United States
Environmental Protection
Agency

Office of
Toxic Substances
Washington DC 20460

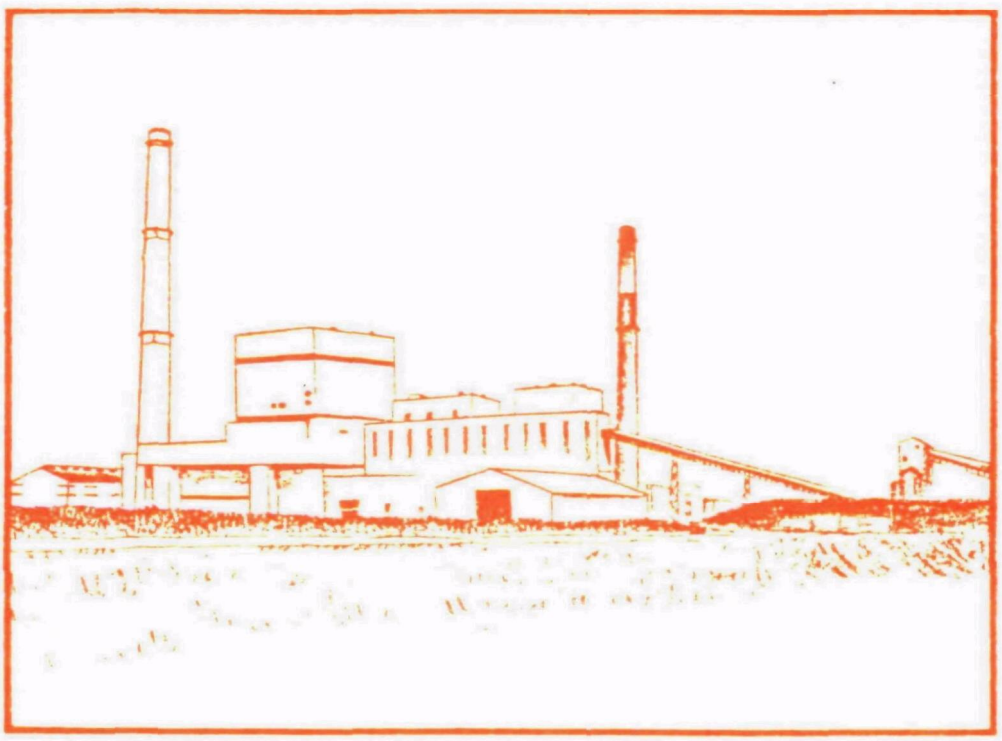
EPA-560/5-83-005
September, 1983

Toxic Substances

EPA

Comprehensive Assessment of the Specific Compounds Present in Combustion Processes

Volume 2
Design for a National Survey of Emission of Specific Compounds from Coal Fired Utility Boiler Plants



COMPREHENSIVE ASSESSMENT OF THE SPECIFIC COMPOUNDS PRESENT IN COMBUSTION PROCESSES

VOLUME 2 - DESIGN FOR A NATIONAL SURVEY OF EMISSION OF SPECIFIC COMPOUNDS FROM COAL FIRED UTILITY BOILER PLANTS

by

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SPECIAL REPORT

EPA Prime Contract No. 68-02-3938
Midwest Research Institute
MRI Project No. 8501-A(1)

August 8, 1985

Prepared for

U.S. Environmental Protection Agency
Office of Pesticides and Toxic Substances
Field Studies Branch
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PREFACE

The research and preparation of the draft of this report was performed for the U.S. Environmental Protection Agency under Contract No. 68-01-5848, Research Triangle Institute Project No. 1864-11. Mr. Joseph Carra was the Contract Officer and Dr. John Smith was the Task Manager. The final revisions and preparation of this final report were completed by Research Triangle Institute under subcontract to Midwest Research Institute under Prime Contract No. 68-02-3938.

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ACKNOWLEDGEMENTS

The authors greatly appreciate the cooperation of Mr. David Redford of the U. S. Environmental Protection Agency, Washington, D.C.; Dr. Clarence Haile of the Midwest Research Institute during the conduct of the study. Dr. Haile directed the chemical analyses that provided the data for many of the tables included in this report. The authors also thank Mr. Frank Potter for his helpful comments in revising this report and Ms. Martha Clegg for excellent work in typing this report.

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I. EXECUTIVE SUMMARY

The emission of several toxic compounds in the polycyclic organic group, specifically polychlorinated dibenzo-p-dioxins, dibenzofurans and biphenyls have been reported from stationary combustion processes. It has been claimed that these compounds are ubiquitous in air and are formed from many combustion sources. It has been demonstrated that a theoretical potential exists for the formation of these compounds as the results of combustion. The most likely sources involve coal-refuse, wood, municipal refuse, waste oil and coal.

To investigate this topic further, a pilot study was designed to obtain data on which to base a national survey. The overall objectives of the pilot study were to ascertain the number of combustion sites and the number of days of sampling required at each site to adequately estimate the level and prevalence of these toxic substances in the emissions from combustion processes and to do so at a minimum cost.

The pilot included two sites. One was a coal-refuse burning electricity generating facility and the other a municipal incinerator. These two types of facilties were selected because they were in categories that were judged most likely to emit the substances of interest.

For each facility a complex, multimedia sampling design was developed for the collection of solid, liquid and gaseous influents and effluents. In addition, measurements of process parameters were also taken. This design allowed for the estimation of the inputs into the process, the efficiency of the combustion process and the emissions from the process.

The level of total organic chlorine (TOCl) was used as a surrogate for the levels of toxic substances being investigated. The use of a surrogate was necessitated because the large number of chemical analyses required to retain sufficient statistical information to design a national study would be beyond budgetary restraints. TOCl was selected because it was believed that its levels and the levels of the toxic substances of interest would be correlated.

The TOCl data was statistically analyzed taking into account the design and compositing of specimens. The level of TOCl was in general higher for the municipal incinerator data and also tended to show more variability among specimens. The TOCl levels for the several media common to both facilities appeared to be significantly different.

The true levels of TOCL at both facilities may be underestimated because of less than complete recovery of the TOCl in the chemical analysis. The underestimation may be more serious for the incinerator estimates.

Using the estimates of the variability of the data and cost estimates based on the experience gained in the pilot, a national survey of two combustion categories was developed. Sampling is planned for seven coal and nine refuse combustion facilities for five days each. Estimates of the levels of toxic substances are anticipated to have a precision of ±50 to ± 60%.

II. INTRODUCTION

A. Background

The emission of several toxic compounds in the polycyclic organic matter (POM) group, specifically polychlorinated dibenzo-p-dioxins (PCDDs), dibenzofurans (PCDFs), and biphenyls (PCBs) have been reported from stationary conventional combustion processes (DC-USA 1978, Olie et al. 1978 and Shin 1979). These compounds have been proposed to be ubiquitous in the aqueous environment and it has been claimed that POMs are ubiquitous in air and are being formed from many combustion sources. (DC-USA 1978).

A study conducted for the U. S. Environmental Protection Agency (EPA) (Shin 1979) demonstrates that a theoretical potential exists for POMs to be formed during and as a result of conventional combustion processes. These POMs may include PCDDs, PCDFs, and PCBs. The major combustion sources are suspected to involve such fuels as coal-refuse, wood, municipal refuse, waste oil and coal.

Because the acquistion of field specimens and their chemical determination are very costly, it is important to carefully plan studies to ascertain the level and prevalence of the substances being emitted into the environment. Because not enough appropriate data were available on which to base a statistical design for a national survey, a pilot study was conducted specifically designed to generate the appropriate data.

B. Objectives of the Pilot Study

To achieve the overall objective of the pilot, several specific objectives were defined; these were:

1. Estimate the variability among sites and among days within sites of the level and prevalence of selected toxic substances in the POM group;

2. Estimate the relationship (correlations) of the level and prevalence of selected toxic substances in the POM group among the various influent and effluent streams;

3. Estimate the fraction of the total varibility of the level and prevalence of selected toxic substances in the POM group due to the chemical analysis;

4. Test the feasibility of the sampling protocols used in the acquisition of field specimens; and

5. To estimate the cost (in dollars) of the various aspects of the study.

For example, the cost of overall project management; the cost of travel, transportation, and shipping of personnel and materials to and from a site; and the cost of the various stages of the chemical analysis from extraction through quantitation and confirmation of specific toxic substances in the POM group would be estimated.

These objectives evolved from the necessity to acquire specific information based on the criteria below.

1. Knowledge of the variability is necessary to anticipate the precision of estimates of the level of toxic substances obtained in the survey for specific sample sizes.

2. If a strong relationship exists among the various influent and effluent streams, the cost efficiency of the study may be improved by collecting more samples from less expensive sampling points. One may be able to use this relationship to improve the precision of the estimates for the more expensive sampling point.

3. Knowledge of the fraction of the total variability of the level of toxic substances due to the chemical analysis is necessary to develop cost efficient compositing protocols which retain sufficient information for proper statistical analysis of the data.

4. Sampling protocols based on statistical principles allows one to assess the quality of the data.

5. The cost of various aspects of the study along with the variability is necessary to design a cost efficient (obtaining the most information for a given cost) national survey.

C. Statistical Design for the Pilot Study

Two sites were selected for the pilot study: one, a coal-refuse burning electrical generating facility Ames Municipal Power Plant, Ames, Iowa, and the other, a municipal incinerator Chicago Northwest (NW) Incinerator, Chicago, Illinois. These types of facilities were selected because they were judged to be most likely to emit chlorinated POMs into the environment (Shin, 1979). Also, because only coal was burned on some days at the Ames, Iowa plant, some information about coal fired plants could be obtained.

Because only two sites were to be used to estimate the variability among sites, they were purposely selected from different categories. This is expected to result in, at worst, an overestimate of the variability among sites within a category. Prudence motivated this conservative approach.

1. Number of Days Per Site

Sampling for 14 days at each site was scheduled. This sample is adequate to detect large correlations among the various media ($\rho \geq .5$) at least 60% of the time. For $\rho \geq .9$, the correlation would be detected at least 95% of the time. Hence, the sample size is adequate to detect correlation of sufficient magnitude to provide substantial improvement in precision. For example, a correlation of .866 is required to attain improvement in the precisions of estimates of 50%.

2. Multimedia Sample Design

The combustion process can be described as consisting of three phases: (i) input, (ii) combustion, and (iii) emission. The amounts of toxic substances that are emitted into the environment from a given site depends on the concentration of the substances and their precursors in the first phase, the efficiency or completeness of combustion in the second phase and the type of emission control devices used before the third phase. (Shin et al 1979 and DC-USA 1978)

To obtain the appropriate data to meet the objectives of the study, the design necessarily involves a complex matrix of multimedia sampling at different time periods and frequencies incorporating specimen and data collection at all three process phases. The specific intervals used in the pilot study were site specific and were based on such factors as type of fuel feed or the frequency and mechanism by which effluents such as bottom ash are removed.

The sampling sites were dispersed in a manner that was intended to give estimates on the input into the combustion process, efficiency or completeness of combustion and the emission from the process. The following is a list of sample points for each phase and the sample point's relative locations are given in Figure 1.

(i) Input

I_1 - Probability sampling of the fuel entering the combustion process was conducted six times per day. The protocols were developed after a site visit to each site.

I_2 - High volume sampling of ambient air (or intake air) was conducted for each 24 hour period during the pilot survey.

I_3 - Intake water was sampled three times during the study.

(ii) Combustion

C_1 - Real time monitoring of carbon monoxide (CO)

C_2 - Real time monitoring of carbon dioxide (CO_2)

C_3 - Real time monitoring of free oxygen (O_2)

C_4 - Real time monitoring of temperature

C_5 - Real time monitoring of hydrocarbons.

(iii) Emissions

E_1 - Effluent gas sampling before emission control devices was conducted. More than one sampling interval (period of time) was desired but was not practical.

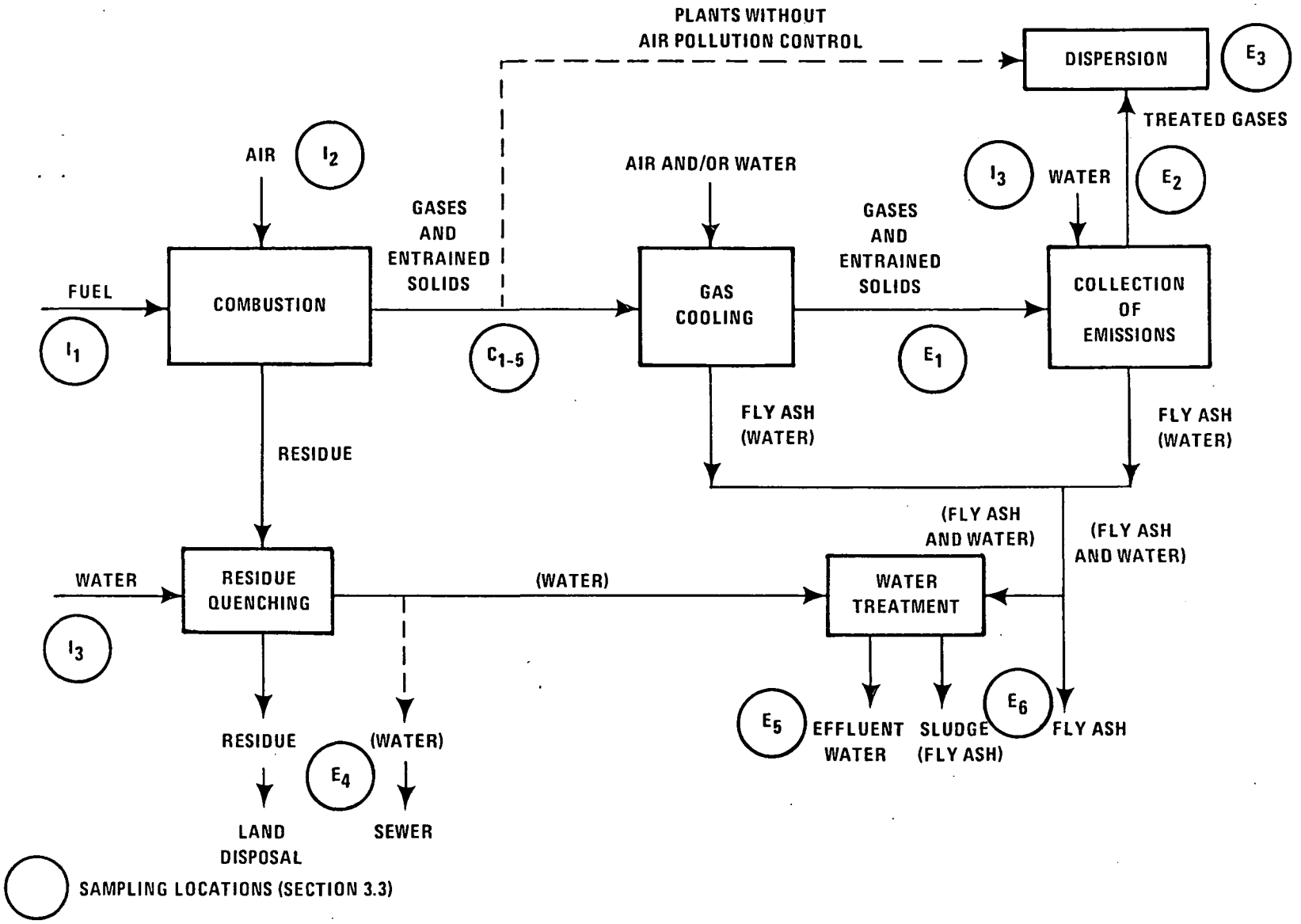

Figure 1. General diagram of combustion site indicating possible sampling points and their relationship to certain operations in the process.

