 (pooled analysis)	0.01
Pneumonia (ages 65+)	Schwartz, 1994a,b,c, 1996 (pooled analysis)	0.00
COPD (ages 65+)	Schwartz, 1994a,b,c, 1996 (pooled analysis)	0.00
Hosp. Admissions - Congestive Heart Failure	**Schwartz and Morris, 1995**	**0.00**
Hosp. Admissions - Ischemic Heart Disease	**Schwartz and Morris, 1995**	**0.00**
Acute Bronchitis	**Dockery et al., 1989**	**0.05**
Lower Respiratory Symptoms	**Schwartz et al., 1994**	**0.44**
Upper Respiratory Symptoms	**Pope et al., 1991**	**0.05**
Any of 19 Acute Symptoms	Krupnick et al., 1990	16.09
Shortness of breath	Ostro et al., 1995	0.06
Work Loss Days	**Ostro, 1987**	**3.91**
MRAD	**Ostro and Rothschild, 1989**	**32.58**
RAD	Ostro, 1987	10.73

*The method of measuring chronic bronchitis in Schwartz (1993) does not necessarily result in the number of cases avoided/year. Instead, this value may represent number of cases avoided over a period of years.

Point Estimate Benefits - Avoided Incidence
Air Quality Scenario- PMMactJuly Incremental to PMBaseJuly
Facility Type-OINC-Large
Modeled Population= 18848701.57

Endpoint	Reference	Avoided Incidence for No-Threshold Analysis (cases/year)
Mortality (long-term exp. - ages 30+)	**Pope et al., 1995**	**1.42**
Mortality (short-term exp.) - PM10	pooled analysis (10 functions)	2.19
Mortality (short-term exp.) - PM2.5	Schwartz et al., 1996a	3.61
Chronic Bronchitis	**Schwartz, 1993b**	**22.05**
Hosp. Admissions - All Respiratory (all ages)	**Thurston et al., 1994**	**3.48**
All Respiratory (ages 65+)	Schwartz, 1995, 1996 (pooled analysis)	2.97
Pneumonia (ages 65+)	Schwartz, 1994a,b,c, 1996 (pooled analysis)	1.07
COPD (ages 65+)	Schwartz, 1994a,b,c, 1996 (pooled analysis)	0.91
Hosp. Admissions - Congestive Heart Failure	**Schwartz and Morris, 1995**	**0.79**
Hosp. Admissions - Ischemic Heart Disease	**Schwartz and Morris, 1995**	**0.88**
Acute Bronchitis	**Dockery et al., 1989**	**17.86**
Lower Respiratory Symptoms	**Schwartz et al., 1994**	**158.42**
Upper Respiratory Symptoms	**Pope et al., 1991**	**18.38**
Any of 19 Acute Symptoms	Krupnick et al., 1990	4,990.20
Shortness of breath	Ostro et al., 1995	70.66
Work Loss Days	**Ostro, 1987**	**1,841.54**
MRAD	**Ostro and Rothschild, 1989**	**15,340.16**
RAD	Ostro, 1987	5,052.23

*The method of measuring chronic bronchitis in Schwartz (1993) does not necessarily result in the number of cases avoided/year. Instead, this value may represent number of cases avoided over a period of years.

Point Estimate Benefits - Avoided Incidence
Air Quality Scenario- PMMactJuly Incremental to PMBaseJuly
Facility Type-OINC-Small
Modeled Population= 53033181.14

Endpoint	Reference	Avoided Incidence for No-Threshold Analysis (cases/year)
Mortality (long-term exp. - ages 30+)	**Pope et al., 1995**	**0.06**
Mortality (short-term exp.) - PM10	pooled analysis (10 functions)	0.24
Mortality (short-term exp.) - PM2.5	Schwartz et al., 1996a	0.41
Chronic Bronchitis	**Schwartz, 1993b**	**2.59**
Hosp. Admissions - All Respiratory (all ages)	**Thurston et al., 1994**	**0.42**
All Respiratory (ages 65+)	Schwartz, 1995, 1996 (pooled analysis)	0.31
Pneumonia (ages 65+)	Schwartz, 1994a,b,c, 1996 (pooled analysis)	0.11
COPD (ages 65+)	Schwartz, 1994a,b,c, 1996 (pooled analysis)	0.10
Hosp. Admissions - Congestive Heart Failure	**Schwartz and Morris, 1995**	**0.08**
Hosp. Admissions - Ischemic Heart Disease	**Schwartz and Morris, 1995**	**0.09**
Acute Bronchitis	**Dockery et al., 1989**	**2.08**
Lower Respiratory Symptoms	**Schwartz et al., 1994**	**18.49**
Upper Respiratory Symptoms	**Pope et al., 1991**	**2.13**
Any of 19 Acute Symptoms	Krupnick et al., 1990	604.52
Shortness of breath	Ostro et al., 1995	6.85
Work Loss Days	**Ostro, 1987**	**228.06**
MRAD	**Ostro and Rothschild, 1989**	**1,900.72**
RAD	Ostro, 1987	625.68

*The method of measuring chronic bronchitis in Schwartz (1993) does not necessarily result in the number of cases avoided/year. Instead, this value may represent number of cases avoided over a period of years.

Point Estimate Benefits - Avoided Incidence
Air Quality Scenario- PMMactJuly Incremental to PMBaseJuly
Facility Type-Area Source CK
Modeled Population= 41626

Endpoint	Reference	Avoided Incidence for No-Threshold Analysis (cases/year)
Mortality (long-term exp. - ages 30+)	**Pope et al., 1995**	**0.00**
Mortality (short-term exp.) - PM10	pooled analysis (10 functions)	0.00
Mortality (short-term exp.) - PM2.5	Schwartz et al., 1996a	0.00
Chronic Bronchitis	**Schwartz, 1993b**	**0.00**
Hosp. Admissions - All Respiratory (all ages)	**Thurston et al., 1994**	**0.00**
All Respiratory (ages 65+)	Schwartz, 1995, 1996 (pooled analysis)	0.00
Pneumonia (ages 65+)	Schwartz, 1994a,b,c, 1996 (pooled analysis)	0.00
COPD (ages 65+)	Schwartz, 1994a,b,c, 1996 (pooled analysis)	0.00
Hosp. Admissions - Congestive Heart Failure	**Schwartz and Morris, 1995**	**0.00**
Hosp. Admissions - Ischemic Heart Disease	**Schwartz and Morris, 1995**	**0.00**
Acute Bronchitis	**Dockery et al., 1989**	**0.00**
Lower Respiratory Symptoms	**Schwartz et al., 1994**	**0.00**
Upper Respiratory Symptoms	**Pope et al., 1991**	**0.00**
Any of 19 Acute Symptoms	Krupnick et al., 1990	0.00
Shortness of breath	Ostro et al., 1995	0.00
Work Loss Days	**Ostro, 1987**	**0.00**
MRAD	**Ostro and Rothschild, 1989**	**0.00**
RAD	Ostro, 1987	0.00

*The method of measuring chronic bronchitis in Schwartz (1993) does not necessarily result in the number of cases avoided/year. Instead, this value may represent number of cases avoided over a period of years.

Point Estimate Benefits - Avoided Incidence
Air Quality Scenario- PMMactJuly Incremental to PMBaseJuly
Facility Type-Area Source INC
Modeled Population= 3951983

Endpoint	Reference	Avoided Incidence for No-Threshold Analysis (cases/year)
Mortality (long-term exp. - ages 30+)	**Pope et al., 1995**	**0.01**
Mortality (short-term exp.) - PM10	pooled analysis (10 functions)	0.04
Mortality (short-term exp.) - PM2.5	Schwartz et al., 1996a	0.06
Chronic Bronchitis	**Schwartz, 1993b**	**0.45**
Hosp. Admissions - All Respiratory (all ages)	**Thurston et al., 1994**	**0.06**
All Respiratory (ages 65+)	Schwartz, 1995, 1996 (pooled analysis)	0.05
Pneumonia (ages 65+)	Schwartz, 1994a,b,c, 1996 (pooled analysis)	0.02
COPD (ages 65+)	Schwartz, 1994a,b,c, 1996 (pooled analysis)	0.01
Hosp. Admissions - Congestive Heart Failure	**Schwartz and Morris, 1995**	**0.01**
Hosp. Admissions - Ischemic Heart Disease	**Schwartz and Morris, 1995**	**0.01**
Acute Bronchitis	**Dockery et al., 1989**	**0.40**
Lower Respiratory Symptoms	**Schwartz et al., 1994**	**3.61**
Upper Respiratory Symptoms	**Pope et al., 1991**	**0.42**
Any of 19 Acute Symptoms	Krupnick et al., 1990	103.70
Shortness of breath	Ostro et al., 1995	1.59
Work Loss Days	**Ostro, 1987**	**33.31**
MRAD	**Ostro and Rothschild, 1989**	**277.61**
RAD	Ostro, 1987	91.39

*The method of measuring chronic bronchitis in Schwartz (1993) does not necessarily result in the number of cases avoided/year. Instead, this value may represent number of cases avoided over a period of years.

