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U.S. Department of Energy
Energy Information Administration
Office of Energy Markets and End Use
Energy End Use Division

Methodological Report on the 1980 Manufacturing Industries Survey of Large Combustors (EIA-463)

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PREFACE

The 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors (EIA-463) was designed to collect information on large combustors in the United States and the manufacturing establishments operating them. The survey was mailed to a list of respondents in late November and early December 1980. On February 20, 1981, the Secretary of Energy received notice from the Office of Management and Budget that authority for this information collection activity had been withdrawn and that the information already collected must be treated in a confidential manner.

At that time, responses had been received from approximately 76 percent of the final survey frame and, even though this represented a respectable response rate, the usefulness of the survey was substantially diminished for the following specific reasons:

- The results of this survey are probably somewhat biased due to systematic nonresponse error.

- Because of the withdrawal of authority for this survey, the Energy Information Administration (EIA) was unable to undertake a follow-up of respondents to resolve problems of missing and apparently questionable data.

This report presents a detailed overview of the methodology for this survey and a discussion of its limitations. This report is technical and is designed for analysts working with the results of this survey and for survey statisticians interested in specific survey methodologies.

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1. INTRODUCTION

The original impetus for the 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors (EIA-463) came from the Federal Energy Administration Act of 1974, as amended, which calls for the establishment of a National Energy Information System. This system, as envisioned by the legislation, would

> "... contain such information as is required to provide a description of and facilitate analysis of energy supply and consumption within and affecting the United States on the basis of such geographic areas and economic sectors as may be appropriate...." (15 USC 790a)

One of the original goals of this study, therefore, was to assemble a subset of information for the manufacturing subsector.

During the early planning stages of this study, discussions were held with several bureaus and agencies within the Federal Government to identify specific data needs. Among these were: the Bureau of the Census, the Bureau of Economic Analysis, and the Bureau of Industrial Economics of the Department of Commerce; the Bureau of Labor Statistics of the Department of Labor; the General Accounting Office; the Environmental Protection Agency; the Solar Energy Research Institute; the Economic Regulatory Administration of the Department of Energy; and the Office of Technology Assessment of the U.S. Congress. During these meetings, EIA contacted the Office of Fuels Conversion (OFC) of the Economic Regulatory Administration (ERA) which was responsible for implementing the Powerplant and Industrial Fuel Use Act of 1978 (FUA), Public Law 95-620. This law requires the identification of combustors that could be feasibly converted to coal. In order to comply with this legislative responsibility, the OFC was planning to implement a survey which would update existing data on large combustors.[1] The OFC data collection effort was to have covered "large combustors" defined as boilers, gas turbines, combined cycle units, and internal combustion engines with a maximum design firing rate of 50 million or more Btu-per-hour.

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[1]A previous survey had been conducted in 1975 resulting in a data set known as the Major Fuel Burning Installation (MFBI) file. A description of this file is provided on page 10.

A major concern in any survey conducted by a Government agency is respondent burden. Every effort is made by an agency conducting such a survey to avoid overburdening respondents. Because many responding establishments would have been included in both the EIA and ERA studies and because a good deal of similar information would have been required, it was decided to combine these efforts in order to reduce overall respondent burden. The first major step was to develop a questionnaire which would satisfy the needs of all parties.

2. DEVELOPMENT OF THE QUESTIONNAIRE

As a result of the legislation which the study was to serve, the following study objectives were jointly established by EIA and ERA:

- Obtain information on the consumption of mineral fuels, nonmineral energy resources, and electricity for the manufacturing sector.
- Gather information to allow for the equitable administration of the Powerplant and Industrial Fuel Use Act.
- Gather information to aid in responding to a national or regional energy emergency.
- Allow for the resulting data base to be matched with Bureau of the Census data so the economic data could be integrated into the results of this study, thus creating an extensive data base at no increase in respondent burden.
- Gather information on alternative-fuel burning capabilities of large combustors.
- Develop estimates of the efficiencies of industrial boilers by boiler characteristics.

These study objectives required information not only on the establishments operating large combustors in the United States but also on the combustors themselves. The questionnaire which was finally developed was therefore in two sections: Section I which collected information at the establishment level and Section II which collected information on individual large combustors within establishments. A copy of the final questionnaire is included in Appendix A.

The questionnaire was designed so that individual questions could simultaneously satisfy several of the study objectives or administrative needs. This approach had the ultimate effect of minimizing respondent burden while still meeting several varied program needs. Tables 1 and 2 show the study objectives or administrative needs which each question met.

Table 1. Study Objectives Fulfilled by Each Question of Section I

Questions	Identification	Edits	Study Objectives: Industrial Energy Consuption	Administer PIFUA	Emergency Planning	Census Match	Alternative Energy Potential	Boiler Efficiency
1. Physical Location	o	--	--	o	--	o	--	--
2. Employer Identification Number	--	--	--	--	--	o	--	--
3. Primary Standard Industrial Code	o	--	o	--	--	o	--	--
4. Number of Paid Employees	--	--	--	--	--	o	--	--
5. Company Ownership	o	--	-	--	--	--	--	--
6. Seasonal Operation	--	o	o	--	o	--	--	--
7. Change in Ownership Status	o	o	--	--	--	--	--	--
8. Acquired Fuels	--	--	o	o	o	--	--	--
9. Generated Fuels	--	--	o	o	o	--	--	--
10. Electricity Consumed and Generated	--	--	o	--	o	--	--	--
11. Nontraditional Energy	--	--	o	--	--	--	o	--
12. Steam Purchase/Sales	--	--	o	--	--	--	o	o
13. Steam Generation	--	--	o	--	--	--	o	o
14. Count of Combustors In-Scope	--	o	o	o	o	--	--	--
15. Inventory of Other Combustors	--	--	o	--	o	--	--	--
16. Contact	o	o	--	--	--	--	--	--
17. Disclosure	--	o	--	--	--	--	--	--
18. Certification	o	--	--	--	--	--	--	--

o = Fulfilled

Table 2. Study Objectives Fulfilled by Each Question of Section II

Questions	Identification	Edits	Study Objectives: Industrial Energy Consuption	Administer PIFUA	Emergency Planning	Census Match	Alternative Energy Potential	Boiler Efficiency
1. Combustor Identification.....	o	--	--	o	--	--	--	--
2. Combined Cycle Unit.....	o	o	--	o	--	--	--	--
3. Combustor Type.....	o	o	--	o	--	--	--	--
4. Boiler Operation.....	--	o	o	o	--	--	o	o
5. Shaft Power.....	--	o	o	o	--	--	o	--
6. Installation Year.....	o	--	--	o	--	--	--	--
7. Combustor Design and Actual Fuel Use.....	--	o	o	o	o	--	o	o
8. Solid Fuel Specification.....	--	--	--	o	o	--	o	--
9. Maximum Design Firing Rate.....	--	o	o	o	o	--	--	o
10. Usual Operating Firing Rate and Range.....	--	o	o	o	o	--	--	o
11. Flue Gas.....	--	--	--	o	--	--	--	o
12. Termination Instruction.....	--	o	--	--	--	--	--	--
13. Hours of Use.....	--	o	o	o	o	--	--	o
14. Downtime.....	--	o	o	o	o	--	--	o

o = Fulfilled

3. SELECTION OF RESPONDENTS

To fulfill its requirements, the ERA specified that it wanted to obtain approximately 95 percent coverage of large combustors and the establishments which operated them. Furthermore, the ERA required a high degree of assurance that this extent of coverage had been achieved. No single listing of establishments met these specifications so it was necessary to construct a frame for the survey.

In an effort to obtain this nearly complete coverage, the survey frame was developed from a number of existing Government-held lists which were supplemented by selected establishments from the Dun and Bradstreet (D&B) file of manufacturing establishments.

To evaluate the extent of the coverage of this frame, a sample of establishments was selected from the unused portions of the D&B file. It was contemplated that if the coverage check sample indicated that the desired coverage of the population of large combustors had not been achieved, the survey would be extended. This section describes the methodologies involved in developing the survey list and the coverage check sample. Because of the complexity and interrelatedness of these procedures, a flow chart of major steps is presented in Figure 1 on page 8. The reader is encouraged to refer to this figure periodically.

Development of the Survey List

The population of interest for this survey included all manufacturing establishments having specified types of combustors (boilers, gas turbines, internal combustion engines, or combined cycle units) with a maximum design firing rate of 50 million or more Btu-per-hour. As noted, no single list was available which contained the names and addresses of such establishments. The survey list was, therefore, developed in two steps. First, a composite list of seven existing Government-held lists was assembled. Second, this composite list was supplemented by selected establishments from the D&B file.

The Composite List

The composite list was developed from an earlier (1975) list of establishments operating large combustors (the Major Fuel Burning Installation file) and six additional Government-held lists. The six additional lists were selected because they identified various types of

Figure 1. Flow Diagram of the Development of the Survey List and Coverage Check Sample

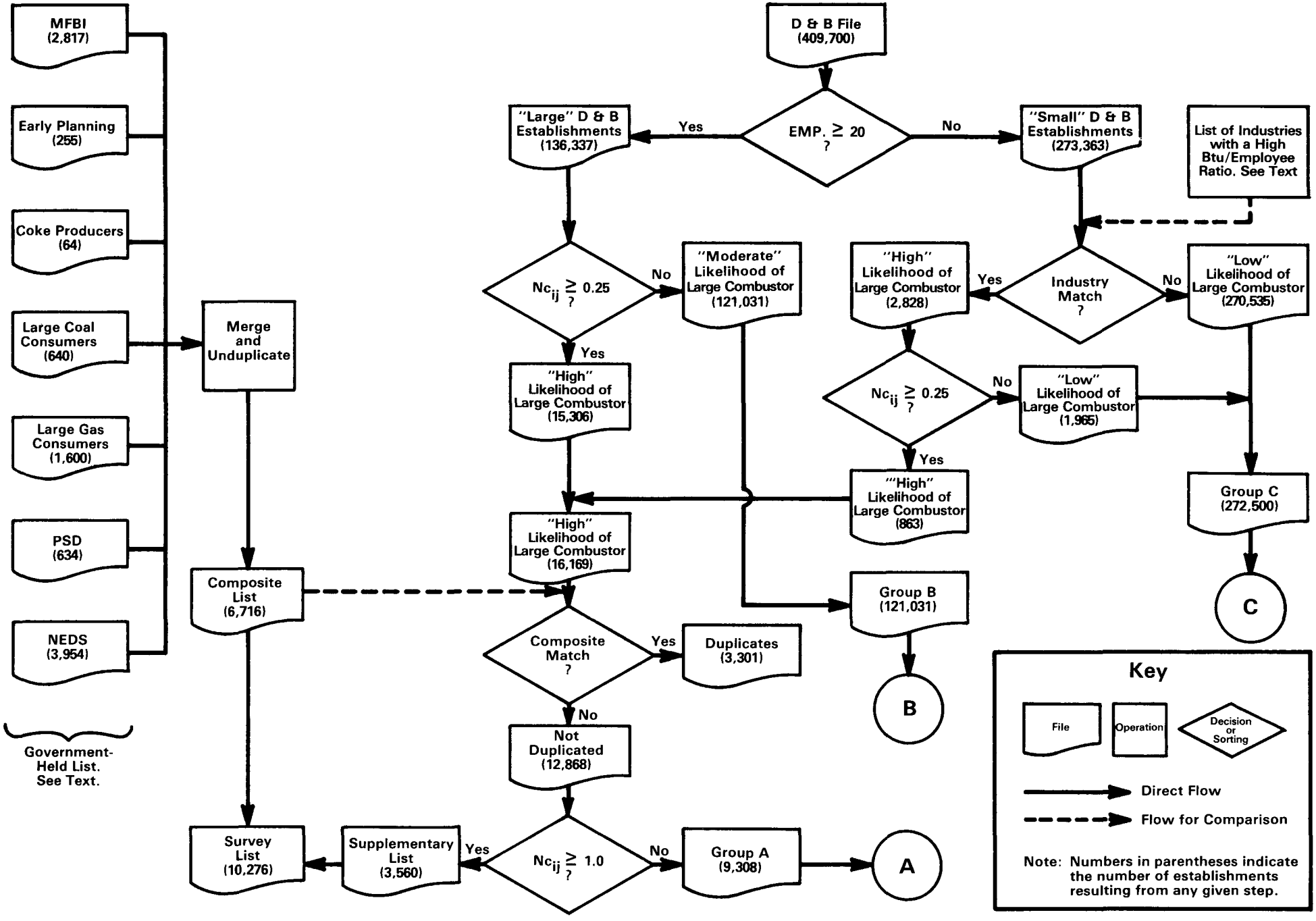
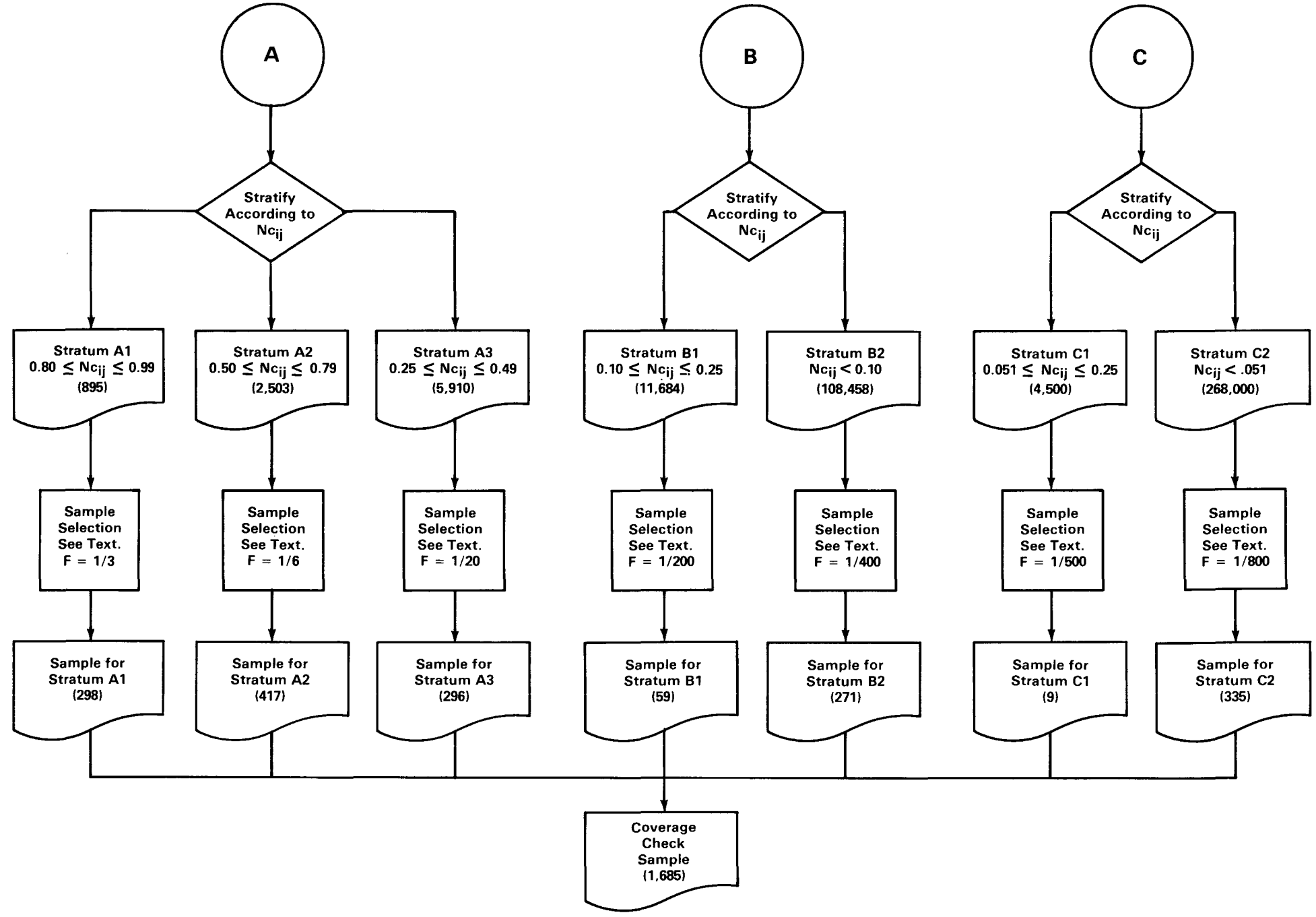


Figure 1. Flow Diagram of the Development of the Master List and Coverage Check Sample (Continued)



establishments which were large fuel consumers and therefore would have been likely to have operated combustors of interest to this study. Because the Government lists were prepared for different needs and reflected different time periods, however, each list would likely contain three types of establishments:

- Those which were in-scope to this study and unique to a given list
- Those which were in-scope but duplicated elsewhere
- Those which were out-of-scope to this study.