*Adapted from Gorden et al.,

E_2 - Effluent gas sampling after emission control devices was also conducted.

E_3 - A high volume sample of ambient air was collected.

E_4 - Probability sampling of bottom ash and quenching water several times daily was planned. The frequency and interval of samples was determined after site visits were made.

E_5 - Probability sampling of effluent water and sludge was planned. The frequency was determined after site visits were made.

E_6 - Probability sampling of collected fly ash from emission control devices was conducted. The frequencies were determined after site visits were made.

The choice and exact location of each sampling point depended on the combustion site. For example, the location where the on-line detection and measuring devices were located depended on the design and access to appropriate locations near the combustion center.

Exact protocols for probability sampling of specific sites were developed. These protocols depended on the physical characteristics of the sampling point, the medium to be sampled and the conventional methods normally used in a similar situation (although not limited to use of "conventional" methods).

Adequate sample volumes and mass to assure satisfactory chemical analysis sensitivity were necessary. These volumes and mass were sufficient to perform the two tier analysis and quality control/quality assurance method of standard additions. Midwest Research Institute (MRI) recommended sample volumes and masses for the different media and sample locations.

Sample handling requirements such as on-site stabilization procedures, equipment cleaning specifications, and container requirements were recommended by MRI. A "Chain of Custody Record" was kept for each specimen collected.

3. Site Specific Sample Designs

One study site was unit number 7 at the coal-refuse fired electrical generating plant in Ames, Iowa. The engineering details of the plant operations and flue gas sampling methods are given in TRWEED (1980). The important statistical design features are summarized below with additional details included in Appendix A. The other study site was boiler number 2 at the Chicago Northwest municipal incinerator in Chicago, Illinois. The engineering details of the plant operations and flue gas sampling methods are given in Bakshi et al (1980). The important statistical design features are summarized below with additional details included in Appendix B.

At Ames, specimens were collected from ten locations. The three gas sample locations were: (i) flue gas inlet (from duct before the electrostatic precipitator (ESP)), (ii) flue gas outlet (from stack after ESP), and (iii) ambient air (located on roof of the plant). The four solid sample locations were: (i) fly ash (from the ESP ash hoppers), (ii) bottom ash (from the base of the furnace), (iii) coal (from the feedline leading from the storage bunkers into the gravimetric feeders) and (iv) refuse-derived fuel (RDF) (from the feeders prior to being pneumatically conveyed to the boiler furnace). The three liquid sample locations were: (i) bottom ash hopper quench water overflow (OW) (from the overflow trough), (ii) quench water influent (cooling tower blow down) (from transport pipes), and (iii) well water (from transport pipe). The designed sample sizes and frequencies per day are summarized in Table 1. Also included in the table are the number of specimens actually collected. The collected number of specimens differs from the design because of physical problems resulting from weather and the operations of the plants.

The sampling schedule varied depending on the medium and location. The gaseous specimens were time integrated samples over 8-to 13-h periods. Exact time durations are given in TRWEED (1980). The solid and OW specimens were collected using a systematic time schedule (every 4 h) based on a random starting time. Two random starting times were used; one for the first week and another for the second. The other two liquid media were collected at randomly selected times during the scheduled two week test period. (Appendix A contains additional details of how the sampling schedule was developed.)

At the Chicago, NW incinerator, specimens were collected from seven locations. The three gas sampling locations were: (i) flue gas inlet (ESP inlet), (ii) flue gas outlet (duct leading from ESP to stack), and (iii) ambient air (located on roof of the plant). The solid samples were collected from three locations (i) fly ash (from ESP ash hopper), (ii) combined ash (from base of incinerator where bottom ash and fly are combined), and (iii) refuse (from charge hopper at top of furnace). One liquid sample of city tap water was collected from a pipe entering the building. The designed sampling sizes and frequencies per day are summarized in Table 2. Also included in the table are the number of specimens actually collected. The number of specimens collected differs from the design because of physical problems resulting from plant operations.

The sampling schedule varied depending on the medium. The gaseous specimens were time integrated samples over 7- to 12-h periods. The exact durations of the samples are given in Bakshi et al (1980). The solid specimens were collected using systematic time schedule (every 4 h) based on a random starting time. Two random starting times were used, one for the first week and another for the second. The liquid samples were collected at randomly selected times during the study period. (Appendix B contains additional details of how the sampling schedule was developed.)

At both combustion sites, several sampling locations had more than one access point (for example, the fly ash could be collected from more than one hopper). For these cases, an access point was randomly selected for each sampling time.

Table 1. Design Sample Sizes and Number of Specimens Actually Collected for Various Media at Ames, Iowa Power Plant

Media	Designed sample size (number of specimens)	Number of specimens actually collected
Gaseous		
Flue gas inlet	14 (1 per day)	19
Flue gas outlet	14 (1 per day)	11
Ambient air	14 (1 per day)	20
Solid		
Fly ash	84 (6 per day)	90
Bottom ash	84 (6 per day)	88
Coal	84 (6 per day)	11[a]
Refuse derived fuel	84 (6 per day)	67
Liquid		
OW[b]	84 (6 per day)	91
Quench water influent	6	6
Well water	3	3

[a]More specimens were collected but only eleven (11) were chemically analyzed because of low levels of Total Organic Chlorine (TOCl).
[b]Bottom ash hopper quench water overflow.

Table 2. Design Sample Sizes and Number of Specimens Actually Collected for Various Media at Chicago, NW Incinerator

Media	Designed sample sizes (number of specimens)	Number of specimens actually collected
Gaseous		
Flue gas inlet	14 (1 per day)	11
Flue gas outlet	14 (1 per day)	11
Ambient air	14 (1 per day)	13
Solid		
Fly ash	84 (6 per day)	72
Combined ash	84 (6 per day)	76
Refuse	84 (6 per day)	61
Liquid		
City tap water	3	3

Continuous monitoring of oxygen (O_2), carbon dioxide (CO_2), carbon monoxide (CO) and total hydrocarbons (TH) was conducted during the gaseous sampling periods at both sites. These parameters give an indication of the efficiency of the combustion process.

III. RESULTS OF THE PILOT STUDY

A. Introduction

This chapter summarizes the total organic chlorine (TOCl) data obtained in the pilot study. These data are presented in Haile et al (1984). More specifically, this chapter includes summary statistics, descriptions of *the compositing protocols for the chemical analysis and statistical analysis* methods, and discussion of the chemical analysis and sampling error. No correlations between the TOCl levels of the different media are included in the summary statistics because none were found to be significant.

B. Summary Statistics

To summarize the data, the arithmetic mean, coefficient of variation (CV) and nominal 95% confidence intervals were calculated for each sampling location at both combustion sites. The arithmetic mean ($\bar{X}$) can be calculated for each sampling location by

$$\bar{X} = \sum_{i=1}^{n} X_i / n$$

where X_i is the TOCl concentration of the ith specimen and n is the number of specimens. The CV can be calculated by first calculating the sample variance (S^2)

$$S^2 = \sum_{i=1}^{n} (X_i - \bar{X})^2 / (n - 1) .$$

The CV = $S / \bar{X}$. The nominal 95% confidence intervals are calculated by

$$(\bar{X} - t_{.05}(df)\ S / \sqrt{n}\ ,\ \bar{X} + t_{.05}(df)\ S / \sqrt{n}\ )$$

where $t_{.05}(df)$ is obtained from tables of Student's t distribution [Snedecor and Cochran p. 469 (1980)] and df denotes the appropriate degrees of freedom which depend on number of independent chemical analyses.

Because some specimens were composited before chemical analysis, the above formulas were not used to calculate $\bar{X}$ and S^2 for all locations. However, the calculations were adjusted to take into account the compositing. These adjustments are discussed below in Section C. The summary statistics are given in Tables 3 and 4.

Table 3. Summary Statistics for Total Organic Chlorine Concentration Data from the Ames, Iowa, Plant[a]

Media (units)	Number of specimens	Mean	Coefficient of variation (%)	Degrees[b] of freedom	Nominal 95%[c] confidence interval
Gaseous (ng/dscm)					
Flue gas inlet	19	562	49	18	(426, 698)
Flue gas outlet	11	632	85	10	(254, 1010)
Ambient air	20	[d]			
Solid (ng/g)					
Fly ash	90	8.3	536	50	(-1.0, 17.6)
[e]	(89)	(3.6)	(81)	(49)	((2.9, 4.2))
Bottom ash	88	58.6	183	50	(35.1, 82.1)
Coal	11	4.4	23	5	(3.5, 5.3)
Refuse-derived fuel	67	11,900	116	36	(8,342, 15,470)
Liquid (ng/L)					
OW[f]	91	664	77	51	(570, 760)
Quench water influent	6	373	33	5	(231, 514)
Well water	3	54	32	2	(1.4, 101)

[a] Original data from Haile et al (1984).
[b] Number of independent chemical analyses minus one.
[c] Nominal value based on normal probability distribution theory.
[d] Measured values in field specimens not significantly different from blanks.
[e] Numbers in ( ) are estimates excluding the maximum value of 210 ng/g. This value is 21 times larger than the next largest value. Both sets of summary statistics are included to illustrate the impact of the one extreme value on the estimates.
[f] Bottom ash hopper quench water overflow.

Table 4. Summary Statistics for Total Organic Chlorine Concentration Data from the Chicago, NW Incinerator[a]

Media (Units)	Number of Specimens	Mean	Coefficient of Variation (%)	Degrees[b] of Freedom	Nominal 95%[c] Confidence Interval
Gaseous (ng/dscm)					
Flue gas inlet	11	2200	36	10	(1698, 2702)
Flue gas outlet	11	3220	109	10	(862, 5578)
d	(10)	(2190)	(36)	(9)	((1330, 3040))
Ambient air	1	1.67	64	11	(-.68, 4.02)
Solid (ng/g)					
Fly ash	72	93.6	85	52	(71.7, 115.6)
Combined ash	67	7.0	162	50	(5.8, 13.9)
Refuse	61	902	251	50	(283.8, 1,520)
Liquids (ng/L)					
City tap water	4	30	0	e	e

[a]Original data from Haile et al. (1984).
[b]Number of independent chemical analyses minus one.
[c]Nominal value based on normal probability distribution theory.
[d]Numbers in ( ) are estimates excluding the maximum value of 13,500 ng/dscm. This value is 4 times larger than the next largest value. Both sets of summary statistics are included to illustrate the impact of the one extreme value on the summary statistics.
[e]Not calculated because there was no variability in the data.

C. Compositing and Weighting

To minimize the cost of chemical analysis while retaining sufficient statistical information, a complex compositing protocol was developed for the sample locations where more than one specimen per day was collected. The compositing varied for the six samples collected each day. On some days all were composited, on others, the two within a shift were composited, and on others none were composited. These locations were fly ash, bottom ash, coal, RDF and OW at the Ames plant and fly ash, combined ash and refuse at the Chicago, NW incinerator. No compositing was done for the specimens collected at the other sample locations.

To modify the calculations for $\bar{X}$ and S^2 to compensate for the compositing, each chemical determination was assigned a weight equal to the number of specimens composited. Then the weighted mean $\bar{Y}_w$ is calculated by

$$\bar{Y}_w = \sum_{i=1}^{m} W_i Y_i \Big/ \sum_{i=1}^{m} W_i$$

where Y_i is the ith chemical determination, W_i is the number of specimens composited for the ith chemical determination and m is the number of chemical determinations. Because $\sum_{i=1}^{m} W_i = n$ and on average $\sum_{i=1}^{m} W_i Y_i = \sum_{i=1}^{n} X_i$, then $\bar{Y}_w$ equals $\bar{X}$ on average.

To estimate S^2 from the composited data, calculate

$$S_w^2 = \sum_{i=1}^{m} W_i^2 (Y_i - \bar{Y}_w)^2 \Big/ \sum_{i=1}^{m} W_i$$

where W_i, Y_i, $\bar{Y}_w$, and m are the same as above. Because $\sum_{i=1}^{m} W_i^2 (Y_i - \bar{Y}_w)^2$ approximately equals $\sum_{i=1}^{n} (X_i - \bar{X})^2$ on average, S_w^2 approximately equals S^2 on average. Hence the CV $(S/\bar{X})$ is estimated by $S_w/\bar{Y}_w$.

The techniques above give a method to estimate the same parameters as if no compositing was done. A theoretical justification of these techniques is given in Appendix C.

D. Chemical Analysis Measurement Errors

To assess the measurement errors in the chemical analysis a method of standard additions was employed. Known amounts of two surrogate compounds, d_8-naphthalene and d_{12}-chrysene, were added to the composited specimens before the chemical analysis. The percent recoveries of the surrogate compounds and their CVs are given in Tables 5 and 6.