Point Estimate Benefits - Avoided Incidence
Air Quality Scenario- PMMactJuly Incremental to PMBaseJuly
Facility Type-All Incinerators
Modeled Population= 77237114

Endpoint	Reference	Avoided Incidence for No-Threshold Analysis (cases/year)
Mortality (long-term exp. - ages 30+)	**Pope et al., 1995**	**1.49**
Mortality (short-term exp.) - PM10	pooled analysis (10 functions)	2.48
Mortality (short-term exp.) - PM2.5	Schwartz et al., 1996a	4.09
Chronic Bronchitis	**Schwartz, 1993b**	**25.15**
Hosp. Admissions - All Respiratory (all ages)	**Thurston et al., 1994**	**3.96**
All Respiratory (ages 65+)	Schwartz, 1995, 1996 (pooled analysis)	3.34
Pneumonia (ages 65+)	Schwartz, 1994a,b,c, 1996 (pooled analysis)	1.20
COPD (ages 65+)	Schwartz, 1994a,b,c, 1996 (pooled analysis)	1.02
Hosp. Admissions - Congestive Heart Failure	**Schwartz and Morris, 1995**	**0.89**
Hosp. Admissions - Ischemic Heart Disease	**Schwartz and Morris, 1995**	**0.98**
Acute Bronchitis	**Dockery et al., 1989**	**20.40**
Lower Respiratory Symptoms	**Schwartz et al., 1994**	**181.00**
Upper Respiratory Symptoms	**Pope et al., 1991**	**20.99**
Any of 19 Acute Symptoms	Krupnick et al., 1990	5,710.92
Shortness of breath	Ostro et al., 1995	79.48
Work Loss Days	**Ostro, 1987**	**2,106.92**
MRAD	**Ostro and Rothschild, 1989**	**17,551.95**
RAD	Ostro, 1987	5,780.31

*The method of measuring chronic bronchitis in Schwartz (1993) does not necessarily result in the number of cases avoided/year. Instead, this value may represent number of cases avoided over a period of years.

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FINAL DRAFT: March 2004

Appendix H

REGULATORY FLEXIBILITY SCREENING ANALYSIS FOR THE PROPOSED HAZARDOUS WASTE COMBUSTION MACT REPLACEMENT STANDARDS

Economic Methods and Risk Analysis Division
Office of Solid Waste and Emergency Response
Environmental Protection Agency

March 2004

INTRODUCTION

This report analyzes the impact of the proposed Hazardous Waste Combustion MACT replacement standards on small businesses, as required by the Small Business Regulatory Enforcement Fairness Act (SBREFA) of March 1996, which amended the Regulatory Flexibility Act (RFA) of 1980. Under these laws, EPA must analyze proposed regulations to determine if they will have a "significant economic impact on a substantial number" of small entities (e.g., businesses, tribes, non-profit organizations). If a regulation is found to have a significant impact on any small entities, EPA must determine whether the number of small entities affected is substantial. If this number is substantial, further analysis must be performed to determine what can be done to lessen the impact. In this report, we primarily analyze the potential impacts of the MACT rule on small combustion facilities. We have determined that combustion facilities are not owned by small entities other than businesses, so only businesses are analyzed in this report. Small businesses are defined either by the number of employees, or by the dollar amount of sales. The level at which a business is considered small is determined for each North American Industrial Classification System (NAICS) code by the Small Business Administration (SBA).[1]

The remainder of the report is divided into three sections - methodology, direct impacts and indirect impacts. The first section lays out EPA's approach for defining "small entities," and for evaluating the extent to which "significant economic impacts" affect a "substantial number" of small entities.

The second section addresses the impacts of the proposed regulation that are borne by individual waste combustors (incinerators, cement kilns, lightweight aggregate kilns, HCl production furnaces, and boilers and process heaters) because they will incur direct compliance costs as a result of the rule. It includes a summary of the sources used, the approach followed to complete the analysis of direct impacts, and a results section that provides data on the number and characteristics of small entities included in the analysis as well as the results of the economic impact analysis for small businesses.

The third section of the report contains a brief discussion of potential indirect impacts to small hazardous waste generators, because some indirect portion of the regulatory burden could potentially be passed on to customers of combustion facilities through price increases at commercial facilities.

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[1] The size eligibility provisions and standards identified by the Small Business Administration (SBA) can be found in 13 CFR 121.201, revised as of January 1, 2003. Additional revisions implemented during 2003 do not affect the size eligibility requirements for any of the industries included in this assessment.

METHODOLOGY

This chapter describes the data and our approach for analyzing the economic impact of the proposed Hazardous Waste Combustion (HWC) MACT replacement standards on small entities. The primary focus of the analysis is on the impact of the regulation on combustors because they will incur direct compliance costs as a result of the rule. In addition, the analysis briefly discusses potential secondary or pass-through effects on generators of hazardous wastes. The scope of this impact analysis includes:

- Small business owners of affected combustion facilities (incinerators, cement kilns, lightweight aggregate kilns, HCl production furnaces, and boilers and process heaters); and

- Small business waste generators who may face higher prices for waste management services as a result of the rule.

To assess direct impacts on combustors, EPA conducted facility-by-facility analyses of small businesses to identify those where impacts might be significant. To assess the potential impacts of the proposed HWC MACT replacement standards on small businesses who generate waste and ship it to commercial combustors, we outline the methods and results of a detailed 1999 screening assessment of over 11,000 generators who ship hazardous waste to commercial combustors.[2] We then assess the extent to which these results are relevant to the proposed replacement standards.

To assess both direct and indirect impacts, we first determine which affected entities are small. In all cases, this is based on a comparison of facility data with size thresholds determined for specific industry groups by SBA. After compiling data on business exposure to the rule (e.g., compliance costs), we identify the number of instances in which compliance costs exceed one percent of corporate sales, and describe the extent to which these results suggest that "significant" impacts would be borne by a "substantial number" of small businesses.[3] If the regulation produces significant costs for a substantial number of small businesses, then further study may be required.

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[2] *Assessment of Small Entity Impacts Associated with the Combustion MACT Final Rule*, prepared by Northbridge Associates, Incorporated and Industrial Economics, Incorporated, for EPA's Office of Solid Waste, Economics, Methods, and Risk Analysis Division, March 1999.

[3] In the "Size Eligibility Provisions and Standards" identified by the Small Business Administration (SBA) in 13 CFR 121.201, the SBA clarifies that the "number of employees or annual receipts indicates the maximum allowed for a concern and its affiliates to be considered small." Therefore, throughout this analysis, we rely on employment and sales data for the overall corporate entity - e.g., the facility, its parent, any subsidiaries, and other branches.

Note on Fuel Blenders: Our 1999 Regulatory Flexibility Screening Analysis also evaluated the indirect impacts of the proposed regulations on small business fuel blenders that send waste to commercial combustors. The analysis examined 67 fuel blending facilities that reported to BRS in 1995, and concluded that 33 percent of the 46 companies that managed these facilities were small businesses. In most cases, the analysis concluded that indirect impacts would not have a significant economic impact on a substantial number of blender companies, though in one aggressive price pass-through scenario (e.g., in which combustors would pass 75 percent of compliance costs through to blenders) 14 small-business facilities (and companies) would encounter cost increases that could be significant.

While it is possible that the indirect impacts of the proposed HWC MACT replacement standards on blenders could be significant, the results of the 1999 analysis are not directly applicable to the current proposed regulations, for two reasons. First, the inclusion of hazardous waste boilers and industrial furnaces in the regulation changes the potential role of fuel blenders in responding to the regulation. Second, the 1999 *Assessment* revealed that the industry structure and pricing for fuel blenders is complex and includes both independent blenders and waste brokers as well as "affiliated" blenders who are related to specific commercial facilities. To properly evaluate the impact of any regulation on blenders would therefore require a new, facility-level analysis that addresses both the structure of the industry and the market impact of the regulation of hazardous waste boilers and industrial furnaces. Because blenders are not directly affected by the regulations, and because the 1999 analysis indicated that under most scenarios the indirect impacts of the MACT standards on small business fuel blenders would likely be modest, this analysis does not address indirect impacts on fuel blenders.

In each of the next two sections we discuss the data sources used and issues encountered in working with these data for the direct and indirect impacts, respectively. Each section then outlines the approach used to conduct the analysis of impacts on small businesses as well as identify significant economic impacts and substantial numbers of small businesses.

DIRECT IMPACTS: COMBUSTION FACILITIES

Data Sources

To evaluate whether companies that own combustion units are small businesses, EPA developed a list of combustion units including the facility name, owner, location, EPA identification number, North American Industry Classification System (NAICS) code, and financial information for the facility and its parent company (if available). The facility information was compiled primarily from the EPA's list of permitted facilities.[4] The financial information consisted of number

[4] Hazardous waste data and NAICS codes were extracted from hazardous waste reporting information contained in the 2001 Biennial Reporting System.

of employees and annual sales (revenues) data, and was compiled primarily from ReferenceUSA and augmented with information from Dun & Bradstreet, company websites, and SEC-related company financial documents (e.g.., the Annual Report or 10-K).[5]

Compliance Costs and Price Pass-Through

The cost of compliance with the proposed HWC MACT replacement standards will determine the severity of impacts on small businesses. Compliance cost information was provided from engineering costs models that assign pollution control measures and their costs to each combustion system.[6] Included along with these pollution control costs are other compliance costs associated with monitoring requirements, sampling and analysis, permit modifications, and other record keeping and reporting requirements.[7] The approach for the direct impact analysis is a conservative one primarily because it relies on an upper-bound estimate of engineering costs that assumes all facilities upgrade to comply with the standards, regardless of cost (as opposed to the best estimate of social costs where facilities may select lower cost waste management options if feasible). In addition, the analysis assumes that commercial facilities do not implement any "price pass-through" (*e.g.*, price increase) to generators (customers) to offset compliance costs. In reality, commercial combustion facilities might mitigate their own compliance costs by increasing prices. Similarly, non-commercial facilities may mitigate compliance costs by changing waste management practices rather than upgrading their facilities.