These seven lists were sequentially merged and unduplicated to the extent that differences in names and other identifying information would permit. Establishments with Standard Industrial Classification (SIC) codes not in manufacturing[1] were also excluded where possible. Similarly, where information about fuel consumption was available, establishments with an annual consumption of less than 100 billion Btu of fuel were excluded. This is the level of consumption that would be required by a 50-million Btu-per-hour combustor--the minimum size of interest--operated for 2,000 hours per year. This cut-off was low, but deliberately so, to try to assure the desired coverage of large combustors. In all, a composite list of 6,716 establishments was developed in this manner. The seven separate lists are described in the following paragraphs and the contribution of each to the composite list is summarized in Table 3 on page 12. The lists are presented and discussed in the same order in which they were merged and unduplicated.

Major Fuel Burning Installations (MFBI). The Federal Energy Administration conducted the MFBI survey in 1975. The survey included fuel consumption data on boilers, burners, or other large combustors that consume at least 100 million Btu-per-hour and the establishments that operated them. The primary purpose of this survey had been to identify large consumers of oil or natural gas that could be switched to coal.

Early Planning Process Evaluation (EPPE). In carrying out its responsiblities, the Department of Energy collects descriptive information on large boilers which are in the process of being built or are planned for construction or installation in the future. This listing was used next to add to the composite list because it identified boilers installed or under construction during the 1974-77 period, most of which would not be included on the 1975 MFBI file.

Coke Producers. The Department of Energy prepares an annual listing of coke producing plants in the United States based on data secured from the Bureau of Mines Form 6-1370A and Department of Energy Forms EIA-5 and EIA-5A. It was assumed that the operations of each of the 64 plants included on the list would require a combustor having a maximum design firing rate of at least 50 million Btu-per-hour.

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[1]The manufacturing SIC codes are 19 through 39.

Large Coal Consumers. The Department of Energy obtains a monthly fuel consumption report (EIA-3) from manufacturing plants which are large consumers of coal. The 1978 annual summary of these reports was next used to add to the survey list. All establishments consuming 4,000 or more tons of coal per year were considered to be likely candidates to have a large combustor.

Large Gas Consumers. The Department of Energy receives reports on large gas consumers (EIA-50) to assist in its analysis of alternative-fuel demand due to natural gas curtailment. The subset of this file consisting of consumers with a potential demand of at least 100 million cubic feet of gas per year[2] were added to the file.

Prevention of Significant Deterioration (PSD). In a pilot project by the Texas Regional Office of the Department of Energy and the Environmental Protection Agency (EPA) to inform industry of the provisions of the Fuel Use Act relating to pollution-associated activities, EPA's 1977-79 permit applications were reviewed. Selected energy and pollution information were entered into a data base known as "the PSD file." The PSD file was valuable in two respects. First, many entries confirmed the active status of an MFBI entry. Second, it was a good source of leads to new or existing plants (non-MFBI) which may have increased their combustor capacity to the extent that they could have been eligible for inclusion in this survey.

National Emissions Data Systems (NEDS). The NEDS file is the largest single body of data dealing with pollution measurement control. It covers the period of 1972-75 and identifies combustors and other sources having a potential emission of over 100 tons per year of any of five criteria pollutants plus characteristics of combustors, such as the design firing rate or the type of combustor. Installations having combustors with a design firing rate of 50 million or more Btu-per-hour were considered for inclusion in the composite mailing list.

The composite list was developed by merging these seven lists one at a time and removing duplicate entries. The MFBI file was designated as the base list because it included those combustors which most closely resembled those of interest for this study. The MFBI file contributed 2,817 establishments to the composite list. The remaining 3,918 establishments were added sequentially from the other six lists. This particular order of matching affected only the number added from any given list; the total number of establishments was unaffected by order, however. A final check of this list yielded 19 duplicates resulting in a final composite list of 6,716 establishments.

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[2]This is equivalent to a 50-million Btu combustor operating for 2,000 hours per year on natural gas containing 1,000 Btu per cubic foot.

Table 3. Contributions of the Government-Held Lists to the Composite List

List Title (in order used)	Total Establishments In List	Total Establishments Potentially In-Scope[a]	Number of Contributions	Contributions as Percent of Potentially In-Scope
Major Fuel Burning Installations	3,500	2,817	2,817	100.0
Early Planning Process Evaluation	789	255	76	29.8
Coke Producers	64	64	26	40.6
Large Coal Consumers	824	640	249	39.9
Large Gas Consumers	3,651	1,600	870	54.4
Prevention of Significant Deterioration	1,561	634	455	71.8
National Emissions Data System	4,251	3,954	2,242	56.7
Subtotal	14,640	9,964	6,735	67.9
Less Additional Duplicates	--	--	-19	--
Final Composite List	--	--	6,716	--

[a]Represents the number of establishments remaining after the removal of various nonqualifying establishments (see text).

The Supplementary List

It was presumed that this composite list was incomplete and should be supplemented by other selected establishments. These supplementary establishments were selected from the Dun and Bradstreet (D&B) file of 409,700 establishments[3] with primary SIC codes in manufacturing. This file also was used to develop the coverage check sample which is described in a subsequent section.

The D&B file contained estimated establishment employment and establishment SIC codes but did not contain information on fuel consumption or combustors. The initial task, therefore, was to convert the available D&B information to an approximate measure of fuel consumption at any given establishment

[3]The original D&B file contained 470,000 establishments. Those which were classified as primarily engaged in a nonmanufacturing activity or as auxiliary establishments not performing manufacturing operations were excluded.

and, from this, to develop a "projected number of combustors." The strategies for developing the supplementary list and the coverage check sample were designed by analyzing a distribution of establishments by the projected number of combustors and the matches of these establishments to the composite list.

Imputation of the Projected Number of Combustors. The methodology for imputing the projected number of combustors can be conveniently described in three steps. The first step, or the initial approximation, resulted in an estimate based upon the ratio of Btu consumed per employee by industry. The second step resulted in a modification of these estimates for differences by industry and size of establishment. The third step resulted in additional fine-tuning based upon confidence in the results of step two.

The initial approximation of the projected number of combustors was developed by first estimating the total fuel consumption (in Btu) for any given D&B establishment and then converting this consumption to a projected number of 50-million Btu-per-hour combustors. Fuel consumption was estimated by multiplying the establishment employment by annual Btu per employee derived from the 1976 Annual Survey of Manufactures.[4] These estimates were prepared at the four-digit SIC level of detail.[5]

In converting these Btu estimates to projected numbers of large combustors, it was assumed that such a combustor would operate for 6,000 hours per year (three shifts a day, 5 days a week, for 50 weeks per year). These estimates were prepared using the equation:

$$Nc_{ij}' = r_i E_{ij} / k \qquad (1)$$

where: Nc_{ij}' = the projected number of 50-million Btu-per-hour combustors in the j^{th} establishment of the i^{th} industry;

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[4]Estimates of the consumption of purchased fuels by industry were taken from U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures "Fuels and Electric Energy Consumed," Publication No. M76(AS)-4.1. These Btu estimates included only purchased fuel used for heat, power, and light. The estimates excluded feedstocks, electricity, and energy from other sources, whether purchased or not. Employment estimates for industries were taken from the U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures, "General Statistics for Industry Groups and Industries," Publication No. M76(AS)-1. Statistics for the year 1976 were the most recent available at the time these estimates were prepared.

[5]The SIC codes are hierarchical in nature. For example, SIC 20 includes establishments primarily engaged in the production of Food and Kindred Products. SIC 201 includes establishments manufacturing Meat Products and SIC 2011 includes only Meat Packing plants.

r_i = the ratio of fuels consumed to employment for the i^{th} four-digit SIC manufacturing industry from the 1976 Annual Survey of Manufactures;

E_{ij} = D&B estimated employment of the j^{th} establishment of the i^{th} industry; and

k = a scaling factor representing the Btu consumption of a 50-million Btu-per-hour combustor operated for 6,000 hours per year, i.e., 3×10^{11} Btu.

The initial projections (Nc_{ij}') given by equation (1) can be interpreted as estimates of the expected or average number of large combustors per establishment. Because some fuel is consumed in nonqualifying combustors, (i.e. less than 50 million Btu-per-hour) the Nc_{ij}' would be too high on the average, but might be considered more or less proportional to the actual average number of large combustors.

This initial approximation did not include two important factors. First, the relationship between fuel consumption and large combustors varies among industries. For example, the food processing industry consumes large quantities of fuels, but a high incidence of large combustors does not appear in that industry. Second, the assumption that the projected number of large combustors is a linear function of employment is probably an over-simplification, especially with respect to smaller and midsize establishments. In general, large establishments would tend to have larger combustors than their smaller counterparts. Therefore, it was necessary to modify the initial estimates to account for these two factors, i.e., to develop a methodology which would assign relatively higher projected numbers of large combustors to the establishments in the industries and size classes that are more prone to use large combustors.

Essentially, this meant developing a second-degree equation for each industry of the form

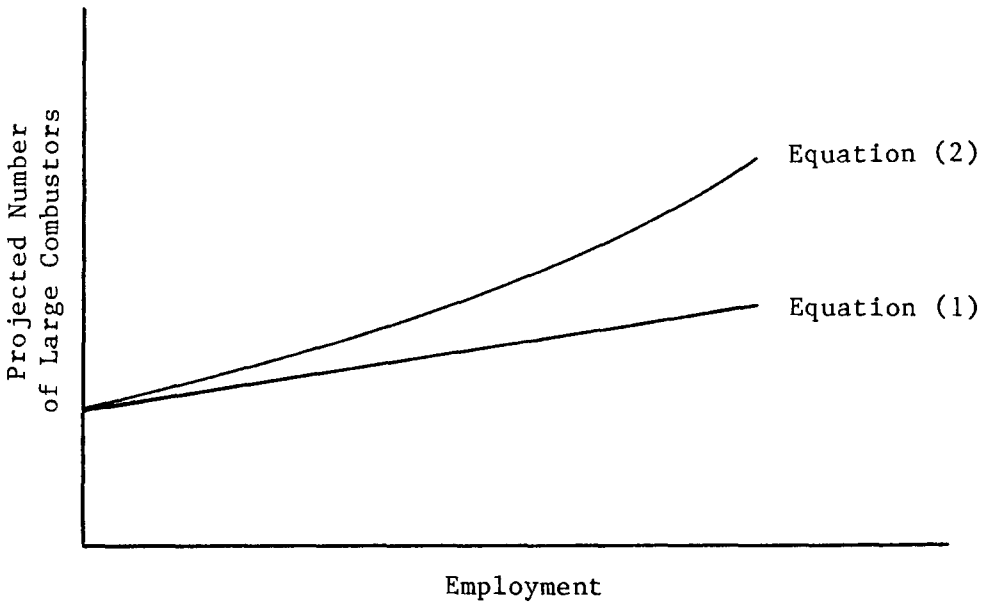
$$Nc_{ij}'' = (a_i E_{ij} + b_i E_{ij}^2)/k \qquad (2)$$

where: a_i and b_i are the necessary coefficients to account for increasing numbers of combustors within certain industries and size classes.

The effect of introducing such an adjustment is hypothetically illustrated in Figure 2 on the next page.

Prior to developing such second-degree equations, however, it was first necessary to identify those industries and size classes that would be more prone than average to use large combustors. This was done by attempting to match the establishments in the composite list with a selected list of large D&B establishments. It was reasoned that the match rates within any given industry would be indicative of the overall incidence

Figure 2: Hypothetical Comparison of First and Second Approximations of the Projected Number of Large Combustors.



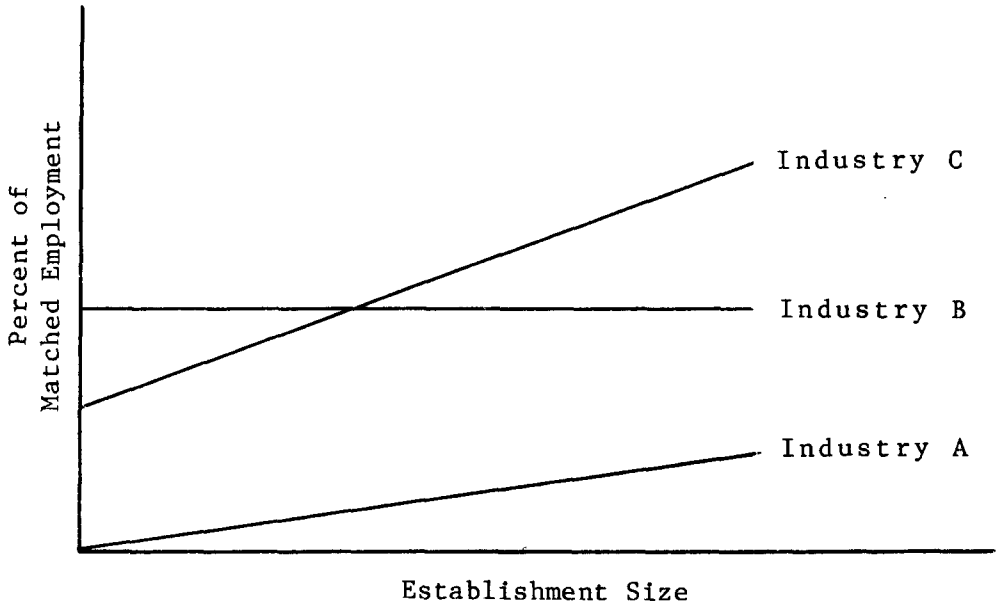
of large combustors within that industry. The rationale is that the composite list primarily included those establishments likely to have a large combustor while the specially constructed D&B list[6] included large establishments without regard to the use or nonuse of large combustors. Match rates between the two lists should therefore have been fairly high in industries which were well-represented in the composite list, thus indicating an overall higher incidence of large combustors. Conversely, low match rates would be expected in those industries not well-represented in the composite list, which would be indicative of an overall lower incidence of large combustors.