Table 5. Summary of Surrogate Compounds Percent Recovery for Specimens from the Ames, Iowa, Plant[a]

Media	d_8-Naphthalene[b]			d_{12}-Chrysene		
	Number of analyses	Mean percent recovery	Coefficient of variation (%)	Number of analyses	Mean percent recovery	Coefficient of variation (%)
Gaseous						
Flue gas inlet	18	56	45	19	71	27
Flue gas outlet	11	47	25	11	86	14
Solid						
Fly ash	51	44	56	51	96	24
Bottom ash	42	55	36	49	85	37
Coal	6	90	18	6	90	19
Coal-derived fuel	37	64	22	37	111	25
Liquid						
OW[c]	40	51	54	48	88	29
Quench water influent	6	69	25	6	111	16
Well water	2	66	1	3	88	29

[a] Data from Haile et al. (1984).
[b] Specimens that were inadvertantly evaporated to dryness were excluded.
[c] Bottom ash quench water overflow.

Table 6. Summary of Surrogate Compound Percent Recovery for Specimens from the Chicago, NW Incinerator[a]

Media	d_8-Naphthalene[b]			d_{12}-Chrysene		
	Number of analyses	Mean percent recovery	Coefficient of variation (%)	Number of analyses	Mean percent recovery	Coefficient of variation (%)
Gaseous						
Flue gas inlet	11	37	84	11	74	48
Flue gas outlet	11	27	98	11	62	82
Ambient air	12	31	75	12	51	88
Solid						
Fly ash	53	26	68	52	36	61
Combined ash	33	35	57	33	22	105
Refuse	44	9	51	44	12	193
Liquid						
City tap water	3	27	131	3	13	92

[a]Data from Haile et al. (1984).

If the percent recoveries in these tables are indicative of the recovery rate for TOCl, then the concentrations of TOCl are under estimated. This under estimation would be greater for the specimens from the Chicago, NW incinerator, than those from the Ames plant. However, the summary statistics reported in Table 3 and 4 above are not adjusted for percent recovery, as recommended by MRI. Biases of this type can affect the true confidence of a nominal 95% confidence interval. Table 7 illustrates the impact of various levels of bias on the true confidence of a nominal 95 percent confidence interval.

Table 8 summarizes the estimates of the CVs ($S/\bar{X}$) for both the sampling and measurement (as indicated by the surrogate recovery data) component. One should note that the measurement CVs for the Ames plant are uniformly less than those for the Chicago, NW incinerator. In fact, for some sampling locations at the Chicago, NW incinerator, the measurement component dominates the total variability giving negative estimates of the sampling component. This is not unexpected for the ambient air and city tap water because at these two locations one would expect the media to be rather homogeneous. However, this is unexpected at the flue gas inlet. Note that the measurement CV is larger than the sampling CV at the inlet but the opposite is true at the outlet. In this report, no physical explanations are attempted for this phenomena.

The design of the national survey of combustion sites is based on the CV of the flue gas outlet. Two important factors motivated this decision; (i) approximately 75 to 80% of the total mass of TOCl is emitted through the flue gas; and (ii) flue gas is, by far, the most expensive location to sample.

Even though the CVs for some of the other sampling locations are much larger than the flue gas outlet CV, the precision for these locations can be easily controlled by the number of specimens collected per day with little effect on the total cost of the survey. Chapter IV discusses the development of the national survey using the TOCl data obtained in the pilot.

IV. NATIONAL SURVEY DESIGN DEVELOPMENT

A. Introduction

In this section the techniques used to determine the number of sites to be sampled and the number of days to sample at each site are discussed. This section also includes the discussions on how the sample is to be dispersed across the U.S. and what procedures are used to select the sampling sites. The first subsection is a discussion of how these estimates of the variability anticipated in the survey are formulated.

B. Variance Components

Because more than one combustion site will be sampled and each site will be sampled for more than one day, the total variability in the data can be partitioned into two components. One due to the differences in the average emissions among the sites and the other due to the differences in the average

Table 7. Validity of Confidence Statements for Selected Levels of Bias

BIAS/SE[b]	True Confidence Level[a] for the $\bar{x} \pm 1.96 \times SE$ Interval
0	0.95
0.5	0.92
1.0	0.83
1.5	0.68
2.0	0.48
2.5	0.29
3.0	0.15
3.5	0.06
4.0	0.02

[a]Calculated according to the integral of the

$$\int_{-1.96 + BIAS/SE}^{1.96 + BIAS/SE} \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}x^2} dx$$

[b]SE denotes the standard error of the estimate and is equal to the standard deviation (σ) divided by the square root of the sample size ($\sqrt{n}$).

Table 8. Summary of Coefficient of Variations for Pilot Study[a]

Media	Ames		Chicago	
	Sampling	Measurement	Sampling	Measurement
Gaseous				
Flue gas inlet	42	25	b	68
Flue gas outlet	83	13	85	68
Ambient air	c	c	b	87
Solid				
Fly ash	555 (78)[c]	24	164	64
Bottom ash	179	38		
Combined ash			143	76
Coal	12	19		
Refuse-derived fuel	114	18		
Refuse			194	159
Liquid				
OW	58	38		
Quench 2ater influent	17	28		
City tap water			b	132

[a]The measurement CVs present above are a weighted average of the CVs in Tables 5 and 6. They were calculated by $CV = (S_8^2 + S_{12}^2)^2/(\bar{X}_8 + \bar{X}_{12})$. Where the subscripts $_8$ and $_{12}$ denote d_8-naphthalene and d_{12}-chrysene respectively.
[b]The estimates of these values were negative and were excluded because the CV must be non-negative.
[c]Not calculated because specimen amounts were not significantly different than blanks.
[d]Number in ( ) are estimates excluding the maximum value of 210 ng/g. This value is 21 times larger than the next largest value. Both sets of summary statistics are included to illustrate the impact of the one extreme value on the estimates.

emissions among days within each site. This concept can be formulated mathematically using the model

$$\sigma_T^2 = \sigma_A^2 + \sigma_W^2 ,$$

where σ_A^2 denotes a measure of variability among the average emissions of all plants and σ_W^2 denotes a measure of the variability of the average emissions among days within all plants. One purpose of the pilot was to gather data to estimate these quantities. Motivated by the hypothesis that these quantities would differ depending on the type of combustion process, two different types of combustion processes were selected for the pilot.

Two major categories were considered, refuse and coal combustion. The estimates of the variance components are given in Table 9 with statistical details included in Appendix C. Note that even though the absolute measures of variability for refuse combustion are much larger than those of coal combustion, the relative measures (percent of average concentration) are only slightly larger. This is a common occurence among data from many different sources.

C. Cost Components

To determine the sample sizes for the two categories of combustion processes, the costs of sampling and chemical analysis were considered. The estimated costs of the survey were broken down into two components; (i) those associated only with the number of sampling sites (such as travel) and (ii) those associated with the number of days of sampling (such as per diem and chemical analyses). The chemical analysis cost can be associated with the number of days because samples will be composited for daily averages. This concept can be formulated mathematically using the model

$$C = C_1 n_1 + C_2 n_1 n_2$$

where C is the total cost, C_1 the cost associated with the number of sites, n_1 the number of sites, C_2 the cost per day and n_2 the number of days of sampling at each site. Hence, for each combination of n_1 and n_2, the total cost of the survey can be estimated.

The variance component and cost models above can be used to determine the best combination of n_1 and n_2. This procedure is discussed below.

D. Optimum Allocation

One common measure of the precision of an estimate is the standard error (SE). This quantity depends upon the inherent variability in the combustion processes being studied and the number of sites and days of sampling conducted. The SE is calculated by

$$SE = \left[\frac{\sigma_A^2}{n_1} + \frac{\sigma_W^2}{n_1 n_2} \right]^{1/2}$$

where σ_A^2, σ_W^2, n_1, and n_2 are the same as above.

Table 9. Estimates of Variance Components

Parameter	Refuse combustion	Coal combustion
σ_A^2	3,340,000	99,000
σ_W^2	12,200,000	289,000
CV_A [a]	57%	50%
CV_W [b]	109%	85%

[a] CV_A denotes coefficient of variation among plants.
[b] CV_W denotes coefficient of variation among days within plants.

Because the average concentrations differ greatly between the two categories, the SE are not easily comparable. To compensate for the difference, the relative standard error (RSE) is used and allows for direct comparison of the two groups on an equal scale. The RSE is calculated by

$$RSE = \left[\frac{CV_A^2}{n_1} + \frac{CV_W^2}{n_1 n_2} \right]^{\frac{1}{2}}$$

where CV_A and CV_W are the coefficients of variation among sites and among days within sites respectively.

The n_1 and n_2 are determined so that the RSE is less than or equal to 25% and the total cost (C) is minimized. The combination of n_1 and n_2 is refered to as the optimum allocation. The recommended sample size allocations are given in Table 10.

To estimate the anticipated size of the 95% confidence intervals for the estimates, one has to make assumptions about the relative variability among sites and among days within sites. If the among days within sites variation is large relative to the among sites variability, one can make the assumption that the correlation among days within sites is close to zero. With this assumption, an estimate for the number of degrees of freedom associated with an estimate of the precision is approximated by the number of sites and the number of days per site less 1 (or $n_1 \times n_2 - 1$). That is, the sample is tending to be like a simple random sample of days. On the other hand, if the among days within sites variability is small relative to the among sites variability one assumes that the correlation among days within sites is high or close to one. Under this assumption, an estimate of the number of degrees of freedom for an estimate of the precision is approximated by the number of sites less 1 (or $n_1 - 1$). Conceptually if the CV among days within sites is small, the number of days per site offer no additional information to explain the variability. That is, the sample is tending to be a random sample of sites with information for only one day per site.

The estimate of the width of the 95 percent confidence interval for the coal combustion sites are based on either 34 degrees of freedom or 6 degrees of freedom providing a lower and upper bound, respectively, for the anticipated precision. Using the equation,

$$\text{Relative 95\% Confidence Interval Half Width} = t_{.05}(df)\ RSE,$$

the anticipated precision was calculated and presented in Table 10. The approximated degrees of freedom for estimates from the refuse combustion sites would be either 44 or 8 assuming little or no correlation or high correlation among days within sites, respectively. The anticipated 95% confidence intervals for the refuse combustion sites are also given in Table 10.

The next phase of design development involves constructing an inventory of potential sampling sites (sampling frame), defining important factors to be considered in partitioning the sampling frame into subsets (stratification) and the methods of site selection. These are discussed below.

Table 10. Recommended Sample Allocations for National Survey

Combustion category	Number of sites	Number of days per site	Anticipated relative standard error (RSE)	Range for anticipated Nominal 95% confidence interval[a]	
				Assumption 1	Assumption 2
Refuse	9	5	25%	± 50% (t = 2.017)	± 58% (t = 2.306)
Coal	7	5	25%	± 51% (t = 2.034)	± 61% (t = 2.447)

[a]Assumptions for range of anticipated nominal 95% confidence intervals are as follows:

Assumption 1: essentially zero correlation between days within the same plant implies that the number of degrees of freedom can be approximated by one less than the product of number of plants and the number of days per plant. (For coal plants 7 plants × 5 days per plant -1 = 35, similarly for refuse plants.)

Assumption 2: high correlation between days within the same plant implies that the number of degrees can be approximated by one less than the number of plants.

E. Sampling Frame

1. Coal Combustion

The scope of this phase of the national study is narrowed to a particular type of coal combustion category. The frame includes only large (greater than 10^8 BTU/h) coal burning electricity generating plants. The frame is a subset of the National Emissions Data System (NEDS) computer file. The sampling frame is given in Appendix D. Each sampling unit is a point source (boiler or group of boilers associated with a particular stack) of emissions.

2. Refuse Combustion

The refuse combustion category will include those facilities that burn refuse for all or part of their fuel. Included will be municipal refuse incinerators and coal-refuse burning sites. The frame will be compiled using information in Gordon et al., the NEDS computer file and other supplementary sources. Completion of this frame was postponed until immediately before the refuse portion of the survey will be conducted.

F. Stratification of Coal Combustion

Because the total amount of emissions was felt to be highly correlated with the amount of coal burned by each plant, the number of tons of coal burned annually was chosen as the measure of size of each plant. In order to distribute the sample geographically, the U.S. was partitioned into seven groups (strata) of contiguous states. The groups were arranged so that the sum of all the size measures (amount of coal burned annually in the stratum) were approximately equal. Table 11 lists the states and the size measures for each stratum. Figure 2 illustrates the strata.

G. Sample Selection of Coal Combustion

One point source was selected at random from each stratum; the probability of its selection was proportional to the size measure. This increased the likelihood that the sample was weighted towards the large emission sources. Alternates or supplements may be selected, if necessary, using the same methods.

Using a random selection technique allows for unbiased estimates of the average emission and estimation of the precision of the estimates. Confidence intervals based on the survey data will give ranges for the true emission values. Even though it is anticipated that the confidence intervals will be wide for the coal combustion category, by combining the estimates obtained for other categories using similar methods, relatively precise (narrow confidence intervals) estimates of the total emissions from combustion sources will result.