Small Organizations and Governments

EPA has determined that hazardous waste combustion facilities are not owned by any small organizations or by small governments.

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[5] ReferenceUSA is an Internet-based reference service accessible via library websites that contains information on more than 12 million U.S. businesses. Information on combustion facilities was collected from ReferenceUSA through the Boston Public Library's website (www.bpl.org) during the period of October 1, 2003 through October 9, 2003. Dun and Bradstreet information was collected via Dialog (an online search tool) and the Dun and Bradstreet website (www.dnb.com) on October 15, 2003 and October 21, 2003.

[6] See Chapter 4 in the 2003 *Assessment* document for more details.

[7] To isolate the activities required under the proposed replacement standards, the 2003 *Assessment* assumes that facilities have already completed upgrades required for full compliance with the 2002 Interim standards.

Approach

The analysis of small business impacts on hazardous waste combustion facilities was conducted using facility-level data. To accomplish this, EPA screened the facilities to identify those that belong to companies that are small businesses, input compliance cost estimates for the rule, and compared the impacts with total parent company sales.

We identified facilities that belong to small businesses based on the characteristics of the company that owns each facility. Small businesses were those where employment or sales at the company that owns the facility fell below statutory small business thresholds defined for each six-digit NAICS code by the SBA in 13 CFR Part 121. Therefore, for each facility, we examined its own employment and sales, as well as employment and sales of other facilities owned by the same company. Six facilities in the regulatory universe belong to companies that met the small business criteria. Information about these facilities is provided in Exhibit H-1.

Compliance cost estimates, based on engineering cost models, were developed for each individual facility. In addition, compliance cost estimates were developed for four regulatory standards considered by the Agency for the proposed HWC MACT replacement standards: the "Agency Preferred Approach" and three options (e.g., Option 1, Option 2, and Option 3).[8] Compliance costs per facility under the Agency Preferred Approach ranged from $9,333 to $1,085,907 for the six facilities. Costs were divided by parent company sales to calculate the economic impact measure and to screen for facilities with potentially significant impacts. Annual compliance costs were divided by annual sales to identify facilities where compliance costs may exceed one percent of sales. The costs and impacts are analyzed in Exhibit H-2.

Results

The discussion of results is divided into two sections. We begin with the results of EPA's analysis of the facility data. These findings provide estimates of the number of small businesses potentially affected by the rule and other facility characteristics. The second section summarizes the findings with respect to impacts. The analysis indicates that the proposed HWC MACT replacement standards would not have a significant economic impact on a substantial number of small hazardous waste combustion entities.

[8] For detailed information on the four regulatory standards considered by EPA, see Chapter 1 of the 2003 *Assessment* document.

Analysis of Facility Data

Given the capital intensity of cement production, commercial incineration, and many of the industries (e.g.., chemicals) that own and operate on-site incinerators, boilers, HCl production furnaces, and process heaters, it is not surprising that few of the hazardous waste combustion facilities meet the definition of a small business. From a list of 150 combustion facilities, only six were classified as owned by small businesses (Exhibit H-1). Three of the small combustor facilities are liquid boilers, one is an on-site incinerator, one is a cement kiln, and one is a lightweight aggregate kiln (LWAK). Three of the six facilities are part of larger corporations (e.g., they have parent companies, subsidiaries, affiliates, or additional branches) and annual sales for the six facilities and affiliated corporate entities range from approximately $49 million to $465 million. Complete size data was not available for one non-U.S. parent company, 3V Incorporated, which was therefore assumed to be small and was left in the analysis.

Impact Results

For this analysis, we compare compliance costs to corporate-wide sales. We believe this analysis presents a worst case result because it uses upper-bound engineering costs and because it does not consider the possibility of passing costs through to customers in the form of higher prices. Specifically, if compliance costs, as a percentage of gross annual revenues are greater than one, that result is an indicator of potential "significant" impacts.

Under the Agency Preferred Approach, the Thermalkem (Norlite) lightweight aggregate kiln is the only one of six small hazardous waste combustors that will likely incur costs greater than one percent of sales (Exhibit H-2). This facility, which is owned by United Oil Recovery, Incorporated, employs 70 people, based on data published on August 22, 2003. Since only one of seventeen commercial kiln facilities in the regulatory universe will incur costs greater than one percent of sales, we conclude that neither a substantial number of facilities nor a substantial fraction of the affected industry faces this adverse impact. In addition, Norlite's estimated compliance costs will likely be offset, at least partially, by revenues and fuel savings associated with waste received from boilers and industrial furnaces that stop burning hazardous waste in response to the proposed HWC MACT replacement standards. The combined revenues and fuel savings associated with this additional waste range from $171 per ton to $1,124 per ton, depending on the specific characteristics of the waste. Taking these savings into account, our model predicts that the Norlite facility will not exit the hazardous waste market in response to the proposed HWC MACT replacement standards.

In the 1999 *Assessment*, Norlite was not included in the RFSA because available data indicated that it was not a small business. More recent data, however, reveal that Norlite and its affiliated facilities employ approximately 325 workers. Affiliated facilities included in this estimate are United Oil Recovery's branches in Meriden, Connecticut; Portsmouth, New Hampshire; and Portland, Connecticut.

Exhibit H-1

Small Business Hazardous Waste Combustion Facilities

Facility Data				Corporate Entity Data[c]		Small Business Size Threshold - Number of Employees[d]
Facility Name/Parent Company [a]	**EPA ID**	**NAICS Code[b]**	**Combustor Type**	**Annual Sales (thousands)**	**Company Employees**	
Reilly Industries, Inc.	IND000807107	32519 - Other Basic Organic Chemical Manufacturing	Liquid Boiler	$329,619	700	750
Rubicon, Inc.	LAD008213191	325192 - Cyclic Crude and Intermediate Manfacturing	Liquid Boiler	$465,039	500	750
Continental Cement Company	MOD054018288	212312 - Crushed and Broken Limestone Mining and Quarrying	Cement Kiln	$52,400	262	500
Thermalkem (Norlite); subsidiary of United Oil Recovery	NYD080469935	327992 - Ground or Treated Mineral and Earth Manufacturing	LWAK	$49,096	325	500
3V, Inc.[e]	SCD980500052	325998 - Other Chemical Product and Preparation Manufacturing	Liquid Boiler	$62,600	270	500
Velsicol Chemical Corporation	TND007024664	32512 - Industrial Gas Manufacturing	On-Site Incinerator	$150,000	475	1,000

Notes:
a Except in the case of Norlite, the name of each facility's parent company is the same as the name of the facility itself.
b NAICS codes obtained from hazardous waste reporting information contained in the 2001 Biennial Reporting System.
c Corporate entity data obtained from public source, including ReferenceUSA, Dun and Bradstreet, company websites, and published company financial documents.
d Small business size thresholds obtained from 13 CFR 121.201.
e 3V, Incorporated is an Italian-owned company with facilities in the United States, Italy, and several other countries. Employment in the U.S. is at least 270 people, and overall employment worldwide is likely over 500 people. However, we've included this 3V, Incorporated facility as a small business because it is an internationally-owned company and we were unable to confirm total employment. The sales and employment data represent the single 3V, Incorporated facility in South Carolina.

Exhibit H-2

Small Business Impacts: Combustors

Facility Name/ Parent Company[a]	EPA ID	Corporate Entity Annual Sales (thousands)[b]	Total Compliance Costs (Agency Preferred Approach)[c] (dollars)	Costs As a Percentage of Sales (CPS)
Reilly Industries, Inc.	IND000807107	$329,619	$715,882	0.22%
Rubicon, Inc.	LAD008213191	$465,039	$848,809	0.18%
Continental Cement Company	MOD054018288	$52,400	$238,948	0.46%
Thermalkem (Norlite); subsidiary of United Oil Recovery	NYD080469935	$49,096	$1,077,563	2.21%
3V, Inc.	SCD980500052	$62,600	$45,050	0.07%
Velsicol Chemical Corporation	TND007024664	$150,000	$5,161	0.01%

Notes:
a Except in the case of Norlite, the name of each facility's parent company is the same as the name of the facility itself.
b Corporate entity data obtained from ReferenceUSA, Dun and Bradstreet, company websites, and company financial documents.
c Compliance costs represent the upper-bound engineering costs assuming facilities upgrade to comply with proposed standards.

In addition, a brief analysis of the direct impacts of compliance costs under the three regulatory options yields similar results. Under Option 1, none of the six facilities would experience costs greater than one percent of sales. Under Options 2 and 3, two of the six facilities would experience costs greater than one percent of sales (the Thermalkem (Norlite) facility in New York and the Continental Cement Company facility in Hannibal, Missouri).

INDIRECT IMPACTS

In addition to assessing the direct impacts of the proposed HWC MACT replacement standards, this screening analysis briefly addresses potential indirect impacts on small business generators that may face price increases for combustion services. While the analysis of indirect impacts is not formally required for a regulatory flexibility screening analysis, the following discussion provides useful information on potential effects of the rule beyond direct impacts. This discussion includes a summary of a more detailed 1999 screening analysis of indirect impacts related

to the 1999 HWC MACT standards, and briefly describes the applicability of that study to the current proposed rule.