Similarly, it was reasoned that the match rates by employment size within industries would be indicative of the relation between employment and the incidence of large combustors for that industry. Five employment size classes were used: 20 through 49 (imputed employment = 32); 50 through

[6]For each four-digit SIC industry, the D&B establishments were arrayed in descending order of employment. Establishments were selected from these arrays until their number reached one and one-half times the number of establishments in the corresponding industry of the composite list. It was further stipulated, however, that no fewer than five D&B establishments be selected within an industry.

99 (imputed employment = 70); 100 through 499 (imputed employment = 260); 500 through 999 (imputed employment = 700); and 1,000 or more (imputed employment = 1,600). It follows that match rates should decline as establishment size (measured by total employment) decreases. Assuming a linear relationship between establishment size and percent of matched employment leads to a series of functions, three of which are depicted hypothetically in Figure 3.

Figure 3: Hypothetical Linear Relationships Between Establishment Size and Percent of Matched Employment



For each of these hypothetical functions, the intercept indicates the increased likelihood of an entire industry having a higher-than-average incidence of large combustors. The slope of these functions indicates the extent to which the incidence of large combustors increases as employment size increases.

In this example,

- Industry A displays no overall increased tendency toward a higher-than-average incidence of combustors. The slightly positive slope of A indicates that there is a tendency to concentrate what large combustors there are in the larger establishments. (Intercept equals 0; slope is greater than 0.)

- Industry B does have an overall higher-than-average incidence of combustors but there is no apparent tendency to concentrate them in the larger establishments. This example is unlikely but is included for illustrative purposes. (Intercept is greater than 0; slope equals 0.)

- Industry C has an overall higher-than-average incidence of combustors and there is also a tendency to concentrate them in the larger establishments. (Intercept is greater than 0; slope is greater than 0.)

Following this argument, linear functions were developed for each industry with employment size class as the independent variable and percent of matched employment as the dependent variable. Because of the small number of observations, no attempt was made to fit these functions by the method of least squares; rather, two points were defined by several approaches including modified methods of semi-averages and the linear function was extrapolated from these two points. Once the function had been thus determined, its intercept (c_i) and its slope (d_i) were calculated and used to adjust the first approximation of the projected number of large combustors. The decision rules and rationales for fitting these functions and the methods of calculating the slope and intercept coefficients are presented in Table 4.

The next step was to factor these adjustments into the equation for the initial approximation of the projected number of combustors (Nc_{ij}'), previously presented in equation (1). The aim was to modify this initial approximation by a factor which reflects the different likelihood that establishments with a given calculated fuel consumption would have large combustors depending on their industry classification and employment size. Letting this overall adjustment factor be represented as F_{ij} and applying it to equation (1), yielded

$$(1 + F_{ij})Nc_{ij}' = (1 + F_{ij})(r_i E_{ij}/k) \quad (3)$$

or,

$$Nc_{ij}'' = (1 + F_{ij})(r_i E_{ij}/k). \quad (4)$$

It should now be recalled that in the linear functions previously defined (see examples in Figure 3), the intercept is the increase in the percent of total matched employment when establishment size is at a minimum. It can be reasoned that the overall number of projected combustors in this industry should be increased by a like percentage. Similarly, the slope reflects the increase in the percent of matched employment given an increase in employment size class. By the same reasoning as with the intercept, the slope should also be factored into the first approximation of the projected number of combustors. Setting the overall adjustment factor (F_{ij}) equal to these linear equations ($F_{ij} = c_i + d_i E_{ij}$) and substituting into equation (4),

$$\begin{aligned} Nc_{ij}'' &= [1 + (c_i + d_i E_{ij})][r_i E_{ij}/k] \\ &= 1/k[r_i E_{ij} + c_i r_i E_{ij} + d_i r_i E_{ij}^2] \\ &= 1/k[(r_i + c_i r_i)E_{ij} + d_i r_i E_{ij}^2]. \end{aligned} \quad (5)$$

This is the second-degree equation that was originally sought.

Table 4. Decision Rules for the Calculation of the Adjustment Coefficients, c_i and d_i

Situation	Coefficients	Rationale
No matches between composite list and selected D&B records. Only five establishments compared.	$c_i = d_i = 0$	The minimum number of records (5) were compared indicating that a small number of establishments are classified in this industry. Additional searching would not be likely to yield a match.
No matches between composite list and selected D&B records. More than five establishments compared.	c_i and d_i determined from the points [0,0] and [1600, 0.5(Y+1)] where Y = number of records searched.	More than the minimum number of records were compared indicating that this industry includes a fairly large number of establishments. Had one more record been searched (Y+1), the probability of a match would have been 0.5. The match, had it been found, would have a high probability of occurring in a large establishment (employment of 1,600 arbitrarily assigned.)
Matches found in only two of the five employment size classes.	c_i and d_i determined from the points [X_1, Y_1] and [X_2, Y_2] where X_1 and X_2 are the midpoints of the employment size classes yielding matches and Y_1 and Y_2 are the percents of matched employment.	Simple linear extrapolation of points. Assumes matches would be found in the other three classes.

(Continued on next page.)

Table 4. Decision Rules for the Calculation of the Adjustment Coefficients, c_i and d_i (Continued)

Situation	Coefficients	Rationale
Matches found in three employment size classes.	c_i and d_i determined from the points $[(X_1 + X_2)/2, (Y_1 + Y_2)/2]$ and $[(X_2 + X_3)/2, (Y_2 + Y_3)/2]$ with X's and Y's defined as above.	Modified method of semi-averages with simple linear extrapolation of two derived points. Assumes matches would be found in other two size classes.
Matches found in four employment size classes.	c_i and d_i determined from the points $[(X_1 + X_2)/2, (Y_1 + Y_2)/2]$ and $[(X_3 + X_4)/2, (Y_3 + Y_4)/2]$ where X_1 and X_2 are the mid-points of the two smaller employment size classes and X_3 and X_4 are the large classes. The values of $Y_1 - Y_4$ are the corresponding percents of matched employment.	Method of semi-averages with simple linear extrapolation of two derived points. Assumes matches would be found in other size class.
Matches found in all five employment classes.	c_i and d_i determined from the points $[(X_1 + X_2 + X_3)/3, (Y_1 + Y_2 + Y_3)/3]$ and $[(X_3 + X_4 + X_5)/3, (Y_3 + Y_4 + Y_5)/3]$ with X's and Y's defined as above.	Modified method of semi-averages with simple linear extrapolation of two derived points.

Confidence in the adjustment factor, F_{ij}, increased as the total number of cases searched increased. It was therefore decided that the final imputation of the projected number of large combustors for each establishment would be a weighted average of the initial approximation, Nc_{ij}', and the second approximation, Nc_{ij}''. That is,

$$Nc_{ij} = W_i(Nc_{ij}'') + (1 - W_i)(Nc_{ij}') \tag{6}$$

where: $W_i = S_i / (5 + S_i)$ and S_i is the total number of records searched in the i^{th} industry and at least 5 records were searched for every industry.

This weighting procedure gave equal weight (0.5) to Nc_{ij}' when the number of records searched equaled 5. As S_i increased, W_i approached unity and $(1 - W_i)$ approached zero, reflecting increased confidence in the second approximation for greater numbers of records searched.

Substitution of equations (1) and (5) into equation (6) yielded

$$Nc_{ij} = W_i[(1 + (c_i + d_iE_{ij}))R_iE_{ij}] + [(1 - W_i)(R_iE_{ij})] \tag{7}$$

where: $R_i = r_i/k$.

This simplified to:

$$Nc_{ij} = (W_ic_i + 1)R_iE_{ij} + W_iR_id_iE_{ij}^2 \tag{8}$$

and its computational version,

$$Nc_{ij} = \alpha_iE_{ij} + \beta_iE_{ij}^2. \tag{9}$$

It is convenient to refer to the Nc_{ij} defined by equation (9) as the imputed expected number of large combustors at a given D&B establishment.[7] However, as in the case of the first approximation, Nc_{ij}', the Nc_{ij} were comparative measures, taken to be roughly proportional to each establishment's expected number of large combustors. Although quite rough, these size measures were useful in choosing the supplementary establishments for the survey and in designing the coverage check sample.

Identification of the Supplementary Establishments. A preliminary analysis of annual Btu per employee within four-digit SIC and of distributions of these establishments by industry and employment size class[8] suggested that a survey list of 10,000 establishments would provide the desired

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[7]Note that the scaling factor, k, is not shown explicitly in equation (9) as it is in equation (2). It is included in the alpha (α) and beta (β) coefficients, however.

[8]See the previous discussion of the development of the first approximation of the projected number of combustors on page 13.

coverage of large combustors. The survey budget tentatively provided for a canvass of approximately 12,000 establishments. Deducting the 6,716 establishments in the composite list and the 2,000 allocated to the coverage check sample, a supplementary list of 3,300 establishments could be compiled from the D&B list. It was expected that adding the 3,300 nonduplicating establishments (with respect to the composite list) with the largest Nc_{ij} values would achieve the desired coverage of large combustors in the survey. Having isolated these supplementary establishments, the size distribution of the remaining D&B establishments then could be analyzed for the purposes of designing the coverage check sample. The next steps, therefore, were to compute the Nc_{ij} as described in the previous section and to determine which D&B establishments with large values were not in the composite list.

Because the size of the D&B file (409,700) made it operationally unwieldly, it was divided into a number of subclasses (see Figure 1) for purposes of computing the Nc_{ij} and subsequent processing. The initial division was by two employment size classes: 20 or more employees, 136,337 establishments, and less than 20 employees, 273,363 establishments. The break at 20 employees was chosen on the premise that few of the smaller establishments would be assigned appreciable values of Nc_{ij}. The algorithm, equation (9), was applied first to the large employment group of D&B establishments. A review of the distribution of establishments' Nc_{ij} values showed that an Nc_{ij} equal to or greater than 0.25 was assigned to 15,306 of those establishments. This file was considered manageable for manual matching to the composite list to remove duplicates.

The establishments in the less-than-20 employment group would have an Nc_{ij} value equal to or greater than 0.25 only if they were located in those four-digit SIC groups for which the α_i and β_i parameters of equation (9) satisfied the condition:

$$(\alpha_i)(19) + (\beta_i)(19)\ 2 \geq 0.25 \qquad (10)$$

This condition was satisfied by only 26 of the 470 four-digit SIC groups. These 26 industries contained a total of 2,828 establishments. Nc_{ij} values were calculated for each of these establishments and 863 had a value of 0.25 or more.

These 863 establishments, along with the 15,306 from the large employment group, were manually unduplicated against the composite list. The results of this unduplicating process are presented in Table 5. Of the 12,868 establishments which were not matched, 3,560 had an Nc_{ij} of 1.00 or more. These 3,560 establishments together with 6,716 of the composite list, yielded a total survey mailing list of 10,276 establishments.

Table 5. Results of Matching Selected D&B Records with the Composite List for all Combustor Size Classes with an Nc_{ij} of 0.25 or More.

Nc_{ij} Class	Number of Establishments			Proportion of Total Matched (π_g)
	Total	Unmatched	Matched	
10 or more.....	1,034	280	754	0.729
7.00-9.99.....	395	145	250	0.633
5.00-6.99.....	474	209	265	0.559
4.00-4.99.....	292	160	132	0.452
3.00-3.99.....	559	337	222	0.397
2.00-2.99.....	982	634	348	0.354
1.50-1.99.....	917	682	235	0.256
1.00-1.49.....	1,372	1,113	259	0.189
0.80-0.99.....	1,044	895	149	0.143
0.50-0.79.....	2,832	2,503	329	0.116
0.25-0.49.....	6,268	5,910	358	0.057
Total.....	16,169	12,868	3,301	0.204

Development of the Coverage Check Sample

While the procedures for developing the survey list were designed to provide a high degree of coverage of large combustors, they could not ensure that this objective would be attained. Therefore, a check of the coverage actually achieved had been contemplated from the inception of the project. The coverage check would serve two specific aims:

- To provide an estimate of how well the final survey list covered the target universe; and
- To provide guidance regarding any further action that might be needed to improve the coverage.

The first of these aims recognizes that the completeness of coverage is an important measure of a survey's quality, and that providing an estimate of completeness is good statistical practice. The second aim recognizes that if there are coverage deficiencies, action may be needed to correct them. The kind of action that would be appropriate would differ, depending on how the undercoverage is distributed and its depth. Although the two aims are related, they are to some extent competitive because they called for different strategies in designing the coverage check sample. These competing strategies and their reconciliation are discussed in the following pages.

Initial Allocation of the Sample

The sampling frame for the coverage check sample was the residual D&B list of 402,839 manufacturing establishments which remained after the 3,301 matched to the composite list and the 3,560 chosen to supplement it had been removed from the original D&B list of 409,700 establishments. Incidental to the earlier operations, the residual D&B list had been divided into the three groups:

Group A: 9,308 establishments with an Nc_{ij} in the range 0.25 - 0.99.

Group B: 120,142 establishments with an Nc_{ij} of less than 0.25, and with 20 or more employees.

Group C: 272,500 establishments with an Nc_{ij} of less than 0.25, and with fewer than 20 employees.

The establishments in Group A were much more likely to have large combustors than the establishments in Groups B and C. From this point of view, it was desirable to emphasize Group A in designing the coverage check sample. However, for estimating the overall coverage, it was desirable to allocate most of the coverage check sample to Groups B and C because of their high frequencies.

As previously mentioned, the survey budget provided for 12,000 establishments for the survey and the coverage check sample combined. The master survey list already contained 10,276 establishments so that a total coverage check sample of approximately 1,700 could be selected. Under some reasonable speculations regarding the allocation that would be optimum for the overall estimate, about 250 establishments would have been allocated to Group A and the remaining 1,450 or so to Groups B and C combined. But a sample of 250 would not provide subgroup estimates of sufficient reliability to identify any serious pockets of undercoverage that might exist in Group A. Determining whether there were such pockets, and if so, identifying them in terms of their characteristics--size, industry, or geographic location--was a prerequisite for any coverage improvement program. Increasing the sample from Group A to about 1,000 establishments would afford a possibility of meeting the objective. Although the standard error of the speculated optimum overall estimate would increase by 30 to 40 percent, it was felt that the additional information gained for Group A would more than offset the loss. Larger shifts would not increase the precision of the Group A estimates by much, and would seriously inflate the standard error of the overall estimate. Accordingly, 1,000 establishments were provisionally allocated to Group A, with about 700 being reserved for Groups B and C combined.