Table 11. Strata of the Coal Combustion Survey and Sum of Size Measures (in millions of tons)

North East	79.5		North Central	75.0	
Maine		0.0	Minnesota		12.1
New Hampshire		0.8	Iowa		8.9
Vermont		0.0	Missouri		21.2
Massachusetts		0.0	Illinois		32.8
Rhode Island		0.0			
Connecticut		0.0	South Central	63.6	
New York		6.3	Tennessee		22.0
New Jersey		2.4	Mississippi		1.6
Pennsylvania		38.5	Arkansas		7.0
Delaware		0.7	Louisiana		4.5
District of Columbia		0.0	Oklahoma		2.1
Maryland		4.4	Texas		26.1
West Virginia		25.8			
South East	72.5		West	69.9	
Virginia		4.8	North Dakota		7.5
North Carolina		20.4	South Dakota		2.4
South Carolina		6.8	Nebraska		1.9
Georgia		17.7	Kansas		7.1
Florida		6.1	Montana		3.2
Alabama		16.7	Wyoming		16.2
			Colorado		8.8
Ohio Valley	74.9		New Mexico		8.0
Ohio		44.9	Idaho		0.0
Kentucky		30.0	Utah		2.5
			Arizona		1.6
Great Lakes	64.2		Washington		4.2
Michigan		21.3	Oregon		0.0
Indiana		31.2	Nevada		4.0
Wisconsin		11.7	California		0.0
			Alaska		0.5
			Hawaii		0.0

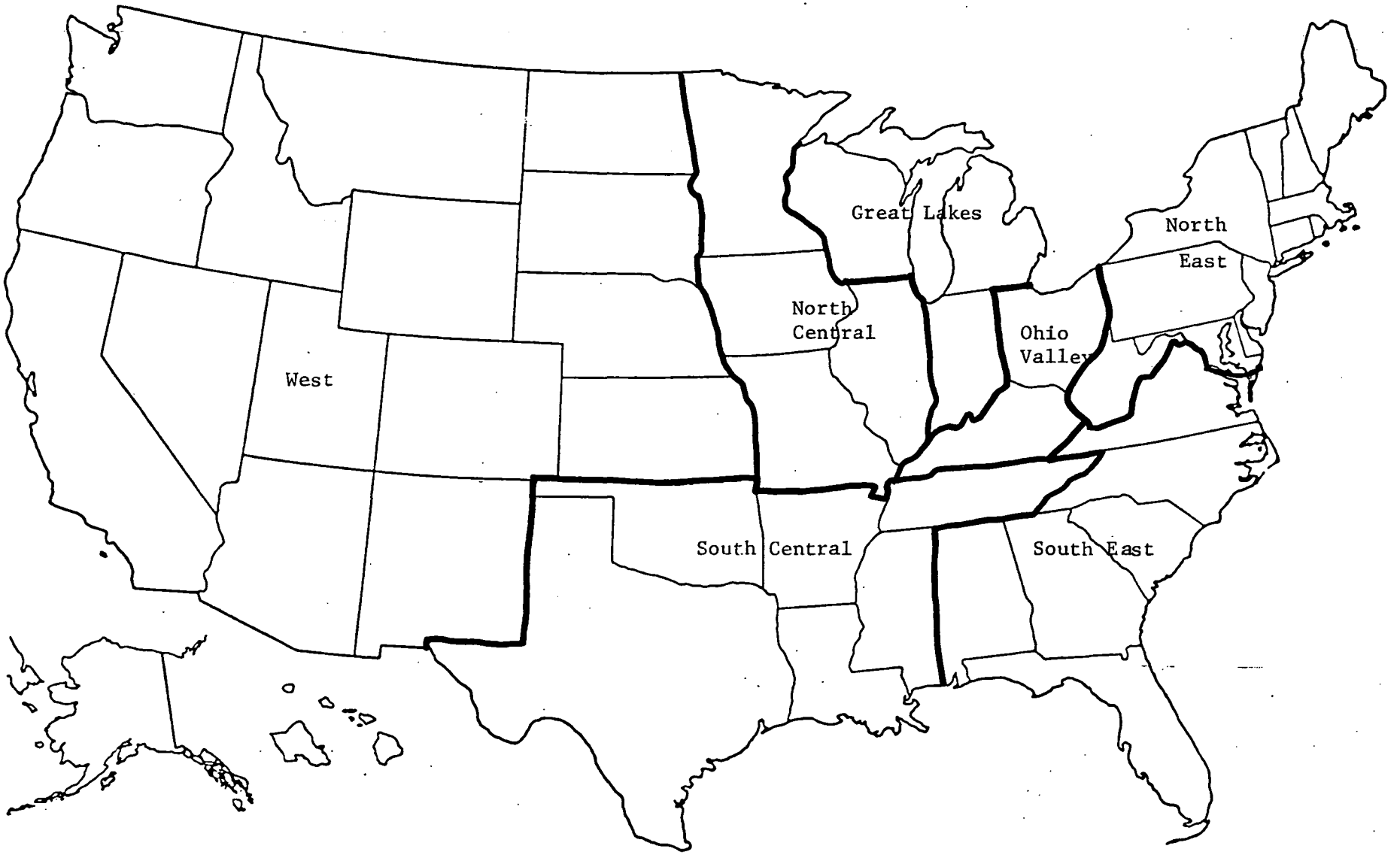

Figure 2. Geographic strata of the coal combustion survey design.

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APPENDIX A

AMES, IOWA PLANT SOLID AND LIQUID SAMPLING PROTOCOL

At Ames, Iowa five non-gaseous locations were sampled six times per day. These were bottom ash (BA), fly ash (FA), coal (CO), refuse-derived fuel (RDF) and bottom ash quench water overflow (OW). A systematic time schedule was developed using the following method.

Because plant cooperation was necessary to obtain BA samples, the schedule was based on BA. Two cycles of the sampling order and time between sampling is given below.

BA	RDF	CO	FA	OW	BA	RDF	CO	FA	OW
	1:00	0:30	1:30	0:30	0:30	1:00	0:30	1:30	0:30

The schedule was based on the times of the working shifts at the plant. They were: (1) 11:00 PM to 7:00 AM, (2) 7:00 AM to 3:00 PM and (3) 3:00 PM to 11:00 PM. The plant restricted the BA sampling for operational reasons, from 1:30 after a shift began to 6:30 after the shift began. To be able to collect two specimens of BA within that time period, little flexibility in the time of the BA sampling was allowed. The allowed times on which to base the schedule were 12:30 AM, 1:00 AM and 1:30 AM. Two times were selected with equal probabilities and without replacement. 1:30 AM was selected for the first week of sampling and 12:30 AM for the second. The resultant schedule is given in Table A.1 for these media.

In addition to the time schedule, the specific location where a specimen would be collected had to be identified. OW had only one access point, hence no randomization was required. However, for RDF, CO, and FA there were four, two and two access points respectively. For these locations, an access point was randomly selected with equal probabilities. The BA sampling was more troublesome. Because of the physical restriction imposed on sampling by the furnace structure, it was impossible to obtain cores of the BA, only surface samples. The surface was divided into an imaginary grid and specimens were selected from randomly selected areas of the grid with equal probabilities.

In addition to the above locations, bottom ash quench water influent (cooling tower blowdown (CTW)) and well water were sampled. The CTW was sampled once per day at a time selected with equal probabilities. The well water was sampled three times during the study. First three days were randomly selected with equal probabilities and then a time was selected for each day with equal probabilities.

Table A-1 Sampling Schedule for Ames, Iowa Plant (Military Time)

Week One					Week Two				
FA	OW	BA	RDF	CO	FA	OW	BA	RDF	CO
0030	0100	0130	0230	0300	2330	2400	0030	0130	0200
0430	0500	0530	0630	0700	0330	0400	0430	0530	0600
0830	0900	0930	1030	1100	0730	0800	0830	0930	1000
1230	1300	1330	1430	1500	1130	1200	1230	1330	1400
1630	1700	1730	1830	1900	1530	1600	1630	1730	1800
2030	2100	2130	2230	2300	1930	2000	2030	2130	2200

APPENDIX B

CHICAGO, NW INCINERATOR SOLID AND LIQUID SAMPLING PROTOCOL

At Chicago, NW incinerator three nongaseous locations were sampled six times per day. These were fly ash (FA), combined ash (CA) and refuse (RF). Combined ash results from the mixing of bottom ash and fly ash in the bottom ash hopper before sampling is possible. A systematic time schedule was developed using the following method.

No plant cooperation was necessary to obtain specimens, hence there was complete flexibility in arranging the schedule. The sampling schedule was based on FA. Two cycles of the sampling order and times between sampling are given below.

FA		CA		RF		FA		CA		RF
	1:00		2:00		1:00		1:00		1:00	

The schedule was based on the times of the working shifts at the plant. They were: (1) 11:00 PM to 7:00 AM, (ii) 7:00 AM to 3:00 PM and (iii) 3:00 PM to 11:00 PM. A random time to begin collecting FA was selected each week. This time was selected with equal probabilities. The ordering above determined the times for the other locations. The resulting schedule is given in table B.1.

In addition to the above locations, city tap water (CTW) was also sampled three times. Three days were randomly selected with equal probabilities and random times within those days were selected with equal probabilities.

More than one access point was available for RF and CA. The physical characteristics of the RF charge bin prohibited core sampling or even randomly selected surface sampling. Specimens were obtained from one side or the other, each side selected with equal probabilities. Because of the physical characteristics of the RF, several cubic feet of RF were collected, homogenized and subsampled. The CA bin was partitioned into five equal areas. The area to be sampled was then selected with equal probabilities. The FA was collected from a single access point in a transport duct.

Table B.1 Sampling Schedule for Chicago, NW Incinerator
(Military Time)

Week One			Week Two		
CA	RF	FA	RF	FA	CA
2300	0100	0200	2300	2400	0100
0300	0500	0600	0300	0400	0500
0700	0900	1000	0700	0100	0900
1100	1300	1400	1100	1200	1300
1500	1700	1800	1500	1600	1700
1900	2100	2200	1900	2000	2100

APPENDIX C

THEORETICAL JUSTIFICATION OF ESTIMATION FORMULAE USED IN STATISTICAL ANALYSIS OF COMPOSITED DATA

Let us consider a random vector $\{X_i\}$, $i = 1$ to n. For the purposes of this discussion we consider the components of the vector to be independent and identically distributed with mean μ and variance σ^2. Hence

$$E[X_i] = \mu \quad i = 1, \ldots, n$$

and

$$\mathrm{Var}[X_i] = \sigma^2 \quad i = 1, \ldots, n$$

Then for

$$\bar{X} = \sum_{i=1}^{n} X_i/n$$

and

$$s^2 = \Sigma (X_i - \bar{X})^2/(n - 1)$$

we have $E[\bar{X}] = \mu$ and $E[s^2] = \sigma^2$.

Two statistics based on composited data which are analogous to $\bar{X}$ and s^2 are:

$$\bar{Y}_w = \sum_{i=1}^{m} W_i Y_i \Big/ \sum_{i=1}^{m} W_i$$

and

$$s_z^2 = \sum_{i=1}^{m} W_i^2 (Y_i - \bar{Y}_w)^2 \Big/ \sum_{i=1}^{m} W_i,$$

where Y_i is the i-th chemical determination obtained from compositing W_i number of specimens (a subset of $\{X_i\}$).

The mathematical expectations are now calculated for $\bar{Y}_w$ and s_w^2 for comparison with those of $\bar{X}$ and s^2.

$$E[\bar{Y}_w] = \sum_{i=1}^{m} W_i E[Y_i] \Big/ \sum_{i=1}^{m} W_i = \mu.$$

because Y_i is the average of a subset of X_i. So $\bar{Y}_w$ and $\bar{X}$ are unbiased estimators of the mean μ.

To compare the expected values of s_w^2 and s^2 we first partition σ^2 into two components, one due to the inherent variability of the media (denoted by σ_1^2) and the other due to the measurement error (denoted by σ_m^2). Hence we can write

$$\sigma^2 = \sigma_1^2 + \sigma_m^2 .$$

and

$$\mathrm{Var}[Y_i] = \frac{\sigma_1^2}{W_i} + \sigma_m^2 .$$

The term σ_1^2 is divided by W_i because Y_i is an estimate of the mean of a subset of W_i members of $\{X_i\}$.

To calculate $E[s_w^2]$ we first calculate

$$E[(n-1)\, s_w^2] = E\left[\sum_{i=1}^{m} W_i^2 (Y_i - \bar{Y}_w)^2\right]$$

where $n = \sum_{i=1}^{m} W_i$. This expectation can be rewritten as

$$E\left[\sum_{i=1}^{m} W_i^2 (Y_i - \bar{Y}_w)^2\right] = \sum_{i=1}^{m} W_i^2 \, E[(Y_i - \mu)^2]$$

$$+ 2 \sum_{i=1}^{m} W_i^2 \, E[(Y_i - \mu)(\bar{Y}_w - \mu)]$$

$$+ \sum_{i=1}^{m} W_i^2 \, E[(\bar{Y}_w - \mu)^2] \qquad \text{(C.1)}$$

The expectation of the three terms in equation (C.1) are now derived. To calculate the expectation of the first term, we have

$$\sum_{i=1}^{m} W_i^2 \, E[(Y_i - \mu)^2) = \sum_{i=1}^{m} W_i^2 \, \mathrm{Var}[Y_i]$$

$$= \sum_{i=1}^{m} W_i^2 \, (\sigma^2/W_i + \sigma_m^2)$$

$$= n\, \sigma_1^2 + \sigma_m^2 \sum_{i=1}^{m} W_i^2 . \qquad \text{(C.2)}$$

For the second term in equation (C.1) we obtain

$$\sum_{i=1}^{m} W_i^2 \, E[Y_i - \mu) \, (\bar{Y}_w - \mu)]$$

$$= \sum_{i=1}^{m} W_i^2 \, E[(Y_i - \mu) \sum_{j=1}^{m} W_j \, (Y_j - \mu)/n]$$

$$= \sum_{i=1}^{m} W_i^2 \, (W_i \, \mathrm{Var}[Y_i]/n$$

$$= \sigma_1^1 \sum_{i=1}^{m} W_i^2/n + \sigma_m^2 \sum_{i=1}^{m} W_i^3/n \; . \qquad (C.3)$$

No covariance terms appear in this expression because Y_i and Y_j, $i \neq j$, are functions of disjoint subsets of the $\{Y_i\}$ and thus are independent.