Summary of 1999 Screening Analysis of Indirect Impacts

The 1999 *Assessment of the Potential Costs, Benefits, and Other Impacts of the Hazardous Waste Combustion MACT Standards: Final Rule* (1999 *Assessment*) included a comprehensive screening-level analysis of the potential indirect impacts of the MACT standards on small entity generators that might face higher combustion costs under the rule.[9] The 1999 analysis used the following data sources and approach to identify generators potentially affected by the rule:

- Identification of small business generators of hazardous waste bound for combustion through interviews with waste brokers, fuel blending industry representatives, and generators, and review of trade industry journals and other publications.

- Assessment of EPA's Biennial Reporting System (BRS) waste shipment data provided by permitted Subtitle C waste management facilities to identify waste type, quantity shipped, and origin for all combusted waste streams.

- Classification of generators according to Standard Industrial Classification (SIC) code (note that BRS data available in 1999 did not include NAICS codes), to identify generators in industries dominated by small businesses (according to the *New Census Based Small Business Data Base* prepared jointly by the Small Business Administration and the Bureau of the Census).[10]

To address indirect costs, the 1999 *Assessment* engineering and cost model calculated expected price increases experienced by generators per ton of waste shipped. The range of price increases in 1999 was assumed to be $5 to $16 per ton across all waste types, depending on the extent of cost pass-through from combustors to their customers.[11] This is generally consistent with the range of increases predicted for different waste forms under the proposed HWC MACT replacement standards. These increases range from one dollar per ton to over $30 per ton, and

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[9] *Assessment of the Potential Costs, Benefits, and Other Impacts of the Hazardous Waste Combustion MACT Standards: Final Rule*, U.S. EPA, July 1999.

[10] This data base contains information on the number of firms and establishments, employment, payroll, and receipts by four-digit SIC code. The data are also grouped according to the employment size of the enterprise in which the establishment is included.

[11] The price increases were assumed to be uniform across facility types and varied based on a 25 percent and a 75 percent pass-through of compliance costs..

represent an average overall cost increase of roughly $10 per ton across waste types. Using data on the volume of waste in shipments tracked in the 1995 BRS, the 1999 analysis computed the incremental cost associated with current shipments of waste for each generator facility.

EPA then identified the generators in small business-dominated industries (SBDIs), e.g., industries in which more than 60 percent of employment is in enterprises with 500 employees or fewer. For each SBDI (defined by four-digit SIC code), EPA also calculated average sales for the small businesses within the industry. To focus on small business impacts, EPA excluded generators in SICs that were not dominated by small business.

EPA estimated economic impacts to generators in small-business dominated industries by performing a "sales test" – calculating facility compliance costs divided by facility sales. To estimate facility sales for the large number of generators EPA used benchmark data derived from the Census to compute average sales per establishment for small businesses within each small business-dominated industrial category (as defined by SIC code).[12] EPA then compared the expected compliance costs to sales information for small businesses in the same industry to identify facilities where incremental costs may be significant.

Results

The 1999 analysis identified 2,113 generators in small business dominated industries (SBDIs), and assumed that these facilities (roughly 24 percent of 8,869 generators with valid SIC codes) represent small business generators. While this approach eliminated from consideration some generators that are small businesses, but are not in SBDIs, we assumed that this exclusion is offset by the fact that the analysis included some generators who are not small, but are part of a SBDI.[13]

Among small business generators, ten industries accounted for more than half of the generators. Service stations (SIC 5541) were the most common, but metal electroplating, plating, coating and engraving shops (SICs 3471 and 3479) together accounted for nearly 300 facilities (Exhibit H-3). The quantity of waste generated is more highly concentrated in a few industries, with

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[12] For each SIC code where 60 percent of employment was in establishments with fewer than 500 employees, we computed the total sales for small entities and then divided the total sales by the number of small establishments. The resulting average sales (by four-digit SIC code) defined the benchmark against which compliance costs for each facility in that SIC would be measured. To set a conservative benchmark, EPA computed the average sales for establishments with 20 or fewer employees. This insured that the screening analysis would err on the side of predicting significant impacts for more small entities than would actually incur them.

[13] EPA examined BRS shipment information for 11,054 generators that sent 1.04 million tons of waste to blenders and combustors, and eliminated facilities that did not designate an SIC codes or designated invalid codes. The Agency also examined the potential impact of invalid SIC codes to address the concern that small businesses might be more likely to be eliminated from the database. BRS quantity data suggested that the facilities with missing or invalid SIC codes shipped relatively less waste than those with SIC data available.

SIC 7389 (Other business services) and 5171 (Petroleum terminals) accounting for 70 percent of the waste shipped; however, these two SICs accounted for only 11.3 percent of small business generators. The analysis noted that one of the industries that dominate the small business generators are represented in the top overall generators of waste sent to combustors, which are dominated by facilities in the chemical and allied products sector (SIC sector 28). The results of the 1999 study indicated that small business generators are also relatively small in terms of waste shipped to combustors. Note that because this analysis was based on data sources produced prior to the use of NAICS codes, it was not possible to update results to conform with the NAICS without undertaking a new analysis. Attachment A provides a reference table identifying the relevant NAICS codes for each of the SIC codes in Exhibit H-3.

Exhibit H-3

Small Business Generators by SIC

Industry - SIC	Generators	Percent of Total	Percent of Waste
Service stations - 5541	165	7.8%	2.5%
Metal coating, engraving - 3479	162	7.7%	2.9%
Other business services - 7389	140	6.6%	58.3%
Metal electroplating, plating, etc.- 3471	132	6.2%	0.8%
Other fabricated metal products - 3499	107	5.1%	0.8%
Petroleum bulk stations & terminals - 5171	99	4.7%	11.5%
Commercial printing - lithographic - 2752	88	4.2%	1.3%
Others (169 SIC codes)	1,220	57.8%	21.9%

EPA's 1999 analysis concluded that the indirect effects on generators would not impose a significant impact on a substantial number of small generators. This conclusion is bolstered by the conservative assumptions EPA used in developing the impact screens. The assumptions were designed to overstate the magnitude of the impacts.[14]

[14] Note that the aggressive "price pass-through" scenarios considered in the indirect analysis are not consistent with the "no price pass-through" assumption used to identify the maximum direct impacts on combustors. In other words, any price pass-through that increases indirect impacts on generators would simultaneously mitigate direct impacts on combustors.

In both pass-through scenarios, some generators experienced impacts (e.g., cost increases) exceeding one percent of sales, but in both cases only a small number of generators was affected. In the 25 percent pass-through scenario, 18 generators (0.85 percent) experienced cost increases of over one percent of sales, as did 58 generators in the 75 percent pass-through scenario (less than three percent). The 1999 analysis also examined facilities who experienced cost increases in excess of three percent of sales (Exhibit H-4). In all screens, sales were conservatively defined as the average sales for the smallest establishments in the SIC code (those with fewer than 20 employees).

The generators that do experience increases of over one percent of sales are concentrated in SIC 7389 (Other business services). In the 25 percent scenario, for example, 14 of the 18 small business generators that exceeded the impact thresholds are in SIC 7389 (Other Business Services). Even given this concentration, these facilities do not account for a substantial fraction of the entities in the industry because SIC 7389 contains so many diverse businesses.

Exhibit H-4

1999 ANALYSIS OF GENERATOR IMPACTS:
SUMMARY OF INDIRECT SMALL BUSINESS GENERATOR IMPACTS

		25% Pass-through Scenario		75% Pass-through Scenario	
	Baseline	**Costs > 1% of Sales**	**Costs > 3% of Sales**	**Costs > 1% of Sales**	**Costs > 3% of Sales**
Number of Small Business Generators	2,113	18	10	58	19
Percentage of Small Business Generators	100%	0.85%	0.47%	2.7%	0.90%
Number in SIC 7389	140	14	8	26	14
Percentage of SIC 7389	100%	10%	6%	19%	10%

Relevance of Analysis to Proposed HWC MACT Replacement Standards

The 1999 analysis of indirect impacts supported the 1999 HWC MACT standards. The cost model developed for the proposed HWC MACT replacement standards calculates price increases similar in magnitude to those predicted in 1999, assuming an aggressive price pass-through scenario of 100 percent (e.g., combustors will be able to pass on the total costs of the rule to generators). Assuming that the industrial composition and waste management practices among generators of waste for combustion has not changed dramatically in the past eight years, the projected price

increases under the proposed HWC MACT replacement standards are unlikely to have significant indirect impacts on a significant number of small business generators.

This conclusion is subject to some uncertainty. It is possible that the composition of SBDIs or waste management practices among generators have changed considerably since the data used in the 1999 analysis. However, the results of the 1999 analysis suggest that significant changes in the universe would be necessary before price changes of the magnitude calculated under the proposed HWC MACT replacement standards would have a significant indirect impact on a significant number of small businesses. In addition, because the analysis of indirect impacts is not formally required for a regulatory flexibility screening analysis, further analysis of apparently modest indirect impacts appears unnecessary.