Allocation to Detailed Strata

These broad groups were further stratified by size for the purpose of selecting the sample. Separate methodologies for allocation to the strata were applied to Groups A and B/C.

Group A. The establishments of Group A were divided into three size strata, according to their values of Nc_{ij}, as shown in Table 6.

Table 6. Distribution of Group A Establishments by Size Strata

Strata	Number of Establishments	Projected Number of Large Combustors	
		Total (Nc_g)[a]	Mean ($\bar{N}c_g$)
A1: $0.80 \leq Nc_{ij} \leq 0.99$.....	895	800	0.89
A2: $0.50 \leq Nc_{ij} \leq 0.79$.....	2,503	1,569	0.63
A3: $0.25 \leq Nc_{ij} \leq 0.49$.....	5,910	2,053	0.35
Total.....	9,308	4,422	0.48

[a] Nc_g represents the total of the Nc_{ij} for stratum g.

This stratification indicated that different actions to correct coverage deficiencies might be appropriate for different size groups. For example, the establishments with Nc_{ij} values close to unity were more likely to have unacceptably high undercoverage rates than establishments with moderate or small Nc_{ij} values. If necessary, a supplementary survey to complete the coverage of the narrowly defined first stratum (A1) would be feasible. A complete survey of the smaller size classes might be unduly expensive relative to their undercoverage rates. However, a selective survey of particularly suspect establishments might be indicated.

The concept that the undercoverage rate was related to size also provided a basis for allocating the sample to the three strata. Assuming that nearly all establishments with Nc_{ij} values less than unity have either no large combustors or only one, their Nc_{ij} may be considered indices of the probabilities that those establishments have a large combustor.

For a given stratum, g, then, the probability that an establishment has a large combustor, $P(Lc_g')$, would be more or less proportional to the mean stratum size, $\bar{N}c_g$, i.e.

$$P(Lc_g') \approx s(\bar{N}c_g) \tag{12}$$

where: s = a proportionality constant.

The total number of establishments with large combustors, Lc_g', would be given approximately by

$$Lc_g' \approx s(\bar{N}c_g)(N_g) = k(Nc_g) \tag{13}$$

where: N_g = the total number of establishments in stratum g.

Allocating the total sample of n = 1,000 establishments proportionally to the Lc_g' gave

$$n_g = (sNc_g/\Sigma_g sNc_g)(1,000) = (Nc_g/\Sigma_g Nc_g)(1,000) \quad (14)$$

(for the proportionality constant, s, cancelled out), and yielded the distribution shown in Table 7.

Table 7. Allocation of Sample of 1,000, Assuming Lc_g' is Proportional to Nc_g

Strata	N_g	Nc_g	n_g	$f_g = n_g/N_g$
A1: $0.80 \leq Nc_{ij} \leq 0.99$....	895	800	181	0.202
A2: $0.50 \leq Nc_{ij} \leq 0.79$....	2,503	1,569	355	0.142
A3: $0.25 \leq Nc_{ij} \leq 0.49$....	5,910	2,053	464	0.079
Total.....	9,308	4,452	1,000	0.107

The results of matching the D&B list against the composite list provided an alternative basis for determining the sample allocation. Recall that such matching had been attempted for the 16,169 D&B establishments with an Nc_{ij} greater than or equal to 0.25. That operation yielded 3,301 matches. The results, by Nc_{ij} classes, were shown in Table 5.

It was reasonable to assume that the proportion of each class total that had been matched (π_g) indicated, roughly, the probability that an establishment in that class had a large combustor. Assuming further that the probabilities were about the same for matched and unmatched establishments in each class gave the relation

$$P(Lc_g") \approx s"\pi_g \quad (15)$$

which, in turn, gave

$$Lc_g" \approx s"\pi_g N_g \quad (16)$$

as the expected number of unmatched establishments with large combustors. The sample allocation for the three strata of Group A then was computed as

$$n_g = (\pi_g N_g/\Sigma_g \pi_g N_g)(1,000) \quad (17)$$

with the results presented in Table 8.

Table 8. Allocation of Sample of 1,000 Assuming Lc_g" is Proportional to $\pi_g N_g$

Strata	N_g	π_g	$\pi_g N_g$	n_g	$f_g = n_g/N_g$
A1: $0.80 \leq Nc_{ij} \leq 0.99$....	895	0.143	128.0	170	0.190
A2: $0.50 \leq Nc_{ij} \leq 0.79$....	2,503	0.116	290.3	384	0.153
A3: $0.25 \leq Nc_{ij} \leq 0.49$....	5,910	0.057	336.9	446	0.075
Total.....	9,308	0.081	755.2	1,000	0.107

A comparison of Tables 7 and 8 indicates that the two methods produced very similar allocations to the strata.

In view of the fact that the coverage of large combustors could be improved as well as evaluated by this sample, it was decided to adjust the allocation to emphasize the strata with the highest likelihood of having a large combustor, i.e., the two strata with an Nc_{ij} greater than 0.50. This was accomplished by allocating the sample to the strata proportional to $\pi_g Nc_g$. These allocations are shown in Table 9 and were calculated by the formula:

$$n_g = (\pi_g Nc_g / \Sigma_g \pi_g Nc_g)(1{,}000). \qquad (18)$$

Table 9. Allocation of Sample of 1,000, Taking n_g Proportional to $\pi_g Nc_g$

Strata	π_g	Nc_g	$\pi_g Nc_g$	n_g	N_g	$f_g = n_g/N_g$
A1: $0.80 \leq Nc_{ij} \leq 0.99$..	0.143	800	114.4	277	895	0.309
A2: $0.50 \leq Nc_{ij} \leq 0.79$..	0.116	1,569	182.0	440	2,503	0.176
A3: $0.25 \leq Nc_{ij} \leq 0.49$..	0.057	2,053	117.0	283	5,910	0.048
Total.....	0.081	4,422	413.4	1,000	9,308	0.107

The sampling fractions, f_g, so derived, then were converted to convenient integral sampling fractions, $\ddot{f}_g$, and then final samples, $\ddot{n}_g$, were selected. These fractions and sample sizes are presented in Table 10.

Table 10. Final Sampling Fractions and Sample Size for the Strata of Group A

Strata	N_g	f_g	$\ddot{f}_g$	n_g	$\ddot{n}_g$
A1: $0.80 \leq Nc_{ij} \leq 0.99$.....	895	0.309	1/3	277	298
A2: $0.50 \leq Nc_{ij} \leq 0.79$.....	2,503	0.176	1/6	440	417
A3: $0.25 \leq Nc_{ij} \leq 0.49$.....	5,910	0.048	1/20	283	296
Total.....	9,308	0.107	0.109	1,000	1,011

Group B/C. The budget for the coverage check sample allowed for a maximum of 689 establishments to be selected from Group B/C (1,700 less than 1,011 selected from Group A). The total number of establishments in Group B/C was quite large. It included 392,642 establishments -- 120,142 with 20 or more employees and 272,500 with less than 20 employees. Because of its large size, stratifying it by the two employment size classes, and within these, by Nc_{ij} values, appeared desirable.

The distribution by Nc_{ij} values was available for the larger employment group. It was not available, however, for the less-than-20 employee group, because the Nc_{ij} values had not been assigned to the bulk of those establishments. For the joint purposes of estimating the distribution and producing a frame from which a final sample could be drawn, a systematic random sample of 545 establishments (1/500) was selected. This sample then was poststratified into the two size groups: establishments with Nc_{ij} values of 0.05 or less and those with larger Nc_{ij} values. The 20-or-more employee group similarly was divided into two strata: one which included all establishments with Nc_{ij} values less than 0.10 and one which included the remaining establishments. The resulting stratum frequencies, N_g, and corresponding projected numbers of large combustors, Nc_g, are shown in Table 11 on the next page.

The next step was to allocate the sample of n = 689 establishments to the four strata. This was done by examining a proportional and theoretically optimum allocation, and striking a compromise between those two methods.

The proportional allocation method distributed the sample according to the known (or estimated) total number of establishments in each stratum, N_g, i.e., by the formula

$$m_g = (n)(N_g/\Sigma_g N_g). \tag{19}$$

The theoretically optimum allocation method distributed the sample, instead, by the formula

$$\ddot{m}_g = (n)(N_g \bar{N}c_g^{1/2}/\Sigma_g N_g \bar{N}c_g^{1/2}). \tag{20}$$

Table 11. Distribution of Establishments with Nc_{ij} Values Less than 0.25 By Stratum

Strata	Number of Establishments (N_g)	Projected Number of Large Combustors (Nc_g)	Mean Per Establishment ($\bar{N}c_g$)
Employment of 20 or more			
B1: $0.10 \leq Nc_{ij} < 0.25$....	11,684	1,880	0.1609
B2: $Nc_{ij} < 0.10$.....	108,458	2,667	0.0246
Employment of less than 20			
C1: $0.05 \leq Nc_{ij} < 0.25$....	4,500[a]	345[a]	0.0767
C2: $Nc_{ij} < 0.05$.....	268,000[a]	736[a]	0.0028
Total.....	392,642	5,628	0.0143

[a]Estimated from sample.

This theoretically optimum allocation had the following rationale. Under stratified random sampling, the ordinary linear unbiased estimate of the total number of establishments having large combustors would be

$$Lc' = \Sigma_g(N_g/n_g)lc_g \tag{21}$$

where: N_g and n_g are, respectively, the total and sample numbers of establishments and lc_g is the sample number with large combustors for each stratum, g. The corresponding variance of Lc' would be

$$Var(Lc') = \Sigma_g N_g^2[(N_g - n_g)/(N_g - 1)n_g](P_g - P_g^2) \tag{22}$$

where: $P_g = L_g / N_g$, the proportion of the establishments in stratum g that have large combustors. Assigning the n_g such that

$$n_g = (n)[(N_g)(P_g - P_g^2)^{1/2}]/[\Sigma_g(N_g)(P_g - P_g^2)^{1/2}] \tag{23}$$

would minimize Var(Lc). When the P_g are small, as expected here, the approximation

$$n_g = (n)(N_g P_g^{1/2})/\Sigma_g N_g P_g^{1/2} \tag{24}$$

is highly satisfactory. Assuming that almost none of the establishments would have more than one large combustor (as was done for Group A), the mean projected number of large combustors per stratum, $\bar{N}c_g$, could be taken as roughly proportional to the P_g. Substituting $\bar{N}c_g$ for P_g in equation (24) yielded

$$n_g = (n)(N_g \bar{N}c_g^{1/2}/\Sigma_g N_g \bar{N}c_g^{1/2}) \tag{25}$$

which is the same as equation (20).

Table 12 on page 30 shows the sample allocations, m_g and $\tilde{m}_g$, for these two methods, and their comparative variances under the assumption that the $\bar{N}c_g$ are satisfactory proxies for the P_g. The variance resulting from the theoretical optimum allocation approach was 64 percent of that produced by proportional allocation indicating that the optimum allocation was substantially better than proportional sampling, provided that the assumed relationship, $P_g = s\bar{N}c_g$, was valid.

The validity of this assumption was not known, however. If it were seriously in error, the allocation based on it could lead to poorer results than simple random sampling. Proportional sampling, on the other hand, seldom produces poorer results than random sampling. As a compromise which would afford protection against any gross disparities between the assumed and actual relations, the theoretical optimum and proportional sample sizes were averaged, and convenient sampling fractions corresponding approximately to those average sample sizes were assigned. The results are shown in Table 13 on page 31. As the comparative total variances indicate, the conservative shift toward proportional sampling increased the variance over that of the theoretical optimum design by merely 6 percent.

The totals in Table 13 are smaller than the corresponding totals in Table 12 because of the use of the convenient assigned sampling fractions.

Final Mailing List

The 674 selected establishments with Nc_{ij} less than 0.25 along with the 1,011 selected from the group with an Nc_{ij} in the range of 0.25 - 1.00 yielded a total sample of 1,685 establishments for the coverage check sample. Together with the 10,276 establishments in the survey list, they gave a combined total of 11,961 establishments to which questionnaires were mailed. The complete mailing list is summarized in Table 14 on page 32.

Table 12. Proportional and Theoretically Optimum Sample Allocation and Comparative Variances, Establishments with Nc_{ij} Values less than 0.25.

Strata	Total number of Establishments	Sample Allocation		Comparative Variances	
		Proportional	Theoretically Optimum	Proportional	Theoretically Optimum
Employment of 20 or more					
B1: $0.10 \leq Nc_{ij} < 0.25$...	11,684	21	87	876,172	210,293
B2: $Nc_{ij} < 0.10$.....	108,458	190	317	1,482,962	887,799
Employment of less than 20					
C1: $0.05 \leq Nc_{ij} < 0.25$...	4,500	8	23	178,977	62,045
C2: $Nc_{ij} < 0.05$.....	268,000	470	262	410,772	737,454
Total.....	392,642	689	689	2,948,883	1,897,591

Table 13. Comparison of Assigned and Theoretical Optimum Sample Allocations, Establishments with Nc_{ij} Values Less Than 0.25

Strata	Assigned Sampling Fraction	Sample Number		Comparative Variance	
		Assigned	Theoretically Optimum	Assigned	Theoretically Optimum
Employment of 20 or more					
B1: $0.10 \leq Nc_{ij} \leq 0.25$....	1/200	59	85	310,841	215,278
B2: $Nc_{ij} < 0.10$.....	1/400	271	310	1,038,937	907,905
Employment of less than 20					
C1: $0.05 \leq Nc_{ij} \leq 0.25$....	1/500	9	23	159,055	62,045
C2: $Nc_{ij} < 0.05$.....	1/800	335	256	556,598	754,755
Total.....	0.00172	674	674	2,065,431	1,939,983

Table 14. Components of the Final Mailing List

Source	Number Contributed	Percent
Composite List.....	6,716	56.1
Supplementary List.....	3,560	29.8
Subtotal--Survey List.....	10,276	85.9
Coverage Check Sample.....	1,685	14.1
Total--Final Mailing List.....	11,961	100.0

4. SURVEY IMPLEMENTATION

In order not to disrupt the normal business operations of the respondents, the establishments on the final mailing list were sorted by parent corporation. Each corporation or company which was identified as having more than one establishment on the list was contacted by telephone to determine whether they preferred to coordinate all reporting for that company through one centralized location or have each establishment contacted separately. In every instance, these multi-establishment corporations chose to have all reporting done through a central office contact. This accounted for approximately two-thirds of the establishments on the final mailing list.

Mailing began on November 17, 1980, and continued for 3 weeks. Each establishment received a letter from the Administrator of EIA, a glossary of terms, one copy of Section I of the questionnaire, which collected information on establishment energy use, and five copies of Section II, which collected information on the individual large combustors at the establishment.[1] (See Appendix A.) Respondents were asked to return the completed forms within 20 calendar days.

A notice (see Appendix B) was placed in the Federal Register (November 24, 1980, page 77507) stating the forms had been mailed and that establishments which fell within the scope of the study and did not receive forms were required to contact the survey control office for inclusion in the study. The instructions and the Federal Register notice contained a toll-free "800" telephone number where inquiries regarding the study could be made. This resulted in establishments being added to the original mailing list.