For the third term we have

$$\sum_{i=1}^{m} W_i^2 \, E[(\bar{Y}_w - \mu)^2]$$

$$= \sum_{i=1}^{m} W_i^2 \, E[(\sum_{j=1} W_j \, Y_j / \sum_{j=1}^{m} W_j - \mu)^2]$$

$$= \sum_{i=1}^{m} W_i^2 \, E[\Sigma \, W_i^2 \, (Y_i - \mu)^2]/n^2$$

$$= \sum_{i=1}^{m} W_i^2 \sum_{j=1}^{m} W_j^2 \, \mathrm{Var}[Y_i]/n^2$$

$$= \sigma_1^2 \sum_{i=1}^{m} W_i^2/n + \sigma_m^2 \, (\sum_{i=1}^{m} W_i^2)^2/n^2 \qquad (C.4)$$

Substituting the results in equations (C.2 - C.4) into equation (C.1) and dividing by (n-1) we obtain

$$E[S_w^2] = n \, \sigma_1^2 \, (1 - \sum_{i=1}^{m} W_i^2/n^2) \, / \, (n-1)$$

$$+ \sigma_m^2 \, (\sum_{i=1}^{m} W_i^2 - 2 \, (\sum_{i=1}^{m} W_i^2)^2 \, / \, n^2 + \sum_{i=1}^{m} W_i^3 \, / \, n^2) \, (n-1) \qquad (C.5)$$

For the case of no compositing, $w_i = 1$ and $m = n$, equation (C.5) reduces to

$$E[S_w^2] = \sigma_I^2 + \sigma_m^2 = E[S^2] = \sigma^2$$

Hence, the bias resulting from using S_w^2 to estimate σ^2 depends on the w_i and σ_I^2 and σ_m^2. Using the surrogate recovery data, an independent estimate of σ_m^2, denoted by S_m^2 can be obtained. If $E[S_m^2] = \sigma_m^2$ then it is not difficult to show that

$$S_I^2 = \{S_w^2 - S_m^2 \left(\sum_{i=1}^{m} W_i^2 - 2 \left(\sum_{i=1}^{m} W_i^2\right)^2/n^2 + \sum_{i=1}^{m} W_i^2/n^2\right)/n-1)\}$$

$$\{n \left(1 - \sum_{i=1}^{m} W_i^2/n^2\right)/n-1\}^{-1}$$

is an unbiased estimator of σ_I^2. That is $E[S_I^2] = \sigma_I^2$. Hence $S^2 = S_I^2 + S_m^2$ is an unbiased estimator of $\sigma^2 = \sigma_I^2 + \sigma_m^2$.

APPENDIX D

COAL COMBUSTION SAMPLING FRAME

STATE=1

OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
1	COLBERT STEAM PLANT TVA CHATT TENN 37401	800	ALABAMA	0010	5
2	ALA ELEC COOPERATIVE US HWY 29 GANTT3642	880	ALABAMA	0001	3
3	ALA. POWER GADSDEN GOODYEAR AVE. GADSDEN	1200	ALABAMA	0002	1
4	ALA POWER-GREENE COUNTY P O DRAWR P36732	1600	ALABAMA	0001	2
5	WIDOWS CREEK STEAM PLANT	1920	ALABAMA	0008	6
6	ALA POWER CO J H MILLER STA	1980	ALABAMA	F001	1
7	US PIPE & FOUNDRY 3500 35TH AV N	1980	ALABAMA	0350	3
8	ALABAMA POWER CO BARRY STEAM PLANT	2400	ALABAMA	1001	5
9	ALA POWER CO VIADUCT ROAD CHICKASAW	2400	ALABAMA	1002	1
10	ALA POWER CO E.C.GASTON WILSONVILLE35186	3060	ALABAMA	0005	5
11	ALABAMA POWER,GORGAS;ROUTE 2,BOX11 35580	3390	ALABAMA	0001	7
12	ALABAMA ELECTRIC COOPERATIVE LEROY 36548	3400	ALABAMA	0001	1

STATE=2

OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
13	AAC/DEMUM ELMENDORF AFB AK 99506	180	ALASKA	0001	1
14	MUNICIPAL UTILITIES SYS 645 5TH AVE99707	180	ALASKA	0002	1
15	HQ,US ARMY ALASKA ARAEN-I APOSEA WA98749	180	ALASKA	0004	1
16	GOLDEN VALLEY E ASSN BOX1249 FAI AK99707	620	ALASKA	0001	1
17	CLEAR MEWS USAF 13 MWS ADC SEATTLE98104	620	ALASKA	0005	1

STATE=3

OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
18	NAVAJO STEAM GEN PLANT SRP PO BOX W PA	200	ARIZONA	0004	3
19	ARIZ PUB SER CO CHOLLA STA JOSEPH CITY	520	ARIZONA	0001	1

STATE=4

OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
20	SOUTHWESTERN ELECT.POWER,GENTRY 040107	160	ARKANSAS	0004	1
21	ARKANSAS P&L, INDEPENDENCE, NEWARK320042	1200	ARKANSAS	0007	2
22	ARK.POWER & LIGHT CO,WHITE BLUFF 350110	1280	ARKANSAS	0011	2

STATE=6

OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
23	PUBLIC SERVICE CO 6198 FRANKLIN ST DEN C	20	COLORADO	0001	4
24	PUBLIC SERVICE CO VALMONT 1792 N 63RD B	220	COLORADO	0001	1
25	PUBLIC SERVICE CO ARAPAHOE 2601 S PLATT	600	COLORADO	0002	4
26	DEPARTMENT OF PUBLIC UTILITIES DRAKE PL	760	COLORADO	0004	3
27	SOUTHERN COLO POWER DIV W HWY 50 CANON C	860	COLORADO	0003	2
28	PUBLIC SERVICE CO OF COLO CAMEO PLANT	1520	COLORADO	0002	1
29	COLORADO-UTE ELEC ASSN NUCLA COLO	1640	COLORADO	0001	3
30	COLORADO-UTE JIM BULLOCK PLANT MONTROSE	1640	COLORADO	0008	2
31	PUBLIC SERVICE CO COMANCHE STN STA PUEB	1840	COLORADO	0003	2
32	COLORADO-UTE ELECT ASSOC HAYDEN COLO	1920	COLORADO	0001	2

STATE=7

OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
33	PIERCE GENERATING STATI100 JOHN WALLIGFD	705	CONNECTICUT	6614	3

STATE=8

OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
34	DELMARVA POWER INDIAN RIVER MILLSBORO	240	DELAWARE	0001	3
35	E I DUPONT NYLON PLT SEAFORD 19973	240	DELAWARE	0002	1

STATE=10

OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
36	GULF POWER CO ST RD 391 LYNN HAVEN	200	FLORIDA	0014	2
37	FLA POWER CORP RED LEVEL FLA.	580	FLORIDA	0004	1
38	GULF POWER CO CRIST PLANT PENSACOLA	1160	FLORIDA	0045	4
39	SIG PEND TECO BOX TE111 TAMPA FLORIDA	1800	FLORIDA	0074	1
40	GULF POWER CO ST RD 271 SNEADS	1940	FLORIDA	0014	2
41	CITY OF NEW SMYRNA BCH BOX 519 32069	4600	FLORIDA	0003	1

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OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
42	GA POWER CO-BOWEN TAYLORSVILLE 30178	380	GEORGIA	0011	3
43	GEORGIA KRAFT COMPANY POY 3215	460	GEORGIA	0001	2
44	GA POWER CO-ARKWRIGHTMACON 31208	460	GEORGIA	0002	4
45	GA POWER CO-MCDONOUGH SMYRNA 30080	1160	GEORGIA	0003	2
46	GA PWR-YATES BX718 NEWNAN 30263.	1420	GEORGIA	0001	7
47	GA POWER CO-MITCHELL ALBANY 31701	1760	GEORGIA	0002	3
48	GREAT SOUTHERN PAPER CO	1860	GEORGIA	0001	2
49	GA POWER CO-HAMMOND COOSA 30129	2140	GEORGIA	0003	4
50	GA. POWER CO-PLANT WANSLEY,ROOPVILLE	2720	GEORGIA	0001	1

STATE=11

OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
51	GA POWER CO-BRANCH MILLEDGEVILLE 31061	4220	GEORGIA	0009	4
52	CRISP CO POWER COMM WARWICK 31796	5660	GEORGIA	0004	1

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OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
53	COM ED - KINCAID GEN4 MI. W. OF KINCAID	1320	ILLINOIS	0013	1
54	WINNETKA ELECTRIC PL725-735 TOWER RD	1540	ILLINOIS	0168	1
55	COM ED - CRAWFORD ST3501 S. PULASKI ROAD	1540	ILLINOIS	0212	2
56	COM ED - FISK STATIO1111 W. CERMAK	1540	ILLINOIS	0219	1
57	CENTRAL ILLINOIS PUBRURAL	1600	ILLINOIS	0002	2
58	CENTRAL ILLINOIS LIGDUCK CREEK GEN	2680	ILLINOIS	0003	1
59	CENTRAL ILLINOIS PUBRURAL GRAND TOWER	3580	ILLINOIS	0005	3
60	CENTRAL ILLINOIS PUB	3620	ILLINOIS	0004	1
61	COM ED - WAUKEGAN ST2800 NORTHWESTERN AV	4000	ILLINOIS	0015	4
62	CITY OF PERU GENERAT1415 WATER STREET	4100	ILLINOIS	0011	1
63	COMMONWEALTH ED CO DIXON STA	4200	ILLINOIS	P001	1
64	ILLINOIS POWER CO-WOP.O.BOX 151	4680	ILLINOIS	0009	2
65	UNION ELECTRIC - VENMAIN ST & MCKINLEY B	4680	ILLINOIS	0030	1
66	ILLINOIS POWER CO - ILLINOIS HIGHWAY 78	4880	ILLINOIS	0004	1
67	ELECTRIC ENERGY,INC.P.O.BOX 165	4900	ILLINOIS	0006	8
68	CENTRAL ILLINOIS PUBRURAL COFFEEN	5200	ILLINOIS	0007	11
69	CENTRAL ILLINOIS PUB1 WATERFRONT	5240	ILLINOIS	0005	3
70	CENTRAL ILLINOIS LIGRURAL BARTONVILLE	6100	ILLINOIS	0025	6
71	WESTERN ILLINOIS POWHWY 100 SOUTH	6220	ILLINOIS	0007	1
72	ILLINOIS POWER CO - P. O. BOX 188	6420	ILLINOIS	0001	2
73	ILLINOIS POWER CO BAP.O. BOX 146	6460	ILLINOIS	0008	2
74	CITY WATER LIGHT & P3100 STEVENSON DRIVE	6980	ILLINOIS	0002	7
75	CITY WATER LIGHT & PEACTORY AND GRIFFITH	6980	ILLINOIS	0006	1
76	CENTRAL ILLINOIS LIG1126 WEST CAMP ST.	7600	ILLINOIS	0007	4
77	COM ED - POWERTON STBOX 158	7600	ILLINOIS	0018	3
78	ILLINOIS POWER CO - P O BOX 257	7780	ILLINOIS	0023	2
79	MT. CARMEL PUBLIC UTCITY OF	7940	ILLINOIS	0001	1
80	FAIRFIED MUNICIPAL LNW 6TH STREET	8040	ILLINOIS	0001	1
81	COM ED - JOLIET STATPATTERSON ROAD	8320	ILLINOIS	0038	5
82	COM ED - WILL COUNTY135TH ST CHICAGO SAN	8320	ILLINOIS	0048	5
83	SOUTHERN ILLINOIS POPOWER PLANT-LAKE OF	8340	ILLINOIS	0003	4

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OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
84	LAWTON PARK GEN STA 1902N CLINTON 46802	60	INDIANA	0001	4
85	LOGANSPORT ELEC L&P 85TH & BRINGHURST	600	INDIANA	0006	2
86	FRANKFORT CTY L&P 758 WSHINGTON AV	780	INDIANA	0001	3
87	IND & MICH ELEC TANNERS CREEK STA L*PURG	1000	INDIANA	0002	4
88	JASPER MUN ELEC E15 ST JASPER 47546	1120	INDIANA	0002	1
89	PUB SERV CO OF IND GALLAGHER STA N.ALB.	1360	INDIANA	0004	4
90	PUBLIC SERVICE INDIANA GIBSON STATION	1560	INDIANA	0013	4

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CPS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
91	PSI-NORLSVLLE GEN STA,RR2 BOX 35A, 46060	1760	INDIANA	0004	3
92	NIPSCO R.M.SCHAHFER STA RR#1 BOX66 46392	2100	INDIANA	0009	2
93	CLIFTY CREEK IKEC BOX 97 HWY 56 & 62 MAD	2140	INDIANA	0001	6
94	EDWDSPORT STA PSI RR 1 EDWARDSPORT 47528	2260	INDIANA	0003	3
95	NORTHERN INDIANA PUBLIC SERVICE COMPANY-	2360	INDIANA	0032	4
96	COM ED STATELINE GEN 103RD & LK MICHIGAN	2360	INDIANA	0035	11
97	MICHIGAN CITY-NIPSCO	2400	INDIANA	0021	4
98	DELCO REMY PLANT #1	2600	INDIANA	0003	1
99	DELCO REMY PLANT #3	2600	INDIANA	0016	3
100	INDPLIS P&L-STOUT STA 3700S HARDIN46206	2640	INDIANA	0033	5
101	INDPLIS PWR & L.PERRY-K STA. 336 KY AVE	2640	INDIANA	0034	6
102	INDPLS PWR&L PERRY W STA,744 WASHNGTN AV	2640	INDIANA	0035	2
103	PERU ELEC L&P 301 E CANAL ST 46970	2720	INDIANA	0001	3
104	CRWFDSVLLE EL&P PO 428 CRAWFDSVLLE 47933	2820	INDIANA	0003	3
105	INDPLS P&L CO PRITCHARD	2880	INDIANA	0004	6
106	HOOSIER EN DIV-IND REC PETERSBURG 47567	3340	INDIANA	0001	2
107	INDIANAPOLIS P&L CO PETERSBURG 47567	3340	INDIANA	0002	4
108	BAILLY GENERATING STA RR3 POX 246 46304	3420	INDIANA	0002	2
109	RUSHVILLE STA PSI PO 311 RUSHVILLE 46173	3660	INDIANA	0003	1
110	I&M ELECT-BREED STA BX568 SULLIVAN 47882	4020	INDIANA	0001	1
111	CAYUGA GEN STA PSI PO 188 CAYUGA 47928	4240	INDIANA	0001	2
112	CRESSER STA PSI PO 359 TERRE HAUTE 47808	4260	INDIANA	0006	7
113	PUBLIC SERVICE WABASH STATION	4260	INDIANA	0021	6
114	SI G&E CULLEY STA NEWBURGH 47630 BX 218	4360	INDIANA	0001	3
115	ALCOA GENERATING CORP	4360	INDIANA	0002	2
116	RICHMOND POWER & LIGHT CO	4440	INDIANA	0009	2