Appendix A:

NAICS CODES RELATED TO INDIRECT IMPACTS

NAICS CODES FOR GENERATORS OF COMBUSTED WASTE IN SMALL BUSINESS DOMINATED INDUSTRIES		
SIC Industry	**SIC Code**	**NAICS Code**
Commercial printing- lithographic	2752	323114, 323110(p)
Electroplating, plating, polishing, anodizing, and coloring	3471	332813(p)
Coating, engraving, and allied services, NEC	3479	339911(p), 339912(p), 339914(p), 332812
Fabricated metal products, NEC	3499	33251(p), 332117, 332439(p), 332919(p), 332999(p), 33636(p), 337215(p)
Service Stations	5541	44711, 44719
Petroleum bulk stations & terminals	5171	42271, 454312(p), 454311(p)
Other business services	7389	51224, 51229(p), 514199(p), 541199, 81299(p), 54137(p), 54141, 54142, 54134, 54149, 54189(p), 54193, 54135, 54199, 51421(p), 71141(p), 42186, 561421, 325998(p), 561422, 561431, 561439, 314999(p), 313311(p), 54187, 49111(p), 81232(p), 561491(p), 56191(p), 56179(p), 561599(p), 56192, 561591, 52232(p), 561499, 56199
Note: The abbreviation (p) means “part of,” and the abbreviation NEC stands for Not Elsewhere Classified.		

Appendix I

FACILITIES AND SYSTEMS IN THE REGULATORY UNIVERSE

This appendix lists the individual combustion systems and facilities to be regulated under the proposed HWC MACT replacement standards. For the purposes of this rulemaking, a system is defined as having a single source that is the route of air emissions resulting from combustion (i.e., a stack). A facility often contains multiple combustion systems, and a system may be connected to more than one combustion unit. Lists of the combustion systems and facilities included in the regulatory universe are presented in Exhibits I-1 and I-2 respectively.

Exhibit I-1

Combustion Systems Included in the Regulatory Universe

EPA ID	System ID	System Type	Facility Name	City	State
ALD001221902	490	OINC	CIBA-Geigy Corporation	McIntosh	AL
ARD006354161	3000	OINC	Reynolds Aluminum	Gum Springs	AR
ARD069748192	486	CINC	ENSCO	El Dorado	AR
ARD069748192	487	CINC	ENSCO	El Dorado	AR
ARD089234884	1009	Coal boiler	Eastman Chemicals Co. - Arkansas Eastman Div	Batesville	AR
ARD089234884	1009a	Coal boiler	Eastman Chemicals Co. - Arkansas Eastman Div	Batesville	AR
ARD089234884	484	OINC	Eastman Chemicals Co. - Arkansas Eastman Div	Batesville	AR
ARD981512270	228	CK	Ash Grove Cement Company	Foreman	AR
ARD981512270	403	CK	Ash Grove Cement Company	Foreman	AR
ARD981512270	404	CK	Ash Grove Cement Company	Foreman	AR
CAD009164021	PH16	Liquid boiler	Shell Martinez Refining Company	Martinez	CA
CAD009547050	733	Liquid boiler	Dow Chemical Co.	Torrance	CA
CAD009547050	733a	Liquid boiler	Dow Chemical Co.	Torrance	CA
CAD076528678	851	HCl production furnace	The Dow Chemical Company	Pittsburg	CA
CTD001159730	729	Liquid boiler	Dow Chemical U.S.A. Allyn's Point Facility	Gales Ferry	CT
DED003930807	700	OINC	Dupont	Wilmington	DE
GAD039046800	A56	OINC	Monsanto (Searle)	Augusta	GA
GAD051011609	754	Liquid boiler	DSM Chemicals North America, Inc.	Augusta	GA
GAD981237118	776	Liquid boiler	Monsanto (Nutrasweet Kelco Co.)	Augusta	GA
GAD981237118	777	Liquid boiler	Monsanto (Nutrasweet Kelco Co.)	Augusta	GA
ILD005083316	3017	OINC	Mcwhorter Inc (Cargill)	Carpentersville	IL
ILD065237851	460	OINC	Akzo Chemie America	Morris	IL
ILD098642424	333	CINC	ONYX Trade Waste Incineration	Sauget	IL
ILD098642424	612	CINC	ONYX Trade Waste Incineration	Sauget	IL
IND000807107	735	Liquid boiler	Reilly Industries, Inc.	Indianapolis	IN
IND000807107	737	Liquid boiler	Reilly Industries, Inc.	Indianapolis	IN
IND000807107	738	Liquid boiler	Reilly Industries, Inc.	Indianapolis	IN
IND000810861	806	OINC	Amoco Oil Co.	Whiting	IN
IND005081542	300	CK	ESSROC Corporation	Logansport	IN
IND005081542	491	CK	ESSROC Corporation	Logansport	IN
IND006050967	3033B	OINC	Eli Lilly And Company	Lafayette	IN
IND006376362	764	Liquid boiler	GE Plastics, Mt. Vernon IN Facility	Mount Vernon	IN
IND006419212	3029	CK	Lone Star Industries, Inc.	Greencastle	IN
IND072040348	701	OINC	Eli Lilly And Company	Clinton	IN
IND072040348	3033	OINC	Eli Lilly And Company	Clinton	IN
IND072040348	3033A	OINC	Eli Lilly And Company	Clinton	IN
KS0213820467	3012	OINC	Kansas Army Ammunition Plant	Parsons	KS
KSD007148034	322	CK	Lafarge	Fredonia	KS
KSD007148034	323	CK	Lafarge	Fredonia	KS
KSD007237746	2007	Liquid boiler	Air Products Manufacturing Corp.	Wichita	KS
KSD031203318	3031	CK	Ash Grove Cement Company	Chanute	KS
KYD006370159	A27	OINC	Elf Atochem North America, Inc.	Calvert City	KY
KYD006373922	359	OINC	Elf Atochem	Carrollton	KY
KYD006390017	741	Liquid boiler	Rohm and Haas Company	Louisville	KY
KYD088438817	210	CINC	LWD, Inc.	Calvert City	KY
KYD088438817	211	CINC	LWD, Inc.	Calvert City	KY
KYD088438817	212	CINC	LWD, Inc.	Calvert City	KY

Exhibit I-1

Combustion Systems Included in the Regulatory Universe

EPA ID	System ID	System Type	Facility Name	City	State
LAD000778381	822	Liquid boiler	Exxon Chemical Co.	Baton Rouge	LA
LAD000778381	822a	Liquid boiler	Exxon Chemical Co.	Baton Rouge	LA
LAD001890367	853	HCl production furnace	Dupont Dow Elastomers	LaPlace	LA
LAD003913449	785	HCl production furnace	Borden Chemicals and Plastics (BCP)	Geismar	LA
LAD008086506	2022	HCl production furnace	PPG Inc	Westlake (Lake Charl	LA
LAD008086506	467	OINC	PPG Inc	Westlake (Lake Charl	LA
LAD008086506	3001	OINC	PPG Inc	Westlake (Lake Charl	LA
LAD008187080	2001	Liquid boiler	Dow Chemical Co.	Plaquemine	LA
LAD008187080	2002	Liquid boiler	Dow Chemical Co.	Plaquemine	LA
LAD008187080	2003	Liquid boiler	Dow Chemical Co.	Plaquemine	LA
LAD008187080	2001a	Liquid boiler	Dow Chemical Co.	Plaquemine	LA
LAD008187080	808	OINC	Dow Chemical Co.	Plaquemine	LA
LAD008187080	3002	OINC	Dow Chemical Co.	Plaquemine	LA
LAD008213191	812	Liquid boiler	Rubicon, Inc	Geismar	LA
LAD008213191	813	Liquid boiler	Rubicon, Inc	Geismar	LA
LAD008213191	814	Liquid boiler	Rubicon, Inc	Geismar	LA
LAD008213191	815	Liquid boiler	Rubicon, Inc	Geismar	LA
LAD010390599	818	Liquid boiler	Westvaco	DeRidder	LA
LAD020597597	828	Liquid boiler	Angus Chemical Company	Sterlington	LA
LAD040776809	834	Liquid boiler	BASF	Geismar	LA
LAD040776809	835	Liquid boiler	BASF	Geismar	LA
LAD040776809	836	Liquid boiler	BASF	Geismar	LA
LAD040776809	604	OINC	BASF	Geismar	LA
LAD041581422	753	Liquid boiler	Union Carbide Corp.	Hahnville	LA
LAD053783445	480	OINC	Novartis (CIBA-Geigy Corporation)	St. Gabriel	LA
LAD053783445	706	OINC	Novartis (CIBA-Geigy Corporation)	St. Gabriel	LA
LAD057117434	855	HCl production furnace	Georgia Gulf	Plaquemine	LA
LAD057117434	2000	Liquid boiler	Georgia Gulf	Plaquemine	LA
LAD059130831	756	Liquid boiler	DSM Copolymer Inc.	Addis	LA
LAD092681824	2005	HCl production furnace	Vulcan Materials Co.	Geismar	LA
LAD980622104	610	OINC	Shell Oil Co	Norco	LA
LAD980622104	611	OINC	Shell Oil Co	Norco	LA
LAR000018333	714	OINC	Arco Chemical Company	Westlake	LA
MAD001039767	PH13	Liquid boiler	Bostik, Inc.	Middleton	MA
MDD003071875	454	OINC	FMC Agricultural Chemical Group	Baltimore	MD
MID000724724	354	OINC	Dow Chemical Co.	Midland	MI
MID000820381	342	OINC	Pharmacia & Upjohn Co.	Kalamazoo	MI
MND006172969	3014	OINC	3M	Cottage Grove	MN
MO4213820489	503	OINC	Lake City Army Ammunition Plant	Independence	MO
MOD029729688	204	CK	Holnam Inc.	Clarksville	MO
MOD050226075	477	OINC	American Cyanamid	Hannibal	MO
MOD050226075	478	OINC	American Cyanamid	Hannibal	MO
MOD050226075	805	OINC	American Cyanamid	Hannibal	MO
MOD054018288	319	CK	Continental Cement Company	Hannibal	MO
MOD056389828	463	OINC	Bayer (Miles, Mobay)	Kansas City	MO
MOD981127319	303	CK	Lone Star Industries, Inc.	Cape Girardeau	MO
MOD985798164	3011	CINC	ICI Explosives	Joplin	MO
MOD985798164	3015	CINC	ICI Explosives	Joplin	MO