Two weeks after the initial mailing, a postcard was sent to each establishment on the mailing list advising that the response would be due in 10 days. During the last week in January, a follow-up letter was mailed to establishments and parent companies which had not asked for an extension advising that their report was now overdue. Both of these notices generated requests for additional time.

A great many calls were received in the early part of the study[2] requesting additional time to complete the form. It was common practice to grant

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[1]Respondent consultations led to the conclusion that 5 copies would be adequate for 90 to 95 percent of the reporting establishments.

[2]Between December 1980 and the end of February 1981, approximately 2,600 calls were received. The nature of the calls changed over time. Initially, there were inquiries concerning who had to report and why, as well as requests for time extensions for reporting. Subsequently, the calls dealt with problems the respondent was having with specific questions--clarifying definitions and intent.

such requests and, because of the volume of the calls, it was decided to publicize this practice. As a result, a notice was placed in the December 31, 1980, Federal Register (page 86531) advising that any reasonable request for an extension would be granted (see Appendix B).

Requests for extensions were received primarily from those corporations having several establishments which were required to report. Most respondents requested an additional 4 to 6 weeks because the forms had arrived at the establishment during the holiday season between Thanksgiving to New Years when a large number of the people who would be completing them were on vacation.

On February 20, 1981, the Secretary of Energy received a letter (see Appendix C) from the Office of Management and Budget advising that EIA's data collection authority for the study had been withdrawn. At that point, all data collection activity was terminated including subsequent follow-up for error resolution on specific responses. A notice (see Appendix B) appeared in the Federal Register on March 5, 1981, (page 15312) advising that the study had been cancelled.

5. THE FINAL SURVEY FRAME AND SURVEY RESPONSE

As described previously, this study was originally designed to collect fuel consumption characteristics and other information on all large combustors and the establishments which operated them. As a result of the withdrawal of authority for this survey, the original goal of obtaining a complete census was not achieved.

This section of the methodology report examines response and nonresponse to the survey. Subsequent sections address methods of error resolution, nonresponse adjustments and bias, and confidentiality procedures--issues which are central to the use and interpretation of the data.

Final Survey Frame

Questionnaires were mailed to a total of 12,369 establishments: 10,276 on the survey list, 1,685 in the coverage check sample, and 408 from establishments which requested forms as a result of the announcement in the Federal Register on November 24, 1980.

As described previously, a substantial effort was made to unduplicate the final mailing list and to exclude from it those establishments which were not intended for inclusion (e.g. nonmanufacturing establishments). Such efforts seldom produce perfectly clean lists, however, because of inconsistencies from sublist-to-sublist such as different versions of corporate names. The initial mailing of 12,369, therefore, could not be considered to be a final survey frame because it undoubtedly contained many of these inconsistencies.

The final frame for this survey was not fully defined until the end of June 1981 when a preliminary analysis of the mailing and receipt operations was completed. This analysis resulted in the exclusion of 1,913 establishments, yielding a final survey frame of 10,456. Four broad types of exclusions were identified.

- Establishments which were not in the 50 States or the District of Columbia were excluded.

- Establishments which were out-of-business were excluded. These consisted of establishments which were unlocatable (i.e. returned by the U.S. Postal Service) and presumed to be out-of-business and those which were returned and known to be out-of-business with no successor.

- Establishments which were out-of-scope were excluded. These consisted of establishments which were Government-operated, nonmanufacturing, or under construction.

- Duplicate listings which were returned by recipients and designated accordingly were excluded.

The mailing list, exclusions, and the final survey frame are summarized by major source in Table 15.

Table 15. The Final Survey Frame by Source

	Total	Survey List	Coverage Check	Other[a]
Forms Mailed.....	12,369	10,276	1,685	408
Less				
Not in U.S.[b].....	61	57	1	3
Subtotal.....	12,308	10,219	1,684	405
Less				
Out-of-Business[c].....	417	328	89	-
Out-of-Scope[d].....	728	370	52	303
Duplicate Listings.....	707	684	19	4
Final Survey Frame.....	10,456	8,837	1,524	98

[a]Establishments which requested forms as a result of the Federal Register notice on November 24, 1980.
[b]The 50 States and the District of Columbia.
[c]Unlocatable establishments and those reported to be out-of-business with no successor.
[d]Establishments which were Government-operated, engaged primarily in a nonmanufacturing activity, or under construction.

Response to the Survey

In general, there were four types of acceptable responses to this survey.[1]

1. The recipient either telephoned or wrote a letter saying that no large combustors were operated but did not return the questionnaire.

[1]Postal Service returns, notification of the receipt of duplicate questionnaires, etc., were not counted as an acceptable response.

2. The recipient returned Section I of the questionnaire stating that no large combustors were operated.

3. The recipient submitted a Section I but the use of a large combustor was not ascertainable.

4. The recipient submitted completed questionnaires indicating that large combustors were operated.

Table 16 summarizes the responses to the survey by these four categories of acceptable responses.

Table 16. Acceptable Response by Response Category and Source

Category	Total Establishments	Survey List	Coverage Check	Other[a]
Letter/No Large Combustor.....	50	50	--	--
Section I/No Large Combustor...	5,341	4,318	1,023	--
Section I/Large Combustor Unknown.....	94	93	--	1
Large Combustor(s) Reported....	2,498	2,354	47	97
Total Response.....	7,983	6,815	1,070	98
Response Rate[b].....	76.4	77.1	70.2	100.0

[a]Establishments which requested forms as a result of the Federal Register notice on November 24, 1981.

[b]The response rate is expressed as a percent of final survey frame or its components.

As can be seen from this table, the overall response rate to this survey was 7,983, or 76.4 percent of the final survey frame. Of these responses, 2,498 establishments are known to operate large combustors.

6. ADJUSTMENT FOR NONRESPONSE

As a result of the withdrawal of data collection authority, data were collected on a sample of establishments and combustors rather than on the population as orginally intended. The sample which resulted may or may not be representative of the original population. To the extent that it is nonrepresentative (i.e., certain groups or types of establishments are systematically excluded), the sample may be said to be subject to nonresponse error or bias.

Possible Sources of Nonresponse Error

There is no reasonable way of ascertaining whether a nonresponse bias actually exists and, if it does, the extent to which it impacts on the results. It is possible, however, to compare the distributions of boilers in this study to the results of the MFBI file[1] to develop some general understanding of the possible existence of a bias. Recall that the MFBI file contributed 2,817 establishments to the composite list (see Table 3). Of these, 1,052 establishments were reported on the MFBI survey as having at least one boiler with a maximum design firing rate of 100 million Btu or more per hour. From the survey control records of the current study, it was possible to classify these 1,052 MFBI establishments by the EIA-463 status classifications of response, nonresponse, or exclusions. This classification is reproduced in Table 17.

Table 17. Classification of MFBI Establishments with Large Boilers by EIA-463 Status

EIA-463 Status	MFBI Establishments	Large Boilers (MFBI) Number	Large Boilers (MFBI) Mean
Response.....	709	2,199	3.10
Nonresponse.....	220	752	3.42
Exclusions[a].....	123	444	3.61
Total.....	1,052	3,395	3.23

[a]Exclusions consists of establishments on the mailing list which were out-of-business, out-of-scope, or duplicates.

[1]This analysis must be confined to large boilers only because other large combustors were excluded from MFBI.

Table 17 provides some evidence that the nonresponding MFBI establishments in the EIA-463 survey had, on the average, larger numbers of MFBI boilers than those which did respond. This is a reasonable generalization because the establishments with larger numbers of combustors would have been likely to have requested and been granted time extensions beyond the date that the EIA-463 survey was terminated.

A similar analysis was undertaken of the MFBI boilers by status and three classes of maximum design firing rate of the boilers. These results are presented in Table 18.

Table 18. MFBI Boilers by EIA-463 Status and Maximum Design Firing Rate

EIA-463 Status	Total	Maximum Design Firing Rate (millions of Btu per hour) 100-249	250-499	500 and over
Response.....	2,199	1,611	467	121
Percent.....	100.0	73.3	21.2	5.5
Nonresponse.....	752	516	195	41
Percent.....	100.0	68.6	25.9	5.4
Exclusions[a].....	444	312	99	33
Percent.....	100.0	70.3	22.3	7.4
Total.....	3,395	2,439	761	195
Percent.....	100.0	71.8	22.4	5.7

[a]Exclusions consist of establishments on the mailing list which were out-of-business, out-of-scope, or duplicates.

This table provides some evidence that nonresponding establishments in the EIA-463 survey had, on the average, somewhat larger MFBI boilers than the responding establishments. However, there was no apparent nonresponse bias among establishments with the largest MFBI boilers (500 million or more Btu per hour).

The analyses presented in Tables 17 and 18 relate to MFBI boilers only. A direct comparison between the MFBI boilers and the boilers reported in this survey is also relevant. Table 17 shows that 2,199 boilers were included in the receipt category entitled "response." Table 19 compares the distributions of these MFBI boilers with the boilers actually reported on this survey by the same establishments. The EIA-463 boilers shown in this table are those with a maximum design firing rate of 100 million or more Btu-per-hour with an installation date of 1975 or earlier. In theory, these two distributions should be the same except for those boilers which had been taken out of service between 1975 and 1979.

Table 19. Comparison of Distributions of Boilers from the MFBI Survey and the EIA-463 Survey by Maximum Design Firing Rate

	Total Boilers	Maximum Design Firing Rate (millions of Btu per hour)		
		100-249	250-499	500 and over
MFBI Boilers.....	2,199	1,611	467	121
Percent.....	100.0	73.3	21.2	5.5
EIA-463 Boilers.....	2,403	1,700	541	162
Percent.....	100.0	70.7	22.5	6.7
Increase on EIA-463...	204	89	74	41
Percent Change.....	+9.3	+5.5	+15.9	+33.9

Table 19 shows, however, that respondents to the EIA-463 reported more pre-1976 boilers with a maximum design firing rate of 100 million or more Btu-per-hour than respondents to the MFBI survey. This would indicate that responses to the EIA-463 were more complete than responses to the MFBI survey.

In summary, comparisons between the results of the MFBI survey and the EIA-463 survey provide limited evidence that:

- Response to the EIA-463 may have been somewhat biased against establishments operating large numbers of boilers and large boilers (250-499 million Btu per hour).
- Those establishments which did respond to the EIA-463 survey did so in an accurate manner.

The Weighting Procedure

In order to approximate complete response levels, and to ameliorate the effect of a likely nonresponse bias, ratio estimation techniques were developed to estimate the total annual consumption of purchased fuels by large combustors. The weighting procedures were only used for the consumption information because the technique was inappropriate for estimating the number of large combustors in the population. In ratio estimation, an auxiliary variable which is known to be correlated with the sample variable (in this case, the consumption of purchased fuels) is obtained for each unit of the sample frame. Population totals are then estimated from

sample totals by taking advantage of the correlation between these two variables. The basic approach uses the following equation:

$$Y_g = W_g X_g \tag{26}$$

where: Y_g = the ratio estimate of the population total for the g^{th} stratum

W_g = the weight derived from the ratio of value of the auxiliary variable for the sampling frame to the value of the auxiliary variable for the responders to the survey for the g^{th} stratum

X_g = the value of the sample variable for the g^{th} stratum.

In this study, recall that during the process of sample selection, the projected number of combustors, Nc_{ij}, was estimated for establishments on the survey list. This value was chosen as the auxiliary variables for the ratio estimates because it should be fairly highly correlated with actual energy consumption in large combustors in 1979.

Prior to weighting, the mailing list had been stratified into Nc_{ij} size classes and, within these classes, by four-digit SIC groups. In all, five Nc_{ij} classes were specified as follows:

- Class 1: Nc_{ij} equal to or greater than 10.0
- Class 2: Nc_{ij} equal to or greater than 4.0 but less than 10.0
- Class 3: Nc_{ij} equal to or greater than 1.5 but less than 4.0
- Class 4: Nc_{ij} equal to or greater than 1.0 but less than 1.5
- Class 5: Nc_{ij} less than 1.0.

Within each of these Nc_{ij} classes, four-digit SIC industries were identified which had 20 or more responding establishments. In cases where the number of responding establishments was less than 20, four-digit industries were combined until the required minimum was reached. Weighting factors were developed separately for each SIC group within Nc_{ij} class using the following formula:

$$W_{gh} = (X_{gh} - Y_{gh})/(X_{gh} - Y_{gh} - Z_{gh}) \tag{27}$$

where: W_{gh} = the weighting factor for the h^{th} SIC group in the g^{th} Nc_{ij} class

X_{gh} = the sum of projected number of large combustors for the establishments in the mailing list

Y_{gh} = the sum of the projected number of large combustors for out-of-business establishments

Z_{gh} = the sum of the projected number of large combustors for nonresponding establishments.

As shown in equation (27), the projected number of large combustors for the out-of-business establishments was excluded from the calculation of weights and duplicates were included. This was done on the basis that nearly all out-of-business establishments had been identified through the sample selection process and returns by the U.S. Postal Service, but that out-of-scope and duplicate responses would have continued to be received had more establishments responded to the survey.

A total of 181 weights were developed for specified SIC groups within these five Nc_{ij} classes. These weights had an overall weighted mean of 1.378 with a minimum value of 1.000 and a maximum of 2.824. Table 20 presents some characteristics of these distributions for each of the five Nc_{ij} groups. It can be seen from this table that, except for the Nc_{ij} class of ten or more, the ranges of weights are fairly narrow and consistent.

Table 20. Parameters of Distributions of Weighting Factors

Range of Nc_{ij}	Weighting Factors			
	Minimum	Maximum	Weighted Means	Number of SIC Groups
10.00 or more.....	1.000	2.824	1.418	20
4.00 - 9.99.....	1.000	1.580	1.221	28
1.50 - 3.99.....	1.000	1.743	1.261	51
1.00 - 1.49.....	1.033	1.754	1.271	38
Less than 1.00.....	1.001	1.482	1.182	47

As previously noted, this procedure was used for establishments on the mailing list for which an Nc_{ij} value was available. There were also, however, a group of manufacturing establishments for which an Nc_{ij} value was not available because of the nonavailability of an establishment employment estimate from the source list. In these cases, the appropriate sums of the numbers of establishments were substituted for the sums of the projected number of large combustors in equation (27). This method of estimation is generally referred to as simple expansion. For this special group of establishments (without Nc_{ij} values), the minimum weight was 1.100 and the maximum was 1.778 with a weighted mean of 1.360.

Accuracy of the Weighted Results

As pointed out previously, ratio estimators are most useful when there is a high correlation between the sample variable and the auxiliary variable.

These correlations are unknown for the establishments on the mailing list, but it was possible to estimate them from the responding establishments which reported using a large (50-million or more Btu-per-hour) combustor. In all, there were 2,354 such establishments.[2] Of these, 2,001 also had an Nc_{ij} value available. These establishments were used to develop correlations between the total annual Btu consumption by large combustors (the sample variable) and the projected Nc_{ij} (the auxiliary variable).