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CPS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
117	INT.POWER,1000 MAIN ST., DUBUQUE, 52001	100	IOWA	0005	5
118	CEDAR FALLS UTILITIES	340	IOWA	0010	2
119	IA PUBLIC SERV CO MAYNARD PLT WATERLOO	340	IOWA	0070	4
120	IOWA ELECTRIC BOONE	400	IOWA	0040	2
121	IA PUB SERVICE CO HAWKEYE PLT STORM LAKE	460	IOWA	0025	1
122	IA PUB SERVICE CO CARROLL PLT CARROLL	560	IOWA	0015	1
123	CORN BELT POWER COOP WISDOM STA SPENCER	860	IOWA	0010	1
124	E.J.DUPONT DE NEMOURS,CLINTON	940	IOWA	0055	1
125	INTERSTATE POWER CO, CLINTON	940	IOWA	0075	3
126	IA SO UTIL BURLINGTON STA BURLINGTON	1200	IOWA	0025	1
127	INTERSTATE POWER CO.	1280	IOWA	0060	3
128	WEBSTER CITY PWR.MUN BLDG WEBSTER CITY	1700	IOWA	0020	1
129	IA ELEC LGT & POW IA FLS STA IOWA FALLS	1760	IOWA	0030	1
130	CORN BELT POW COOP 1300 13TH N HUMBOLDT	1900	IOWA	0010	4
131	UNIVERSITY OF IOWA, IOWA CITY	2120	IOWA	0060	2
132	CENT IA POWER COOP PRAIRIE CRK.C.RAPIDS	2280	IOWA	0050	2
133	IA ELEC LGT + POW PRAIR CRK CEDAR RAPIDS	2280	IOWA	0120	1
134	IA LGT + POWER 5TH ST STA CEDAR RAPIDS	2280	IOWA	0125	5
135	PELLA MUNICIPAL PELLA	2460	IOWA	0030	2
136	IOWA-ELECTRIC MARSHALLTOWN	2480	IOWA	0090	2

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OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
137	S IA LGT*&*POW*COOP*MONTPELIER**********	2740	IOWA	0020	2
138	MUSCATINE PWR.700 MAPLE GROVE,MUSCATINE	2740	IOWA	0055	4
139	IA. POWER & LIGHT CO.. 3392 SE 46. DES M	3120	IOWA	0380	6
140	IA POWER & LIGHT BOX 128 COUNCIL BLUFFS	3140	IOWA	0115	3
141	IA-ILL GAS + ELEC RIVERSIDE PLT BETTNDRF	3280	IOWA	0090	9
142	AMES MUNICIPAL ELECTRIC	3480	IOWA	0015	3
143	IOWA STATE AMES	3480	IOWA	0080	6
144	CENTRAL IOWA POWER COOP	3600	IOWA	0005	3
145	IA.SO.UTILITIES.PRIDGEPORT STA,EDDYVILLE	3680	IOWA	0025	2
146	IOWA PUBLIC SERVICE CO. SARGEANT BLUFF	4020	IOWA	0190	3
147	IA.PUB.SERVICE.EAGLE GROVE PLT,EAGLE GRV	4060	IOWA	0015	1

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OBS	PLNMAD		COUNTY	STNAME	PLANT	POINTS
148	EMPIRE DISTRICT ELEC CO RIVERTON		440	KANSAS	0002	2
149	KS POWER&LIGHT LAWRENCE GENERATING STN		860	KANSAS	0014	4
150	KANSAS GAS*ELEC,NEOSHO PLANT		1900	KANSAS	0001	1
151	KC POWER&LIGHT LACYGNE		2100	KANSAS	0005	1
152	KS POWER&LIGHT JEFFREY ENERGY CEN BELVUE		2960	KANSAS	0001	4
153	KS POWER&LIGHT TECUMSEH GENERATING STN		3380	KANSAS	0030	2
154	BOARD OF PUBLIC UTILITIES NEARMAN CREEK		3840	KANSAS	0008	1
155	BOARD OF PUBLIC UTIL,QUINDARO #3	66101	3840	KANSAS	0048	2
156	BOARD OF PUBLIC UTL,KAW STA	66101	3840	KANSAS	0049	3
157	BOARD OF PUBLIC UTIL,QUINDARO #2	66101	3840	KANSAS	0050	3

STATE=18

OBS	PLNMAD		COUNTY	STNAME	PLANT	POINTS
158	KY. UTILITIES-PINEVILLE PINEVILLE-FOUR		200	KENTUCKY	0001	1
159	CINCINNATI GAS & ELECTRICCINN OHIO 45201		280	KENTUCKY	0029	1
160	KENTUCKY UTILITIES CO. GHENT		580	KENTUCKY	0010	4
161	E.KY.RURAL ELECTRIC-DALE DALE STATIO		720	KENTUCKY	0003	4
162	C.M.U. STATION NO. 1 1531 EAST F		920	KENTUCKY	0026	4
163	C.M.U. ELMER SMITH 4301 HARDIN		920	KENTUCKY	0027	2
164	BIG RIVERS ELEC.-COLEMAN COLEMAN-HAW		1560	KENTUCKY	0003	3
165	HEND. MUNIC. POW & LIGHT SAME		1760	KENTUCKY	0012	2
166	LOUISVILLE GAS & ELECTRICPADDYS RUN		1920	KENTUCKY	0125	5
167	LOUISVILLE GAS & ELECTRICCANE RUN		1920	KENTUCKY	0126	6
168	LOUISVILLE GAS & ELECTRICMILL CREEK STAT		1920	KENTUCKY	0127	4
169	KY POWER-BIG SANDY 6 MI N LOUISA O		2140	KENTUCKY	0003	2
170	TVA -SHAWNEE PLANT *		2460	KENTUCKY	0006	10
171	E KY POWER COOP MAYSVILLE		2640	KENTUCKY	0009	2
172	KY.UTILITIES-BROWN STA. P.O.BOX 355 BUR		2740	KENTUCKY	0001	3
173	KENTUCKY UTILITIES COMPANCENTRAL CITY FA		2960	KENTUCKY	0001	4
174	TVA -PARADISE PLANT 5 MI NE DRA		2960	KENTUCKY	0006	3
175	E.KY.POWER COOP.-COOPER BURNSIDE		3460	KENTUCKY	0005	2
176	BIG RIVERS ELECTRIC CORP.REID STATION		4020	KENTUCKY	0001	5

STATE=18

OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
177	KY. UTILITIES -TYRONE BOX 48 VERS	4140	KENTUCKY	0001	1

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OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
178	CAJUN ELECTRIC POWER BIG CAJUN NO 2	2260	LOUISIANA	0005	2
179	CENTRAL LA ELEC PTE 1 LENA 71447 (BOYCE)	2360	LOUISIANA	0010	1

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OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
180	PG+E WAGNER PT SMALLWD RD 5 OF HWKNS PT	80	MARYLAND	0004	1
181	PEPCO MORGANTOWN NEWBURG 20664	440	MARYLAND	0004	2
182	PEPCO DICKERSON STATION KICKERSON 20753	1160	MARYLAND	0008	3
183	PEPCO CHALK POINT PLANT AQUASCO	1300	MARYLAND	0007	2
184	POTOMAC EDISON WILLIAMSPORT 21795	1680	MARYLAND	0010	2

STATE=22

OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
185	MASS ELECTRIC-WEBSTER 59 WEBSTER WORCSTR	369	MASSACHUSETTS	0113	1
186	HOLY WATER POWER.MT TOM PLANT .HOLYOKE	1798	MASSACHUSETTS	0040	1
187	WESTERN MASS ELECT WST SPRINGFIELD	1798	MASSACHUSETTS	0117	3

STATE=23

OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
188	JOHN WARDEN STATION 49946	340	MICHIGAN	0001	1
189	D E KARN PLANT 2555 N MEADOCK HWY 48732	400	MICHIGAN	0011	2
190	J C MEADOCK PLANT 2555 N MEADOCK HWY	400	MICHIGAN	0012	2
191	CONSUMERS POW.ELM ST.PLT BOX 279 49017	760	MICHIGAN	0015	1
192	NORTHERN MICHIGAN ELEC COOP 1950 E DIVIS	860	MICHIGAN	0007	3
193	LANSING BD OF WATER & LIGHT 3725 SOUTH C	1340	MICHIGAN	0007	1
194	JOHN H WARDEN STATION 616 SHELDEN AVENUE	2240	MICHIGAN	0005	1
195	HARBOR BEACH 755 NORTH HURON 48441	2340	MICHIGAN	0001	1
196	MICHIGAN SUGAR COMPANY FESEWAING MI	2340	MICHIGAN	0002	1
197	LANSING BOARD WAT & LGT ECKERT PLT 48903	2360	MICHIGAN	0008	4
198	ECKERT & MOORES PARK STATION ISLAND AVEN	2360	MICHIGAN	0018	4
199	PRESQUE ISLE STATION PRESQUE ISLE DR	3280	MICHIGAN	0011	5
200	MONROE POWER PLANT 3500 E FRONT ST 48161	3600	MICHIGAN	0023	4
201	J R WHITING PLANT 4525 ERIE ROAD 48157	3600	MICHIGAN	0024	3
202	E C COBB PLANT 151 NORTH CAUSEWAY 49440	3760	MICHIGAN	0024	5
203	J H CAMPBELL PLANT 16900 POLK STREET	4160	MICHIGAN	0004	2
204	HOLLAND BD OF PUBLIC WORKS CITY HALL	4160	MICHIGAN	0016	3

STATE=23

OBS	PLNMAD		COUNTY	STNAME	PLANT	POINTS
205	DETROIT EDISON MARYSVILLE 301 GRATIOT		4620	MICHIGAN	0010	4
206	DETROIT EDISON ST CLAIR 4901 POINTE DR		4620	MICHIGAN	0011	6
207	DETROIT EDISON PORT HURON 1705 WASHINGTO		4620	MICHIGAN	0020	1
208	MICHIGAN SUGAR CO CARO MI		4780	MICHIGAN	0010	2
209	PENNSALT 4655 RIDDLE AVE	48192	5320	MICHIGAN	0094	2
210	WYANDOTTE NORTH 60 MULBERRY ST	48192	5320	MICHIGAN	0097	4
211	MISTERSKY POWER STATION 5425 JEFFERSON W		5320	MICHIGAN	0166	2
212	RIVER ROUGE 1 BELANGER PARK DRIVE	48218	5320	MICHIGAN	0172	1
213	TRENTON CHANNEL 4695 JEFFERSON W	48183	5320	MICHIGAN	0173	5
214	CONNERS CREEK 200 LYCASTE	48214	5320	MICHIGAN	0174	4

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OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
215	OTTERTAIL POWER CO ORTONVILLE PLANT	320	MINNESOTA	0002	1
216	NORTHERN STATES POWER COWILMARTH SITE,MA	400	MINNESOTA	0015	2
217	NORTHERN STATES POWER COGRANITE FALLS SI	640	MINNESOTA	0012	1
218	NORTHERN STATES POWER COBURNSVILLE SITE	940	MINNESOTA	0003	5
219	NORTHERN STATES POWER CORED WING PLANT	1380	MINNESOTA	0005	2
220	NORTHERN STATES POWER MARSHALL SITE	1480	MINNESOTA	0015	3
221	MINNESOTA POWER + LIGHT COMASSET SITE	1660	MINNESOTA	0004	3
222	MUNICIPAL UTILITIES COMMWILLMAR SITE	1740	MINNESOTA	0005	6
223	TWO HARBORS WATER + LITES AVE AND 1ST	1840	MINNESOTA	0002	2
224	RESERVE MINING COMPANY SILVER BAY SITE	1840	MINNESOTA	0003	2
225	INTERSTATE POWER COMPANYFOX LAKE STATION	2180	MINNESOTA	0007	2
226	PUBLIC UTILITIES COMM. FAIRMONT SITE	2180	MINNESOTA	0009	2
227	AUSTIN UTILITIES NE AUSTIN SITE	2420	MINNESOTA	0001	1
228	WORTHINGTON MUNICIPAL U.WORTHINGTON SITE	2560	MINNESOTA	0004	1
229	ROCHESTER PUBLIC UTILITYBROADWAY SITE RO	2660	MINNESOTA	0001	2
230	ROCHESTER PUBLIC UTILITYSILVER LAKE PLAN	2660	MINNESOTA	0011	4
231	OTTERTAIL POWER CO HOOTLAKE PLANT	2720	MINNESOTA	0002	1
232	NORTHERN STATES POWER COSHEPARD ROAD SIT	2940	MINNESOTA	0012	6
233	NORTHERN STATES POWER COTHIRD STREET PLA	2940	MINNESOTA	0063	6
234	MINNESOTA POWER+LIGHT COAURORA STATION	3260	MINNESOTA	0013	2
235	DULUTH STEAM COOP. ASSN.DULUTH SITE	3260	MINNESOTA	0022	4
236	HIBBING PUBLIC UTILITY	3260	MINNESOTA	0027	3
237	DEPT. OF PUBLIC UTILITY VIRGINIA SITE	3260	MINNESOTA	0028	5
238	UNITED POWER ASSOCIATIONELK RIVER SITE	3440	MINNESOTA	0003	3
239	NORTHERN STATES POWER COSHERCO PLANT/REC	3440	MINNESOTA	0004	2
240	NORTHERN STATES POWER COOAK PARK HEIGHTS	4900	MINNESOTA	0005	1
241	NORTHERN STATES POWER COMINNESOTA VALLEY	4260	MINNESOTA	0009	4

STATE=25

OBS	PLNMAD		COUNTY	STNAME	PLANT	POINTS
242	MISSISSIPPI PWR CO-WATSON	(DUMMY)	1020	MISSISSIPPI	P001	3
243	SO MISS ELEC PWR PURVIS/MORROW STA	(DUMY	1440	MISSISSIPPI	P001	1
244	GREENWOOD UTIL HENDERSON STA P O BOX 896		1560	MISSISSIPPI	P001	2