Exhibit I-1

Combustion Systems Included in the Regulatory Universe

EPA ID	System ID	System Type	Facility Name	City	State
MSD033417031	904	OINC	First Chemical Corporation	Pascagoula	MS
MSD077655876	203	CK	Holnam Inc.	Artesia	MS
NCD042091975	778	Liquid boiler	Mallinckrodt Inc.	Raleigh	NC
NCD042091975	1000	Liquid boiler	Mallinckrodt Inc.	Raleigh	NC
NCD047373766	708	OINC	Catalytica Phar (Burroughs Wellcome)	Greenville	NC
NCD065655599	341	OINC	Glaxo Welcome	R.T.P.	NC
NED981723513	3010	CINC	Clean Harbors (Ecova Corp.)	Kimball	NE
NJD001787944	725	OINC	Zeneca Inc.	Bayonne	NJ
NJD002373579	A10	OINC	Air Products And Chemicals Inc	Paulsboro	NJ
NJD980753875	824	OINC	Ausimont (Pennwalt Corp)	Thorofare	NJ
NYD000824482	348	OINC	Occidental Chemical Corp.	Niagara Falls	NY
NYD002014595	712	OINC	Nepera	Harriman	NY
NYD002080034	825	OINC	General Electric Co.	Waterford	NY
NYD002080034	3020	OINC	General Electric Co.	Waterford	NY
NYD066832023	766	Liquid boiler	General Electric Plastics	Selkirk	NY
NYD080469935	307	LWAK	Thermalkem (Norlite)	Cohoes	NY
NYD080469935	479	LWAK	Thermalkem (Norlite)	Cohoes	NY
NYD980592497	915	OINC	Eastman Kodak	Rochester	NY
NYD980592497	3016	OINC	Eastman Kodak	Rochester	NY
OHD004172623	A36	OINC	Lubrizol Corporation	Painesville	OH
OHD004233003	840	Liquid boiler	Bayer (Monsanto Co. Port Plastic Plant)	Addyston	OH
OHD004304689	495	OINC	PPG Industries, Inc.	Circleville	OH
OHD005108477	911	Liquid boiler	Aristech Chemical Corporation	Haverhill	OH
OHD005108477	912	Liquid boiler	Aristech Chemical Corporation	Haverhill	OH
OHD005108477	911a	Liquid boiler	Aristech Chemical Corporation	Haverhill	OH
OHD005108477	911b	Liquid boiler	Aristech Chemical Corporation	Haverhill	OH
OHD039128913	730	Liquid boiler	Dow Chemical Co. Hanging Rock Plant	Ironton	OH
OHD039128913	730a	Liquid boiler	Dow Chemical Co. Hanging Rock Plant	Ironton	OH
OHD046202602	3013	OINC	Aztec Peroxides Inc	Elyria	OH
OHD048415665	331	CINC	Ross Incineration Services	Grafton	OH
OHD980613541	222	CINC	Waste Technologies Industries	East Liverpool	OH
OHD987048733	302	CK	Lafarge	Paulding	OH
OHD987048733	302a	CK	Lafarge	Paulding	OH
OK6213822798	3032	OINC	McAlester Army Ammunition Plant	McAlester	OK
PAD002292068	739	Liquid boiler	Rohm and Haas Company	Bristol	PA
PAD002292068	739a	Liquid boiler	Rohm and Haas Company	Bristol	PA
PAD002292068	739b	Liquid boiler	Rohm and Haas Company	Bristol	PA
PAD002312791	2008	Liquid boiler	Sun Company, Inc. (R & M) Frankford Plant	Philadelphia	PA
PAD002312791	2008a	Liquid boiler	Sun Company, Inc. (R & M) Frankford Plant	Philadelphia	PA
PAD002389559	207	CK	Keystone Cement Company	Bath	PA
PAD002389559	208	CK	Keystone Cement Company	Bath	PA
PAD003043353	PH4	OINC	Merck & Co Inc - Cherokee Plant	Riverside	PA
PAD980550412	468	OINC	Lonza (Smithkline)	Conshohocken	PA
PRD090021056	3018	OINC	Squibb Manufacturing, Inc.	Humacao	PR
PRD090021056	3019	OINC	Squibb Manufacturing, Inc.	Humacao	PR
PRD090028101	3021	OINC	Merck Sharp & Dohme Quimica	Barceloneta	PR
PRD090028101	PH2	OINC	Merck Sharp & Dohme Quimica	Barceloneta	PR

Exhibit I-1

Combustion Systems Included in the Regulatory Universe

EPA ID	System ID	System Type	Facility Name	City	State
PRD090613357	PH3	OINC	Chemsource (SK&F)	Guayama	PR
PRD091024786	728	OINC	Eli Lilly And Company	Mayaguez	PR
SCD003351699	200	CK	Giant Cement Company	Harleyville	SC
SCD003351699	201	CK	Giant Cement Company	Harleyville	SC
SCD003351699	680	CK	Giant Cement Company	Harleyville	SC
SCD003351699	681	CK	Giant Cement Company	Harleyville	SC
SCD003368891	205	CK	Holnam Inc.	Holly Hill	SC
SCD003368891	206	CK	Holnam Inc.	Holly Hill	SC
SCD043384072	763	Liquid boiler	Albermarle Corp.	Orangeburg	SC
SCD980500052	2006	Liquid boiler	3V Inc.	Georgetown	SC
TN0890090004	357	OINC	US Department Of Energy	Oak Ridge	TN
TND003376928	719	Coal boiler	Eastman Chemical Company	Kingsport	TN
TND003376928	1011	Coal boiler	Eastman Chemical Company	Kingsport	TN
TND003376928	1012	Coal boiler	Eastman Chemical Company	Kingsport	TN
TND003376928	1011a	Coal boiler	Eastman Chemical Company	Kingsport	TN
TND003376928	1011b	Coal boiler	Eastman Chemical Company	Kingsport	TN
TND003376928	1012a	Coal boiler	Eastman Chemical Company	Kingsport	TN
TND003376928	719a	Coal boiler	Eastman Chemical Company	Kingsport	TN
TND003376928	809	OINC	Eastman Chemical Company	Kingsport	TN
TND003376928	810	OINC	Eastman Chemical Company	Kingsport	TN
TND007024664	905	OINC	Velsicol Chemical Corporation	Memphis	TN
TND982109142	901	Liquid boiler	Diversified Scientific Services, Inc.	Kingston	TN
TX0000201202	1006	Liquid boiler	PO/MTBE Plant	Port Neches	TX
TX0000201202	1006a	Liquid boiler	PO/MTBE Plant	Port Neches	TX
TXD000017756	3024	OINC	Dow Chemical Co.	La Porte	TX
TXD000461533	910	Liquid boiler	Union Carbide Corporation	Texas City	TX
TXD000461533	2021	Liquid boiler	Union Carbide Corporation	Texas City	TX
TXD000461533	3025	OINC	Union Carbide Corporation	Texas City	TX
TXD000838896	603	CINC	Chemical Waste Management	Port Arthur	TX
TXD001700806	232	Liquid boiler	Solutia (Chocolate Bayou Plant)	Alvin	TX
TXD001700806	232a	Liquid boiler	Solutia (Chocolate Bayou Plant)	Alvin	TX
TXD007330202	854	HCl production furnace	Texas Eastman Division Eastman Chemical Company	Longview	TX
TXD007330202	492	OINC	Texas Eastman Division Eastman Chemical Company	Longview	TX
TXD007330202	613	OINC	Texas Eastman Division Eastman Chemical Company	Longview	TX
TXD007349327	318	CK	Midlothian Cement Plant	Midlothian	TX
TXD007349327	473	CK	Midlothian Cement Plant	Midlothian	TX
TXD007349327	3030	CK	Midlothian Cement Plant	Midlothian	TX
TXD007376700	1013	Coal boiler	Celanese	Pampa	TX
TXD007376700	1014	Coal boiler	Celanese	Pampa	TX
TXD008076846	1005	Liquid boiler	Huntsman Corp. (formerly Texaco)	Port Neches	TX
TXD008076846	1005a	Liquid boiler	Huntsman Corp. (formerly Texaco)	Port Neches	TX
TXD008076853	A62	OINC	Hunstman (Texaco Chemical Co)	Conroe	TX
TXD008077190	767	Liquid boiler	Goodyear Tire and Rubber Company	Beaumont	TX
TXD008077190	767a	Liquid boiler	Goodyear Tire and Rubber Company	Beaumont	TX
TXD008077190	767b	Liquid boiler	Goodyear Tire and Rubber Company	Beaumont	TX
TXD008077190	767c	Liquid boiler	Goodyear Tire and Rubber Company	Beaumont	TX
TXD008077190	767d	Liquid boiler	Goodyear Tire and Rubber Company	Beaumont	TX