In general, it was expected that there would be little if any correlation between Nc_{ij} and the Btu consumption of large combustors for establishments across SIC groups within Nc_{ij} groups. It was expected that fairly high correlations would be found within SIC groups, however. This is due to the fact that Nc_{ij} functions were developed uniquely for establishments within four-digit SIC industries (see previous discussions). Correlation coefficients developed from a set of values spanning several heterogeneous SIC groups would therefore be expected to be zero or nearly so. By a similar line of reasoning, it was also expected that correlations within SIC groups would be low when the group contained several heterogeneous four-digit industries which had been combined in order to fulfill the requirements of having 20 mailing list establishments per SIC group (see above).

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[2]Responses were also received from 144 establishments in the coverage check sample or in response to the notice in the Federal Register. This yields a total of 2,498 responding establishments. See Table 13.

By and large, these expectations were confirmed. None of the correlations across SIC groups within the Nc_{ij} groups were significantly different from zero.[3] Within the Nc_{ij} group of 10 or more, 13 of the 20 SIC groups had positive correlations which are significantly different than zero. These correlations range from 0.32 to 0.97. All of these SIC groups with significant correlations contained either one four-digit SIC or were dominated by one or two closely related four-digit SIC's. The seven SIC groups which did not reach significance contained either a large number of four-digit SIC's with none dominant or the four-digit SIC which did dominate was a "not elsewhere classified" industry group, usually a heterogeneous collection of establishments with a low product specialization ratio.

Significant correlations were far less frequent within the SIC groups of the other four Nc_{ij} classes. Specifically, out of 164 SIC groups comprising these 4 classes, only 10 were positive and significantly different from zero. At least two causes of this situation can be identified. First, of the 154 nonsignificant SIC groups, 144 had fewer than 20 respondents with a large combustor and 98 had fewer than 10. In general, significant correlations become progressively more difficult to find as the sample size decreases. For example, with one-tail probability set at 0.05 and a sample size of 20, all correlations of less than 0.38 would be rejected as not significantly different from zero. With a sample size of 10, all correlations of less than 0.55 would be rejected. Moderate correlations may actually exist which were undetectable with these small sample sizes.

The second possible reason for the large number of nonsignificant correlations in these four Nc_{ij} groups is that the SIC classes tended to be heterogeneous, that is, the SIC classes contained several unrelated SIC industries. As noted previously, this would tend to result in nonsignificant correlations within the SIC groups.

Heterogeneity seems to be more of an intractable problem than small sample size. With the fairly large number of significant correlations which were found in the homogeneous SIC groups of the Nc_{ij} group of 10 or more, it is reasonable to assume that had sample sizes been larger in the other Nc_{ij} - SIC groups, a substantially larger number of significant correlations would have been found for those which were homogeneous.

In other words, the population correlation coefficients for homogeneous SIC groups are probably positive and high. Increased sample sizes, however, would probably not have resulted in increased numbers of significant correlations in the heterogeneous groups because the population correlation coefficient probably approaches zero. Overall, however, it is reasonable to assume that the correlations were significantly high to warrent the use of Nc_{ij} as the auxiliary variable in the development of the nonresponse weights for this survey.

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[3]One-tail probabilities were all greater than 0.05.

This weighting procedure will, to some extent, compensate for the possible nonresponse biases identified in the previous section but the weighted numbers may still be subject to other problems. Inherent in the entire weighting procedure is the basic assumption that fuel use patterns and other combustor and establishment characteristics are invariant with respect to respondents and nonrespondents. The strength of this assumption is not known. Finally, there may be other nonresponse errors or biases which are present in the sample and not compensated for by the weighting procedure.

Given these limitations, however, it is possible to attach a very rough margin of error to the weighted estimates. Assuming that the weights developed for these SIC groups with significant correlations result in reasonably accurate weighted totals of Btu consumed for these groups and that the weights for remaining groups are in error by as much as 25 percent in estimating Btu consumption for nonrespondents, total estimated Btu consumption by the population of large combustors could be in error by as much as 3.8 percent. If it assumed that all nonrespondent estimates are in error by 25 percent, the overall error in Btu consumption would be 6.3 percent.[4] It is felt that these error rates are reasonable and will prevail as long as the data are fairly highly aggregated. Undoubtedly, error rates would increase with increased disaggregation.

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[4]Increasing nonresponse errors from 25 to 50 percent results in overall error rates of 7.6 percent if confined to nonsignificant SIC's and 12.5 percent if assumed for all SIC groups.

7. ERROR RESOLUTION

Normal error resolution procedures followed by the EIA consist of respondent follow-up for omitted or suspect questionnaire entries which have been identified through a computer edit consisting of range checks, consistency checks, etc. For this survey, normal procedures for error resolution were precluded because of the withdrawal of data collection authority by OMB. In lieu of direct respondent follow-up, therefore, a series of edit checks were developed along with appropriate internal error resolution procedures. Most of these checks and recodes focused on Section II of the questionnaire with reference to Section I as appropriate and necessary.

Description of Error Resolution Procedures for Section II

Item 2: Identification of Combined Cycle Units (CCU)

Only combinations of fired components consisting of a gas turbine or an internal combustion engine with one or more fired boilers were accepted as CCU's. All others were appropriately recoded.

Item 3: Kind of Combustors

All single entries in Item 3 were checked and recoded based upon responses to Items 4 and 5. Inappropriate multiple entries were recoded as appropriate single entries based upon specially developed fuel tests or efficiency tests.

Items 4a and 4b: Boiler Operation

When flow rate entries for both steam and hot water were present, the appropriate one was selected based upon ratios of the maximum design firing rate to these entries. Flow rates were also subjected to a range check. Where possible, range check failures were corrected from other data in the questionnaire supplied by the respondent.

Item 4c: Functional End Use

For hot water boilers, only the functional end uses of (1) space-heating, and (2) process heat were acceptable. Other entries were deleted.

Item 5: Shaft Power

For a gas turbine or internal combustion engine, the entries for electricity generation (kw) or mechanical drive (hp) were subjected to a range check. Failures which were physically possible were accepted. Others were double-checked based on other responses and were corrected, if possible; otherwise, they were deleted.

Item 7: Fuel Design and Use

Several checks were performed on the data reported in this item. The first was a consistency check between the amounts of specific fuels consumed in all combustors of a given establishment with the total amount of that fuel consumed at the establishment level as reported in items 8 and 9 of Section I. Discrepancies of up to 5 percent were accepted. Large discrepancies were corrected, if possible, based on other information supplied by the respondent.

A range check was also performed on the amounts of fuel consumed by a given combustor. Acceptable ranges were established for solid and liquid fuels, blast furnace gas, and all other gaseous fuels. Range check failures were adjusted, if possible, based on other data.

Finally, all fuels consumed by a given combustor were converted to Btu and summed. This total was divided by the product of the usual design firing rate (Item 10) and the hours used at this rate (Item 13). Ratios within the range of 0.2 to 5.0 were acceptable. This broad range was established because waste heat inputs, extensive periods of banking, various interpretations of "usual," or difficulty in estimating hours could lead to substantial variations in the ratio. This test was particularly useful in identifying and correcting entries which reported gaseous fuels in cubic feet rather than in thousands of cubic feet (mcf) as requested.

Item 9: Combustor Size

The major edit for this item consisted of estimating the maximum design firing rate when it had not been entered by the respondent. These "provisional MDFR" estimates were prepared by one of the following approaches as appropriate:

Steam flow rate	X	1,350.00
Hot water flow rate	X	1.25
Shaft power (kw)	X	22,700.00
Shaft power (hp)	X	30,500.00

This approach produced approximate values suitable for categorizing combustors into MDFR classes but which lacked the precision for accurate MDFR values.

8. SUPPRESSION OF CONFIDENTIAL INFORMATION

When the Office of Management and Budget withdrew data collection authority for this survey, it also specified that "... the data already collected be treated in a confidential manner." Several steps were taken to assure compliance with this requirement.

- All identifying information was physically separated from the rest of the questionnaire and was destroyed prior to keytaping and all remaining hard copy questionnaires were destroyed after keytaping.

- Separate random identification numbers were assigned Section I (establishment report) and Section II (combustor report) of questionnaires from the same respondent so that combustors could not be linked to specific establishments.

- Standard Industrial Classification codes, geographic identification, and employment was collapsed so that no cell was dominated by a single establishment or combustor beyond a specified level of dominance.

The basic units of analysis for dominance were the cells resulting from crossing SIC codes with employment levels. In this collapsing process, SIC codes were given priority for maintaining maximum detail. As a result, it was often necessary to confound the geographic dimension.

For example, a given four-digit SIC level may have passed the dominance test when considered by itself. When crossed with the geographic dimension, however, the resulting cells could fail the dominance test. In order to avoid collapsing the SIC codes, the geographic dimension was confounded by classifying the establishments into two or more of the cells. Thus, within a given SIC code, the same set of establishments may appear in two or more geographic regions. Data users should consider this deliberate confounding when performing an analysis by geographic regions.

Appendix A

QUESTIONNAIRE AND OTHER MATERIALS

Department of Energy
Washington, D.C. 20585

We need your help...

The U.S. Department of Energy is collecting information on energy consumption in manufacturing establishments (plants) which have large combustors of the types cited in the Powerplant and Industrial Fuel Use Act of 1978. These are stationary units consisting of a boiler, gas turbine, internal combustion engine, or combinations of combustors referred to as combined cycle units, with a maximum design firing rate of 50 million Btu per hour or greater. We have asked Westat, Inc., a research firm located in Rockville, Maryland, to help us in this data collection effort.

The survey form enclosed, Form EIA-463, consists of two sections. Section I deals with overall establishment (plant) information. (The definition of an establishment is the same as that used by the U.S. Bureau of the Census.) If your establishment does not operate any combustors of the kind cited, only Section I need be filled out. Section II deals with individual combustors. A separate Section II is to be filled out for each combustor.

Response to this survey is mandatory under the Federal Energy Administration Act of 1974 and the Powerplant and Industrial Fuel Use Act of 1978. Failure to respond may result in criminal fines, civil penalties, and other sanctions as provided by law. Refer to the instructions on the form for information regarding the confidentiality of the survey.

Please return your completed survey forms within twenty (20) calendar days after receipt. A postage-paid addressed label is enclosed for your use. If you have questions about this survey, please write or telephone:

Mr. Stephen J. Dienstfrey
U.S. Department of Energy
Industrial Survey Manager
P.O. Box 2100
Rockville, MD 20852
(800) 638-6584

The data collected in this survey will provide important information on current energy use and help the Department of Energy administer its programs in an effective and equitable manner. Your cooperation will be very much appreciated.

Sincerely,

Albert H. Linden, Jr.
Acting Administrator
Energy Information Administration

4 Enclosures
Section I (1)
Section II (5)
Instructions and Glossary of Terms
Postage-paid Addressed Mailing Label

FORM EIA-463
SECTION I

UNITED STATES
DEPARTMENT OF ENERGY
ENERGY INFORMATION ADMINISTRATION

FORM APPROVED
OMB NUMBER 038-S80011

1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors

SAMPLE COPY FOR
INFORMATIONAL PURPOSES ONLY.

This report is mandatory under the Federal Energy Administration Act of 1974, P.L. 93-275, and the Powerplant and Industrial Fuel Use Act of 1978, P.L. 95-620. Failure to respond may result in criminal fines, civil penalties and other sanctions, as provided by law.

The information reported on these forms may be (i) information that is exempt from disclosure to the public under the exemption for trade secrets and confidential commercial information specified in the Freedom of Information Act, 5 USC 552 (b) (4) (FOIA), or (ii) prohibited from public release by 18 USC 1905. However, before the determination can be made that particular information is within the coverage of either of these statutory provisions, the person submitting the information must make a showing, satisfactory to the Department of Energy, concerning its confidential nature.

Therefore, respondents wishing to claim such exemption must state specifically (on an element by element basis, if possible) in a letter accompanying submission of this form, why they consider the information concerned to be a trade secret or other proprietary information, whether such information is customarily treated as confidential information by these companies and the industry, and the type of competitive harm that would result from disclosure of the information. In accordance with the provisions of 10 CFR 1004.11, DOE's Freedom of Information Act Regulations, DOE will determine whether the information submitted should be withheld from public disclosure. If DOE receives the responses and does not receive a request with substantive justification that the information submitted should not be released to the public, DOE may assume that the respondent does not object to disclosure to the public of any information submitted by it on the forms.

The provisions of Section 711(a) of P.L. 95-620, the Powerplant and Industrial Fuel Use Act of 1978, which incorporate by reference the provisions of Section 11 (d) of P.L. 93-319, the Energy Supply and Environmental Coordination Act of 1974, apply to the information submitted on this form. Upon request, therefore, DOE must provide information obtained on this form to the Attorney General, the Secretary of the Interior, and the Federal Trade Commission in accordance with the cited statutes and other applicable authority. The information must also be made available upon request to the Congress or any committee of the Congress and to the General Accounting Office.

WHAT TO FILL OUT:

- Complete Section I (on yellow paper) only once; it applies to your establishment (shown on mail label below) as a whole.
- Complete a separate copy of Section II (on blue paper) for:
  - each boiler, gas turbine, and internal combustion engine with a maximum design firing rate of 50 million Btu/hr or greater, **and**
  - each fired **component** of a combined cycle unit in which the components **total** a firing rate of 50 million Btu/hr or greater.
- If your company did not operate this establishment at any time in 1979 answer only items 1 through 7 and 14 through 18 of Section I. Then complete Section II forms required.
- If your establishment **does not have** any boiler, gas turbine, internal combustion engine and/or combined cycle units with a maximum design firing rate of 50 million Btu/hr or greater, answer **only** items 1 through 7 and 15 through 18 of Section I.

SEE SECTION II, PAGE 4 FOR ADDITIONAL INSTRUCTIONS

SECTION I — ESTABLISHMENT (PLANT) REPORT

1. Name and physical location of establishment.

NAME

NUMBER AND STREET

CITY, TOWN, VILLAGE, ETC.

COUNTY STATE ZIP

MAIL LABEL

(Please correct any error in name and mail address on label, including zip code.)

ESTABLISHMENT IDENTIFICATION

2. Current Employer Identification Number (EIN). *(This is the number used by this establishment on the latest Quarterly Federal Tax Return Form 941.)*

|__|__|-|__|__|__|__|__|__|__|

3. **Primary** Standard Industrial Classification (SIC) code for this establishment.

|__|__|__|__|

4. Number of **paid employees** at this establishment for the pay period including March 12, 1979. *(Use the definition of employees specified by your State Employment Security Agency; be sure to include production workers and all other employees.)*

THOU UNITS

|__|__| Employees

5. Is this establishment owned or controlled by another organization or company?

(1) ☐ No *(go to item 6)*

(2) ☐ Yes *(enter name and address of parent company)*

NAME _____ NUMBER AND STREET _____

CITY _____ STATE _____ ZIP _____

6. Is this a seasonal operation?

(1) ☐ No (2) ☐ Yes *(indicate number of months this establishment operated in 1979)*

Months _____

7. Change in status of this establishment in 1979 or 1980. *(mark one box only)*

(1) ☐ No change in 1979 or 1980.