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OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
245	COLUMBIA WATER & LIGHT/P.O. BOX N/COLUMB	380	MISSOURI	0002	2
246	UNIVERSITY OF-MO. POWER PLANT/110 GENERA	380	MISSOURI	0004	4
247	ST. JOSEPH P&L-LAKE ROAD PLANT/520 FRANC	520	MISSOURI	0004	3
248	MO PUB SERV CO PLEASANT HILL RLR 1	840	MISSOURI	0003	1
249	UNION ELEC,BX 149,LABADIE PLT,ST LOUIS	1680	MISSOURI	0003	4
250	SPRINGFIELD UTILITIES/JAMES RIVER POWER	1860	MISSOURI	0005	5
251	SPRINGFIELD UTILITIES/SOUTHWEST PLANT/SP	1860	MISSOURI	0039	1
252	K. C. POWER & LIGHT, MONTROSE PLANT	2020	MISSOURI	0001	3
253	KCPL. 115 GRAND AVE. K.C.	2240	MISSOURI	0021	4
254	KCPL. 8700 HAWTHORN K.C.	2240	MISSOURI	0022	2
255	MO.PUB.SERV.CO. SIBLEY 10700 EAST 50 HWY	2240	MISSOURI	0031	2
256	INDEP. P&L/21500 E.TRUMAN RD/INDEPENDENC	2240	MISSOURI	0050	3
257	EMPIRE DIST ELECT CO. ASBURY PLNT JOPLIN	2260	MISSOURI	0001	1
258	UNION ELECTRIC, RUSH ISLAND	2280	MISSOURI	0016	2
259	ASSOCIATED ELECTRIC POWER COOP.,NEW MADR	3300	MISSOURI	0004	1
260	CENTRAL ELECT PWR COOP, CHAMOIS	3480	MISSOURI	0002	2
261	KANSAS CITY POWER & LIGHT CO./ST. JOSE&H	3740	MISSOURI	0007	1
262	ASSOC ELE. COOP/THOMAS HILL PLNT/BX 158/	3920	MISSOURI	0001	2
263	UNION ELECTRIC,SIOUX PLT, HWY 94,W.ALTON	4160	MISSOURI	0001	2
264	UNION ELEC 8200 PINE RD. MERAMEC PLANT	4300	MISSOURI	0010	4

STATE=27

OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
265	MONTANA-DAKOTA UTIL, HWY 23, SIDNEY	1320	MONTANA	0003	1
266	MONTANA POWER CO COLSTRIP UNIT #1	1360	MONTANA	P001	1
267	MONT POWER(CORETTE)B 2536,BILLINGS 59103	1720	MONTANA	0015	1

STATE=28

OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
268	ELECTROSTATIC PRECIPITATOR 6-1-76	780	NEBRASKA	0002	5
269	NEBR PUBLIC PWR DIST SHELDON STA	1520	NEBRASKA	0005	2
270	LINCOLN ELEC SYS LINCOLN STA	1520	NEBRASKA	0007	2
271	NEBR PUBLIC POWER BELLEVUE NE	2180	NEBRASKA	0002	4

STATE=29

OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
272	MOHAVE GEN STA LAUGHLIN NV 89046	80	NEVADA	0001	2
273	NEVADA POWER CO GARDNER STA	80	NEVADA	0006	3
274	SIERRA PACIFIC PO BOX 10100 RENO 89510	280	NEVADA	0007	2

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OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
275	PUB SERV CO OF NH-MERRIMACK PL,POW 03301	440	NEW HAMPSHIRE	0026	2

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OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
276	ATLANTIC CTY ELEC ATL CTY 08404	80	NEW JERSEY	0002	2
277	ATL CITY ELEC MARMORA 08223	780	NEW JERSEY	0001	2
278	VINELAND MUNICIPAL ELEC UTIL WEST &PLUMM	1050	NEW JERSEY	0020	1
279	PUB SERV ELEC-HUDSON STA,JERSEY CY,07306	2240	NEW JERSEY	0021	1
280	JERSEY CENTRAL POWER & LIGHT GILBERT ST	2260	NEW JERSEY	0001	3
281	PUB SER ELEC LAMBERT RD TRENTON 08608	2980	NEW JERSEY	0001	2

STATE=32

OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
282	RATON PUB SERV CO, RATON	260	NEW MEXICO	0001	1
283	ARIZ PUB SERV CO. FOUR CORNERS	1000	NEW MEXICO	0002	5
284	PUBLIC SERV CO OF NM BOX 2267 ALB 87103	1000	NEW MEXICO	0035	3

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OBS	PLNMAD			COUNTY	STNAME	PLANT	POINTS
285	GOUDEY STA	NY ROUTE 201	JOHNSON	640	NEW YORK	0292	1
286	NIAGARA MOHAWK	DUNKIRK STEAM S	DUNKIRK	1000	NEW YORK	0325	3
287	JAMESTOWN POWER	136 STEELE ST	JAMESTOW	1000	NEW YORK	0340	2
288	JENNISON STA	RT #7	BAINBRID	1080	NEW YORK	0083	2
289	C R HUNTLEY STE	RIVER ROAD	TONAWAND	2000	NEW YORK	1700	2
290	RG&E #3(EEEPEE)	254 MILL ST	ROCHESTE	4380	NEW YORK	1152	1
291	RG&E #7 (RUSSEL	1101 BEACH AVE	ROCHESTE	4380	NEW YORK	1752	2
292	CONSOL ED CO OF	NY INC RAVENSWOOD	11101	5660	NEW YORK	0002	2
293	CONSOL ED CO OF	NY INC ASTORIA	11105	5660	NEW YORK	0003	5
294	CONCOL ED CO OF	NY INC ARTHUR KILL	10314	5720	NEW YORK	0001	2
295	N Y S GAS AND E	RTE	E COPNIN	6500	NEW YORK	0110	2
296	MILLIKEN STA	RD #1	LUDLOWVI	6720	NEW YORK	0120	2
297	GREENIDGE STA	GREENIDGE STA	DRESDEN	7600	NEW YORK	0028	4

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OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
298	CARCLINA POWER & LIGHT CO SKYLAND	480	NORTH CAROLINA	0033	2
299	DUKE POWER CO MARSHALL PLT TERRELL	660	NORTH CAROLINA	0073	4
300	CP&L CAPE FEAR PLT BX 161 MONCURE	720	NORTH CAROLINA	0019	4
301	DUKE POWER COMPANY ALLEN STA BELMONT	1560	NORTH CAROLINA	0335	5
302	DUKE POWER CO RIVERBEND STA MT HOLLY	1560	NORTH CAROLINA	0336	7
303	CAROLINA POWER & LIGHT CO L V SUTTON PLT	2880	NORTH CAROLINA	0036	3
304	CP&L ROXBORO PLT SR 1377 ROXBORO	3140	NORTH CAROLINA	0029	4
305	CP&L WEATHERSPOON PLT BX 231 LUMBERTON	3380	NORTH CAROLINA	0147	3
306	DUKE POWER CO DAN RIVER STA EDENTON	3420	NORTH CAROLINA	0015	2
307	DUKE POWER CO BUCK STA BX 25 SPENCER	3460	NORTH CAROLINA	0004	4
308	DUKE POWER CO CLIFFSIDE STA CLIFFSIDE	3500	NORTH CAROLINA	0028	5
309	DUKE POWER BELEWS CREEK STA WALNUT COVE	3940	NORTH CAROLINA	0004	2
310	C P & L H F LEE PLT QUAKER NECK RD GOLDS	4280	NORTH CAROLINA	0017	3

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OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
311	BASIN ELECTRIC W J NEAL STATION VELVA ND	660	NORTH DAKOTA	0001	2
312	LELAND OLDS STATION,BOX A STANTON ND	760	NORTH DAKOTA	0001	2
313	MDU BEULAH PLANT, BEULAH NORTH DAKOTA	760	NORTH DAKOTA	0002	2
314	UNITED POWER ASSOCIATION STANTON ND	760	NORTH DAKOTA	0004	1
315	MONTANA DAKOTA UTILITIES MANDAN NORTH D	800	NORTH DAKOTA	0001	2
316	MINNKOTA POWER COOPERATIVE CENTER N D	860	NORTH DAKOTA	0001	1
317	OTTER TAIL POWER CO WAHPETON ND	980	NORTH DAKOTA	0003	2
318	OTTER TAIL POWR CO JAMESTOWN ND	1180	NORTH DAKOTA	0004	1

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OBS	PLNMAD		COUNTY	STNAME	PLANT	POINTS
319	JAMES M STUART ELEC GENERATING STA	45101	40	OHIO	5001	4
320	CLEVELAND ELECTRIC & ILLUMINATING	44004	220	OHIO	5001	4
321	CLEVE ELEC ILLUM CO ASHTABULA PLAN	44004	220	OHIO	5002	1
322	COLS & S OHIO ELEC CO POSTON STATI	45701	260	OHIO	5001	4
323	CITY OF ST. MARYS PLANT	45885	290	OHIO	5004	1
324	OHIO EDISON COMPANY R E BURGER PLA	43947	540	OHIO	5002	8
325	MUNICIPAL POWER PLANT	45011	900	OHIO	5009	2
326	OHIO EDISON CO MAD RIVER PLANT	45502	1260	OHIO	5008	4
327	C G AND E W C BECKJORD STA	45157	1280	OHIO	5001	6
328	OHIO EDISON-E PALESTINE STEAM ELEC	44413	1440	OHIO	5003	1
329	CONESVL GENERATNG STA C & S OHIO E	43811	1520	OHIO	5001	6
330	DIV OF LIGHT AND POWER	44114	1600	OHIO	5006	5
331	CLEV ELEC ILLUM CO LAKE SHORE PLAN	44103	1600	OHIO	5017	1
332	KYGER CREEK PLANT OHIO VALLEY ELEC	45620	2320	OHIO	5001	5
333	GEN. JAMES M. GAVIN	45631	2320	OHIO	5002	2
334	MIAMI FORT STATION	45052	2720	OHIO	5052	7
335	MUNICIPAL LIGHT PLANT	43545	2820	OHIO	5008	1
336	OHIO EDISON POWER PLANT	44857	3020	OHIO	5003	3
337	CARDINAL OPERATING COMPANY	43913	3160	OHIO	5002	2

STATE=36

OBS	PLNMAD		COUNTY	STNAME	PLANT	POINTS
338	OHIO POWER COMPANY - TIDD PLANT	43913	3160	OHIO	5003	3
339	PAINESVILLE MUNICIPAL ELECTRIC PLA	44077	3280	OHIO	5007	7
340	CLEVELAND ELEC ILLUM CO EAST LAKE	44094	3280	OHIO	5012	6
341	CLEVELAND ELEC ILLUM CO AVON LAKE	44012	3640	OHIO	5001	4
342	OHIO EDISON - EDGWATER	44052	3640	OHIO	5003	3
343	TOLEDO EDISON CO, ACME STATION	43605	3720	OHIO	5017	6
344	TOLEDO EDISON CO, BAY SHORE STATIO	43616	3720	OHIO	5045	4
345	OHIO EDISON CO - N AVE PLT	44502	3820	OHIO	5014	4
346	CELINA MUNCIPAL UTILITIES	45822	4240	OHIO	5004	1
347	DAYTN PWR & LT CO F M TAIT ELE GEN	45439	4500	OHIO	5027	2
348	DAYTN POWER & LT CO HUTCHNGS ELC G	45342	4500	OHIO	5041	6
349	COLS & S OHIO ELEC CO PICWAY GEN S	43137	5480	OHIO	5001	7
350	BUCKEYE SUGARS INC	45875	5660	OHIO	5002	1
351	SHELBY MUNICIPAL LIGHT PLANT	44875	5740	OHIO	5010	3
352	OHIO EDISON CO GORGE PLANT	44310	6500	OHIO	5027	1
353	OHIO EDISON CO - NILES PLT	44446	6700	OHIO	5007	2
354	DOVER MUNICIPAL POWER PLANT	44622	6720	OHIO	5004	1
355	MUSKINGUM RIVER PLANT	45715	7100	OHIO	5001	5
356	UNION CARBIDE CORP. - METALS DIV.	45750	7100	OHIO	5004	4
357	ORRVILLE MUNICIPAL UTILITIES	44667	7160	OHIO	5006	1

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OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
358	OKLA GAS & ELEC PX 1149 PONCA CITY 74601	1500	OKLAHOMA	0003	1
359	OKLA. GAS&ELEC. BOX 1270 MUSKOGEE74401	2000	OKLAHOMA	0003	1

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OBS	PLNMAD		COUNTY	STNAME	PLANT	POINTS
360	DUQUESNE LIGHT CO-2845 WEST CARSON		100	PENNSYLVANIA	0035	4
361	DUQUESNE LIGHT CO-COLFAX STA-DUQUESNE		100	PENNSYLVANIA	0036	21
362	WEST PENN POWER CO-BUTLER ST EXTENSION		100	PENNSYLVANIA	0037	5
363	DUQUESNE LIGHT CO-JORDAN ST-CRESCENT TWP		100	PENNSYLVANIA	0039	6
364	PA POWER CO-NEW CASTLE STM PLT-WEST		100	PENNSYLVANIA	0039	5
365	DUQUESNE LIGHT CO CHESWICK	15219	100	PENNSYLVANIA	0040	4
366	WEST PENN POWER P.O. BOX 489	16201	260	PENNSYLVANIA	0001	2
367	PENNSYLVANIA ELEC1001 BROAD STREET	15907	260	PENNSYLVANIA	0004	2
368	PENNSYLVANIA POWER COMP.O. BOX 128	15077	560	PENNSYLVANIA	0021	1
369	METROPOLITAN EDISON COP.O. BOX 542	19603	720	PENNSYLVANIA	0038	3
370	PENNSYLVANIA ELECTRIC COMPANY	16653	820	PENNSYLVANIA	0003	1
371	PHILADELPHIA ELETWP LINE&CROMEY RD	19460	1660	PENNSYLVANIA	0010	1
372	PENNSYLVANIA ELECTRI1001 BROAD ST.	15907	1820	PENNSYLVANIA	0012	3
373	METROPOLITAN EDISON CO. PIKE ST.	17057	2340	PENNSYLVANIA	0014	2
374	PHILADELPHIA ELEH1 INDUSTRIAL HWY.	19013	2360	PENNSYLVANIA	0015	2
375	PENNSYLVANIA ELECEAST FRONT STREET	16507	3080	PENNSYLVANIA	0005	4
376	WEST PENN POWER COMP800 CABIN HILL	15601	3720	PENNSYLVANIA	0001	2
377	PENNSYLVANIA ELECTRIC COP.O. BOX K	15944	4240	PENNSYLVANIA	0006	2