Exhibit I-1

Combustion Systems Included in the Regulatory Universe

EPA ID	System ID	System Type	Facility Name	City	State
TXD008079212	707	OINC	Dupont	La Porte	TX
TXD008079527	746	Liquid boiler	Sterling Chemicals, Inc.	Texas City	TX
TXD008079642	338	OINC	E.I. duPont de Nemours & Co., Inc.	Orange	TX
TXD008081697	833	Liquid boiler	BASF Corporation	Freeport	TX
TXD008081697	506	OINC	BASF Corporation	Freeport	TX
TXD008081697	PH10	OINC	BASF Corporation	Freeport	TX
TXD008092793	786	HCl production furnace	Dow Chemical Company	Freeport	TX
TXD008092793	788	HCl production furnace	Dow Chemical Company	Freeport	TX
TXD008092793	842	HCl production furnace	Dow Chemical Company	Freeport	TX
TXD008092793	844	HCl production furnace	Dow Chemical Company	Freeport	TX
TXD008092793	845	HCl production furnace	Dow Chemical Company	Freeport	TX
TXD008092793	848	HCl production furnace	Dow Chemical Company	Freeport	TX
TXD008092793	2017	HCl production furnace	Dow Chemical Company	Freeport	TX
TXD008092793	2018	HCl production furnace	Dow Chemical Company	Freeport	TX
TXD008092793	2020	HCl production furnace	Dow Chemical Company	Freeport	TX
TXD008092793	2017a	HCl production furnace	Dow Chemical Company	Freeport	TX
TXD008092793	843	Liquid boiler	Dow Chemical Company	Freeport	TX
TXD008092793	849	Liquid boiler	Dow Chemical Company	Freeport	TX
TXD008092793	843a	Liquid boiler	Dow Chemical Company	Freeport	TX
TXD008092793	843b	Liquid boiler	Dow Chemical Company	Freeport	TX
TXD008092793	600	OINC	Dow Chemical Company	Freeport	TX
TXD008106999	724	Liquid boiler	Merichem Company	Houston	TX
TXD008113441	1018	Liquid boiler	Celanese Ltd	Bishop	TX
TXD008123317	759	Liquid boiler	E.I. duPont de Nemours & Co., Inc.	Victoria	TX
TXD008123317	760	Liquid boiler	E.I. duPont de Nemours & Co., Inc.	Victoria	TX
TXD008123317	761	Liquid boiler	E.I. duPont de Nemours & Co., Inc.	Victoria	TX
TXD008123317	2012	Liquid boiler	E.I. duPont de Nemours & Co., Inc.	Victoria	TX
TXD008123317	2013	Liquid boiler	E.I. duPont de Nemours & Co., Inc.	Victoria	TX
TXD008123317	2016	Liquid boiler	E.I. duPont de Nemours & Co., Inc.	Victoria	TX
TXD008123317	2012a	Liquid boiler	E.I. duPont de Nemours & Co., Inc.	Victoria	TX
TXD008123317	759a	Liquid boiler	E.I. duPont de Nemours & Co., Inc.	Victoria	TX
TXD008123317	761a	Liquid boiler	E.I. duPont de Nemours & Co., Inc.	Victoria	TX
TXD010797389	743	Liquid boiler	Schenectady International	Freeport	TX
TXD026040709	721	Liquid boiler	Celanese Ltd	Bay City	TX
TXD026040709	721a	Liquid boiler	Celanese Ltd	Bay City	TX
TXD055141378	609	CINC	Safety Kleen (Rollins)	Deer Park	TX
TXD058260977	B32	OINC	Bayer (Miles Corp.)	Baytown	TX
TXD058275769	774	Liquid boiler	Equistar Chemicals, LP - Channelview Complex	Channelview	TX
TXD058275769	774a	Liquid boiler	Equistar Chemicals, LP - Channelview Complex	Channelview	TX
TXD058275769	774b	Liquid boiler	Equistar Chemicals, LP - Channelview Complex	Channelview	TX
TXD058275769	774c	Liquid boiler	Equistar Chemicals, LP - Channelview Complex	Channelview	TX
TXD065096273	740	Liquid boiler	Rohm and Haas	Deer Park	TX
TXD067261412	1016	Liquid boiler	BASF Corporation	Beaumont	TX
TXD067285973	Unnumbered system	Liquid boiler	Shell Deer Park Refining Company	Deer Park	TX
TXD078432457	720	Liquid boiler	Celanese Ltd., Chemical Group Clear Lake Plant	Pasadena	TX

Exhibit I-1

Combustion Systems Included in the Regulatory Universe

EPA ID	System ID	System Type	Facility Name	City	State
TXD078432457	3026	OINC	Celanese Ltd., Chemical Group Clear Lake Plant	Pasadena	TX
TXD078432457	3027	OINC	Celanese Ltd., Chemical Group Clear Lake Plant	Pasadena	TX
TXD083472266	1002	Liquid boiler	ARCO Chemical Co.	Channelview	TX
TXD083472266	1003	Liquid boiler	ARCO Chemical Co.	Channelview	TX
TXD083472266	1004	Liquid boiler	ARCO Chemical Co.	Channelview	TX
TXD083472266	1002a	Liquid boiler	ARCO Chemical Co.	Channelview	TX
TXD083472266	1002b	Liquid boiler	ARCO Chemical Co.	Channelview	TX
TXD084970169	772	Liquid boiler	Lonza, Inc.	Pasadena	TX
TXD084970169	1001	Liquid boiler	Lonza, Inc.	Pasadena	TX
TXD084970169	772a	Liquid boiler	Lonza, Inc.	Pasadena	TX
TXD086981172	811	Liquid boiler	Fina Oil & Chemical Co.	La Porte	TX
TXD086981172	811a	Liquid boiler	Fina Oil & Chemical Co.	La Porte	TX
TXD086981172	PH11	OINC	Fina Oil & Chemical Co.	La Porte	TX
TXD093565653	1015	Liquid boiler	Georgia Gulf Corporation	Pasadena	TX
TXD980626014	1007	Liquid boiler	Huntsman Polymers	Odessa	TX
TXD980808778	1017	Liquid boiler	Aristech Chemical Corp.	Pasadena	TX
TXD981911209	3028	OINC	Occidental Chemical VCM	Deer Park	TX
TXD981911209	3028A	OINC	Occidental Chemical VCM	Deer Park	TX
TXD982286932	614	OINC	Occidental Chemical Corp.	Gregory	TX
UT3213820894	3008	OINC	Tooele Army Depot North	Tooele	UT
UT5210090002	347	OINC	Deseret Army Depot CAMDS	Tooele	UT
UT5210090002	493	OINC	Deseret Army Depot CAMDS	Tooele	UT
UT5210090002	494	OINC	Deseret Army Depot CAMDS	Tooele	UT
UT5210090002	3003	OINC	Deseret Army Depot CAMDS	Tooele	UT
UT5210090002	3004	OINC	Deseret Army Depot CAMDS	Tooele	UT
UT5210090002	3005	OINC	Deseret Army Depot CAMDS	Tooele	UT
UTD981552177	327	CINC	Safety Kleen (Aptus)	Aragonite	UT
VA1210020730	349	OINC	Radford Army Ammunition Plant	Radford	VA
VA1210020730	349a	OINC	Radford Army Ammunition Plant	Radford	VA
VAD042755082	313	LWAK	Solite	Arvonia	VA
VAD042755082	314	LWAK	Solite	Arvonia	VA
VAD046970521	311	LWAK	Solite	Cascade	VA
VAD046970521	312	LWAK	Solite	Cascade	VA
VAD046970521	336	LWAK	Solite	Cascade	VA
VAD065385296	465	OINC	Honeywell (Allied Fibers)	Hopewell	VA
WAD092899574	771	Liquid boiler	Kalama Chemical (BF Goodrich)	Kalama	WA
WVD004325353	3006	OINC	Crompton Corp (OSI Specialties, Inc.)	Sisterville	WV
WVD004341491	3007	OINC	Cytec Industries	Willow Island	WV
WVD005005483	908	Coal boiler	Union Carbide Corporation	South Charleston	WV
WVD005005509	819	Liquid boiler	Rhone-Poulenc AG Company	Charleston	WV
WVD005005509	819a	Liquid boiler	Rhone-Poulenc AG Company	Charleston	WV
WVD056866312	340	OINC	Bayer (Miles, Inc.)	New Martinsville	WV

Exhibit I-2

Combustion Facilities in the Regulatory Universe

EPA ID	Facility Name	City	State
ALD001221902	CIBA-Geigy Corporation	McIntosh	AL
ARD006354161	Reynolds Aluminum	Gum Springs	AR
ARD069748192	ENSCO	El Dorado	AR
ARD089234884	Eastman Chemicals Co. - Arkansas Eastman Div	Batesville	AR
ARD981512270	Ash Grove Cement Company	Foreman	AR
CAD009164021	Shell Martinez Refining Company	Martinez	CA
CAD009547050	Dow Chemical Co.	Torrance	CA
CAD076528678	The Dow Chemical Company	Pittsburg	CA
CTD001159730	Dow Chemical U.S.A. Allyn's Point Facility	Gales Ferry	CT
DED003930807	Dupont	Wilmington	DE
GAD039046800	Monsanto (Searle)	Augusta	GA
GAD051011609	DSM Chemicals North America, Inc.	Augusta	GA
GAD981237118	Monsanto (Nutrasweet Kelco Co.)	Augusta	GA
ILD005083316	Mcwhorter Inc (Cargill)	Carpentersville	IL
ILD065237851	Akzo Chemie America	Morris	IL
ILD098642424	ONYX Trade Waste Incineration	Sauget	IL
IND000807107	Reilly Industries, Inc.	Indianapolis	IN
IND000810861	Amoco Oil Co.	Whiting	IN
IND005081542	ESSROC Corporation	Logansport	IN
IND006050967	Eli Lilly And Company	Lafayette	IN
IND006376362	GE Plastics, Mt. Vernon IN Facility	Mount Vernon	IN
IND006419212	Lone Star Industries, Inc.	Greencastle	IN
IND072040348	Eli Lilly And Company	Clinton	IN
KS0213820467	Kansas Army Ammunition Plant	Parsons	KS
KSD007148034	Lafarge	Fredonia	KS
KSD007237746	Air Products Manufacturing Corp.	Wichita	KS
KSD031203318	Ash Grove Cement Company	Chanute	KS
KYD006370159	Elf Atochem North America, Inc.	Calvert City	KY
KYD006373922	Elf Atochem	Carrollton	KY
KYD006390017	Rohm and Haas Company	Louisville	KY
KYD088438817	LWD, Inc.	Calvert City	KY
LAD000778381	Exxon Chemical Co.	Baton Rouge	LA
LAD001890367	Dupont Dow Elastomers	LaPlace	LA
LAD003913449	Borden Chemicals and Plastics (BCP)	Geismar	LA
LAD008086506	PPG Inc	Westlake (Lake Charles)	LA
LAD008187080	Dow Chemical Co.	Plaquemine	LA
LAD008213191	Rubicon, Inc	Geismar	LA
LAD010390599	Westvaco	DeRidder	LA
LAD020597597	Angus Chemical Company	Sterlington	LA
LAD040776809	BASF	Geismar	LA
LAD041581422	Union Carbide Corp.	Hahnville	LA
LAD053783445	Novartis (CIBA-Geigy Corporation)	St. Gabriel	LA
LAD057117434	Georgia Gulf	Plaquemine	LA
LAD059130831	DSM Copolymer Inc.	Addis	LA
LAD092681824	Vulcan Materials Co.	Geismar	LA
LAD980622104	Shell Oil Co	Norco	LA
LAR000018333	Arco Chemical Company	Westlake	LA
MAD001039767	Bostik, Inc.	Middleton	MA

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Combustion Facilities in the Regulatory Universe

EPA ID	Facility Name	City	State
MDD003071875	FMC Agricultural Chemical Group	Baltimore	MD
MID000724724	Dow Chemical Co.	Midland	MI
MID000820381	Pharmacia & Upjohn Co.	Kalamazoo	MI
MND006172969	3M	Cottage Grove	MN
MO4213820489	Lake City Army Ammunition Plant	Independence	MO
MOD029729688	Holnam Inc.	Clarksville	MO
MOD050226075	American Cyanamid	Hannibal	MO
MOD054018288	Continental Cement Company	Hannibal	MO
MOD056389828	Bayer (Miles, Mobay)	Kansas City	MO
MOD981127319	Lone Star Industries, Inc.	Cape Girardeau	MO
MOD985798164	ICI Explosives	Joplin	MO
MSD033417031	First Chemical Corporation	Pascagoula	MS
MSD077655876	Holnam Inc.	Artesia	MS
NCD042091975	Mallinckrodt Inc.	Raleigh	NC
NCD047373766	Catalytica Phar (Burroughs Wellcome)	Greenville	NC
NCD065655599	Glaxo Welcome	R.T.P.	NC
NED981723513	Clean Harbors (Ecova Corp.)	Kimball	NE
NJD001787944	Zeneca Inc.	Bayonne	NJ
NJD002373579	Air Products And Chemicals Inc	Paulsboro	NJ
NJD980753875	Ausimont (Pennwalt Corp)	Thorofare	NJ
NYD000824482	Occidental Chemical Corp.	Niagara Falls	NY
NYD002014595	Nepera	Harriman	NY
NYD002080034	General Electric Co.	Waterford	NY
NYD066832023	General Electric Plastics	Selkirk	NY
NYD080469935	Thermalkem (Norlite)	Cohoes	NY
NYD980592497	Eastman Kodak	Rochester	NY
OHD004172623	Lubrizol Corporation	Painesville	OH
OHD004233003	Bayer (Monsanto Co. Port Plastic Plant)	Addyston	OH
OHD004304689	PPG Industries, Inc.	Circleville	OH
OHD005108477	Aristech Chemical Corporation	Haverhill	OH
OHD039128913	Dow Chemical Co. Hanging Rock Plant	Ironton	OH
OHD046202602	Aztec Peroxides Inc	Elyria	OH
OHD048415665	Ross Incineration Services	Grafton	OH
OHD980613541	Waste Technologies Industries	East Liverpool	OH
OHD987048733	Lafarge	Paulding	OH
OK6213822798	McAlester Army Ammunition Plant	McAlester	OK
PAD002292068	Rohm and Haas Company	Bristol	PA
PAD002312791	Sun Company, Inc. (R & M) Frankford Plant	Philadelphia	PA
PAD002389559	Keystone Cement Company	Bath	PA
PAD003043353	Merck & Co Inc - Cherokee Plant	Riverside	PA
PAD980550412	Lonza (Smithkline)	Conshohocken	PA
PRD090021056	Squibb Manufacturing, Inc.	Humacao	PR
PRD090028101	Merck Sharp & Dohme Quimica	Barceloneta	PR
PRD090613357	Chemsource (SK&F)	Guayama	PR
PRD091024786	Eli Lilly And Company	Mayaguez	PR
SCD003351699	Giant Cement Company	Harleyville	SC
SCD003368891	Holnam Inc.	Holly Hill	SC
SCD043384072	Albermarle Corp.	Orangeburg	SC
SCD980500052	3V Inc.	Georgetown	SC

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Combustion Facilities in the Regulatory Universe

EPA ID	Facility Name	City	State
TN0890090004	US Department Of Energy	Oak Ridge	TN
TND003376928	Eastman Chemical Company	Kingsport	TN
TND007024664	Velsicol Chemical Corporation	Memphis	TN
TND982109142	Diversified Scientific Services, Inc.	Kingston	TN
TX0000201202	PO/MTBE Plant	Port Neches	TX
TXD000017756	Dow Chemical Co.	La Porte	TX
TXD000461533	Union Carbide Corporation	Texas City	TX
TXD000838896	Chemical Waste Management	Port Arthur	TX
TXD001700806	Solutia (Chocolate Bayou Plant)	Alvin	TX
TXD007330202	Texas Eastman Division Eastman Chemical Company	Longview	TX
TXD007349327	Midlothian Cement Plant	Midlothian	TX
TXD007376700	Celanese	Pampa	TX
TXD008076846	Huntsman Corp. (formerly Texaco)	Port Neches	TX
TXD008076853	Hunstman (Texaco Chemical Co)	Conroe	TX
TXD008077190	Goodyear Tire and Rubber Company	Beaumont	TX
TXD008079212	Dupont	La Porte	TX
TXD008079527	Sterling Chemicals, Inc.	Texas City	TX
TXD008079642	E.I. duPont de Nemours & Co., Inc.	Orange	TX
TXD008081697	BASF Corporation	Freeport	TX
TXD008092793	Dow Chemical Company	Freeport	TX
TXD008106999	Merichem Company	Houston	TX
TXD008113441	Celanese Ltd	Bishop	TX
TXD008123317	E.I. duPont de Nemours & Co., Inc.	Victoria	TX
TXD010797389	Schenectady International	Freeport	TX
TXD026040709	Celanese Ltd	Bay City	TX
TXD055141378	Safety Kleen (Rollins)	Deer Park	TX
TXD058260977	Bayer (Miles Corp.)	Baytown	TX
TXD058275769	Equistar Chemicals, LP - Channelview Complex	Channelview	TX
TXD065096273	Rohm and Haas	Deer Park	TX
TXD067261412	BASF Corporation	Beaumont	TX
TXD067285973	Shell Deer Park Refining Company	Deer Park	TX
TXD078432457	Celanese Ltd., Chemical Group Clear Lake Plant	Pasadena	TX
TXD083472266	ARCO Chemical Co.	Channelview	TX
TXD084970169	Lonza, Inc.	Pasadena	TX
TXD086981172	Fina Oil & Chemical Co.	La Porte	TX
TXD093565653	Georgia Gulf Corporation	Pasadena	TX
TXD980626014	Huntsman Polymers	Odessa	TX
TXD980808778	Aristech Chemical Corp.	Pasadena	TX
TXD981911209	Occidental Chemical VCM	Deer Park	TX
TXD982286932	Occidental Chemical Corp.	Gregory	TX
UT3213820894	Tooele Army Depot North	Tooele	UT
UT5210090002	Deseret Army Depot CAMDS	Tooele	UT
UTD981552177	Safety Kleen (Aptus)	Aragonite	UT
VA1210020730	Radford Army Ammunition Plant	Radford	VA
VAD042755082	Solite	Arvonia	VA
VAD046970521	Solite	Cascade	VA
VAD065385296	Honeywell (Allied Fibers)	Hopewell	VA
WAD092899574	Kalama Chemical (BF Goodrich)	Kalama	WA
WVD004325353	Crompton Corp (OSI Specialties, Inc.)	Sisterville	WV
WVD004341491	Cytec Industries	Willow Island	WV
WVD005005483	Union Carbide Corporation	South Charleston	WV
WVD005005509	Rhone-Poulenc AG Company	Charleston	WV
WVD056866312	Bayer (Miles, Inc.)	New Martinsville	WV