(2) ☐ Started as a new business *(i.e., 1979 or 1980 was the initial year of operation of this establishment).*

Specify month and year started: _____ | _____
MONTH YEAR

(3) ☐ Establishment was acquired or leased from another company in 1979 or 1980.

Specify month and year in which acquired or leased: _____ | _____
MONTH YEAR

Former operator: _____
NAME NUMBER AND STREET

_____
CITY STATE ZIP

(4) ☐ Establishment was sold or leased to another company in 1979 or 1980.

Specify month and year in which sold or leased: _____ | _____
MONTH YEAR

New operator: _____
NAME NUMBER AND STREET

_____
CITY STATE ZIP

(5) ☐ Establishment was permanently closed, dismantled, abandoned, or destroyed.

Specify month and year in which closed, etc.: _____ | _____
MONTH YEAR

FUEL CODES *(for office use only)*

FUEL CONSUMPTION

8. Fill out the following table for fuels used by this establishment during calendar year 1979 for heat, power, and/or generation of electricity. Actual shipment of fuels may have occurred earlier than 1979.

- Fill out all portions that apply; leave others blank.
- Include: — purchased fuels.
  — non-purchased fuels, such as interplant transfers.
  — fuels mined or extracted onsite and **used** at the site.
- Do not include: — fuels produced as byproducts of onsite operations (these are to be reported in item 9).
  — fuels used for transportation equipment.
  — fuels used for feedstocks (see Glossary for "feedstocks").
- Note that the amount of "wood, bark, wood waste" is asked for on a "50 percent moisture" basis. Adjustments may be necessary in estimating the amount used.
- Figures for amounts in excess of 100,000 may be rounded to thousands; if you prefer, however, you may report exact amounts.

Example: *If this establishment used 1,256,680 mcf of natural gas in 1979, report* ***either:***

MIL	THOU	UNITS		MIL	THOU	UNITS
1	256	680	*or*	1	257	000

FUEL	AMOUNT USED FOR HEAT, POWER AND/OR GENERATION OF ELECTRICITY (MIL THOU UNITS)	AVERAGE Btu CONTENT (HIGHER HEATING VALUE) (THOU UNITS)	AVERAGE % SULFUR (BY WEIGHT)
SOLIDS			
(11) Anthracite	ton	per lb	%
(12) Bituminous coal *(non-metallurgical uses)*	ton	per lb	%
(13) Lignite	ton	per lb	%
(14) Coke and breeze	ton	per lb	%
(15) Wood, bark, wood waste *(50% moisture basis)*	ton	per lb	
Other solid fuels *(specify)*			
_____	ton	per lb	%
_____	ton	per lb	%
LIQUIDS			
(21) Motor gasoline *(for stationary engines)*	gal	per gal	
(22) Distillate fuel oils *(1, 2, 4 & light diesel)*	gal	per gal	%
(23) Residual fuel oils *(5, 6 & heavy diesel)*	gal	per gal	%
Other liquid fuels *(specify)*			
_____	gal	per gal	%
_____	gal	per gal	%
GASES			
(31) Natural gas	mcf	per cu ft	
(32) LPG, butane, propane	gal	per gal	
Other gaseous fuels *(specify)*			
_____	mcf	per cu ft	%
_____	mcf	per cu ft	%

FUEL CODES *(for office use only)*

FUEL CONSUMPTION

9. Please fill out the following table for fuels which were produced onsite as byproducts of establishment operations during 1979.

- DO NOT INCLUDE any amounts of fuel reported in item 8.
- Note that "pulping liquor" is specified on a "bone-dry" basis; give the amount used in tons.
- Fill out all portions that apply; leave others blank.

☐ No fuels produced as byproducts in 1979 *(go to item 10a & b)*

FUEL	AMOUNT USED AT SITE FOR HEAT, POWER AND/OR GENERATION OF ELECTRICITY (MIL THOU UNITS)	AVERAGE Btu CONTENT (HIGHER HEATING VALUE) (THOU UNITS)	AMOUNT SOLD OR TRANSFERRED OFFSITE (MIL THOU UNITS)
(14) Coke	ton	per lb	ton
(15) Wood, bark, wood waste *(50% moisture basis)*	ton	per lb	ton
(24) Pulping liquor *(bone dry basis)*	ton	per lb	ton
Other solid fuel *(specify)* _____	ton	per lb	ton
Other liquid fuel *(specify)* _____	gal	per gal	gal
PROCESS OFF GASES:			
(33) Blast furnace gas	mcf	per cu ft	mcf
(34) Coke oven gas	mcf	per cu ft	mcf
(35) Refinery off gas	mcf	per cu ft	mcf
Other process gases *(specify)* _____	mcf	per cu ft	mcf

ELECTRICITY

10a. Please complete the following. *(if "none" enter zero for units)*

	BIL MIL THOU UNITS
(1) Amount of electricity **purchased or received** in 1979	kWh
(2) Total amount of electricity **generated onsite** in 1979	kWh
(3) Amount of electricity **sold or transferred offsite** in 1979	kWh
(4) Electricity **used onsite** in 1979 [this figure should be the same as (1) + (2) – (3)]	kWh

10b. Of the total amount of electricity generated **onsite** in 1979 [the amount reported in 10a (2)] please report the amounts generated by each of the following:

☐ No electricity generated *(go to item 11)*

	BIL MIL THOU UNITS
(1) Steam	kWh
(2) Gas turbines	kWh
(3) Internal combustion engines	kWh
(4) Hydro	kWh
(5) Other *(specify)* _____	kWh

OTHER ENERGY SOURCES

11. Please report the Btu output from any of the following energy sources used by this establishment in 1979. *(do not report any amounts of energy reported in items 8, 9 or 10)*

☐ None used in 1979 *(go to item 12)*

ENERGY SOURCE	Btu OUTPUT DERIVED FROM SOURCE IN 1979 (MIL THOU UNITS)
(1) Hydro	____ ____ ////// Btu
(2) Wind	____ ____ ////// Btu
(3) Geothermal	____ ____ ////// Btu
(4) Solar	____ ____ ////// Btu
(5) Any other energy sources *(specify)* _____	____ ____ ////// Btu

STEAM TRANSFERS

12. Indicate amount of steam transferred into or out of this establishment during 1979. *(if none, enter zero)*

	AMOUNT OF STEAM (BIL MIL THOU UNITS)		PRESSURE	TEMPERATURE
a. Steam purchased or received	____ ____ ____ ////// lb	@	____ psig	____ °F
	____ ____ ____ ////// lb	@	____ psig	____ °F
b. Steam sold or transferred off site	____ ____ ____ ////// lb	@	____ psig	____ °F
	____ ____ ____ ////// lb	@	____ psig	____ °F

STEAM GENERATION

13. Indicate amounts of steam **generated** at this establishment during 1979.

☐ No steam generated *(go to item 14)*

- *Include* — Steam generated in any boilers, waste heat boilers, or other steam generating units.
- *Do not include* — purchased steam or steam from blow down or condensate.

AMOUNT OF STEAM (BIL MIL THOU UNITS)		PRESSURE	TEMPERATURE
____ ____ ____ ////// lb	@	____ psig	____ °F
____ ____ ____ ////// lb	@	____ psig	____ °F
____ ____ ____ ////// lb	@	____ psig	____ °F
____ ____ ____ ////// lb	@	____ psig	____ °F
____ ____ ____ ////// lb	@	____ psig	____ °F

LARGE COMBUSTORS

14. Indicate the current number of combustors of each type at this establishment with a maximum design firing rate of 50 million Btu/hr or greater. *(write single digits as 01, 03, 08, etc.)*

	NUMBER	
a.	____ ____	Boilers
b.	____ ____	Gas turbines
c.	____ ____	Internal combustion engines
d.	→ ____ ____	Combined cycle units
e.	____ ____	Number of **fired components** in combined cycle units
f.	____ ____ ____	Total (a + b + c + e); equals the number of Section II forms to be completed for this report

OFFICE USE ONLY

OTHER COMBUSTORS

15. Indicate the **current** number of all **other** combustors at this establishment *(i.e., combustors not reported in item 14)* in each category.

- **Do not** report combustors with a maximum design firing rate of less than 1 million Btu/hr.
- Under "internal combustion engines" **do not** include self-propelled vehicles; **do** include equipment such as portable generators with a maximum firing rate of 1 million Btu/hr or greater.

NUMBER OF OTHER COMBUSTORS

	Maximum Design Firing Rate *(in millions of Btu/hr)*						
	1-9	10-24	25-49	50-99	100-249	250 or greater	For office use only
Boilers							
Gas turbines							
Internal combustion engines							
Fluid heaters *(fired petroleum heater, blast furnace stove, etc.)*							
Dryers *(mineral dryer, paint dryer, food dryer, etc.)*							
Calciners *(cement kiln, lime kiln, alumina kiln, etc.)*							
Reactors *(blast furnace, cupola, reforming furnace, pyrolysis furnace, incinerator, etc.)*							
Melters *(regenerative glass melter, reverberatory furnace, open hearth furnace, etc.)*							
Heat treaters *(annealing lehr, brick kiln, tempering furnace, oven, etc.)*							
Reheaters *(soaking pit, reheat furnace, etc.)*							
Sinterers/Pelletizers *(vertical shaft furnace, grate kiln, sintering furnace, etc.)*							
For office use only							

CONTACT

16. Person to be contacted regarding this report. Name: _____

Title: _____ Telephone No. (_____) _____

Mailing address *(if different from mailing label in item 1)*: _____

DISCLOSURE

17. Disclosure Statement

a. Does the information supplied on this form contain trade secrets and/or privileged or confidential commercial or financial information?

(1) ☐ No *(go to item 18)* (2) ☐ Yes *(continue with item 17b)*

b. Have you attached a written justification for exemption from Freedom of Information Act, 5 USC 552(b)(4)? *(see page 1)*

(1) ☐ No (2) ☐ Yes

OFFICE USE ONLY

CERTIFICATION

18. Certification *(to apply to Section I and all forms which constitute Section II of this report)*: print the name and title of the individual designated by the company to sign this certification. This individual must sign in the space provided and enter date of signing.

This report is substantially accurate and has been prepared in accordance with instructions, and covers the period _____ **to** _____.

PRINTED NAME _____ TITLE _____

SIGNATURE _____ DATE _____

SAMPLE COPY FOR INFORMATIONAL PURPOSES ONLY.

FORM EIA-463
SECTION II

UNITED STATES
DEPARTMENT OF ENERGY
ENERGY INFORMATION ADMINISTRATION

1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors

FORM APPROVED
OMB NUMBER 038-S80011

ID NO.:

SECTION II — INDIVIDUAL COMBUSTOR REPORT

THIS REPORT IS MANDATORY *(see page 4 of Section II, General Instructions)*

Assign sequential numbers to each boiler, gas turbine, internal combustion engine and each fired component of a combined cycle unit for which you are reporting. As an example, if you are reporting for four boilers and one combined cycle unit with two fired components the numbers should go from 01 through 06 (01 through 04 would identify individual boilers; 05 and 06 would identify the two components of the combined cycle unit).

IDENTIFICATION

1a. Enter the sequential number assigned to this combustor. |__|__|

1b. Name or identification number assigned to this combustor in your company's records:

_____

2a. Is this combustor part of a combined cycle unit?

(1) ☐ No *(go to item 3)* (2) ☐ Yes *(continue with item 2b)*

2b. Please list the numbers *(as assigned in item 1a)* of all **other** fired components of this combined cycle unit.

|__|__| |__|__| |__|__| |__|__|

KIND OF COMBUSTOR

3. What kind of combustor or component of a combined cycle unit is this? *(mark one box only)*

(1) ☐ Boiler *(continue with items 4a, b, & c)*

(2) ☐ Gas Turbine *(go to item 5)*

(3) ☐ Internal Combustion Engine *(go to item 5)*

BOILER OPERATION

4a. What is this boiler's **design** *(rated)* steam/hot water:

(1) Pressure? _____ psig (2) Temperature? _____ °F

(3) Flow Rate? MIL THOU UNITS |__|__|////| lb/hr *(steam), or,* MIL THOU UNITS |__|__|////| Btu/hr *(hot water boilers only)*

4b. For this boiler, what is the annual average steam/hot water:

(1) Pressure? _____ psig (2) Temperature? _____ °F

(3) Deaerator pressure? _____ psig, *or,* Feedwater temperature? _____ °F

4c. Is the steam or hot water produced by this boiler used for: *(mark all that apply)*

(1) ☐ Space heating, ventilating, or air conditioning?

(2) ☐ Process heat?

(3) ☐ Electricity generation?

(4) ☐ Mechanical drive *(other than electricity generation)*?

(NOW GO TO ITEM 6)

SHAFT POWER

5. Indicate below whether this gas turbine/internal combustion engine is used for electricity generation or mechanical drive *(mark one box only)*. Also indicate the rated output of this unit.

USE	RATED OUTPUT (THOU UNITS)	
(1) ☐ Electricity generation	|__|__|	kW
(2) ☐ Mechanical drive	|__|__|	hp

YEAR INSTALLED

6. In what year was this combustor initially installed at this establishment? Report year of initial installation regardless of any alterations or modifications since then.

_____ YEAR

FUEL CODES *(for office use only)*

COMBUSTOR DESIGN AND FUEL USE

7. In column (1) of the following table, indicate all the fuel(s) that this combustor was initially designed, or has been modified, to use *(mark all that apply)*. Indicate in column (2) the amount of each fuel used **in this combustor** in 1979.

FUEL	DESIGNED OR MODIFIED TO USE (1)	AMOUNT USED IN 1979 (2) MIL THOU UNITS
SOLIDS		
(11) Anthracite	☐	ton
(12) Bituminous coal	☐	ton
(13) Lignite	☐	ton
(14) Coke and breeze	☐	ton
(15) Wood, bark, wood waste *(50% moisture basis)*	☐	ton
Other solid fuels *(specify)*		
_____	☐	ton
_____	☐	ton
LIQUIDS		
(21) Motor gasoline	☐	gal
(22) Distillate fuel oils *(1, 2, 4 & light diesel)*	☐	gal
(23) Residual fuel oils *(5, 6 & heavy diesel)*	☐	gal
(24) Pulping liquor *(bone dry basis)*	☐	ton
Other liquid fuels *(specify)*		
_____	☐	gal
_____	☐	gal
GASES		
(31) Natural gas	☐	mcf
(32) LPG, butane, propane	☐	gal
(33) Blast furnace gas	☐	mcf
(34) Coke oven gas	☐	mcf
(35) Refinery off gas	☐	mcf
Other gaseous fuels *(specify)*		
_____	☐	mcf
_____	☐	mcf
OTHER *(specify)* _____	☐	Btu
_____	☐	Btu

DESIGN SULFUR AND Btu CONTENT

8. If this combustor was either designed, or has been modified, to use a solid fuel, what was the **design** sulfur and Btu content of that fuel?

☐ Not applicable _____% Sulfur THOU UNITS |___|___| Btu/lb

FIRING RATES

9. What is this combustor's current maximum design firing rate? BIL MIL THOU UNITS |___|___|___|////| Btu/hr

10. At what firing rate is this combustor operated when it is in use? *(indicate both range and usual rate when not banked)*

BIL MIL THOU UNITS BIL MIL THOU UNITS

RANGE: From |___|___|___|////| Btu/hr to |___|___|___|////| Btu/hr

USUAL RATE: |___|___|___|////| Btu/hr

FLUE GAS

11a. Approximately what is the temperature of the flue gas at the exit of this combustor while in use at the usual firing rate? *(the rate indicated as usual in item 10)*

_____°F

11b. What type of heat recovery equipment is used beyond this exit? *(mark all that apply)*

(1) ☐ None
(2) ☐ Regenerative air preheater
(3) ☐ Recuperative air preheater
(4) ☐ Economizer
(5) ☐ Waste heat boiler
(6) ☐ Raw material preheater
(7) ☐ Other *(specify)* _____

COMBUSTOR USAGE

12. If your company did not operate this plant in 1979, or if this combustor was installed after 1979, check box below.

☐ Skip items 13 & 14

13. Please estimate the number of hours in 1979 this combustor was in use at approximately the usual firing rate.

_____Hours

14. During 1979, **approximately** how many days each month was this combustor **not** in use? *(count only days on which this combustor was shut down for a 24 hour period)*

	NUMBER OF DAYS		NUMBER OF DAYS		NUMBER OF DAYS		NUMBER OF DAYS
(1) January	|__|__|	(4) April	|__|__|	(7) July	|__|__|	(10) October	|__|__|
(2) February	|__|__|	(5) May	|__|__|	(8) August	|__|__|	(11) November	|__|__|
(3) March	|__|__|	(6) June	|__|__|	(9) September	|__|__|	(12) December	|__|__|

NOTES OR COMMENTS:

GENERAL INSTRUCTIONS

This report is mandatory under the Federal Energy Administration Act of 1974, P.L. 93-275, and the Powerplant and Industrial Fuel Use Act of 1978, P.L. 95-620. Failure to respond may result in criminal fines, civil penalties and other sanctions, as provided by law.

The information reported on these forms may be (i) information that is exempt from disclosure to the public under the exemption for trade secrets and confidential commercial information specified in the Freedom of Information Act, 5 USC 552 (b) (4) (FOIA), or (ii) prohibited from public release by 18 USC 1905. However, before the determination can be made that particular information is within the coverage of either of these statutory provisions, the person submitting the information must make a showing, satisfactory to the Department of Energy, concerning its confidential nature.

Therefore, respondents wishing to claim such exemption must state specifically (on an element by element basis, if possible) in a letter accompanying submission of this form, why they consider the information concerned to be a trade secret or other proprietary information, whether such information is customarily treated as confidential information by these companies and the industry, and the type of competitive harm that would result from disclosure of the information. In accordance with the provisions of 10 CFR 1004.11, DOE's Freedom of Information Act Regulations, DOE will determine whether the information submitted should be withheld from public disclosure. If DOE receives the responses and does not receive a request with substantive justification that the information submitted should not be released to the public, DOE may assume that the respondent does not object to disclosure to the public of any information submitted by it on the forms.

The provisions of Section 711(a) of P.L. 95-620, the Powerplant and Industrial Fuel Use Act of 1978, which incorporate by reference the provisions of Section 11 (d) of P.L. 93-319, the Energy Supply and Environmental Coordination Act of 1974, apply to the information submitted on this form. Upon request, therefore, DOE must provide information obtained on this form to the Attorney General, the Secretary of the Interior, and the Federal Trade Commission in accordance with the cited statutes and other applicable authority. The information must also be made available upon request to the Congress or any committee of the Congress and to the General Accounting Office.

1. Complete a separate copy of Section II for:
   - each boiler, gas turbine, and internal combustion engine with a maximum design firing rate of 50 million Btu/hr or greater, *and*
   - each ***fired component*** of a combined cycle unit in which the components total a firing rate of 50 million Btu/hr or greater.

2. Fill out a copy of Section II for each combustor of the specified maximum firing rate, even if the combustor was unused in 1979, unless the combustor was permanently destroyed or removed from the site prior to 1979.

3. All items which ask for figures for "1979" refer to the 12 months of *calendar year 1979.* If your establishment maintains its records on a fiscal year basis and the fiscal year ended between September 30, 1979 and March 31, 1980, you may use records from the fiscal year.

4. If records are not available for an item, carefully derived estimates are acceptable.

5. The Glossary explains key terms used in the forms.

6. If the space allowed for your answers is insufficient, use extra sheets of paper to record additional pertinent information. Be sure to identify the question number for each item reported on the extra sheets.

7. For additional copies of the forms write or call:

   Mr. Stephen J. Dienstfrey, Industrial Survey Manager
   U.S. Department of Energy
   P.O. Box 2100
   Rockville, MD 20852
   800-638-6584

   or you may duplicate as many copies of the forms as needed. If you make duplicate copies, please be sure that the printed ID number which appears on page 1 is clearly legible on all reproduced copies.

8. If you wish to amend or correct any items after returning your completed forms, send the corrections to Mr. Dienstfrey at the address above. Clearly identify the item(s) to be amended or corrected.

GLOSSARY

Anthracite — ASTM class I coal.

Bituminous Coal — ASTM classes II and III coal. Please note that sub-bituminous coal should be reported under this category.

Boiler — A unit which heats water for the generation of steam and/or hot water.

Bone Dry — 0% moisture.

Calciner — A combustor which heats solid material to a high temperature without fusing. Its principal function is to decompose hydrates, carbonates, and other compounds and expel volatile matter. This will primarily refer to the heating of unformed materials in a kiln such as a rotary cement kiln, lime kiln, or alumina kiln.

Coke — The solid residue remaining from the destructive distillation of coal or other carbonaceous material such as pitch, petroleum, or petroleum residue. Coke which is used as a raw material in a blast furnace, cupola furnace or any other operation should not be reported as a fuel in this survey.

Combined Cycle Unit — An electric or mechanical power generating unit that consists of a combination of one or more combustion turbine units and one or more boilers with a substantial portion of the required energy input to the boiler(s) provided by the exhaust gas of the combustion turbine unit(s). Use of supplemental firing for the boiler does not preclude the unit from being designated a combined cycle unit.

Combustor — A unit which consumes fuels that are used primarily to provide heat. Examples are boilers, furnaces, ovens, combustion turbines, blast furnaces, internal combustion engines, and combined cycle units.

Dryer — A combustor which drives off or removes water or other volatile compounds from the material being processed. Typical types of dryers would be rotary mineral dryers, shaft mineral dryers, paint drying ovens, or food dryers.

Establishment — The definition of establishment for this survey is the same as that used by the Bureau of Census; in general, that is a single physical location where manufacturing is performed.

Feedstocks — Materials (which can also be used as fuels) which are consumed as raw materials in the production of intermediate or finished products. Feedstocks do not include materials used primarily for process heat. Coal used for coking, crude oil that is refined, and coke used in blast furnaces, are all considered feedstocks for this survey.

Firing Rate — Fuel heat input rate. The rate at which fuel is supplied to a combustor. The firing rate calculation is based on the higher heating value of the fuel.

Fluid heater — A combustor that heats (or preheats) gases or liquids. Examples of fluid heaters are fired petroleum heaters and blast furnace stoves. Combustors where a chemical reaction takes place simultaneously with heating are considered reactors, not heaters.

Gas Turbine — A heat engine that converts energy of fuel into work by using compressed hot gas as the working medium. Usually delivers its mechanical output through a rotating shaft. Also known as a combustion turbine.

Heat Treater — A combustor that heats a material to create or remove specific properties in the material. Heat treating is particularly widespread in the metals industries. Examples of heat treaters are glass annealing lehrs and brick kilns.

Higher Heating Value — The total heat obtained from the combustion of a specified amount of fuel and the stoichiometrically correct amount of air, both at 60° F when combustion starts, and the combustion products being cooled to 60° F before the heat release is measured. This is the heating value that is typically reported in the United States.

Hot Water Boiler — A boiler that can produce only hot water and not steam.

Internal Combustion Engine — A prime mover in which the fuel is burned within the engine and the products of combustion serve as the working medium.

Lignite — ASTM class IV coal.

GLOSSARY *(CONTINUED)*

Maximum Design Firing Rate — The maximum firing rate that the combustor is designed to achieve over a period of continuous operation.

mcf — One thousand cubic feet at 14.73 psia and 60° F.

Melter — A combustor where the principal function is the conversion of a solid to a liquid at high temperature. Examples include glass melters, aluminum reverberatory melters and open hearth furnaces.

Metallurgical Coal — Bituminous or coking coals which are used to produce coke for blast furnaces and cupola furnaces.

Onsite — Pertains to operations which are performed on the grounds of the establishment itself.

Reactor — A combustor in which a chemical reaction takes place. Examples include reforming furnaces or pyrolysis furnaces in the chemical industry, or blast furnaces or coke ovens in the steel industry.

Recuperative Air Preheater — A continuous heat exchanger where heat passes through a surface separating the exiting flue gases, which are being cooled, and the material being heated, usually incoming combustion air.

Regenerative Air Preheater — A cyclical heat exchanger where the exiting flue gases give up heat as they pass over exchanger internals. This heat is released to the material being heated, usually incoming combustion air, as it passes over the exchanger internals in the opposite part of the cycle (includes heat wheels).

Reheater — A combustor where the primary function is to bring the temperature of a solid material to a level appropriate for subsequent operations. Examples include steel reheating furnaces and soaking pits.

Sinterer/Pelletizer — A combustor which agglomerates ores, coke breeze, or metal powders without melting.

Usual Rate — The most typical or frequent rate of operation.

CONVERSION FACTORS

MULTIPLY	BY	TO OBTAIN
Barrels	42.0	Gallons
Btu	0.000393	Horsepower-hour
Btu	0.000293	kWh
Btu/hr	0.000393	Horsepower
Btu/hr	0.000293	Kilowatt
Horsepower	2545.0	Btu/hr
Horsepower	0.7457	Kilowatt
Horsepower-hour	2545.0	Btu
Kilowatt	3412.0	Btu/hr
Kilowatt	1.34	Horsepower
Kilowatt-hour	3412.0	Btu

Appendix B

FEDERAL REGISTER NOTICES

ENERGY INFORMATION ADMINISTRATION

1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors

The U.S. Department of Energy has recently mailed out Form EIA-463, "The 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors," to 10,000 establishments within Standard Industrial Classification Codes 20 to 39 that are likely to have a boiler, gas turbine, combined cycle unit, or internal combustion engine with a maximum design firing rate of 50 million Btu per hour or greater. (The selection of 50 million Btu per hour as the basis for inclusion in the survey relates to the final regulation developed by the Department of Energy and reported in the Federal Register, Friday, June 6, 1980, (45 FR 38276), 10 CFR 500.4 and 500.5.)

Response to this report is mandatory under the Federal Energy Administration Act of 1974 (Pub. L. 93-275) and the Powerplant and Industrial Fuel Use Act of 1978 (Pub. L. 95-620). If you did not receive this form and operate a combustor as described above, please contact: Mr. Stephen Dienstfrey, Industrial Survey Manager, U.S. Department of Energy, P.O. Box 2110, Rockville, Maryland 20852, (800) 638-6584.

Issued in Washington, D.C., November 13, 1980.

Albert H. Linden, Jr.
Acting Administrator, Energy Information Administration

Federal Register, Vol. 45, No. 228, Monday, November 24, 1980, p. 77507

ENERGY INFORMATION ADMINISTRATION

1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors, Form EIA-463

The U.S. Department of Energy has recently mailed out Form EIA-463. The information collected from this study will allow the Department to meet several statutory and regulatory mandates. These include, but are not limited to, the following: preparation of contingency plans for the purposes of advising the President should specific fuels be unavailable due to international events, labor stoppages, distribution malfunctions, or weather; forecasts of mid- and long-range energy needs in the industrial sector as required by the Congress; analysis of potential incentives for the conversion of certain combustors and/or processes to alternative and more plentiful energy supplies.

In view of the importance of these data, industries' desire to provide quality data, and the possible difficulties encountered by mailing the questionnaires over the holiday season, the Department of Energy will grant reasonable extensions beyond the normal filing date on a company by company basis. Requests for extensions should be sent to Mr. Stephen J. Dienstfrey, Industrial Survey Manager, U.S. Department of Energy, P.O. Box 2100, Rockville, Maryland 20852. Further clarification of this notice may be obtained by calling the Survey Receipt Center at (800) 638-6584.

Establishments which operate any boiler, gas turbine, internal combustion engine and/or combined cycle units with a maximum design firing rate of 50 million Btu/hr or greater and have not received a copy of Form EIA-463 should contact the above address for inclusion in this study. This study is mandatory under the Federal Energy Administration Act of 1974 (Pub. L. 93-275), and the Powerplant and Industrial Fuel Use Act of 1978, (Pub. L. 95-620).

Issued in Washington, D.C., December 24, 1980.

Albert H. Linden, Jr.
Acting Administrator, Energy Information Administration

Federal Register, Vol. 45, N. 252, Wednesday, December 31, 1980, p. 86531.

ENERGY INFORMATION ADMINISTRATION

1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors, Form EIA-463

On February 20, 1981, the Department of Energy received notice from the Office of Management and Budget withdrawing approval of Form EIA-463. As a result, those industrial establishments which have not yet responded are no longer required to do so. For further information regarding this matter contact Mr. Stephen J. Dienstfrey at (202) 252-1128.

Issued in Washington, D.C., February 26, 1981.

Albert H. Linden, Jr.
Acting Administrator, Energy Information Administration

Federal Register, Vol. 46, No. 43, Thursday, March 5, 1981, p. 15312.

Appendix C

LETTER FROM THE OFFICE OF MANAGEMENT AND BUDGET

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

FEB 17 [illegible]

Honorable James B. Edwards
Secretary
Department of Energy
Washington, D.C. 20585

Dear Mr. Secretary:

On October 15, 1980, the Office of Management and Budget approved form EIA-463, the "1980 Survey of Large Combustors in Manufacturing Industries" for use through December 31, 1981. The estimated number of respondents was 10,000; the estimated total of respondent burden was 69,000 hours.

We understand this form is the first of many being developed to expand the Department's collection of energy consumption data. Subsequent to the issuance of the form, many respondents furnished data showing that the information requested is needlessly detailed and cannot be used for the purposes intended.

We have reviewed these comments, and under the authority provided by 44 U.S.C. 3506, have determined that the collection is unnecessary and therefore unduly burdensome. Therefore, I hereby withdraw OMB's approval of this information collection activity and direct the Department of Energy not to engage in any further collection of this information. We also expect you to treat the data already collected in a confidential manner.

Sincerely,

David A. Stockman
Director

[illegible]

* U.S. GOVERNMENT PRINTING OFFICE: 1982 361-068/2012

U.S. Department of Energy
Energy Information Administration
National Energy Information Center, EI-20
Forrestal Building
Washington, D.C. 20585