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OBS	PLNMAD		COUNTY	STNAME	PLANT	POINTS
378	PENNSYLVANIA ELECTRIC CP.O. BOX 29	15748	4240	PENNSYLVANIA	0007	2
379	PENNSYLVANIA ELEAST WHEATFIELD TWP	15954	4240	PENNSYLVANIA	0008	4
380	PENNSYLVANIA POWER & LIGHT CO.	17532	4700	PENNSYLVANIA	0062	2
381	UGI CORPORATION ROUTE 11	18621	5220	PENNSYLVANIA	0010	2
382	FIRESTONE TIRE & RUBBER CO.BOX 699	19464	6000	PENNSYLVANIA	0046	1
383	PENNSYLVANIA POWER & LIGHT CO.	17884	6020	PENNSYLVANIA	0002	2
384	METROPOLITAN EDISON COP.O. BOX 458	18351	6580	PENNSYLVANIA	0003	2
385	PENNSYLVANIA POWER & LP.O. BOX 257	18063	6580	PENNSYLVANIA	0014	2
386	PENNSYLVANIA POWER & LIP O BOX 302	17801	8320	PENNSYLVANIA	0001	12
387	SUSQUEHANNA UNIVERSUNIVERSITY AVE.	17870	8320	PENNSYLVANIA	0003	2
388	PENNSYLVANIA ELECTRIC P.O. BOX 126	16365	9180	PENNSYLVANIA	0001	4
389	DUQUESNE LGT CO ELRAMA STA		9200	PENNSYLVANIA	P001	4
390	WEST PENN POWERC02 AMERICAN STANDA	07206	9200	PENNSYLVANIA	0006	1
391	PENNSYLVANIA POWER & LIGHT CO.	17370	9570	PENNSYLVANIA	0005	5

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OBS	PLNMAD		COUNTY	STNAME	PLANT	POINTS
392	NARRAG ELEC,SOUTH ST STA,PROVIDENCE	02903	320	RHODE ISLAND	0037	2

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OBS	PLNMAD		COUNTY	STNAME	PLANT	POINTS
393	SCE &G CO URQUHART STATION BEECH ISLAND		80	SOUTH CAROLINA	0011	3
394	DUKE POWER COMPANY-LEE STEAM STATION		200	SOUTH CAROLINA	0004	3
395	SOUTH CAROLINA PUBLIC SERVICE AUTH JEFFR		420	SOUTH CAROLINA	0003	2
396	SHIPYARD, CHARLESTON		560	SOUTH CAROLINA	A001	5
397	SCE&G CO CANADYS STATION CANADYS S C	294	740	SOUTH CAROLINA	0002	3
398	CAROLINA POWER AND LIGHT-H B ROBINSON ST		820	SOUTH CAROLINA	0002	1
399	SC CAR ELEC GAS PAR STEAM STA	29066	1000	SOUTH CAROLINA	0033	7
400	SCPSA WINYAH STEAM PLANT		1140	SOUTH CAROLINA	0005	2
401	SC CAR PUB SER AUTH GRAINGER STA	29526	1340	SOUTH CAROLINA	0003	2
402	SC COR ELEC COS CO MCMEEKIN STC	29210	1560	SOUTH CAROLINA	0003	2
403	DUKE POWER BUZZARD BOOST CHAPPELLS	29037	1780	SOUTH CAROLINA	0004	2
404	SC CAR ELEC GAS CO WATEREE STA	29044	1900	SOUTH CAROLINA	0013	2

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OBS	PLNMAD		COUNTY	STNAME	PLANT	POINTS
405	OTTER TAIL PWR CO BIG STONE		640	SOUTH DAKOTA	P001	1
406	NO ST POWR LAWRENCE PL SIOUX FALLS	57101	1220	SOUTH DAKOTA	0001	3
407	BLACK HILLS P+L PEN FRENCH RAPID C	57701	1300	SOUTH DAKOTA	0001	1

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OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
408	TVA BULL RUN STEAM PLANT CLINTON 37716	40	TENNESSEE	0009	1
409	TVA JOHN SEVIER ST PLT ROGERSVILLE 37857	1380	TENNESSEE	0007	4
410	TVA JHNSNVLLE STEAM PLT NEW JHNSNVL37134	1540	TENNESSEE	0011	10
411	WATTS BAR STEAM PLANT WATTS BAR DAM	2840	TENNESSEE	0027	4
412	KINGSTON STEM PLANT KINGSTON 37763	2880	TENNESSEE	0013	9
413	ALLEN STEAM PLANT MEMPHIS	3080	TENNESSEE	0528	3
414	CUMBERLAND STM PLT TVA CHATTANOOGA 37401	3280	TENNESSEE	0011	2
415	GALLATIN STEAM PLANT GALLATIN	3320	TENNESSEE	0025	4

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OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
416	CITY PUBLIC SERVICE BOARD J T DEELY STA	420	TEXAS	HA01	1
417	HOUSTON LGT&PWR PARISH PLANT RICHMOND	1860	TEXAS	0005	1
418	TEXAS UTILITIES GENERATING CO BIG BROWN	1930	TEXAS	0002	2
419	SW PUBLIC SERVICE CO TUCO STA ABERNATHY	3350	TEXAS	P001	1
420	SOUTHWESTERN PUB SER CO HARRINGTON STA	4250	TEXAS	H001	1
421	MARTIN LAKE STEAM ELECTRIC STATION	4540	TEXAS	P001	1
422	SOUTHWESTERN ELEC PWR CO WELSH.STA	5190	TEXAS	P001	1
423	TEXAS UTILITIE SERVICES MONTICELLO	5190	TEXAS	P001	2

STATE=46

OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
424	UTAH POWER & LIGHT CO PO 899 SLC UTAH	140	UTAH	0002	2
425	UTAH POWER & LIGHT PO 899 SLC	280	UTAH	0001	2
426	CAL PACIFIC UTILITY PO 550 CEDAR CITY	360	UTAH	0002	1
427	UTAH POWER & LIGHT CO PO 899 SLC 84110	900	UTAH	0067	2
428	UTAH POWER LIGHT CO PO 899 SLC	900	UTAH	0068	2
429	PROVO CITY POWER 251 W 800 NORTH PROVO	1220	UTAH	0018	1
430	UTAH POWER & LIGHT CO PO 899 SLC 84110	1220	UTAH	0028	1

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OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
431	PEPCO*1400 N ROYAL ST ALEXANDRIA	80	VIRGINIA	0003	5
432	VEPCO DUTCH GAP RT 615 CHESTERFIELD COUN	720	VIRGINIA	0002	2
433	VEPCO-CREEK BLUFF 1 MI/RT 15 ON 656 PREM	1160	VIRGINIA	0001	2
434	APPALACHIAN POWER CO INT OF SR649 & 460	1300	VIRGINIA	0002	3
435	VEPCO REEVES AVENUE NORFOLK VIRGINIA	2140	VIRGINIA	0004	1
436	CITY OF DANVILLE LOWER END OF MONUMENT S	2380	VIRGINIA	0009	2
437	APPALACHIAN POWER CO CLINCH RIVER PLT CA	2780	VIRGINIA	0003	3

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OBS	PLNMAD		COUNTY	STNAME	PLANT	POINTS
438	PACIFIC POWER	8531	1100	WASHINGTON	0010	2

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OBS	PLNMAD		COUNTY	STNAME	PLANT	POINTS
439	VA ELECTRIC & POWER MOUNT STORM 26739		560	WEST VIRGINIA	0003	3
440	HARRISON POWER STATION HAYWOOD		660	WEST VIRGINIA	0015	3
441	APPALACIAN POWER-KANAWHA RIVER-GLASGOW		760	WEST VIRGINIA	0006	2
442	CABIN CREEK POWER ST.N. OF HGY. 61		760	WEST VIRGINIA	0007	4
443	RIVESVILLE POWER ST.P.O.BOX 1342 RIVESVI		980	WEST VIRGINIA	0009	2
444	OHIO POWER - MITCHELL PLANT CRESAP		1020	WEST VIRGINIA	0005	2
445	OHIO POWER - KAMMER WVA RT 2 IN CRESAP		1020	WEST VIRGINIA	0006	3
446	CENTRAL OPERATING PHILIP SPORN OFF US 33		1060	WEST VIRGINIA	0001	5
447	FORT MARTIN POWER STATION 2MILES PT.MARI		1140	WEST VIRGINIA	0001	2
448	WILLOW ISLAND POWER ST. WILLOW IS.		1460	WEST VIRGINIA	0004	2
449	ALBRIGHT POWER STATION ALBRIGHT		1520	WEST VIRGINIA	0001	3
450	APP PWR JOHN AMOS POBOX4000 ST HLBANS		1560	WEST VIRGINIA	0006	3
451	E. I. DUPONT WASH. WORKS	WASHINGTON	2220	WEST VIRGINIA	0001	3

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OBS	PLNMAD		COUNTY	STNAME	PLANT	POINTS
452	LK SUPERIOR DIST POWER-BAY FRNT PLT	54806	120	WISCONSIN	0002	3
453	WIS PUB SER CORP JP PULLIAM PLT		360	WISCONSIN	0006	6
454	DAIRYLAND PWR CO-OP ALMA WISCONSIN	54610	400	WISCONSIN	0001	5
455	WIS PWR & LIGHT COLUMBIA GEN STA PORTAGE		600	WISCONSIN	0004	2
456	MADISON GAS ELEC BLOUNT ST STATION	53701	680	WISCONSIN	0003	5
457	WIS PWR LIGHT CASSVILLE		1140	WISCONSIN	0001	2
458	DAIRYLAND POWER CO-OP CASSVILLE	53806	1140	WISCONSIN	0002	2
459	MANITOWOC PUB UTIL 1303 S8TH ST	54220	1900	WISCONSIN	0001	3
460	WIS PUB SER CORP ROTHSCHILD	54474	1920	WISCONSIN	0008	2
461	WEP-EAST WELLS STA 108 E WELLS ST	53203	2220	WISCONSIN	0006	4
462	WISCONSIN ELEC PWR ELM RD OAK CREEK	53154	2220	WISCONSIN	0017	8
463	WISCONSIN ELEC PWR 1035 W CANAL	53233	2220	WISCONSIN	0023	4
464	MENASHA ELEC & WATER UTIL RIVER ST	54952	2580	WISCONSIN	0008	2
465	WIS ELEC PWR 146 S WISCONSIN	53074	2600	WISCONSIN	0004	5
466	RICHLAND CNTR MUNIC ELECT GAGE&MAIN	53581	2980	WISCONSIN	0001	2
467	WISCONSIN PWR LIGHT ROCK RIVER		3060	WISCONSIN	0003	2
468	WISCONSIN PWR & LIGHT 852 PLEASANT	53511	3060	WISCONSIN	0008	2
469	WISCONSIN PWR LIGHT BOX 356 SHEBOYGAN		3280	WISCONSIN	0001	4
470	DAIRYLAND PWR COOP GENOA WISCONSIN	54632	3620	WISCONSIN	0001	1
471	MENASHA ELEC&WATER 180 MAIN ST	54952	4020	WISCONSIN	0002	4
472	MARSHFIELD E AND W 2000 S ROBBIS	54449	4060	WISCONSIN	0001	2

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OBS	PLNMAD	COUNTY	STNAME	PLANT	POINTS
473	BLACK HILLS P&L GARNER LAKE RT GILLETTE	80	WYOMING	0002	1
474	PP&C WYOPAK GARNER LAKE RT GILLETTE82716	80	WYOMING	0004	1
475	PP&L DAVE JOHNSTON BOX 398 GLENROCK82637	180	WYOMING	0001	4
476	UTAH POWER AND LIGHT KEMMERER	440	WYOMING	0004	3
477	BASIN ELECT MISSOURI BASIN PWR.PROJECT	540	WYOMING	0003	3
478	JIM BRIDGER POWER PLANT POINT OF ROCKS	700	WYOMING	0007	4

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. 560/5-83-005	2.	3. Recipient's Accession No.

4. Title and Subtitle
Comprehensive Assessment of the Specific Compounds Present in Combustion Processes, Volume 2. Design for a National Survey of Emission of Specific Compounds from Coal Fired Utility Boiler Plants

5. Report Date
August 1985

6.

7. Author(s)
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8. Performing Organization Rept. No.

9. Performing Organization Name and Address
Midwest Research Institute with subcontract to
Research Triangle Institute
P.O. Box 12194
Research Triangle Park, NC 27709

10. Project/Task/Work Unit No.
1A

11. Contract(C) or Grant(G) No.
(C) 68-02-3938
(G)

12. Sponsoring Organization Name and Address
Field Studies Branch
USEPA
401 M Street, S.W.
Washington, DC 20460

13. Type of Report & Period Covered
Final

14.

15. Supplementary Notes
J. J. Breen, Project Officer
D. T. Heggem, Work Assignment Manager

16. Abstract (Limit: 200 words)

The emission of several toxic compounds in the polycyclic organic group has been reported from stationary combustion processes. It has been demonstrated that a theoretical potential exists for the formation of these compounds as the results of combustion of coal-refuse, wood, municipal refuse, waste oil, and coal. To investigate this topic further, a pilot study was designed to obtain data on which to base a national survey. The overall objectives of the pilot study were to ascertain the number of combustion sites and the number of days of sampling required at each site to adequately estimate the level and prevalence of these toxic substances in the emissions from combustion processes and to do so at a minimum cost.

For each facility a complex, multimedia sampling design was developed for the collection of solid, liquid, and gaseous influents and effluents. In addition, measurements of process parameters were also taken. This design allowed for the estimation of the inputs into the process, the efficiency of the combustion process, and the emissions from the process. Using the estimates of the variability of the resulting data and cost estimates based on the experience gained in the pilot, a national survey design was developed. Sampling is planned for seven coal and nine refuse combustion facilities for 5 days each. Estimates of the levels of toxic substances are anticipated to have a precision of ± 5 to ± 60%.

17. Document Analysis a. Descriptors
Combustion,
Survey design,
PAH, PCB, PCDD, PCDF

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Release to Public	Unclassified	61
	20. Security Class (This Page) Unclassified	22. Price

(See ANSI-Z39.18)

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce