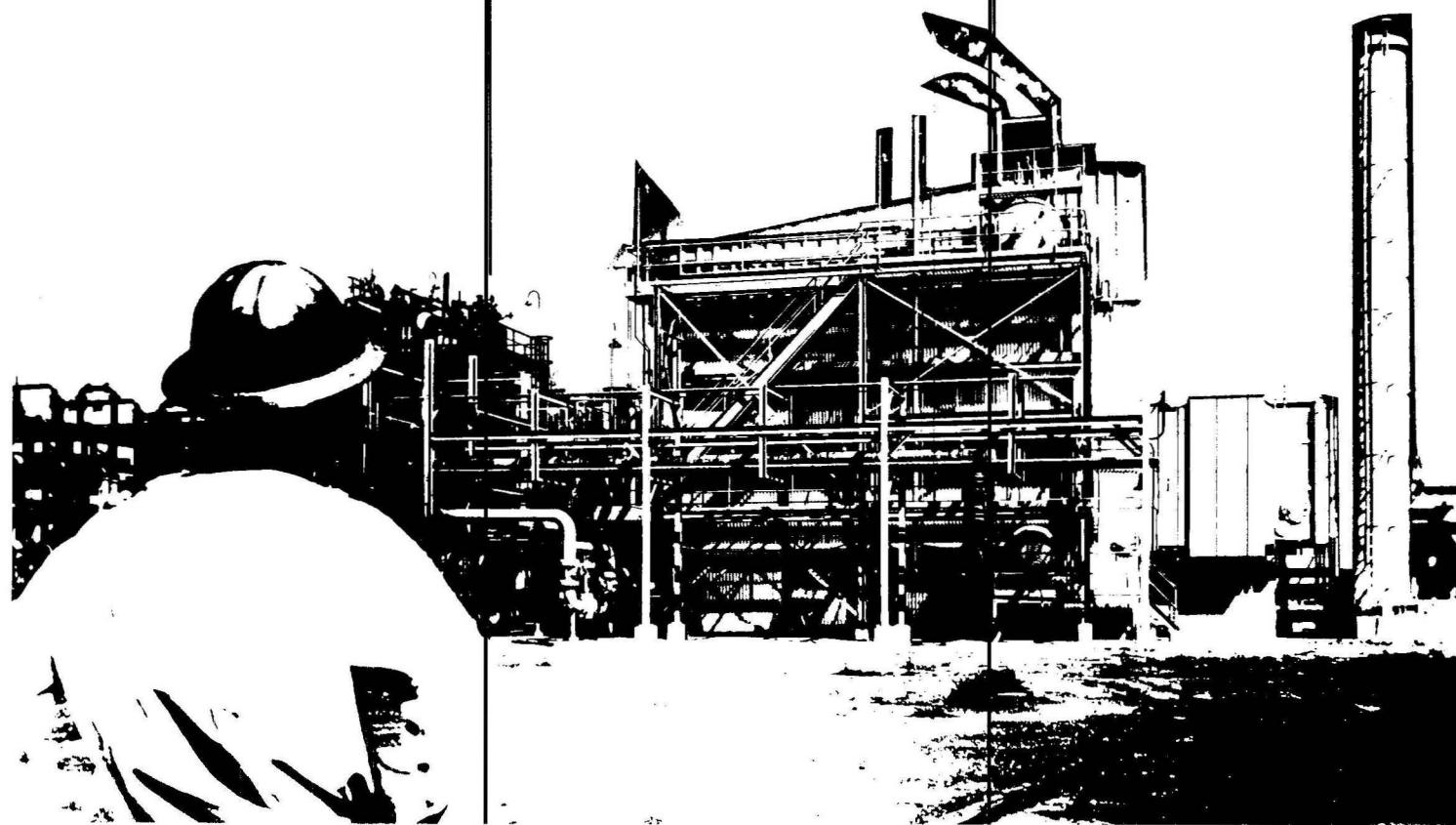


# **Report on the 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors**



**Energy Information Administration**  
Washington, D.C.

January 1983



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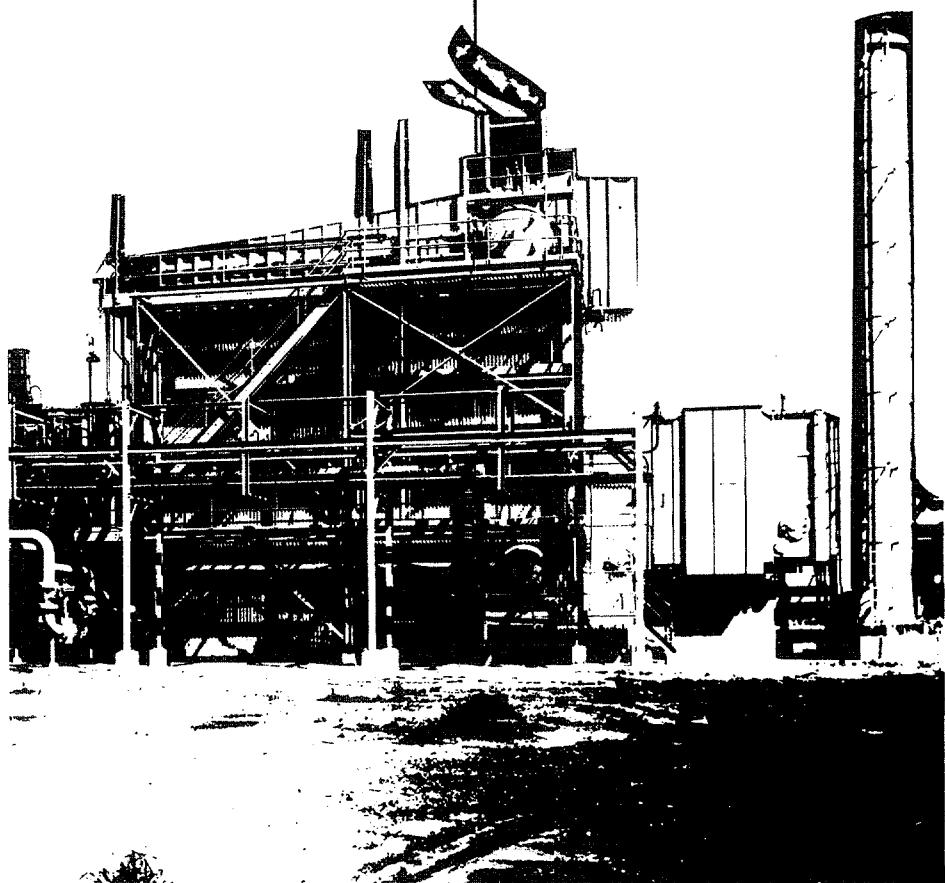


January 1983

**Energy Information Administration**  
Office of Energy Markets and End Use  
U.S. Department of Energy  
Washington, D.C. 20585

DOE/EIA-0358

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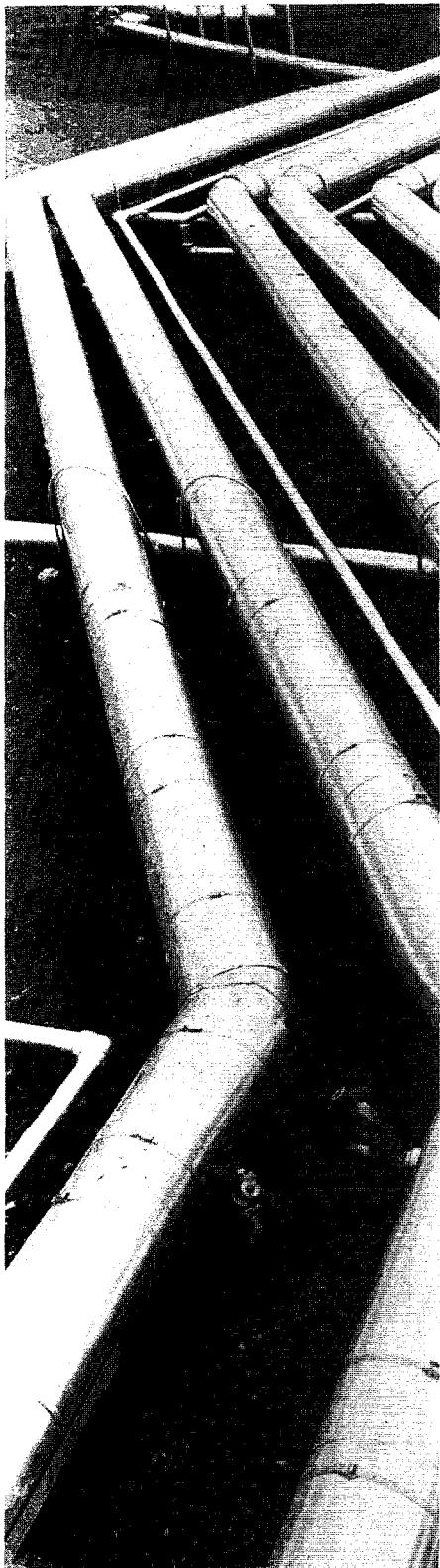
A major guiding force in this survey was Kenneth A. Vagts who was the Director of the Energy End Use Division until October 1, 1982. Other participants in the design and implementation of this survey were John W. Makens, Robert B. Latta, and Thomas H. Woteki. Additional assistance was provided by Westat, Inc., of Rockville, Maryland, which also served as the collection agent.

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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notice from the Office of Management and Budget that authority for the information collection activity had been withdrawn and that the information already collected should be treated in a confidential manner. The Energy Information Administration (EIA) proceeded to carry out these instructions to insure the maximum confidentiality of the data.

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 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 EIA was unable to undertake a followup of respondents to resolve problems of missing and seemingly questionable data.

This report presents an overview of the data collected by this study. This will be the only report prepared covering the entire study. Other reports from this study include a methodological report, Methodological Report on the 1980 Manufacturing Industries Survey of Large Combustors (EIA-463) DOE/EIA-0306, and the Report on Alternative-Fuel Burning Capabilities of Large Boilers, DOE/EIA-0304.

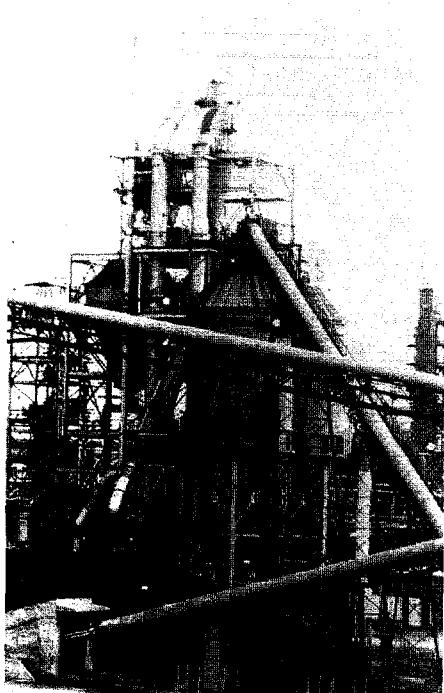




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# Introduction



During 1979, total annual industrial energy consumption, including electrical energy losses in the United States, was 31.5 quadrillion Btu. This amounts to almost 40 percent of the energy consumed in the final consuming sectors of the economy.<sup>1</sup> Manufacturing is by far the largest energy consuming component, totaling 12.9 quadrillion Btu of purchased fuels and electricity for heat and power during 1979. Of this amount, 10.5 quadrillion Btu was accounted for by purchased fuels alone (fuel oil, coal, natural gas, etc.).<sup>2</sup>

From the data collected in this survey,<sup>3</sup> it is estimated that all establishments which operate large combustors<sup>4</sup> consumed 12.1 quadrillion Btu in 1979. Of this amount, 7.2 quadrillion Btu was purchased fuels and 4.9 quadrillion Btu was nonpurchased fuels, such as woodchips, pulping liquor, and process off-gases. Establishments which operate large combustors consumed almost 70 percent of the purchased fuels and 40 percent of the nonpurchased fuels were consumed in the manufacturing subsector.

Of the estimated 12.1 quadrillion Btu used in establishments with large combustors, slightly more than 50 percent, or 6.2 quadrillion Btu, was used in these combustors. This amount includes an estimated 3.8 quadrillion Btu of purchased fuel and 2.4 quadrillion Btu of nonpurchased fuels.

This report covers the energy consumption characteristics of respondents/establishments that operate large combustors. The energy consumption characteristics of large boilers, the predominant combustor, are also covered.<sup>5</sup>

<sup>1</sup>The industrial sector includes manufacturing, mining, construction, and agriculture. The amount of energy consumed is reported in the Energy Information Administration's 1980 Annual Report to Congress, DOE/EIA-0173(80).

<sup>2</sup>U.S. Department of Commerce, Bureau of the Census. 1979 Annual Survey of Manufactures, Fuels and Electric Energy Consumed, M79(AS)-4.1.

<sup>3</sup>The 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors, Form EIA-463 appears in Appendix A. The survey design is detailed in the Methodological Report of the 1980 Manufacturing Industries of Large Combustors (EIA-463), DOE/EIA-0306, March 1982.

<sup>4</sup>For the purpose of this study, large combustors are defined as boilers, gas turbines, combined cycle units, or internal combustion engines with a maximum design firing rate of 50 million Btu-per-hour or more.

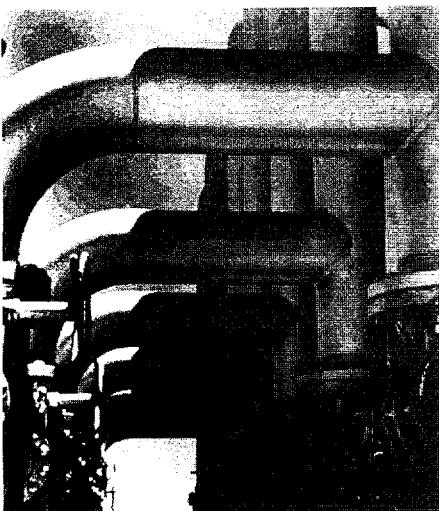
<sup>5</sup>Due to the cancellation of this study, coverage of the intended universe is not complete. See the methodology report for details concerning coverage.



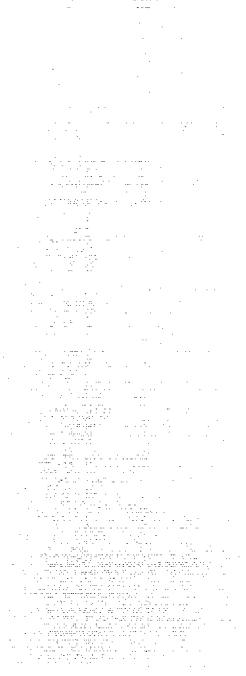


# Summary of Findings

## Characteristics of Establishments and Combustors



## Standard Industrial Classification Breakdown Characteristics



Responses to this study were received from 7,983 establishments. Of this number, 2,498 reported having one or more large combustors for a total of 7,680.<sup>1</sup> While 7,510 of these combustors were classified as boilers, 102 were found to have a maximum design firing rate (MDFR) of less than 50 million Btu (MMBtu) per hour.<sup>2</sup> This report will consider only the remaining 7,408 boilers unless otherwise indicated.<sup>3</sup>

The establishments responding to the survey reported consuming 8,518.5 trillion Btu of energy. Almost 63 percent of this amount was purchased fuel with the balance made up of nonpurchased byproduct or waste stream fuels and a negligible amount of nontraditional energy sources such as solar, hydropower, etc. When this figure is adjusted to account for those establishments, which did not respond, the total fuel consumption is estimated to be 12,089.6 trillion Btu but the purchased fuel component drops to slightly less than 60 percent.

In addition, these establishments used 857.5 trillion Btu of electricity, of which 26 percent is generated onsite. The amount of electricity consumed increases to 1,130.4 trillion Btu after adjusting for nonresponse. This adjustment does not substantially change the proportion generated onsite.

Approximately 63 percent of the fuel consumed in large boilers consists of coal, natural gas, or fuel oil. This figure remains constant after adjusting for nonresponse.

This section of the report indicates that, based on various measures of size, energy consumption among establishments with large combustors is concentrated in five industries: Food and Kindred Products, Paper and Allied Products, Chemicals and Allied Products, Petroleum and Coal Products, and Primary Metals. These five industries are not the same five industries which the 1979 Annual Survey of Manufactures reported as the most energy intensive. The Stone, Clay, and Glass Products industry, the third most energy intensive in terms of purchased fuels consumed in 1979,<sup>4</sup> is not among the most energy intensive industries as reported in this study. As will be seen later in Tables 1, 3, and 4 of this report, the 33 establishments included in this study from this industry reported 4,832 combustors with an MDTR of at least one million Btu-per-hour. Only 574 were boilers of which only 84 had an MDTR of 50 million Btu-per-hour or more. So while this industry has a large number of combustors, they do not have a large number of large boilers.

<sup>1</sup>Individual reports were received for 7,386 boilers, 116 gas turbines, and 25 internal combustion engines. In addition, from information provided by partially completed questionnaires, an additional 124 combustors were classified as boilers, 2 as gas turbines, and 7 as internal combustion engines. The remaining 20 combustors are unclassified due to a lack of information.

<sup>2</sup>They were either separately filed components of combined cycle units or were erroneously reported.

<sup>3</sup>A public use data tape covering all data from this study is available from the National Technical Information Service of the U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161.

<sup>4</sup>U.S. Department of Commerce, Bureau of the Census, 1979 Annual Survey of Manufactures, Fuels and Electric Energy Consumed, 1979(AS)--4.1.



## Summary of Findings (continued)

The four largest industry groups in terms of fuel used<sup>5</sup> at the establishment level are chemicals, paper, petroleum, and primary metals (Table 1). These four industries account for 85 percent of the fuel consumed at the establishment level but less than half of the establishments responding to this survey. These high-energy-use industries also report the highest amounts of energy consumed per establishment (Figure 1).

The food industry is the fifth largest energy consuming industry at the establishment level. Fuels consumed in this industry accounted for only about one-third as much as the fourth largest industry, primary metals. When the food industry is added to the four largest, these five industries account for 90 percent of the fuel consumed at the establishment level and 66 percent of the establishments with large boilers (Figure 1).

Table 1 provides similar information for large boilers. The five largest industry groups, which consume the most energy at the establishment level, are also the five largest industries in terms of energy consumption at the boiler level. These five industries account for 66 percent of the establishments reported and comprise 74 percent of the boilers. Further, they consumed 90 percent of the reported energy at the establishment level, and 89 percent of the fuel reported for boilers.



<sup>5</sup>Several steps were taken to avoid the disclosure of the individual respondents. These are detailed in Appendix C.



## Summary of Findings (continued)

**Table 1. Number of Establishments and Large Boilers, Together with Total and Average Amount of Fuel Consumed (Trillion Btu) by Standard Industrial Classification (SIC) Code**

Industry	SIC Code	Establishments			Large Boilers		
		Number	Total	Average	Number	Total	Average
Food and Kindred Products.....	20	462	445.7	0.96	1,122	321.0	0.29
Tobacco.....	21	See Other Nondurables			49	6.9	0.14
Textile Mill Products.....	22	186	152.0	0.82	382	70.9	0.19
Apparel.....	23	See Other Nondurables			14	1.5	0.11
Lumber and Wood.....	24	142	163.7	1.15	240	134.6	0.56
Furniture.....	25	See Other Durables			13	1.4	0.11
Paper and Allied Products.....	26	370	1,994.5	5.39	1,239	1,575.2	1.27
Printing and Publishing.....	27	See Other Nondurables			10	2.5	0.25
Chemicals.....	28	518	2,004.9	3.87	1,783	1,223.1	0.69
Petroleum.....	29	163	1,847.3	11.33	653	467.4	0.72
Rubber and Plastics.....	30	97	80.5	0.83	224	62.3	0.28
Leather.....	31	See Other Nondurables			5	0.8	0.16
Stone, Clay and Glass.....	32	33	52.4	1.59	84	26.1	0.31
Primary Metals.....	33	134	1,385.3	10.34	647	565.2	0.87
Fabricated Metals...	34	50	27.7	0.55	115	17.2	0.15
Machinery.....	35	81	102.4	1.26	221	41.5	0.19
Electronic Equipment.....	36	63	47.3	0.75	165	32.1	0.19
Transportation Equipment.....	37	112	121.4	1.08	331	59.8	0.18
Instruments.....	38	See Other Durables			61	35.3	0.58
Miscellaneous.....	39	See Other Durables			13	12.8	0.98
Other Nondurables <sup>a</sup> ..	NA	38	33.4	0.88	c78	c11.7	c0.15
Other Durables <sup>b</sup> ....	NA	33	60.0	1.82	c87	c49.5	c0.57
Unclassified.....	NA	16	20.4	1.28	37	13.6	0.37
Total.....	NA	2,498	8,538.9	3.42	7,408	4,671.2	0.63

<sup>a</sup>SIC codes 21, 23, 27, and 31.

<sup>b</sup>SIC codes 25, 38, and 39.

<sup>c</sup>Not included in column totals since they are already in the table above.

<sup>d</sup>From the information requested, it was impossible to determine the industry group.

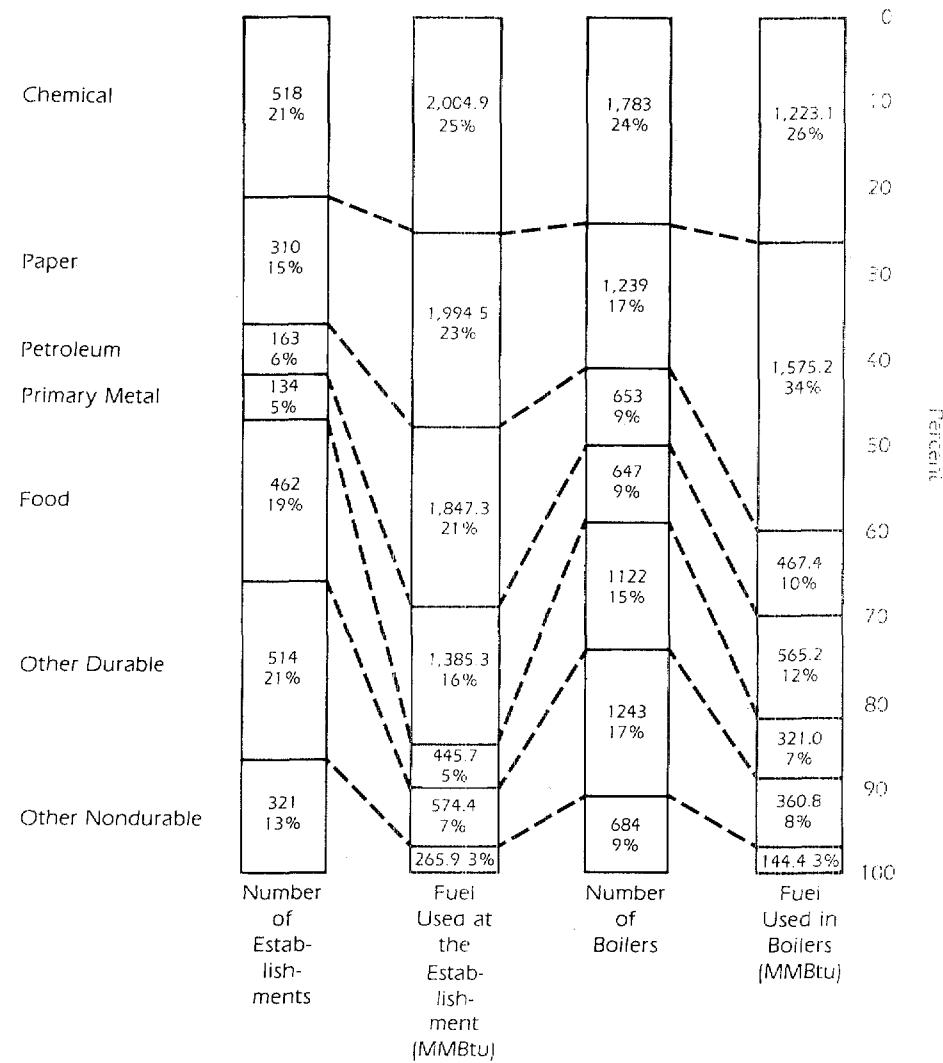
NA = Not Applicable.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.



## Summary of Findings (continued)

Figure 1. Number of Establishments and Large Boilers and the Amount of Fuel Used in Establishments and Large Boilers by Major Industrial Classification<sup>a</sup>



<sup>a</sup>The percentages on this figure have been rounded. Those establishments and large combustors which could not be classified by Standard Industrial Classification (SIC) Code are not shown. The 16 establishments in this category represent 0.6 percent of the establishments and consume 20.4 trillion Btu, or 0.2 percent of the total fuel consumption at the establishment level. The 37 large boilers which could not be classified by SIC Code represent 0.5 percent of the large boilers and consume 13.6 trillion Btu, or 0.3 percent of the total fuel consumption at the boiler level.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.



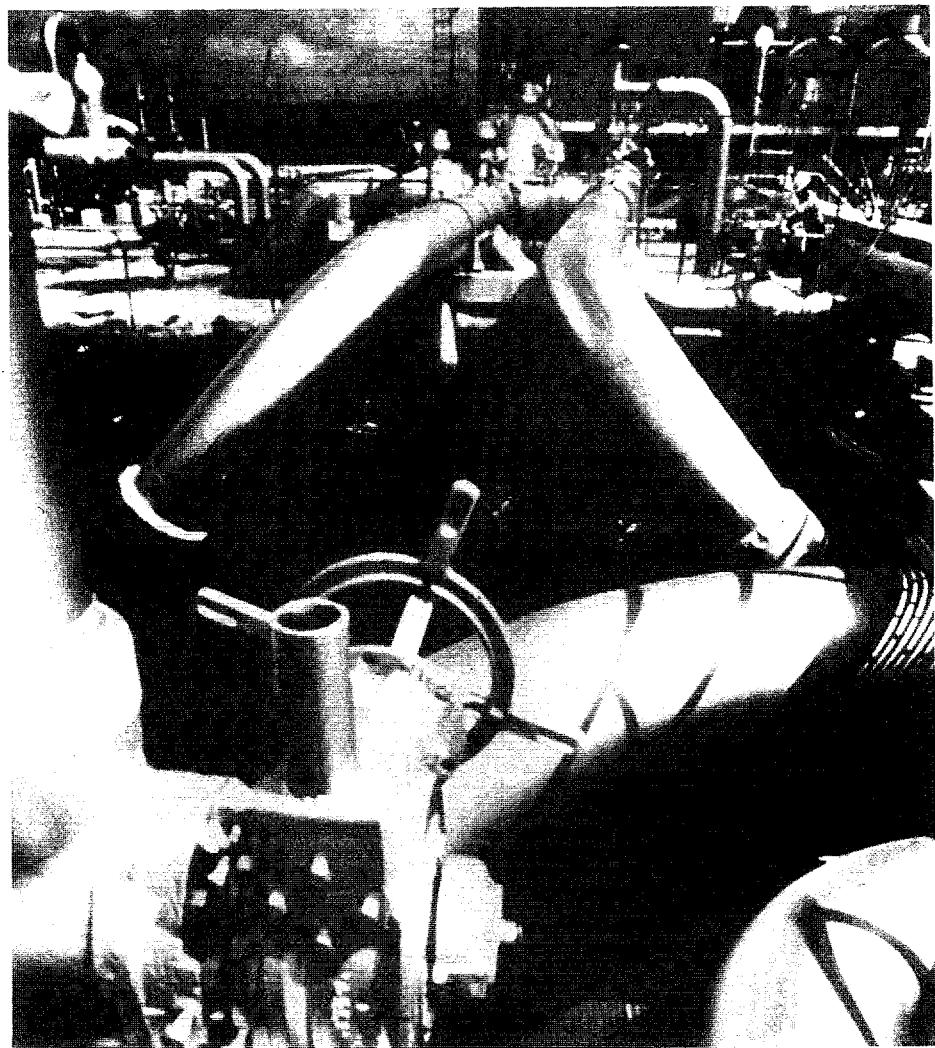
## Summary of Findings (continued)

As will be discussed in the section on the role of larger boilers in industry, the size of boiler varies considerably by industry. Table 2 highlights this point. This fact means that two industries which have the same number of boilers may consume vastly different amounts of energy due to the size of the boilers. For example, the food and paper industries (as shown in Table 1) have approximately the same number of boilers, yet the paper industry uses almost five times as much fuel (as shown in Table 2) because its boilers are considerably larger.

Table 2 presents some general characteristics of boilers. The industries with the largest number of boilers per establishment are primary metals, petroleum, paper, and chemicals. The lumber and wood industry reported the fewest number of boilers per establishment.

Nationwide, the median size of large boilers in operation during 1979 was 123 million Btu-per-hour. Some industries, particularly paper, primary metals, chemicals, and petroleum, have a median size considerably higher than the national average.

The median year of installation for large boilers nationally is 1962. However, there is a fairly wide range for this date. The oldest boilers are in the stone, clay, and glass; and primary metals industries where the median years of installation are 1951 and 1952, respectively.





## Summary of Findings (continued)

Table 2. General Characteristics of Large Boilers by Standard Industrial Classification (SIC) Code

Industry	SIC Code	Number of Establishments	Number of Large Boilers	Mean Large Boilers Per Establishment	Firing Rate <sup>a</sup> (MMBtu/hr.)	Mean Design Year of Installation <sup>b</sup>	Median
Food and Kindred Products.....	20	462	1,122	2.43	96	1966	
Tobacco.....	21	c	49	c	88	1968	
Textile Mill Products.....	22	186	382	2.05	83	1965	
Apparel.....	23	c	14	c	77	1958	
Lumber and Wood.....	24	142	240	1.69	95	1968	
Furniture.....	25	c	13	c	77	1959	
Paper and Allied Products.....	26	370	1,239	3.35	184	1960	
Printing and Publishing.....	27	c	10	c	86	1971	
Chemicals.....	28	518	1,783	3.44	149	1963	
Petroleum.....	29	163	653	4.01	143	1957	
Rubber and Plastics.....	30	97	224	2.31	86	1965	
Leather.....	31	c	5	c	75	1976	
Stone, Clay, and Glass.....	32	33	84	2.55	115	1951	
Primary Metals.....	33	134	647	4.83	163	1952	
Fabricated Metals...	34	50	115	2.30	94	1955	
Machinery.....	35	81	221	2.73	89	1959	
Electronic Equipment.....	36	63	165	2.62	84	1961	
Transportation Equipment.....	37	112	331	2.96	96	1956	
Instruments.....	38	c	61	c	138	1966	
Miscellaneous.....	39	c	13	e	175	1962	
Other Nondurables...	NA	38	d78	2.05	84	1967	
Other Durables.....	NA	33	d57	2.64	126	1965	
Unclassified <sup>e</sup> .....	NA	16	37	2.31	94	1966	
Total.....	NA	2,498	7,408	2.97	121	1961	

<sup>a</sup>This column is based on a total of 7,204 boilers due to the exclusion of 167 boilers which could not be classified by maximum design firing rate.

<sup>b</sup>This column is based on a total of 7,027 boilers due to the exclusion of 344 boilers which could not be classified by year of installation.

<sup>c</sup>In order to avoid the possible identification of respondents, establishments in SIC codes 21, 23, 27, and 31 are reported in "Other Nondurables" and establishments in SIC codes 25, 38, and 39 are reported in "Other Durables." <sup>d</sup>Not included in column totals since they are already in the table above.

<sup>e</sup>From the information requested, it was impossible to determine the industry group.

NA = Not Applicable.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.

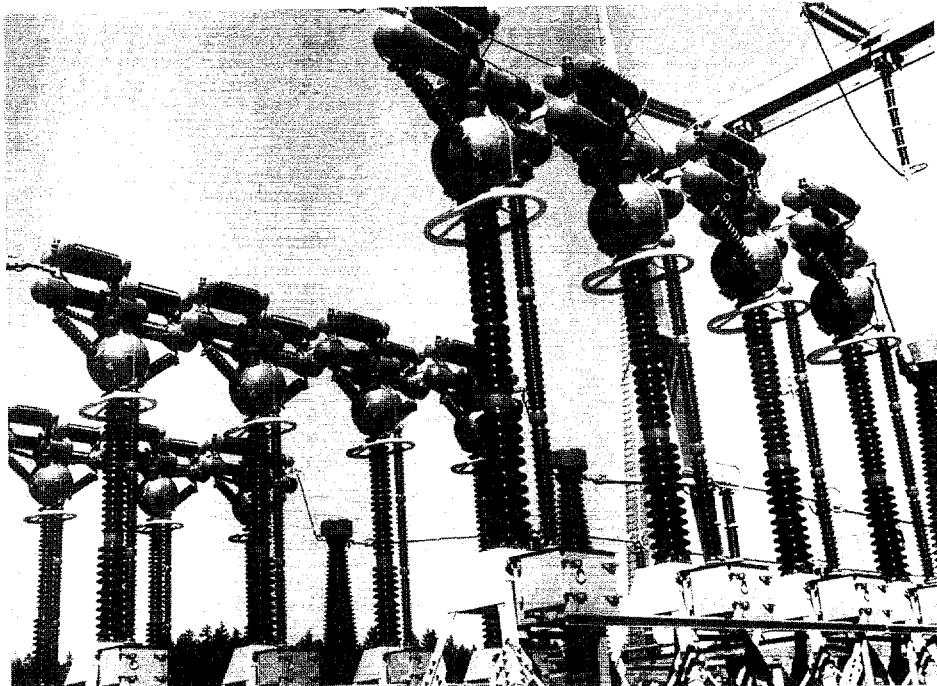


## Summary of Findings (continued)

In an effort to determine the population of both process and nonprocess combustors, respondents were asked to indicate the number and MDFR size class of all combustors with a maximum design firing rate greater than one MMBtu per hour.<sup>6</sup> Almost 63,000 combustors were reported. Table 3 presents these combustors divided into the eleven categories by SIC code.<sup>7</sup>

The primary metals industry reported 16,898 combustors. This is approximately 27 percent of all combustors reported. A little less than one fourth of these combustors were identified as heat treaters, with an almost equal number of reheaters. The chemicals industry reported 8,529 combustors, or a little less than 14 percent of the total reported. A little more than one in five of these combustors were identified as boilers.<sup>8</sup>

Table 4 shows the distribution of all combustors by maximum design firing rate and SIC code. While the primary metals industry has the largest number of combustors, they are relatively small. On the other hand, the paper industry has only 15 percent as many combustors as the primary metals industry, but the typical combustor in the paper industry is almost 9 times larger as measured by the MDFR. Other industries with high median MDFR among those industries reporting 2,000 or more combustors are the petroleum, food, and chemicals industries.



<sup>6</sup>Of the 7,983 establishments which responded to this survey, 6,550 reported at least one combustor.

<sup>7</sup>The detailed data from which Tables 3, 4, 7, and 8 were extracted are part of the public use data tape.

<sup>8</sup>The reader is reminded that due to the cancellation of this study (see Appendix B), the number of combustors reported by an industry is less than the number actually in use. However, the relative proportion of the types of combustors, particularly in industries with a large number of reporting establishments, may more accurately represent the true distribution of combustors.



## Summary of Findings (continued)

Table 3. Number of Combustors  
with a Maximum Design Firing  
Rate of One-Million Btu-per-hour  
or More by Type of Combustora  
and Standard Industrial  
Classification (SIC) Code

Industry	SIC Code	Total		Internal Combustion Engines								Heat Treaters				Re-heaters		Sintering and Pelletizers		Other <sup>b</sup>
		Com-bus-tors	Boilers	Gas Tur-bines	Combus-tion Engi-nes	Fluid Heat-ers	Dryers	Cal-ciners	Reac-tors	Mel-ters	Treat-ers	Re-hea-ters	Pellet-i-zers							
Primary Metal...	33	16,898	1,571	19	301	1,416	727	180	3,169	1,251	4,073	3,914	277	-	-	-	-	-	-	-
Chemicals.....	28	8,529	3,700	62	607	1,495	858	300	1,219	81	111	52	40	4	-	-	-	-	-	-
Petroleum.....	29	7,002	1,173	80	913	3,852	614	40	260	2	25	34	5	4	-	-	-	-	-	-
Stone, Clay, and Glass.....	32	4,892	574	5	63	66	725	933	40	593	1,789	35	57	12	-	-	-	-	-	-
Food.....	20	4,661	2,732	8	132	186	1,134	82	66	4	310	4	1	2	-	-	-	-	-	-
Fabricated Metals.....	34	3,783	744	-	21	457	552	15	63	99	1,121	702	9	-	-	-	-	-	-	-
Transportation..	37	3,595	1,245	15	91	632	574	8	121	98	755	52	3	1	-	-	-	-	-	-
Machinery.....	35	2,719	793	12	94	119	267	10	38	59	1,065	255	7	-	-	-	-	-	-	-
Paper.....	26	2,576	1,788	7	18	43	510	163	23	5	11	5	1	2	-	-	-	-	-	-
Electrical Equipment.....	36	2,496	725	-	36	138	472	15	112	83	875	22	18	-	-	-	-	-	-	-
Textile.....	22	2,018	821	-	4	32	1,048	3	9	4	86	5	-	1	-	-	-	-	-	-
Rubber and Plastic.....	30	842	543	3	23	72	122	0	23	10	46	-	-	-	-	-	-	-	-	-
Lumber and Wood.....	24	767	525	-	8	19	169	-	13	-	33	-	-	-	-	-	-	-	-	-
Furniture.....	25	344	118	-	-	118	64	-	13	-	19	12	-	-	-	-	-	-	-	-
Instruments....	38	316	232	5	44	1	28	2	4	-	-	-	-	-	-	-	-	-	-	-
Printing and Publishing.....	27	257	76	-	-	13	144	19	2	1	1	1	-	-	-	-	-	-	-	-
Miscellaneous...	39	220	105	4	14	19	55	12	4	3	4	-	-	-	-	-	-	-	-	-
Apparel.....	23	144	48	-	-	8	59	-	-	2	12	15	-	-	-	-	-	-	-	-
Tobacco.....	21	118	99	-	7	1	11	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather.....	31	89	60	-	-	5	16	1	2	3	2	-	-	-	-	-	-	-	-	-
Unclassified <sup>c</sup> ...	NA	450	100	5	4	242	81	6	1	-	5	-	-	-	-	-	-	-	-	-
Total.....	NA	62,716	d17,778	225	2,380	8,939	8,230	1,789	5,182	2,298	10,343	5,108	418	2	-	-	-	-	-	-

<sup>a</sup>See the Glossary in Appendix A for the definitions of the types of combustors.

<sup>b</sup>Includes 21 combustors which were either boilers, gas turbines, or internal combustion engines and 5 which were not identifiable.

<sup>c</sup>From the information reported, it was impossible to determine the industrial group.

<sup>d</sup>Includes 10,370 boilers with a maximum design firing rate between 1 and 49 MMBtu per hour as well as the 7,408 larger boilers with an MDFR of 50 MMBtu or more per hour reported elsewhere in this report.

"-" = None

NA = Not applicable.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.



## Summary of Findings (continued)

Table 4. Number of Combustors with a Maximum Design Firing Rate of One-Million Btu-per-hour or More by Maximum Design Firing Rate and Standard Industrial Classification (SIC) Code

Industry	SIC Code	Total	Maximum Design Firing Rate (MMBtu per hour)							
			1-9	10-24	25-49	50-99	100-249	250 +	50+a	Unknown <b>b</b>
Primary Metals...	33	16,898	10,361	2,970	1,476	689	954	441	2	5
Chemicals.....	28	8,529	3,488	1,654	895	949	1,109	405	29	-
Petroleum.....	29	7,002	2,476	1,269	1,072	1,096	872	200	16	1
Stone, Clay, and Glass.....	32	4,872	2,677	994	462	328	321	92	18	-
Food.....	20	4,661	1,670	1,039	686	707	460	53	42	4
Fabricated Metals.....	34	3,783	2,768	576	175	86	167	1	5	5
Transportation...	37	3,595	2,569	486	173	199	141	20	7	-
Machinery.....	35	2,719	2,012	277	158	177	85	10	-	7
Paper.....	26	2,576	554	302	326	436	544	389	25	-
Electronic Equipment.....	36	2,496	1,816	368	143	123	40	3	3	-
Textile.....	22	2,018	1,042	331	255	292	84	3	11	-
Rubber and Plastic.....	30	842	416	108	82	163	60	7	6	-
Lumber and Wood..	24	767	259	131	118	144	93	13	9	-
Furniture.....	25	344	244	54	31	14	1	-	-	7
Instruments.....	38	316	161	67	23	28	26	11	-	-
Printing.....	27	257	194	37	16	7	3	-	-	7
Miscellaneous....	39	220	114	61	31	5	5	4	-	10
Apparel.....	23	144	84	27	18	11	2	-	2	-
Tobacco.....	21	118	23	26	15	35	16	-	3	-
Leather.....	31	89	46	28	8	6	1	-	-	9
Unclassified <sup>c</sup> ....	NA	220	279	41	33	54	41	2	-	-
Total.....	NA	2,716	33,253	10,846	6,196	5,549	5,025	1,654	178	15
										9

<sup>a</sup>From the information reported, it was possible only to determine an MDFR greater than 50 MMBtu/hr. This column was not included in the median calculations.

<sup>b</sup>From the information reported, it was impossible to determine the MDFR.

<sup>c</sup>From the information reported, it was impossible to determine the industry group.

"-" = None

N/A = Not applicable.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.



## Summary of Findings (continued)

### Regional Characteristics

The data reported in the previous section focused on standard industrial classification. The focus of this section is on regions of the country.<sup>9</sup>

The data presented in this section will repeatedly show that while the North Central region of the country -- traditionally thought of as the industrial center of the country -- has the largest number of establishments and combustors, the South Central region uses considerably more energy. While this report should not be considered as conclusive evidence of this fact, it is a further indication that the new industrial centerland may well be in the South.

Table 5 presents similar information as presented in Table 1. The trend, mentioned above, is very obvious. As can be seen, energy use varied substantially across the five regions of the country. The North Central region stands out because it has the largest number of establishments and the largest number of boilers. However, the South Central region, with two-thirds as many establishments and 88 percent as many boilers, consumes 41 percent more energy at the establishment level and 54 percent more fuel at the combustor level. The average establishment in the South Central region consumes more than twice as much energy as the average

Table 5. Number of Establishments and Large Boilers Together with Total and Average Amount of Fuel Consumed (Trillion Btu) by Region

Region	Establishments			Large Boilers		
	Number	Fuel Consumed		Number	Fuel Consumed	
	Total	Average		Total	Average	
Northeast.....	388	1,015.0	2.62	1,080	494.3	0.46
North Central....	630	1,857.2	2.95	1,811	921.5	0.51
South Atlantic....	342	937.4	2.74	990	722.3	0.73
South Central....	426	2,624.3	6.16	1,593	1,423.4	0.89
West.....	299	1,038.6	3.47	819	523.7	0.64
Other <sup>a</sup> .....	413	1,066.4	2.58	1,115	585.6	0.53
Total.....	2,498	8,538.9	3.42	7,408	4,670.8	0.63

<sup>a</sup>This category includes those establishments and combustors which, in order to avoid disclosure, are reported in 2 or more regions. Also included in this category are 8 establishments with 18 boilers which were not classified by region.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.

<sup>9</sup>In an effort to protect the confidentiality of the respondents, the regional divisions chosen were the four regions defined by the U.S. Bureau of the Census with the Southern region further divided into the South Atlantic and South Central regions. For the purposes of this report, the geographic regions are made up of the following States: Northeast: Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, and Pennsylvania; North Central: Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, North Dakota, South Dakota, Iowa, Nebraska, Missouri, and Kansas; South Atlantic: Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, and Florida; South Central: Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Texas, and Oklahoma; West: Montana, Wyoming, Idaho, Colorado, Utah, New Mexico, Arizona, California, Nevada, Oregon, Washington, Alaska, and Hawaii. See Appendix C.



## Summary of Findings (continued)

establishment in the North Central region. The average combustor in the South Central region consumes 75 percent more energy than the average combustor in the North Central region.

Table 6 continues to highlight the difference between the North Central and South Central regions. While the North Central region has the most boilers, they tend to be among the smallest in terms of median MDFR and oldest in terms of median year of installation. The boilers in the South Central region, on the other hand, are among the largest and newest.

The biggest contributing factor to this difference comes from the boilers used in the paper and chemical regions. The largest boilers for these two industries are in the South Central region. These boilers are also among the newest.

Table 6. General Characteristics of Large Boilers by Region and Selected Standard Industrial Classification (SIC) Code

Region	Number of Establishments	Number of Large Boilers	Mean Large Boilers Per Establishment (MMBtu/Hr.) <sup>a</sup>	Median Design Firing Rate	Median Year of Installation <sup>b</sup>
Northeast.....	388	1,080	2.78	99	1958
Food.....	38	100	2.63	102	1961
Paper.....	98	244	2.49	105	1959
Chemicals.....	59	164	2.78	102	1961
Petroleum.....	13	62	4.77	134	1951
Primary Metals.....	25	148	5.92	179	1948
Other Durables.....	104	274	2.63	90	1958
Other Nondurables...	51	88	1.73	79	1961
North Central.....	630	1,811	2.87	99	1959
Food.....	150	355	2.37	92	1964
Paper.....	103	262	2.54	136	1955
Chemicals.....	103	263	2.55	97	1964
Petroleum.....	39	151	3.87	135	1953
Primary Metals.....	43	257	5.98	177	1953
Other Durables.....	176	495	2.81	90	1957
Other Nondurables...	16	28	1.75	79	1959
South Atlantic.....	342	990	2.89	122	1964
Food.....	29	97	3.34	131	1968
Paper.....	43	203	4.72	238	1959
Chemicals.....	84	312	3.71	133	1962
Petroleum.....	9	12	1.33	130	1971
Primary Metals.....	-	-	-	-	-
Other Durables.....	20	27	1.35	95	1967
Other Nondurables...	157	339	2.16	86	1966
South Central.....	426	1,593	3.74	172	1964
Food.....	69	188	2.72	91	1966
Paper.....	57	275	4.82	312	1963
Chemicals.....	156	686	4.40	191	1964
Petroleum.....	51	252	4.94	161	1957
Primary Metals.....	-	-	-	-	-
Other Durables.....	52	94	1.81	126	1971
Other Nondurables...	41	98	2.39	80	1967

End Notes Appear at End of Table.



## Summary of Findings (continued)

Table 6. General Characteristics of Large Boilers by Region and Selected Standard Industrial Classification (SIC) Code (continued)

Region	Number of Establishments	Number of Large Boilers	Mean Number of Large Boilers Per Establishment	Median Firing Rate (MMBtu/Hr.) <sup>a</sup>	Median Maximum Design Year of Installation <sup>b</sup>
West.....	299	819	2.74	121	1961
Food.....	106	244	2.30	105	1961
Paper.....	44	176	4.00	182	1960
Chemicals.....	19	59	3.11	96	1960
Petroleum.....	34	138	4.06	133	1958
Primary Metals.....	10	35	3.50	142	1959
Other Durables.....	82	156	1.90	93	1961
Other Nondurables...	4	10	2.50	92	1964
Other <sup>c</sup> .....	413	1,115	2.70	104	1962
Food.....	70	138	1.97	90	1970
Paper.....	25	79	3.16	186	1963
Chemicals.....	97	299	3.08	122	1962
Petroleum.....	17	38	2.24	89	1971
Primary Metals.....	56	207	3.70	138	1958
Other Durables.....	80	197	2.46	98	1959
Other Nondurables...	52	121	2.33	86	1965
Unclassified <sup>d</sup> .....	16	37	2.31	94	1966
Total.....	2,498	7,408	2.97	121	1961

<sup>a</sup>The calculations in this column are based only on those boilers which could be classified by MDFR.

<sup>b</sup>The calculations in this column are based only on those boilers which could be classified by year of installation.

<sup>c</sup>This category includes those establishments and combustors which, in order to avoid disclosure, are reported in 2 or more regions. Also included in this category are 8 establishments with 18 boilers which were not classified by region.

<sup>d</sup>From the information reported, it was impossible to determine the industrial group. Also included in this category is one large boiler which is incorrectly identified on the data tape as being in the West region.

"—" = None

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.

Table 7 provides a regional distribution of all process and nonprocess combustors with an MDFR of at least one million MMBtu per hour.<sup>10</sup> Boilers predominate in each region as the most common type of combustor. However the mix of combustors varies widely. Boilers range from a high of 34.3 percent of all combustors in the South Atlantic to a low of 25.9 percent in the North Central. Other types of combustors have an even larger range than the 8.4 percentage points seen among boilers. The range for heat treaters, the second most common combustor, is 15.6 points while the range for fluid heaters, the third most common combustor, is 13.5 points.

<sup>10</sup>The combustors reported in Tables 7 and 8 are reported in only one region. The data used to develop these tables exist only in an aggregated format either by Standard Industrial Classification or by region, rather than in a micro-level establishment format.



## Summary of Findings (continued)

Table 7. Number of Combustors  
with a Maximum Design Firing  
Rate of One-Million Btu-per-  
Hour or More by Type of  
Combustor and Region<sup>a</sup>

Region	Total		Internal Combustion								Sinterers		
	Combus-tors	Boilers	Gas Tur-bines	Combus-tion Engi-nes	Fluid Heat-ers	Dryers	Cal-ciners	Reac-tors	Mel-ters	Heat Treat-ers	Re-heat-ers	Pelit-izers	Other <sup>c</sup>
Northeast.....	b13,569 (100.0)	3,720 (27.4)	48 (0.4)	172 (1.3)	1,375 (10.1)	1,220 (9.0)	370 (2.7)	1,607 (11.3)	532 (3.9)	2,890 (21.3)	1,565 (11.5)	64 (0.5)	6 (0.1)
North Central....	21,387 (100.0)	5,541 (25.9)	26 (0.1)	447 (0.1)	2,460 (11.5)	2,966 (13.9)	381 (1.8)	1,718 (8.0)	841 (3.9)	4,700 (22.0)	2,174 (10.2)	124 (0.6)	9 (*)
South Atlantic...	7,021 (100.0)	2,412 (34.3)	12 (0.2)	119 (1.7)	593 (8.4)	1,704 (24.3)	242 (3.4)	229 (3.3)	250 (3.6)	1,036 (14.8)	399 (5.7)	23 (0.3)	2 (*)
South Central....	12,618 (100.0)	3,419 (27.1)	91 (0.7)	1,034 (8.2)	2,764 (21.9)	1,382 (10.9)	412 (3.3)	1,268 (10.0)	400 (3.2)	1,213 (9.6)	576 (4.6)	53 (0.5)	6 (*)
West.....	7,691 (100.0)	2,581 (33.6)	38 (0.5)	603 (7.8)	1,506 (19.6)	914 (11.9)	376 (4.9)	358 (4.7)	272 (3.5)	492 (6.4)	394 (5.1)	154 (2.0)	3 (*)
Other <sup>d</sup> .....	430 (100.0)	105 (24.4)	10 (2.3)	5 (1.2)	241 (56.0)	44 (10.2)	8 (1.7)	2 (0.5)	3 (0.7)	12 (2.8)	- (-)	- (-)	- (-)
Total.....	62,716 <sup>e</sup> (100.0)	17,778 (28.3)	225 (0.4)	2,380 (3.8)	8,939 (14.3)	8,230 (13.1)	1,789 (2.8)	5,182 (8.3)	2,298 (3.7)	10,343 (16.5)	5,108 (8.1)	418 (0.7)	26 (*)

<sup>a</sup>The tabulations reported in this table are based on separate files of the responses of 7,946 establishments. Of this number, 1,605 were in the Northeast, 2,323 were in the North Central, 1,237 were in the South Atlantic, 1,520 were in the South Central, 1,222 were in the West, and 39 were unclassified.

<sup>b</sup>The top figure in each cell is the number of combustors of that type in that region. The bottom figure is the percent of the total combustors in that region.

<sup>c</sup>Includes 21 combustors which were either boilers, gas turbines, or internal combustion engines and 5 which were not identifiable.

<sup>d</sup>This category includes only those combustors in establishments which could not be classified by region.

<sup>e</sup>Includes 10,370 boilers with a maximum design firing rate between 1 and 49 MMBtu per hour as well as the 7,408 large boilers with an MDFR of 50 MMBtu or more per hour reported elsewhere in this report.

"—" = None

"\*" = Less than 0.05 percent

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.



## Summary of Findings (continued)

The regional distribution of combustors by capacity (i.e., MDFR) is presented in Table 8. Here again is an indication of the differences between the North Central and South Central regions. The median MDFR for combustors in the North Central region is among the lowest at 9 MMBtu per hour, whereas the South Central region is the highest at 16 MMBtu per hour.

Just as the distribution of types of combustors varied by region, so does the distribution by MDFR. The largest combustors, those of 250 MMBtu per hour or more, comprise 2.6 percent of all combustors in the Nation. However, these combustors are only 1.5 percent of the combustors in the Northeast; 2.1 percent of the combustors in the North Central; 2.6 percent in the West; 3.1 percent in the South Atlantic region; and 4.6 percent in the South Central region.

The South Central region has over 15 percent more combustors of 100 or more MMBtu per hour than any other region. This region has 1-1/2 times as many combustors as the Nation's average for combustors of this size. Further, this region has the smallest proportion of combustors of under 9 MMBtu per hour. This is a further indication of the energy intensiveness of this region.

**Table 8. Number of Combustors with a Maximum Design Firing Rate of One-Million Btu-per-Hour or More by Maximum Design Firing Rate and Region**

Region <sup>a</sup>	Total	Maximum Design Firing Rate (MMBtu per hour)								
		1-9	10-24	25-49	50-99	100-249	250 +	50 + <sup>b</sup>	Unknown <sup>c</sup>	Median
Northeast.....	d13,569 (100.0)	7,851 (57.7)	2,232 (16.4)	1,242 (9.2)	1,022 (7.5)	979 (7.2)	209 (1.5)	26 (0.2)	8 (0.1)	9
North Central....	21,387 (100.0)	12,792 (59.8)	3,476 (16.3)	1,802 (8.4)	1,542 (7.2)	1,275 (6.0)	444 (2.1)	51 (0.2)	5 (*)	9
South Atlantic...	7,021 (100.0)	3,279 (46.7)	1,279 (18.2)	787 (11.2)	784 (11.2)	641 (9.1)	216 (3.1)	35 (0.5)	~ (~)	13
South Central....	12,618 (100.0)	5,344 (42.3)	2,471 (19.6)	1,463 (11.6)	1,297 (10.3)	1,411 (11.2)	575 (4.6)	55 (0.4)	2 (*)	15
West.....	7,691 (100.0)	3,688 (47.9)	1,365 (17.7)	882 (11.5)	866 (11.3)	681 (8.9)	198 (2.6)	11 (0.1)	~ (-)	12
Other <sup>e</sup> .....	430 (100.0)	299 (69.5)	23 (5.4)	20 (4.7)	38 (8.8)	38 (8.8)	12 (2.8)	- (-)	~ (-)	7
Total.....	62,716 (100.0)	33,253 (53.0)	10,846 (17.3)	6,196 (9.9)	5,549 (8.9)	5,025 (8.0)	1,654 (2.6)	178 (0.3)	15 (*)	9

<sup>a</sup>This table is based on a separate file of the responses from 7,946 establishments. Of this number, 1,605 were in the Northeast, 2,323 were in the North Central, 1,237 were in the South Atlantic, 1,520 were in the South Central, 1,222 were in the West, and 39 were unclassified.

<sup>b</sup>From the information reported, it was possible only to determine an MDFR of at least 50MMBtu/hr.

<sup>c</sup>From the information reported, it was impossible to determine the MDFR.

<sup>d</sup>The top figure in each cell is the number of combustors of that type in that region. The bottom figure is the percent of the total combustors in the region.

<sup>e</sup>This category includes only those combustors from establishments which could not be classified by region.

"-" = None

"\*" = Less than 0.05 percent

NA = Not applicable

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.



## Fuel and Energy Use at the Establishment Level



As shown in Table 9, establishments responding to the survey consumed 8,518.5 trillion Btu of fuel in 1979. This includes 5,345.7 trillion Btu, or 62.8 percent, of purchased fuels, 3,172.1 trillion Btu or 37.2 percent of nonpurchased or byproduct fuels, and 0.7 trillion Btu or 0.008 percent of energy from hydropower, wind, geothermal, solar, or other energy sources. In general, industry uses more purchased than nonpurchased fuels. The petroleum industry is the exception because of its heavy consumption of refinery off-gases. Other industries which consume relatively larger amounts of nonpurchased fuels are the paper (pulping liquor), primary metals (coke oven gas), and wood and lumber (wood waste) industries. The data reported in Table 10 are weighted to account for the nonresponse of establishments. This table shows estimated total fuel consumption as 12,089.6 trillion Btu. Of this amount, 7,212.2 trillion Btu came from purchased fuels; 4,907.4 trillion Btu from nonpurchased fuels; and 1.0 trillion Btu from nontraditional energy sources.

Natural gas accounts for 58 percent of all purchased fuels. Almost 36 percent of the natural gas is consumed in the chemical industry. Residual oil accounts for 17 percent of purchased fuel consumption. The paper industry is the largest user of residual oil. The third most consumed purchased fuel is coal which accounts for 15 percent.

Table 11 presents establishment fuel use by region. Only in the West region is the proportion of purchased fuel less than the proportion of nonpurchased fuel. This is possibly due to the high concentration of lumber and paper industries in the West. The highest use of nonpurchased fuel occurs in the South Central region due to the large number of petroleum, chemical, and paper establishments.

<sup>1</sup>The 1979 Annual Survey of Manufactures, Fuels and Electric Energy Consumed reports that natural gas accounts for 57 percent of all purchased fuels; 26 percent of the natural gas was consumed in the chemical industry; residual oil accounts for 10 percent of purchased fuel consumption; and coal accounts for 11 percent.



## Fuel and Energy Use at the Establishment Level (continued)

Table 9. Establishment Fuel Use  
by Standard Industrial  
Classification (SIC) Code—  
Unweighted Data (Trillion Btu)

Industry	SIC	Totals All Fuels	Purchased Fuels									Non- Pur- chased	Non- tradi- tional <sup>a</sup>
			Total	Coal	Other Solid	Dis- til- late	Resid- ual	Other Liquid	Natural Gas	Other Gas			
Chemicals.....	28	2,004.9	1,689.9	297.0	7.3	30.4	191.9	7.7	1,116.4	39.1	314.6	0.4	..
Paper.....	26	1,994.5	1,052.3	226.0	116.4	12.2	338.7	7.0	348.1	4.0	942.0	0.2	..
Petroleum.....	29	1,847.3	679.8	5.6	8.9	6.2	122.1	8.9	456.4	71.7	1,167.5	..	..
Primary Metal.....	33	1,385.3	773.2	89.6	10.6	15.3	93.2	5.2	527.6	31.8	612.1	..	..
Food.....	20	445.7	395.6	83.0	10.5	16.4	51.9	2.1	227.7	4.0	50.0	0.1	0.1
Durable Goods.....	NA	574.9	490.7	80.0	57.5	7.8	65.4	2.4	269.9	7.8	84.1	..	..
Lumber and Wood..	24	163.7	85.5	1.6	53.4	0.4	10.3	—	16.5	3.4	78.1	..	..
Transportation...	37	121.4	121.4	19.8	0.1	2.0	16.3	2.4	80.2	0.7	*	..	..
Machinery.....	35	102.4	102.3	15.1	0.1	2.5	13.2	*	67.8	3.5	0.1	..	..
Stone, Clay, and Glass.....	32	52.4	49.2	10.6	2.8	0.6	4.1	—	31.1	*	3.2	..	..
Electric Equipment.....	36	47.3	45.6	8.4	0.7	0.9	11.9	*	23.6	0.1	1.7	..	..
Fabricated Metal..	34	27.7	27.7	2.1	—	0.9	2.7	*	21.9	0.1	NA	..	..
Other Durables <sup>b</sup> ..	NA	60.0	59.0	22.4	0.4	0.5	6.9	*	28.8	*	1.0	..	..
Nondurable Goods...	NA	265.9	264.2	44.1	1.9	6.9	48.0	*	161.9	1.2	1.8	..	..
Textile.....	22	152.0	152.0	22.1	1.9	1.6	23.3	*	102.1	0.9	0.1	..	..
Rubber and Plastic.....	30	80.5	80.2	19.4	—	5.1	19.9	*	35.5	0.3	0.3	..	..
Other Non- durables <sup>c</sup> .....	NA	33.4	32.0	2.6	—	0.2	4.8	—	24.3	*	1.4	..	..
Unclassified <sup>d</sup> .....	NA	20.4	20.4	3.5	*	.5	.2	2.1	14.0	—	—	..	..
Total.....	NA	8,538.9	5,366.2	828.8	213.1	95.7	911.4	35.5	3,122.0	159.6	3,172.1	0.7	..

<sup>a</sup>Includes energy derived from hydropower, wind, geothermal, solar, or any other energy source.

<sup>b</sup>SIC Codes 25, 38, and 39.

<sup>c</sup>SIC Codes 21, 23, 27, and 31.

<sup>d</sup>From the information reported, it was impossible to determine the industrial group.

"—" = None

"\*" = Less than 0.05 trillion Btu.

NA = Not Applicable

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.



## Fuel and Energy Use at the Establishment Level (continued)

Table 10. Establishment Fuel Use by Standard Industrial Classification (SIC) Code—Weighted Data (Trillion Btu)

Industry	SIC	Totals (All Fuels)	Purchased Fuels								Non- Pur- chased	Non- tradi- tional <sup>a</sup>
			Total	Coal	Other Solid	Dis- til- late	Residual	Other Liquid	Natural Gas	Other Gas		
Chemicals.....	28	2,622.9	2,213.9	383.4	7.9	40.2	241.4	9.9	1,478.3	52.9	408.4	0.6
Paper.....	26	2,418.2	1,272.1	281.5	139.7	15.1	403.9	8.1	419.0	4.8	1,145.8	0.3
Petroleum.....	29	3,828.1	1,379.6	10.5	13.9	13.5	245.5	11.4	917.9	166.9	2,448.6	-
Primary Metal.....	33	1,662.9	923.9	108.0	12.0	19.0	108.7	6.8	630.1	39.3	739.0	-
Food.....	20	541.9	482.4	102.4	12.5	20.2	63.7	2.7	275.9	5.0	59.5	0.1
Durable Goods.....	NA	743.3	639.9	111.1	70.2	10.2	81.9	3.7	352.5	10.3	103.2	*
Lumber and Wood..	24	197.4	101.9	1.8	64.5	0.5	11.3	-	19.1	4.7	95.4	-
Transportation...	37	195.9	195.8	37.2	0.1	3.3	23.5	3.7	126.8	1.1	*	*
Machinery.....	35	120.2	120.1	19.9	0.1	2.8	15.4	*	77.7	4.3	0.1	*
Stone, Clay, and Glass.....	32	65.0	60.8	12.7	3.9	0.8	5.3	-	38.0	*	4.2	-
Electric Equipment.....	36	56.2	53.9	9.0	1.0	1.0	14.8	*	28.0	0.1	2.3	-
Fabricated Metal.....	34	36.8	36.8	3.5	-	1.1	3.4	*	28.6	0.1	-	-
Other Durables <sup>b</sup> ..	NA	71.8	70.6	27.0	0.6	0.7	8.2	*	34.2	*	1.2	*
Nondurable Goods...	NA	302.3	300.4	50.0	2.1	7.7	55.4	*	183.8	1.4	1.8	*
Textile.....	22	170.5	170.4	25.2	2.1	1.8	26.7	*	113.5	1.1	0.1	-
Rubber and Plastic.....	30	92.3	91.9	21.8	-	5.6	22.9	*	41.3	0.3	0.3	*
Other Non- durables <sup>c</sup> .....	NA	39.5	38.1	3.0	-	0.3	5.8	-	29.0	*	1.4	-
Inclassified <sup>d</sup> .....	NA	21.3	21.3	4.0	*	0.5	0.3	2.1	14.4	-	-	-
Total.....	NA	12,140.9	7,233.5	1,050.9	258.3	126.4	1,200.8	44.7	4,271.9	280.6	4,906.3	1.0

<sup>a</sup>Includes energy derived from hydropower, wind, geothermal, solar, or any other energy source.

<sup>b</sup>SIC Codes 25, 38, and 39.

<sup>c</sup>SIC Codes 21, 23, 27, and 31.

<sup>d</sup>From the information reported, it was impossible to determine the industrial group.

"—" = None

"\*" = Less than 0.05 trillion Btu.

NA = Not Applicable

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study of Large Combustors.



## Fuel and Energy Use at the Establishment Level (continued)

Table 11. Establishment Fuel Use by Region (Trillion Btu)

Region	Totals		Purchased Fuels							Non-traditional <sup>a</sup>
	All Fuels	Total	Coal	Other Solid	Dis-tillate	Residual	Other Liquid	Natural Gas	Other Gas	
<b>Unweighted Data</b>										
Northeast.....	1,015.0	705.4	93.9	7.1	18.7	251.4	5.1	304.5	24.7	309.5
North Central..	1,857.2	1,205.5	242.5	12.6	24.4	137.6	4.9	733.1	50.3	651.5
South Atlantic.	937.4	614.8	180.4	41.6	11.2	201.6	2.7	162.8	14.5	322.2
South Central..	2,624.3	1,522.3	118.4	53.7	17.4	137.5	11.5	1,147.7	36.0	1,102.0
West.....	1,038.6	512.5	52.4	68.9	7.3	65.8	4.5	305.2	8.5	526.1
Other <sup>b</sup> .....	1,066.4	800.9	118.9	28.9	16.7	116.8	6.9	467.1	25.6	256.8
Total.....	8,538.9	5,366.1	826.7	213.0	95.8	911.4	35.5	3,122.0	159.6	3,172.1
<b>Weighted Data</b>										
Northeast.....	1,421.1	940.3	122.1	8.4	25.1	334.5	6.8	399.7	43.7	480.6
North Central..	2,653.7	1,620.1	317.0	16.8	30.8	199.7	6.8	962.3	86.6	1,033.5
South Atlantic.	1,147.3	754.0	220.6	49.3	13.2	250.3	3.2	193.5	23.9	392.7
South Central..	3,837.1	2,146.6	147.5	68.4	23.2	177.9	13.9	1,647.2	68.5	1,690.5
West.....	1,732.0	778.0	70.2	81.3	10.6	88.1	5.9	501.4	20.6	953.9
Other <sup>b</sup> .....	1,349.6	994.4	173.4	34.0	23.4	150.4	8.1	567.9	37.3	355.2
Total <sup>c</sup> .....	12,140.8	7,233.4	1,050.8	258.2	126.3	1,200.9	44.7	4,272.0	280.6	4,906.4

<sup>a</sup>Includes energy from hydropower, wind, geothermal, solar, or any other energy source.

<sup>b</sup>This category includes the combustors from 2 or more regions in a given SIC which, for disclosure purposes were combined. These combustors are reported in all regions represented.

<sup>c</sup>Differences between the total reported in this table and those reported in Table 9 and 10 occur due to rounding.

"\*" = Less than 0.05 trillion Btu.

Source: Energy Information Administration, Office of Energy Markets and End Use Division, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.



## Fuel and Energy Use at the Establishment Level (continued)

Table 12 shows the amount of electricity which is used by the establishment and the amount generated onsite. Overall, slightly more than one-fourth of the electricity needs of establishments are generated onsite. Among the industries which are the largest electricity users, the paper industry generates 57 percent of its electricity needs. Some of this information is shown graphically in Figure 2. Table 13 shows these data by Region.

Table 12. Electricity Generated and Used Onsite by Standard Industrial Classification (SIC) Code (Trillion Btu)

Industry	SIC	Unweighted		Weighted	
		Generated Onsite	Used Onsite	Generated Onsite	Used Onsite
Chemicals.....	28	32.7	246.3	45.8	320.6
Paper.....	26	115.4	201.1	140.5	243.0
Primary Metals.....	33	38.4	165.1	46.6	196.8
Petroleum.....	29	13.0	71.1	26.9	145.5
Food.....	20	12.1	39.1	14.6	48.3
Durable Goods.....	NA	11.8	94.7	14.6	128.8
Transportation.....	37	1.6	30.0	2.2	49.2
Machinery.....	35	1.3	16.6	1.6	20.7
Electrical Equipment..	36	0.7	13.2	0.8	15.2
Lumber and Wood.....	24	2.9	12.6	3.5	15.0
Fabricated Metals.....	34	0.2	6.2	0.2	8.6
Stone, Clay and Glass.	32	0.9	5.8	1.3	7.3
Other Durables <sup>a</sup> .....	NA	4.2	10.3	4.8	13.0
Nondurable Goods.....	NA	3.0	40.9	3.3	47.2
Rubber and Plastic....	30	1.7	20.3	1.9	23.5
Textile Mills.....	22	1.2	16.8	1.3	19.0
Other Nondurables <sup>b</sup> ....	NA	0.1	3.8	0.1	4.7
Unclassified <sup>c</sup> .....	NA	2.0	2.0	2.3	2.0
Total.....	NA	228.4	860.3	294.6	1,132.2

<sup>a</sup>SIC Codes 25, 38, and 39.

<sup>b</sup>SIC Codes 21, 23, 25, and 31.

<sup>c</sup>From information reported, it was impossible to determine the industrial group.

NA = Not applicable

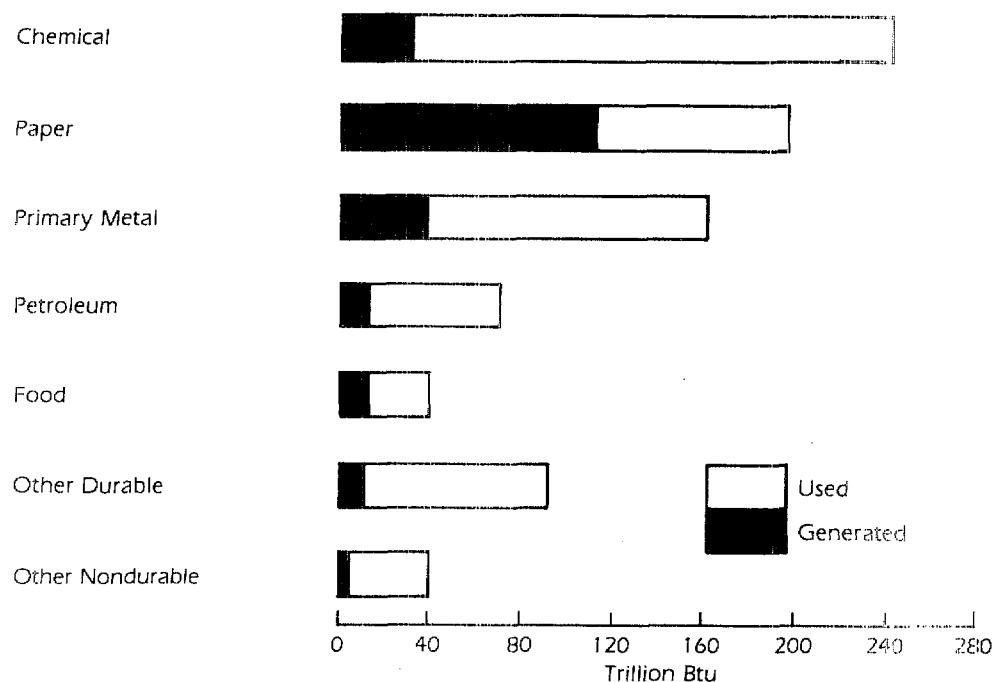
"\*" = Less than 0.05 trillion Btu of electricity.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.



## Fuel and Energy Use at the Establishment Level (continued)

Figure 2. Electricity Generated and Used Onsite by Major Industrial Classification (Unweighted)<sup>a</sup>



<sup>a</sup>This figure does not include the 16 establishments which could not be classified by Standard Industrial Classification code. These establishments use 2.0 trillion Btu of electricity, all of which was generated onsite.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors



## Fuel and Energy Use at the Establishment Level (continued)

Table 13. Electricity Generated and Used Onsite by Region (Trillion Btu)

Region	Unweighted		Weighted	
	Generated Onsite	Used Onsite	Generated Onsite	Used Onsite
Northeast.....	25.9	106.9	32.7	136.4
North Central.....	39.7	198.3	49.7	268.0
South Atlantic.....	39.7	107.0	47.5	130.7
South Central.....	55.2	220.9	77.0	299.7
West.....	23.0	88.1	30.0	124.0
Other <sup>a</sup> .....	44.8	139.1	57.8	173.3
Total <sup>b</sup> .....	228.3	860.3	294.7	1,132.1

<sup>a</sup>For disclosure purposes, the establishments and combustors from 2 or more regions in a given SIC grouping were combined. They are reported in all regions represented. Also included in this category are 8 establishments and 6 boilers which were not classified by region.

<sup>b</sup>Differences between the total reported in this table and those reported in Table 12 occur due to rounding.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.

Steam use by industry is shown in Table 14. For 1979, industry was able to generate more steam onsite than was required. Less than 1 percent of the reported steam used was purchased. With the exception of three industries--petroleum, food, and rubber--more steam was sold or transferred offsite than was purchased or received. It appears that only in rare instances is industry unable to meet its own steam needs.

The chemicals and paper industries account for almost 60 percent of industrial steam use. When adjustments are made for nonresponse, over three-quarters of the estimated steam used by industry in 1979 was used in the chemicals, paper, and petroleum industries.

These data are shown by region in Table 15. This table continues to demonstrate the South Central region's dominance of energy consumption. This region consumes over one-third of the steam used in industry in the Nation.



## Fuel and Energy Use at the Establishment Level (continued)

Table 14. Steam Balance by Standard Industrial Classification (SIC) Code (Trillion Btu)

Industry	SIC	Unweighted Data				Weighted Data			
		Purchased or Received	Generated Onsite	Sold or Transferred	Used Onsite	Purchased or Received	Generated Onsite	Sold or Transferred	Used Onsite
Chemicals.....	28	12.6	1,586.5	33.0	1,566.1	16.2	2,110.5	44.8	2,081.9
Paper.....	26	5.6	1,374.0	15.5	1,364.1	6.7	1,677.2	18.1	1,665.8
Petroleum.....	29	10.6	753.7	6.3	758.0	24.0	1,545.4	16.1	1,553.5
Primary Metals.....	33	6.9	501.0	8.6	499.3	9.9	600.1	10.6	599.4
Food.....	20	4.1	301.6	2.7	303.0	4.9	371.5	2.9	373.5
Durable Goods.....	NA	5.1	310.0	11.1	304.0	6.6	406.3	14.6	398.5
Lumber and Wood.....	24	2.5	83.5	3.3	82.7	2.8	101.3	4.2	99.6
Transportation.....	37	2.6	70.0	2.6	70.0	3.8	114.1	3.9	104.0
Machinery.....	35	-	42.9	0.9	42.0	-	53.2	1.0	52.2
Electrical Equipment.	36	*	29.8	2.0	27.8	*	33.8	2.3	31.5
Stone, Clay, and Glass.....	32	-	17.5	-	17.5	-	22.2	-	22.2
Fabricated Metals....	34	-	14.4	2.2	12.2	-	19.7	3.0	16.7
Other Durables <sup>a</sup> ....	NA	-	51.9	0.1	51.8	-	62.0	0.1	61.9
Nondurable Goods.....	NA	2.5	151.3	2.6	151.2	2.9	173.6	3.0	172.5
Rubber and Plastic....	30	2.5	69.8	0.2	72.1	2.9	80.6	0.2	83.5
Textile Mills.....	22	-	72.2	2.4	69.8	-	81.7	2.8	78.9
Other Nondurables <sup>b</sup> ...	NA	-	9.3	*	9.3	-	11.3	*	11.3
Unclassified <sup>c</sup> .....	NA	-	21.6	0.1	21.5	-	22.5	0.1	22.4
Total.....	NA	47.4	4,999.7	79.9	4,967.2	71.2	6,907.1	110.1	6,865.2

<sup>a</sup>SIC Codes 25, 38, and 39.

<sup>b</sup>SIC Codes 21, 23, 27, and 31.

<sup>c</sup>From the information reported, it was impossible to determine the industrial group.

"-" = None

NA = Not applicable

"\*" = Less than 0.05 trillion Btu

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.



## Fuel and Energy Use at the Establishment Level (continued)

Table 15. Steam Balance by Region (Trillion Btu)

Region	Purchased or Received	Generated Onsite	Sold or Transferred	Used Onsite
Unweighted Data				
Northeast.....	3.1	525.7	5.9	522.9
North Central.....	5.8	865.1	14.3	856.6
South Atlantic.....	5.8	644.0	11.7	638.1
South Central.....	18.9	1,701.8	21.2	1,699.5
West.....	10.5	534.8	8.7	536.6
Other <sup>a</sup> .....	3.3	718.5	18.2	713.6
Total.....	47.4	4,999.9	80.0	4,967.3
Weighted Data				
Northeast.....	4.6	736.5	8.2	732.9
North Central.....	8.1	1,196.4	18.4	1,186.1
South Atlantic.....	10.4	800.2	13.8	796.8
South Central.....	27.0	2,417.1	35.8	2,408.3
West.....	16.8	823.8	11.8	828.8
Other <sup>a</sup> .....	4.3	933.2	22.1	915.4
Total <sup>b</sup> .....	71.2	6,907.2	110.1	6,868.3

<sup>a</sup>To prevent disclosure, the establishments and combustors from 2 or more regions in a given SIC grouping were combined. They are reported in all regions represented. Also included in this category are 8 establishments and 13 boilers which were not classified by region.

<sup>b</sup>Differences between the total reported in this table and the totals reported in Table 14 occur due to rounding.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.





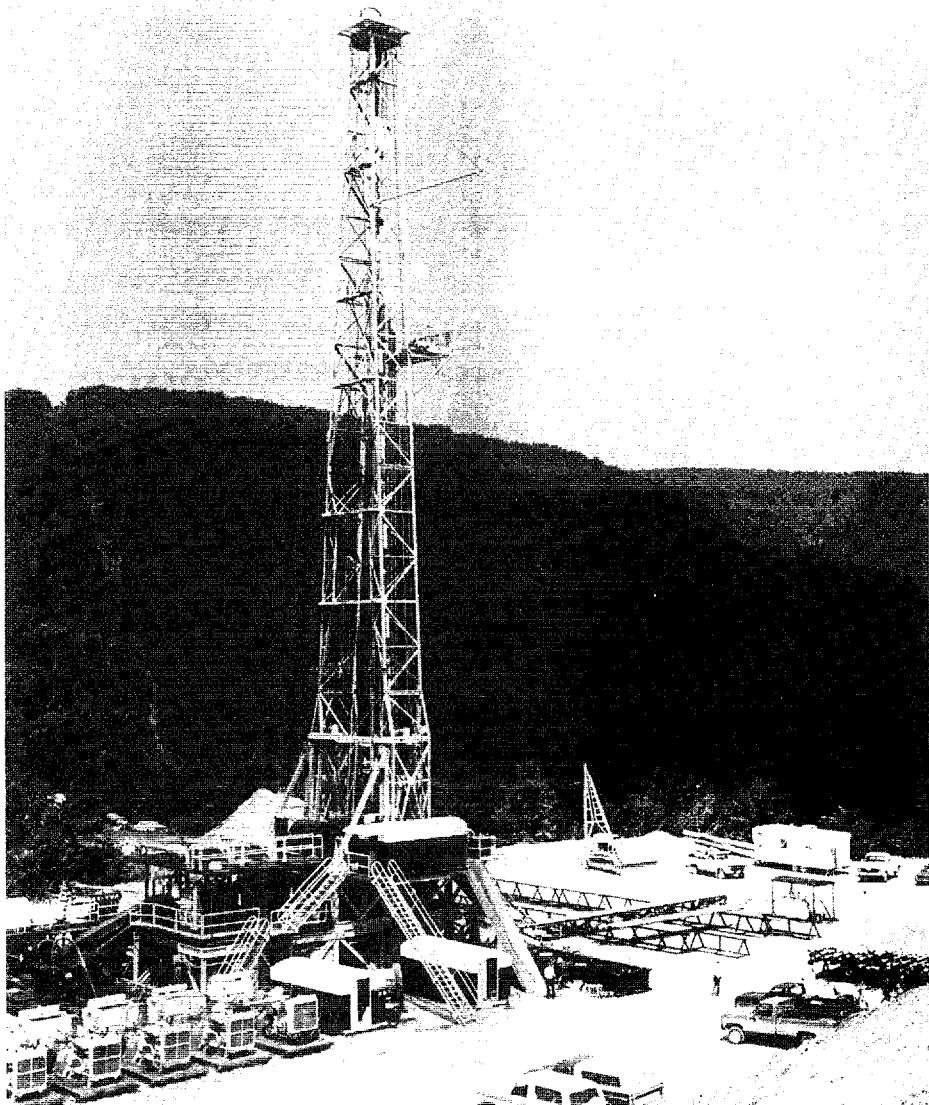
# Energy Use in Large Boilers

## The Role of Large Boilers in Industry

As was shown earlier in this report, a few industries have most of the large industrial boilers. This information is repeated in Table 16 with more details. About 56 percent of all large industrial boilers are in three industries: chemicals, paper, and food. After adding the petroleum and primary metals industries, these five industries account for almost three-fourths of the boilers under consideration. With the exception of the food industry, the remaining four industries are among the highest in terms of the median maximum design firing rate of boilers.

Approximately 44 percent of large industrial boilers reported in this study have an MDFR of between 50 and 99 MMBtu per hour. An additional 40 percent have an MDFR of between 100 and 249 MMBtu per hour. Of the remaining 16 percent, there are approximately three times as many boilers in the 250 to 499 MMBtu per hour range as the 500 and above range.

Table 17 presents this information by region. The South Central region, repeatedly shown as the dominant energy-consuming section of the country, has more boilers with an MDFR of 100 MMBtu per hour or more than any other region.





## Energy Use in Large Boilers (continued)

**Table 16. Number of Large  
Boilers by Maximum Design  
Firing Rate and Standard  
Industrial Classification  
(SIC) Code**

Group	SIC Code	50-99 Total	50-99 MMBtu/Hr.	100-249 MMBtu/Hr.	250-499 MMBtu/Hr.	500 + MMBtu/Hr.
Chemicals.....	28	1,755	618	803	275	59
Paper and Allied Products.....	26	1,216	331	496	253	136
Food and Kindred Products.....	20	1,080	593	436	44	7
Primary Metals.....	33	645	207	275	116	47
Petroleum.....	29	642	241	277	99	25
Textile Mill Products.....	22	371	286	83	2	-
Transportation Equipment.....	37	324	178	136	10	-
Lumber and Wood.....	24	231	128	90	13	-
Machinery.....	35	221	142	73	6	-
Rubber and Plastics...	30	218	152	59	5	2
Electronic Equipment.....	36	162	118	41	3	-
Fabricated Metals....	34	110	62	48	-	-
Stone, Clay and Glass.....	32	66	30	30	6	-
Instruments.....	38	61	24	26	6	5
Tobacco.....	21	49	33	16	-	-
Furniture.....	25	13	12	1	-	-
Miscellaneous.....	39	13	4	5	-	4
Apparel.....	23	12	11	1	-	-
Printing Publishing...	27	10	7	3	-	-
Leather.....	31	5	5	-	-	-
Unclassified <sup>a</sup> .....	NA	37	21	14	2	-
Total <sup>b</sup> .....	NA	7,241	3,203	2,913	840	285
Percent of Total.....	NA	100.0	44.2	40.2	11.6	4.0

<sup>a</sup>From the information report, it was impossible to determine the industrial group.

<sup>b</sup>This total excludes 167 boilers which are unclassified by industry. Of these, 23 are in the Paper industry, 28 in Chemicals, 42 in Food, 2 in Primary Metals, 11 in Petroleum, 11 in Textile Mills, 7 in Transportation Equipment, 9 in Lumber and Wood, 6 in Rubber and Plastics, 3 in Electrical Equipment, 5 in Fabricated Metals, 18 in Stone, Clay, and Glass, and 2 in Apparel. These boilers may be included in other tables in this report as appropriate.

"-" = None

NA = Not Applicable.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.



## Energy Use in Large Boilers (continued)

Table 17. Number of Large  
Boilers by Maximum Design  
Firing Rate and Region

Region	Total	50-99 MMBtu/Hr.	100-249 MMBtu/Hr.	250-499 MMBtu/Hr.	500 + MMBtu/Hr.
Northeast.....	1,062	543	406	94	19
North Central.....	1,775	903	683	155	34
South Atlantic.....	962	423	394	104	41
South Central.....	1,554	447	692	293	122
West.....	809	359	318	100	32
Other <sup>a</sup> .....	1,079	526	420	94	37
Total <sup>b</sup> .....	7,241	3,203	2,913	840	285

<sup>a</sup>For disclosure purposes, the establishments and combustors from 2 or more regions in a given SIC grouping were combined. They are reported in all regions represented. Also included in this category are 8 establishments and 18 boilers which were not classified by region.

<sup>b</sup>This total does not include 167 boilers for which size classification was not available but which apparently had a maximum design firing rate of at least 50 MMBtu/hr. Of these boilers, 18 are in the Northeast region, 36 are in the North Central Region, 28 are in the South Atlantic Region, 39 are in the South Central Region, 10 are in the West, and 36 are in the Other category.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large of Combustors.

Table 18 shows boilers by MDFR and year of installation. This information is shown graphically in Figure 3. Overall, the number of boilers installed has decreased slightly over the last decade. It is interesting to note from this table that in 1979, one boiler in four had been operating for 30 years or more, and slightly less than 1 in 2 had been operating for 20 years or more. Boilers installed between 1940 and 1974 vary only slightly in terms of MDFR. However, those installed prior to 1940 are appreciably smaller while those installed after 1974 are considerably larger.



## Energy Use in Large Boilers (continued)

Table 18. Percent of Large  
Boilers by Maximum Design  
Firing Rate and Year of  
Installation

Maximum Design Firing Rate	Total	1939 or Earlier	1940- 1949	1950- 1959	1960- 1969	1970- 1974	1975 or Later
50-99 MMBtu/hr....	a3,095 (100)	a355 (12)	476 (15)	623 (20)	870 (28)	479 (15)	292 (9)
100-249 MMBtu/hr..	2,845 (100)	274 (10)	542 (19)	521 (18)	729 (26)	435 (15)	344 (12)
250-499 MMBtu/hr..	830 (100)	53 (6)	138 (17)	197 (24)	260 (31)	90 (11)	92 (11)
500 + MMBtu/hr....	279 (100)	5 (2)	8 (3)	38 (14)	96 (34)	57 (20)	75 (27)
All Large Boilers.....	b7,049 (100)	687 (10)	1,164 (16)	1,379 (20)	1,955 (28)	1,061 (15)	803 (11)
Median MDFR.....	123	98	129	119	122	118	148

<sup>a</sup>The top number in each cell is the actual number of boiler in the given size and year of installation class. The bottom number, in parentheses, is the percent of boilers in a given class that were installed in a given group of years.

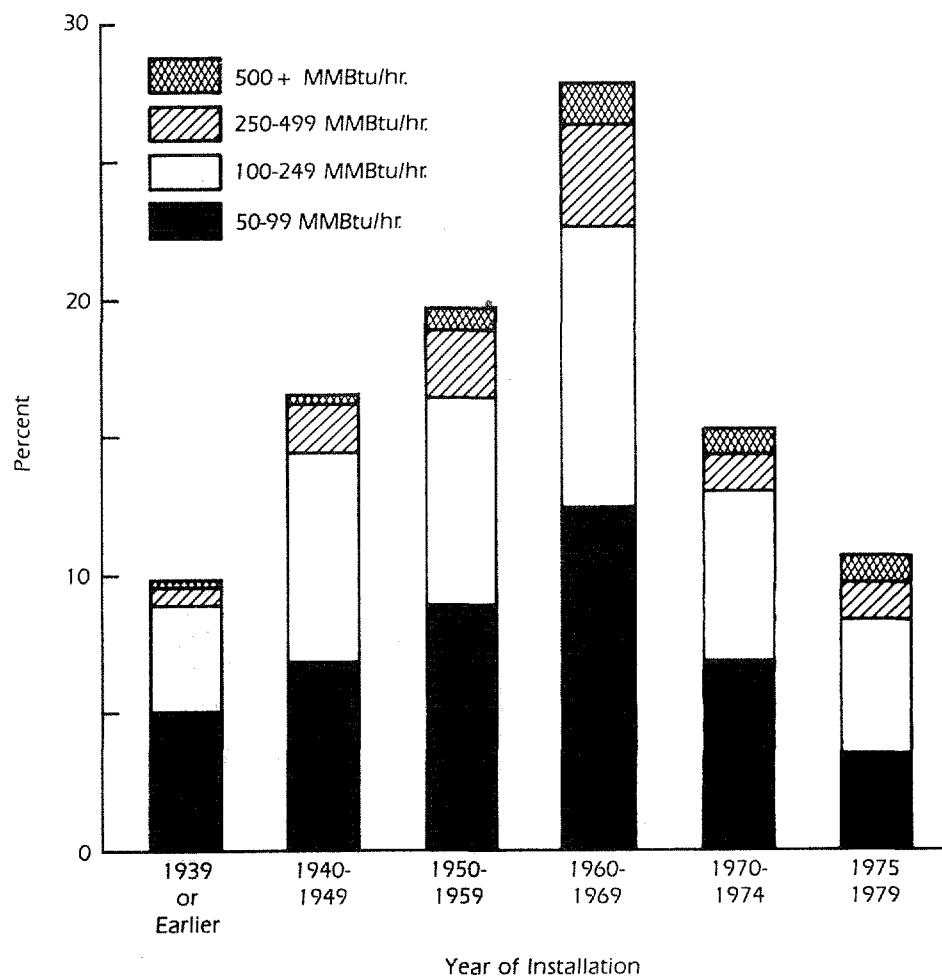
<sup>b</sup>This total does not include 359 boilers which were unclassified by size and/or year of installation. Of this number, 108 are in the 50-99 MMBtu/hr. size class, 68 are in the 100-249 MMBtu/hr. size class, 10 are in the 250-499 MMBtu/hr. size class, 6 are in the 500 + MMBtu/hr. size class, 5 were installed before 1939, 2 were installed between 1940 and 1949, 3 were installed between 1950 and 1959, 1 was installed between 1960 and 1969, 3 were installed between 1970 and 1974, and 1 was installed in 1975 or later. The remaining 152 were not classified by both size and year of installation.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.



## Energy Use in Large Boilers (continued)

Figure 3. Percent of Large Boilers of Various Size by Year of Installation



Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.



## Energy Use in Large Boilers (continued)

### Fuels Used

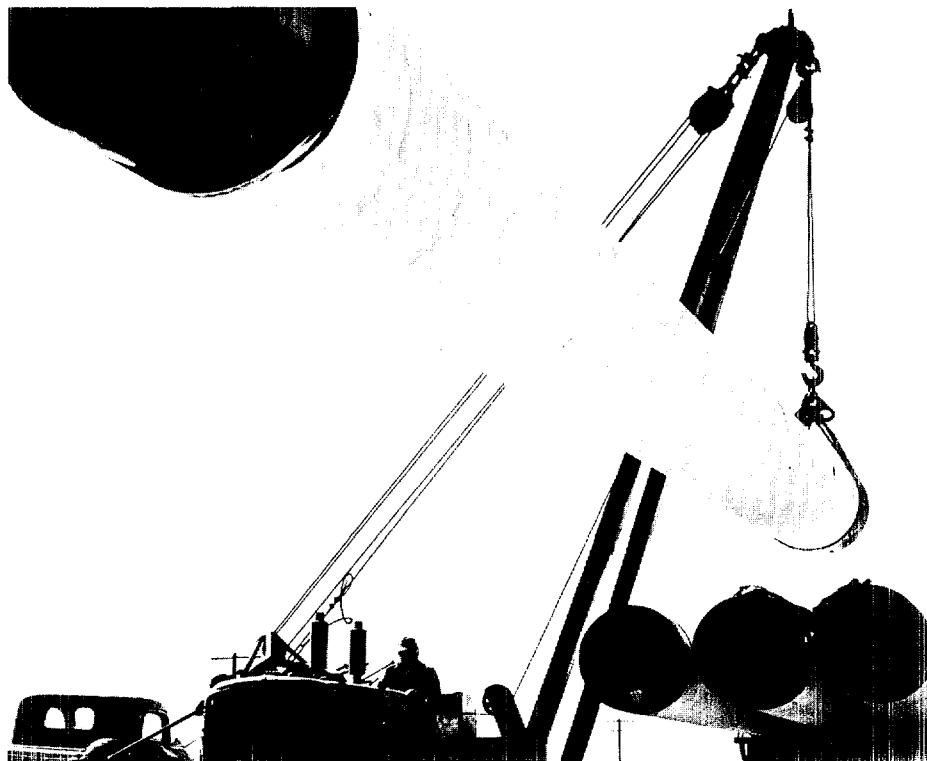
#### Fuels Used

As detailed in Table 19, natural gas is the most widely used fuel in large industrial boilers, accounting for 29.5 percent of the Btu consumed. The second most widely used fuel is coal<sup>1</sup> accounting for 17.1 percent of large boiler fuel use. This is followed by fuel oil, both distillate and residual; pulping liquor; waste gases;<sup>2</sup> wood waste; and other fuels. Fuel use by SIC code is also shown in this table.

Table 19 also shows that the fourth most common fuel in large industrial boilers, accounting for 14.2 percent of total fuel consumption, is pulping liquor. This fact should not be interpreted as meaning that this fuel is widely used in industry. Such a conclusion would be incorrect. Almost 99 percent of all pulping liquor is used in the paper industry. In fact, only 242 boilers, 3.3 percent, reported using this fuel in 1979.

The paper industry is followed in total fuel use by chemicals with about one fourth of the fuel reported in this survey. The five largest fuel consuming industries, which, as shown earlier, account for some three-fourths of the boilers, use slightly less than 90 percent of the fuel use reported in Table 19.

Table 20 presents the fuels used in large boilers after adjusting for nonresponse. Table 21 offers these data, both unweighted and weighted, by region.



<sup>1</sup>For the purpose of this report, coal includes anthracite, bituminous coal, lignite, coke, and breeze. This category, however, is overwhelmingly dominated by bituminous coal.

<sup>2</sup>Blast furnace gas, coke oven gas, and refinery off-gas.



## Energy Use in Large Boilers (continued)

**Table 19. Fuel Consumption in Large Boilers by Standard Industrial Classification (SIC) Code—Unweighted Data (Trillion Btu)**

Group	SIC	Percent of Boilers	All Fuels <sup>b</sup>	Natural Gas	Coal	Fuel Oil	Pulping Liquor	Waste Gases	Wood	Other
Paper.....	26	17	1,575.2	256.6	193.9	283.9	654.0	-	185.0	1.8
Chemicals.....	28	24	1,223.1	590.0	302.8	164.7	5.0	28.3	7.7	124.6
Primary Metals.....	33	9	565.2	117.0	105.4	45.9	-	295.8	-	1.3
Petroleum.....	29	9	467.4	108.5	6.3	93.1	-	209.2	1.2	49.2
Food.....	20	15	321.0	145.1	59.7	58.7	-	-	*	57.4
Lumber and Wood.....	24	3	134.6	11.1	1.7	9.5	2.2	-	107.9	2.2
Textile Mills.....	22	5	70.9	27.6	20.5	21.1	-	-	1.6	0.1
Rubber and Plastic.....	30	3	62.3	28.2	14.6	19.3	-	-	0.1	0.1
Transportation Equipment.....	37	4	59.8	26.5	17.8	15.4	-	-	-	0.1
Machinery.....	35	3	41.5	16.2	14.8	10.5	-	-	-	*
Instruments.....	38	1	35.3	5.3	23.5	5.9	-	-	-	0.6
Electrical Equipment....	36	2	32.1	13.5	7.5	8.9	c1.5	-	c0.6	*
Stone, Clay, and Glass.....	32	1	26.1	9.7	9.9	3.4	-	2.7	-	0.4
Fabricated Metals.....	34	2	17.2	11.9	2.1	3.3	-	-	-	-
Miscellaneous.....	39	*	12.8	0.8	11.1	0.8	-	-	-	-
Tobacco.....	21	1	6.9	2.2	2.2	2.5	-	-	-	-
Printing.....	27	*	2.5	0.5	-	0.9	-	-	1.1	-
Apparel.....	23	*	1.5	0.8	0.3	0.3	-	-	-	-
Furniture.....	25	*	1.4	0.4	0.3	-	-	-	0.5	0.1
Leather.....	31	*	0.8	0.4	-	0.3	-	-	-	-
Unclassified <sup>d</sup> .....	NA	*	13.6	6.2	3.8	0.8	-	-	*	2.8
Total.....	NA	100	4,671.2	1,378.5	798.2	749.2	662.7	536.0	305.7	240.6
Percent of All Fuel.....	NA	NA	100.0	29.5	17.1	16.0	14.2	11.5	6.5	5.2

<sup>a</sup>Differences in the fuel consumption reported in this Table and that reported in the alternate fuels report are caused by a combination of rounding error, the exclusion of unusual fuels from the Report on Alternative-Fuel Burning Capabilities in Large Boilers, the exclusion of boilers unclassified by industry from this Table, and the error inoculation procedure reported earlier in this report.

<sup>b</sup>This column may differ from the sum of the individual fuels due to rounding.

<sup>c</sup>It is possible that the boilers reporting consumption of pulping liquor and wood, should be classified in SIC 26. However, no such changes have been made in this report.

<sup>d</sup>From the information reported, it was impossible to determine the industrial group.

"—" = None

NA = Not Applicable.

"\*" = Less than 0.5 percent.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.



## Energy Use in Large Boilers (continued)

Table 20. Fuel Consumption in Large Boilers by Standard Industrial Classification (SIC) Code—Weighted Data (Trillion Btu)

Group	SIC	All Fuels <sup>a</sup>	Natural Gas	Coal	Fuel Oil	Pulping Liquor	Waste Gases	Wood	Other
Paper.....	26	1,910.7	312.5	242.7	339.4	793.4	-	220.2	2.4
Chemicals.....	28	1,616.4	795.3	396.3	208.8	5.3	39.4	8.4	162.9
Primary Metals.....	33	678.1	141.5	126.2	54.3	-	354.7	-	1.3
Petroleum.....	29	938.8	215.2	11.5	193.7	-	441.0	1.4	76.0
Food.....	20	395.5	180.3	74.2	72.3	-	-	*	68.6
Lumber and Wood.....	24	162.7	12.6	1.9	10.5	2.3	-	132.5	2.9
Textile Mills.....	22	80.1	30.8	23.3	24.0	-	-	1.8	0.1
Rubber and Plastic.....	30	71.5	32.7	16.6	22.0	-	-	0.1	0.1
Transportation Equipment.....	37	100.4	43.7	33.4	23.1	-	-	-	0.1
Machinery.....	35	51.4	20.0	19.4	12.2	-	-	-	*
Instruments.....	38	42.0	6.8	27.6	6.9	-	-	-	0.7
Electrical Equipment.....	36	36.9	15.1	8.1	10.8	b2.0	-	b0.8	*
Stone, Clay, and Glass....	32	33.5	12.4	12.7	4.4	-	3.5	-	0.5
Fabricated Metals.....	34	23.6	15.8	3.6	4.2	-	-	-	"
Miscellaneous.....	39	15.8	1.2	13.5	1.1	-	-	-	"
Tobacco.....	21	8.2	2.8	2.5	2.9	-	-	-	"
Printing.....	27	2.8	0.6	NA	1.0	-	-	1.1	"
Apparel.....	23	1.8	1.0	0.4	0.4	-	-	-	"
Furniture.....	25	1.6	0.4	0.4	-	-	-	0.6	0.2
Leather.....	31	0.9	0.5	NA	0.4	-	-	-	"
Unclassified <sup>c</sup> .....	NA	14.5	6.6	4.3	0.8	-	-	-	"
Total.....	NA	6,187.2	1,847.8	1,018.6	993.2	803.0	838.6	366.9	318.6
Percent of All Fuel.....	NA	100.0	29.9	16.4	16.1	13.0	13.6	5.1	5.1

<sup>a</sup>This column may differ from the sum of the individual fuels due to rounding.

<sup>b</sup>It is possible that the boilers reporting consumption of pulping liquor and wood should be classified in SIC 26. However, no such changes have been made in this report.

<sup>c</sup>From the information reported, it was impossible to determine the industrial group.

"—" = None

NA = Not Applicable.

"\*" = Less than 0.5 percent.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.



## Energy Use in Large Boilers (continued)

Table 21. Fuel Consumption in Large Boilers by Region  
(Trillions of Btu)

Region	Percent of Boilers	All Fuels <sup>a</sup>	Natural Gas	Coal	Fuel Oil	Pulping Liquor	Waste Gases	Wood	Other
Unweighted Data									
Northeast.....	14.6	494.3	61.0	97.5	216.2	28.4	79.2	6.4	5.5
North Central....	24.4	921.5	291.6	239.6	98.4	23.4	214.6	9.0	44.9
South Atlantic....	13.4	722.3	91.1	157.0	165.3	207.9	2.6	63.0	35.5
South Central.....	21.5	1,423.4	616.8	125.0	112.6	239.3	131.0	92.5	106.2
West.....	11.1	523.7	136.5	38.1	51.5	120.5	42.9	105.5	28.7
Other <sup>b</sup> .....	15.0	585.6	181.4	140.9	105.2	43.3	65.7	29.2	20.0
Total <sup>c</sup> .....	100.0	4,670.8	1,378.4	798.1	749.2	662.8	536.0	305.7	240.8
Weighted Data									
Northeast.....	NA	669.4	82.1	127.4	304.5	33.8	104.8	7.7	9.2
North Central....	NA	1,239.5	381.6	311.1	142.1	29.0	301.8	11.0	62.9
South Atlantic....	NA	878.0	108.1	191.8	204.7	248.2	5.9	73.8	45.5
South Central.....	NA	1,962.7	859.9	163.5	142.9	291.8	256.0	111.9	136.7
West.....	NA	714.2	193.1	51.3	67.7	145.2	90.2	127.4	39.4
Other <sup>b</sup> .....	NA	723.2	222.9	173.3	131.7	55.1	80.0	35.2	25.0
Total <sup>c</sup> .....	NA	6,187.0	1,847.7	1,018.4	993.6	803.1	838.7	367.0	318.7

<sup>a</sup>This column may differ from the sum of the individual fuels due to rounding.

<sup>b</sup>For disclosure purposes, the establishments and combustors from 2 or more regions in a given SIC grouping were combined. They are reported in all regions represented. Also included in this category are 8 establishments and 6 boilers which were not classified by region.

<sup>c</sup>Differences between the total reported in this Table and those reported in Tables 19 and 20 occur due to rounding.

"NA"=Not applicable since no effort has been made to estimate the number of large industrial boilers not included due to nonresponse.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.



## Energy Use In Large Boilers (continued)

Table 22 shows the types of fuel consumed by size of boilers. Among all boilers, natural gas is the most commonly used fuel. The use of natural gas, however, decreases substantially as MDFR increases from 43 percent (283.6 trillion Btu) of all fuels consumed in the 50-99 MMBtu per hour size class to 16 percent in the 500 or more MMBtu per hour class. Consumption of coal, the second most-consumed fuel, remains relatively constant over all.

Table 22. Fuel Use in Large Boilers by Maximum Design Firing Rates (Trillion Btu)

FUEL	All Large Boilers	50 - 99 MMBtu/Hr.	100 - 244 MMBtu/Hr.	250 - 499 MMBtu/Hr.	500 + MMBtu/Hr.
Natural Gas.....	<sup>a</sup> 1,374.9 (30)	283.6 (43)	582.9 (35)	352.2 (25)	156.0 (16)
Coal.....	797.5 (17)	89.6 (14)	280.6 (17)	247.4 (18)	178.9 (18)
Fuel Oil.....	748.0 (16)	150.8 (23)	336.4 (20)	150.7 (11)	110.1 (12)
Pulping Liquor....	662.9 (14)	9.4 (1)	79.7 (5)	262.7 (19)	311.1 (33)
Waste Gases.....	535.2 (11)	48.8 (7)	188.8 (11)	195.9 (14)	102.5 (11)
Wood.....	304.9 (7)	58.0 (9)	101.9 (6)	91.6 (7)	53.4 (6)
Other.....	240.7 (5)	16.2 (3)	103.0 (6)	80.5 (6)	41.0 (4)
Total <sup>b</sup> .....	4,663.6 (100)	656.4 (100)	1,673.2 (100)	1,381.0 (100)	953.0 (100)
Number of Boilers.....	<sup>c</sup> 7,241	3,203	2,913	840	283

<sup>a</sup>The top number in each cell is the Btu consumption of the fuel by boilers of given MDFR. The bottom number, in parentheses, is the percent of total Btu consumed in the size class of the fuel.

<sup>b</sup>The total may be different than the sum of the values in the column due to rounding.

<sup>c</sup>The table does not include the 167 boilers which were not classified by size. These boilers account for 7.3 trillion Btu of all fuels.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.



## Energy Use in Large Boilers (continued)

size classes. The use of fuel oil also decreases in terms of percent of fuels consumed as MDFR increases. Almost twice as much fuel oil is used as the two smaller size categories than in either of the two larger size categories.

The most dramatic change takes place with the consumption of pulping liquor. The use of this fuel increases substantially as MDFR increases from 1 percent in 50-99 MMBtu/per hr. boilers to 33 percent in MMBtu/per hr. boilers with an MDFR of 500 or more. As was seen in Table 19, the paper industry accounts for almost all of this.

Several interesting facts are apparent when fuel use patterns are examined by the date of installation (Table 21). Natural gas consumption appears to increase with new boilers until the latter half of the 1970's. Coal usage seems to exhibit an opposite pattern. The consumption of fuel oil does not vary in any discernible pattern. However, the use of waste fuels, i.e. pulping liquor, waste gases, wood, and other fuels, has increased. Such fuels account for almost half of all fuel consumed in the newest boilers.

**Table 23. Fuel Use in Large Boilers by Year of Installation (Trillion Btu)**

Fuel	1939						
	All Large Boilers	or Earlier	1940- 1949	1950- 1959	1960- 1969	1970- 1974	1975
Natural Gas.....	a1,355.5 (30)	57.3 (20)	182.0 (28)	267.2 (27)	478.0 (34)	214.8 (33)	156.2 (25)
Coal.....	793.2 (17)	72.4 (25)	158.1 (25)	240.1 (24)	209.7 (15)	39.2 (6)	73.7 (12)
Fuel Oil.....	741.9 (16)	60.9 (21)	125.2 (19)	141.0 (14)	192.0 (13)	126.0 (19)	96.8 (16)
Pulping Liquor....	660.1 (14)	- (-)	23.8 (4)	107.8 (11)	266.7 (19)	133.9 (21)	127.9 (21)
Waste Gases.....	534.1 (12)	66.4 (23)	118.9 (18)	145.0 (15)	102.8 (7)	57.6 (9)	43.4 (7)
Wood.....	289.2 (6)	16.4 (6)	17.3 (3)	62.3 (6)	86.4 (6)	41.3 (6)	65.5 (11)
Other.....	236.9 (5)	12.8 (5)	20.0 (3)	29.0 (3)	87.9 (6)	40.7 (6)	46.8 (8)
Total <sup>b</sup> .....	4,611.3 (100)	286.2 (100)	645.4 (100)	992.4 (100)	1,423.5 (100)	653.5 (100)	610.3 (100)
Number of Boilers .....	c7,064	692	1,166	1,382	1,956	1,064	804

<sup>a</sup>The top number in each cell is the actual number of Btu of the fuel consumed in a boiler of the given age. The bottom number in parentheses is the percent of total Btu consumed in the age group of the fuel.

<sup>b</sup>The total may be different than the sum of the values in the column due to rounding.

This table does not include 344 boilers not classified by age. These boilers account for 59.6 trillion Btu of all fuels.

"—" = None

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.



## Energy Use in Large Boilers (continued)

Tables 22 and 23 showed fuel mix by size and year of installation. Table 24 shows the mean Btu consumption by a typical boiler in a given MDFR and age class.

Table 24. Mean Fuel Consumption for a Typical Large Boiler by Maximum Design Firing Rate and Year of Installation Categories<sup>a</sup> (Trillion Btu)

Maximum Design Firing Rate	Total	1939 or Earlier	1940-1949	1950-1959	1960-1969	1970-1974	1975 or Later
50-99 MMBtu/hr.....	0.21	0.20	0.22	0.22	0.20	0.20	0.19
100-249 MMBtu/hr.....	0.58	0.52	0.62	0.73	0.53	0.45	0.61
250-499 MMBtu/hr.....	1.65	1.15	1.21	1.76	1.95	1.73	1.30
500 + MMBtu/hr.....	3.34	1.63	2.83	3.27	3.72	3.61	3.01
Total.....	0.65	0.42	0.55	0.72	0.73	0.62	0.76

<sup>a</sup>The calculations in this table do not include 64.5 trillion Btu of fuel consumed in those boilers which were not classified by size or year of installation. (See footnote b in Table 17 for details.)

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.

The amount of fuel consumed in boilers in the range of 50 to 99 MMBtu per hour apparently has no relationship to the year of installation. Boilers in the 100 to 249 MMBtu per hour range show increased usage (as measured by mean fuel consumption) as age decreases, that is, as year of installation approaches the present, through the decade of the 1950's. Beginning with boilers installed in the 1960's, the consumption decreases substantially through the mid-1970's, when it increases once again. Boilers in the two largest size categories show an increase in fuel consumption through the 1960's.

It is interesting to note that the newest boilers do not have the highest fuel consumption.

### Boiler Utilization

The questionnaire used in this study did not ask for any direct measure of boiler utilization. An approximate measure was constructed using the data reporting the usual firing rate and the number of hours of operation during 1979.



## Energy Use in Large Boilers (continued)

Respondents were asked to report the usual firing rate of the boiler. This information was converted to the percent of the MDFR and rounded to the nearest 5 percent with a range of 0 percent to 110 percent.<sup>3</sup> Hours of operation are reported to the nearest hundred hours with a range of 0 to 88, even though the maximum number of hours is 8,760 (365 days times 24 hours per day). The utilization measure compares the actual use of the boiler as measured in terms of usual firing rate and hours of use against a theoretical maximum.<sup>4</sup>

This utilization measure was calculated for the 6,504 boilers which had a value for both variables used in the formula and which could be classified by size and year of installation. The calculated utilization rate ranged from a low of 0 to a high of 1.06. Table 25 reports the average calculated utilization rate for size and year of installation categories.

Overall, the mean boiler utilization is 39 percent. As would be expected, the largest boilers have the highest utilization rates. In terms of year of installation, the boilers with the highest utilizations were installed in the 1950's. The least utilized boilers were installed before 1940 and the first half of the 1970's. The deviation from this pattern among those boilers with the largest MDFR is possibly a function of the small number of boilers, particularly among the oldest age classes.

Table 25. Average Calculated Large Boiler Utilization by Maximum Design Firing Rate and Year of Installation<sup>a</sup>

Maximum Design Firing Rate	Total	1939 or Earlier	1940-1949	1950-1959	1960-1969	1970-1974	1975 or Later
50-99 MMBtu/hr.....	33	30	34	36	33	31	32
100-249 MMBtu/hr.....	40	39	42	48	38	34	40
250-499 MMBtu/hr.....	53	38	48	58	58	50	49
500 + MMBtu/hr.....	59	65	53	61	62	58	54
Total.....	39	34	40	44	40	35	40

<sup>a</sup>This table is based on the 7,049 boilers which had both size and year of installation data. (See footnote b on Table 7 for details.)

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.

<sup>3</sup>A small number of respondents reported usual firing rates in excess of the reported MDFR. These values were excepted since it was impossible to verify these figures. Of the 7,408 large boilers included in this study, 174 reported a usual firing rate that rounded to 100 percent, 14 to 105 percent and 6 to 110 percent.

<sup>4</sup>The following formula was used to calculate the utilization index.

Utilization Index =	Usual Firing Rate as a Percent of Maximum	X	Number of Hours in Use Rounded to the Nearest Hundred
	100	X	88
	(The theoretical maximum usual firing as a percent of maximum design firing rate)		(The maximum number of hours rounded to the nearest hundred a boiler can operate)



## Energy Use in Large Boilers (continued)

### Heat Recovery Equipment

As energy costs increase, it becomes increasingly important to use energy fully. Waste heat recovery equipment which may not have been feasible at the lower energy costs of the past, may now be economically attractive. As Table 26 indicates, the use of waste-heat recovery equipment has increased considerably in all boilers of all sizes installed during the last half of the 1970's.

Nationwide, 60 percent of the boilers in operation during 1979 had some sort of heat recovery equipment. The presence of heat recovery equipment increases as size increases in all age groupings. Of more interest, however, is the pattern of the existence of heat recovery equipment over time.

Table 26. Percentage of Large Boilers with Heat Recovery Equipment by Maximum Design Firing Rate and Year of Installation<sup>a</sup>

Maximum Design Firing Rate	Total	1939 or Earlier	1940-1949	1950-1959	1960-1969	1970-1974	1975 or Later
50-99 MMBtu/hr.....	41	39	46	42	36	37	55
100-249 MMBtu/hr.....	70	76	71	72	68	59	78
250-499 MMBtu/hr.....	83	83	85	86	87	73	85
500 + MMBtu/hr.....	86	100	75	84	90	82	87
Total.....	60	58	63	61	57	52	72

<sup>a</sup>This table is based on the 7,049 boilers which had both size and year of installation data. See footnote b on table 17 for details.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors.

For the 30 years starting in 1940, the presence of heat recovery equipment remained relatively constant. Boilers installed during the first half of the 1970's show the lowest rate of the use of heat recovery equipment. However, those boilers installed starting in 1975 show the highest use. This pattern reflects both the increased cost of energy and the several year lead time required from the time a boiler is designed until it is in operation.

## **Appendix A**

### Questionnaire and Other Materials





# Questionnaire and Other Materials

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

*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 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 determines 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 1 (d) of P.L. 91-219, 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. This 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.

MAIL LABEL

NAME

NUMBER AND STREET

CITY, TOWN, VILLAGE, ETC

COUNTY

STATE

ZIP

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



## Questionnaire and Other Materials (continued)

### ESTABLISHMENT IDENTIFICATION

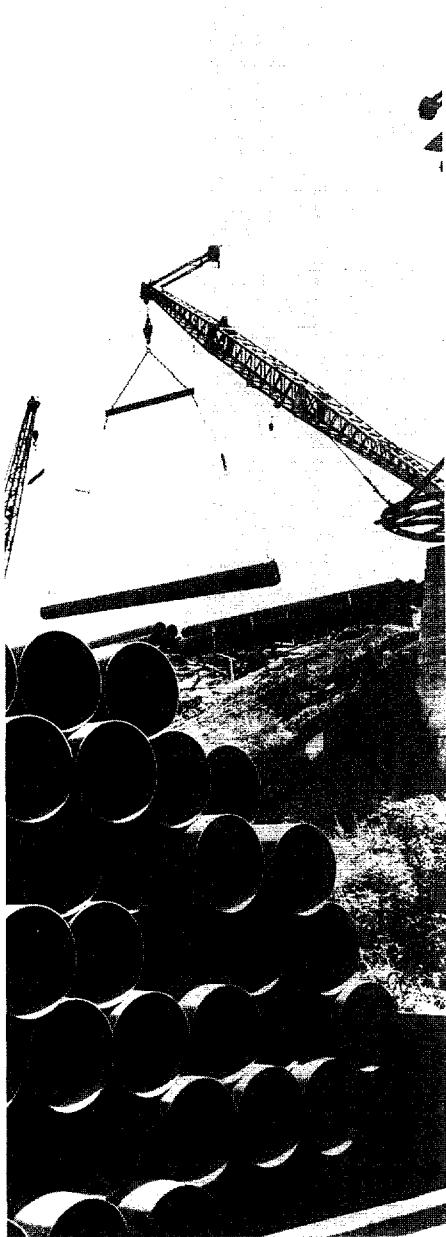
2. Current Employer Identification Number (EIN). (This is the number used by this establishment on the latest Quarterly Federal Tax Return Form 941.)  _____	
3. Primary Standard Industrial Classification (SIC) code for this establishment.  _____	
4. Number of paid employees at this establishment for 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.) _____ UNITS _____ Employees	
5. Is this establishment owned or controlled by another organization or company? (1) <input type="checkbox"/> No (go to item 6) (2) <input type="checkbox"/> Yes (enter name and address of parent company)  NAME _____ NUMBER AND STREET _____ STATE _____ ZIP _____	
6. Is this a seasonal operation? (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Yes (specify 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) <input type="checkbox"/> Started in 1979 or 1980. (2) <input type="checkbox"/> 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) <input type="checkbox"/> 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 _____ STATE _____ ZIP _____  (4) <input type="checkbox"/> 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 _____ STATE _____ ZIP _____  (5) <input type="checkbox"/> Establishment was permanently closed, dismantled, abandoned, or destroyed. Specify month and year in which closed, etc.: MONTH _____ YEAR _____	

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## Questionnaire and Other Materials (continued)



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

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(CONTINUE ON REVERSE SIDE)



## Questionnaire and Other Materials (continued)

<b>FUEL CONSUMPTION</b>  FUEL CODES <small>(for office use only)</small>	<p>9. Please fill out the following table for fuels which were produced onsite as byproducts of establishment operations during 1979.</p> <p>* 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.</p> <p><input type="checkbox"/> No fuels produced as byproducts in 1979 (go to item 10a &amp; b)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2">FUEL</th> <th colspan="3">AMOUNT USED AT SITE FOR HEAT, POWER AND/OR GENERATION OF ELECTRICITY</th> <th colspan="3">AVERAGE Btu CONTENT (HIGHER HEATING VALUE)</th> <th colspan="3">AMOUNT SOLD OR TRANSFERRED OFFSITE</th> </tr> <tr> <th>MIL</th> <th>THOU</th> <th>UNITS</th> <th>THOU</th> <th>UNITS</th> <th>MIL</th> <th>THOU</th> <th>UNITS</th> </tr> </thead> <tbody> <tr> <td>(14) Coke</td> <td></td> <td></td> <td>ton</td> <td></td> <td></td> <td>per lb</td> <td></td> <td></td> </tr> <tr> <td>(15) Wood, bark, wood waste (50% moisture basis)</td> <td></td> <td></td> <td>ton</td> <td></td> <td></td> <td>per lb</td> <td></td> <td></td> </tr> <tr> <td>(24) Pulping liquor (bone dry basis)</td> <td></td> <td></td> <td>ton</td> <td></td> <td></td> <td>per lb</td> <td></td> <td></td> </tr> <tr> <td>Other solid fuel (specify)</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>per lb</td> <td></td> <td></td> </tr> <tr> <td>Other liquid fuel (specify)</td> <td></td> <td></td> <td>gal</td> <td></td> <td></td> <td>per gal</td> <td></td> <td></td> </tr> <tr> <td>PROCESS OFF GASES</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>(33) Blast gas</td> <td></td> <td></td> <td>mcf</td> <td></td> <td></td> <td>per cu ft</td> <td></td> <td></td> </tr> <tr> <td>(34) Coke oven gas</td> <td></td> <td></td> <td>mcf</td> <td></td> <td></td> <td>per cu ft</td> <td></td> <td></td> </tr> <tr> <td>(35) Refinery off gas</td> <td></td> <td></td> <td>mcf</td> <td></td> <td></td> <td>per cu ft</td> <td></td> <td></td> </tr> <tr> <td>Other process gases (specify)</td> <td></td> <td></td> <td>mcf</td> <td></td> <td></td> <td>per cu ft</td> <td></td> <td></td> </tr> </tbody> </table>	FUEL	AMOUNT USED AT SITE FOR HEAT, POWER AND/OR GENERATION OF ELECTRICITY			AVERAGE Btu CONTENT (HIGHER HEATING VALUE)			AMOUNT SOLD OR TRANSFERRED OFFSITE			MIL	THOU	UNITS	THOU	UNITS	MIL	THOU	UNITS	(14) Coke			ton			per lb			(15) Wood, bark, wood waste (50% moisture basis)			ton			per lb			(24) Pulping liquor (bone dry basis)			ton			per lb			Other solid fuel (specify)						per lb			Other liquid fuel (specify)			gal			per gal			PROCESS OFF GASES									(33) Blast gas			mcf			per cu ft			(34) Coke oven gas			mcf			per cu ft			(35) Refinery off gas			mcf			per cu ft			Other process gases (specify)			mcf			per cu ft		
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<b>ELECTRICITY</b>	<p>10a. Please complete the following. If "none" enter zero for units.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th>BIL</th> <th>MIL</th> <th>THOU</th> <th>UNITS</th> </tr> </thead> <tbody> <tr> <td>(1) Amount of electricity purchased or received in 1979</td> <td></td> <td></td> <td></td> <td>kWh</td> </tr> <tr> <td>(2) Total amount of electricity generated onsite in 1979</td> <td></td> <td></td> <td></td> <td>kWh</td> </tr> <tr> <td>(3) Amount of electricity sold or transferred offsite in 1979</td> <td></td> <td></td> <td></td> <td>kWh</td> </tr> <tr> <td>(4) Electricity used onsite in 1979 (this figure should be the same as (1) + (2) - (3))</td> <td></td> <td></td> <td></td> <td>kWh</td> </tr> </tbody> </table> <p>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:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th>BIL</th> <th>MIL</th> <th>THOU</th> <th>UNITS</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/> No electricity generated (go to item 11)</td> <td></td> <td></td> <td></td> <td>kWh</td> </tr> <tr> <td>(1) Steam</td> <td></td> <td></td> <td></td> <td>kWh</td> </tr> <tr> <td>(2) Gas turbines</td> <td></td> <td></td> <td></td> <td>kWh</td> </tr> <tr> <td>(3) Internal combustion engines</td> <td></td> <td></td> <td></td> <td>kWh</td> </tr> <tr> <td>(4) Hydro</td> <td></td> <td></td> <td></td> <td>kWh</td> </tr> <tr> <td>(5) Other (specify)</td> <td></td> <td></td> <td></td> <td>kWh</td> </tr> </tbody> </table>		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		BIL	MIL	THOU	UNITS	<input type="checkbox"/> No electricity generated (go to item 11)				kWh	(1) Steam				kWh	(2) Gas turbines				kWh	(3) Internal combustion engines				kWh	(4) Hydro				kWh	(5) Other (specify)				kWh																																																
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FORM EIA-463 SECTION I

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## Questionnaire and Other Materials (continued)

OTHER ENERGY SOURCES	<p>11. Please report the Btu output from any of the following energy sources used by this establishment in 1979. <i>If do not report any amounts of energy reported in items 8, 9 or 10.</i></p> <p><input type="checkbox"/> None used in 1979 (go to item 12)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">ENERGY SOURCE</th> <th style="text-align: center;">Btu OUTPUT DERIVED FROM SOURCE IN 1979</th> <th style="text-align: center;">M<sub>W</sub></th> <th style="text-align: center;">T<sub>HOU</sub></th> <th style="text-align: center;">G<sub>TNS</sub></th> </tr> </thead> <tbody> <tr> <td>(1) Hydro.....</td> <td>..... Btu</td> <td>.....</td> <td>.....</td> <td>.....</td> </tr> <tr> <td>(2) Wind .....</td> <td>..... Btu</td> <td>.....</td> <td>.....</td> <td>.....</td> </tr> <tr> <td>(3) Geothermal.....</td> <td>..... Btu</td> <td>.....</td> <td>.....</td> <td>.....</td> </tr> <tr> <td>(4) Solar .....</td> <td>..... Btu</td> <td>.....</td> <td>.....</td> <td>.....</td> </tr> <tr> <td>(5) Any other energy sources <i>(specify)</i></td> <td>..... Btu</td> <td>.....</td> <td>.....</td> <td>.....</td> </tr> <tr> <td></td> <td>..... Btu</td> <td>.....</td> <td>.....</td> <td>.....</td> </tr> </tbody> </table>					ENERGY SOURCE	Btu OUTPUT DERIVED FROM SOURCE IN 1979	M <sub>W</sub>	T <sub>HOU</sub>	G <sub>TNS</sub>	(1) Hydro.....	..... Btu	.....	.....	.....	(2) Wind .....	..... Btu	.....	.....	.....	(3) Geothermal.....	..... Btu	.....	.....	.....	(4) Solar .....	..... Btu	.....	.....	.....	(5) Any other energy sources <i>(specify)</i>	..... Btu	.....	.....	.....		..... Btu	.....	.....	.....
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STEAM TRANSFERS	<p>12. Indicate amount of steam transferred into or out of this establishment during 1979. <i>If none, enter zero</i></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">AMOUNT OF STEAM</th> <th style="text-align: center;">PRESSURE</th> <th style="text-align: center;">TEMPERATURE</th> </tr> </thead> <tbody> <tr> <td>a. Steam purchased or received</td> <td>..... lb @ ..... psig</td> <td>..... °F</td> </tr> <tr> <td>b. Steam sold or transferred off site</td> <td>..... lb @ ..... psig</td> <td>..... °F</td> </tr> <tr> <td>c. Steam transferred to another building</td> <td>..... lb @ ..... psig</td> <td>..... °F</td> </tr> </tbody> </table>					AMOUNT OF STEAM	PRESSURE	TEMPERATURE	a. Steam purchased or received	..... lb @ ..... psig	..... °F	b. Steam sold or transferred off site	..... lb @ ..... psig	..... °F	c. Steam transferred to another building	..... lb @ ..... psig	..... °F																							
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STEAM GENERATION	<p>13. Indicate amount of steam generated at this establishment during 1979</p> <p><input type="checkbox"/> No steam generated (go to item 14)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">AMOUNT OF STEAM</th> <th style="text-align: center;">PRESSURE</th> <th style="text-align: center;">TEMPERATURE</th> </tr> </thead> <tbody> <tr> <td>• <i>Include</i> - Steam generated in any boilers, waste heat boilers, or other steam generating units</td> <td>..... lb @ ..... psig</td> <td>..... °F</td> </tr> <tr> <td>• <i>Do not include</i> - purchased steam or steam from blow down or condensate</td> <td>..... lb @ ..... psig</td> <td>..... °F</td> </tr> <tr> <td></td> <td>..... lb @ ..... psig</td> <td>..... °F</td> </tr> <tr> <td></td> <td>..... lb @ ..... psig</td> <td>..... °F</td> </tr> <tr> <td></td> <td>..... lb @ ..... psig</td> <td>..... °F</td> </tr> </tbody> </table>					AMOUNT OF STEAM	PRESSURE	TEMPERATURE	• <i>Include</i> - Steam generated in any boilers, waste heat boilers, or other steam generating units	..... lb @ ..... psig	..... °F	• <i>Do not include</i> - purchased steam or steam from blow down or condensate	..... lb @ ..... psig	..... °F		..... lb @ ..... psig	..... °F		..... lb @ ..... psig	..... °F		..... lb @ ..... psig	..... °F																	
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LARGE COMBUSTORS	<p>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. <i>(write single digits as 01, 03, 08, etc.)</i></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">NUMBER</th> </tr> </thead> <tbody> <tr> <td>a. <input type="text"/> Boilers</td> </tr> <tr> <td>b. <input type="text"/> Gas turbines</td> </tr> <tr> <td>c. <input type="text"/> Internal combustion engines</td> </tr> <tr> <td>d. <input type="text"/> Combined cycle units</td> </tr> <tr> <td>e. <input type="text"/> Number of fired components in combined cycle units</td> </tr> <tr> <td>f. <input type="text"/> Total (a + b + c + e). equals the number of Section II forms to be completed for this report</td> </tr> </tbody> </table>					NUMBER	a. <input type="text"/> Boilers	b. <input type="text"/> Gas turbines	c. <input type="text"/> Internal combustion engines	d. <input type="text"/> Combined cycle units	e. <input type="text"/> Number of fired components in combined cycle units	f. <input type="text"/> Total (a + b + c + e). equals the number of Section II forms to be completed for this report																												
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# Questionnaire and Other Materials (continued)

OTHER COMBUSTORS	<p>15. Indicate the current number of all other combustors at this establishment (i.e., combustors not reported in item 14) in each category.</p> <p><b>• Do not report combustors with a maximum design firing rate of less than 1 million Btu/hr.</b></p> <p><b>• Under "internal combustion engines":</b> 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</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="7" style="text-align: center;">NUMBER OF OTHER COMBUSTORS</th> </tr> <tr> <th colspan="7" style="text-align: center;">Maximum Design Firing Rate (in millions of Btu/hr.)</th> </tr> <tr> <th style="text-align: center;">1-9</th> <th style="text-align: center;">10-24</th> <th style="text-align: center;">25-49</th> <th style="text-align: center;">50-99</th> <th style="text-align: center;">100-249</th> <th style="text-align: center;">250- or greater</th> <th style="text-align: center;">Total</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">Boilers</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td style="text-align: center;">Gas turbines</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td style="text-align: center;">Internal combustion engines</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td style="text-align: center;">Fluid heaters (fired petroleum heater, blast furnace stove, etc.)</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td style="text-align: center;">Dryers (mineral dryer, paint dryer, food dryer, etc.)</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td style="text-align: center;">Calciners (cement kiln, lime kiln, alumina kiln, etc.)</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td style="text-align: center;">Reactors (blast furnace, cupola, reforming furnace, pyrolysis furnace, incinerator, etc.)</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td style="text-align: center;">Melters (regenerative glass melter, electric furnace, open hearth furnace, etc.)</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td style="text-align: center;">Heat treaters (annealing, brick kiln, tempering furnace, oven, etc.)</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td style="text-align: center;">Reheaters (baking pit, reheat furnace, etc.)</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td style="text-align: center;">Sinterers (Processors, iron shaft furnace, grate kiln, sintering furnace, etc.)</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td style="text-align: center;">For office use only</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	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	Total	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, electric furnace, open hearth furnace, etc.)							Heat treaters (annealing, brick kiln, tempering furnace, oven, etc.)							Reheaters (baking pit, reheat furnace, etc.)							Sinterers (Processors, iron shaft furnace, grate kiln, sintering furnace, etc.)							For office use only						
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Melters (regenerative glass melter, electric furnace, open hearth furnace, etc.)																																																																																																										
Heat treaters (annealing, brick kiln, tempering furnace, oven, etc.)																																																																																																										
Reheaters (baking pit, reheat furnace, etc.)																																																																																																										
Sinterers (Processors, iron shaft furnace, grate kiln, sintering furnace, etc.)																																																																																																										
For office use only																																																																																																										
CONTACT	<p>16. Person to be contacted regarding this report. Name _____</p> <p>Title: _____ Telephone No.: _____</p> <p>Mailing address (if different from mailing label in item 1): _____</p>																																																																																																									
DISCLOSURE	<p>17. Disclosure Statement</p> <p>a. Does the information supplied on this form contain trade secrets and/or privileged or confidential commercial or financial information?</p> <p>(1) <input type="checkbox"/> No (go to item 18)      (2) <input type="checkbox"/> Yes (continue with item 17b)</p> <p>b. Have you attached a written justification for exemption from Freedom of Information Act, 5 USC 552(b)(4)? (see page 1)</p> <p>(1) <input type="checkbox"/> No      (2) <input type="checkbox"/> Yes</p>																																																																																																									
OFFICE USE ONLY	<p>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 the space provided and enter date of signing.</p> <p>This report is substantially accurate and has been prepared in accordance with instructions, and covers the period _____ to _____</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%;">PRINTED NAME</td> <td style="width: 33%;">TITLE</td> <td style="width: 34%;">DATE</td> </tr> <tr> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>SIGNATURE</td> <td>_____</td> <td>_____</td> </tr> </table>	PRINTED NAME	TITLE	DATE	_____	_____	_____	SIGNATURE	_____	_____																																																																																																
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FORM EIA-463 SECTION I

Page 6



# Questionnaire and Other Materials (continued)

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-S8001

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. <input type="text"/> 1b. Name or identification number assigned to this combustor in your company's records: <input type="text"/>
	2a. Is this combustor part of a combined cycle unit? (1) <input type="checkbox"/> No (go to item 3)      (2) <input type="checkbox"/> Yes (continue with item 2b) 2b. Please list the numbers (as assigned in item 1) of all other components of this combined cycle unit. <input type="text"/> <input type="text"/> <input type="text"/>
KIND OF COMBUSTOR	3. What kind of combustor or component of a combined cycle unit is this? (mark one box only) (1) <input type="checkbox"/> Boiler (continued from item 2a)      (3) <input type="checkbox"/> Internal Combustion Engine (go to item 5) (2) <input type="checkbox"/> Gas Turbine (go to item 5)
	4a. What is the boiler's design (rated) steam/hot water: (1) Pressure? _____ psig      (2) Temperature? _____ °F MIL THOU UNITS      MIL THOU UNITS (3) Flow Rate? <input type="text"/> lb/hr (steam), or, <input type="text"/> Btu/hr (hot water boilers only)
BOILER OPERATION	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) <input type="checkbox"/> Space heating, ventilating, or air conditioning?      (3) <input type="checkbox"/> Electricity generation? (2) <input type="checkbox"/> Process heat?      (4) <input type="checkbox"/> Mechanical drive (other than electricity generation)? <i>(NOW GO TO ITEM 5)</i>
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      THOU UNITS (1) <input type="checkbox"/> Electricity generation ..... <input type="text"/> kW (2) <input type="checkbox"/> Mechanical drive ..... <input type="text"/> hp



## Questionnaire and Other Materials (continued)

COMBUSTOR DESIGN AND FUEL USE	FUEL CODES <i>(for office use only)</i>	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		
		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 <i>(mark all that apply)</i> . 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	<input type="checkbox"/>	100			
(12) Bituminous coal	<input type="checkbox"/>	100			
(13) Lignite	<input type="checkbox"/>	100			
(14) Coke and breeze	<input type="checkbox"/>	100			
(15) Wood, bark, wood waste <i>(50% moisture basis)</i>	<input type="checkbox"/>	100			
Other solid fuels <i>(specify)</i>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	100 100 100			
LIQUIDS					
(21) Motor gasoline	<input type="checkbox"/>	gal			
(22) Distillate fuels #1, 2, 4 & light diesel	<input type="checkbox"/>	gal			
(23) Residual fuels #5, 6 & heavy diesel	<input type="checkbox"/>	gal			
(24) Pulping liquor <i>(bone dry basis)</i>	<input type="checkbox"/>	ton			
Other liquid fuels <i>(specify)</i>	<input type="checkbox"/> <input type="checkbox"/>	gal gal			
GASES					
(31) Natural gas	<input type="checkbox"/>	mcf			
(32) LPG, butane, propane	<input type="checkbox"/>	gal			
(33) Blast furnace gas	<input type="checkbox"/>	mcf			
(34) Coke oven gas	<input type="checkbox"/>	mcf			
(35) Refinery off gas	<input type="checkbox"/>	mcf			
Other gaseous fuels <i>(specify)</i>	<input type="checkbox"/> <input type="checkbox"/>	mcf mcf			
OTHER <i>(specify)</i>	<input type="checkbox"/>	Stu Btu			

FORM EIA-463 SECTION II

Page 2

CONTINUE ON REVERSE SIDE



## Questionnaire and Other Materials (continued)

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?																																			
	<input type="checkbox"/> 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) 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) <input type="checkbox"/> None (4) <input type="checkbox"/> Economizer (7) <input type="checkbox"/> Other (specify) _____ (2) <input type="checkbox"/> Regenerative air preheater (5) <input type="checkbox"/> Waste heat boiler _____ (3) <input type="checkbox"/> Recuperative air preheater (6) <input type="checkbox"/> Raw material preheater _____																																			
COMBUSTOR USAGE	12. If your company did not operate this plant in 1979, or if this combustor was installed after 1979, check box below. <input type="checkbox"/> 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) <table border="0"><thead><tr><th></th><th>NUMBER OF DAYS</th><th></th><th>NUMBER OF DAYS</th><th></th><th>NUMBER OF DAYS</th><th></th><th>NUMBER OF DAYS</th></tr></thead><tbody><tr><td>(1) January</td><td>_____</td><td>(4) April</td><td>_____</td><td>(7) July</td><td>_____</td><td>(10) October</td><td>_____</td></tr><tr><td>(2) February</td><td>_____</td><td>(5) May</td><td>_____</td><td>(8) August</td><td>_____</td><td>(11) November</td><td>_____</td></tr><tr><td>(3) March</td><td>_____</td><td>(6) June</td><td>_____</td><td>(9) September</td><td>_____</td><td>(12) December</td><td>_____</td></tr></tbody></table>						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	_____
	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:   																																				

FORM EIA-463 SECTION II

Page 3



# Questionnaire and Other Materials (continued)

## 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, there are to be made available information obtained on this form to the Attorney General, the Secretary of the Interior, and the General Accounting 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.

- SAMPLE**
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 mil. or 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.



## Questionnaire and Other Materials (continued)

### 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(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 to generate heat 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.



## Questionnaire and Other Materials (continued)

### 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 air to be 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 usual 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**

Letter from the Office of  
Management and Budget





# Letter from the Office of Management and Budget



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

RE 17 21

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,

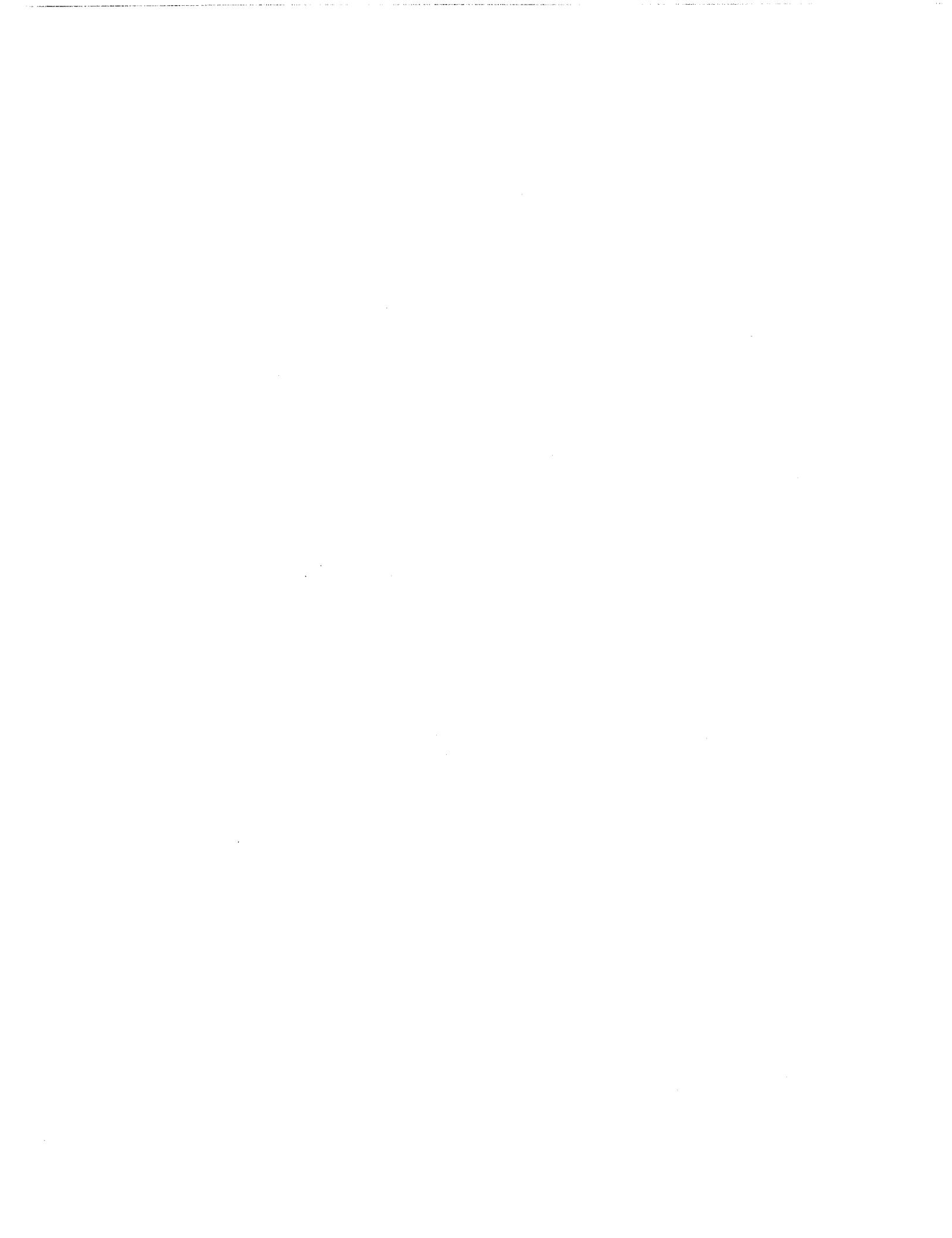
David A. Stockman  
Director

RE 17 21



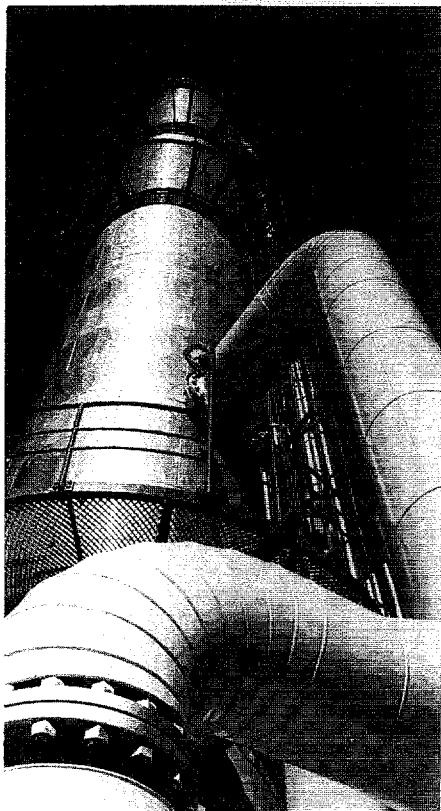
## **Appendix C**

### Steps Taken to Minimize the Potential to Identify Respondents





# Steps Taken to Minimize the Potential to Identify Respondents



In an effort to fully comply with the directive from the Director of the Office of Management and Budget "to treat the data...collected in a confidential manner (See Appendix B)", the following procedures were taken to modify the data in such a way as to minimize the potential to identify respondents while at the same time still allowing for a full range of potential analysis.

First, all links were broken between the sampling frame used for the study, the establishment reports, Section 1, and the individual combustor reports, Section 2. This was done in such a way as to make it impossible to group combustors for the same establishment together. In addition, a separate file was created for the information reported in Question 15 of Section 1, the number of process and nonprocess combustors with an MFDR of one million Btu/hr. or more.

Second, the Standard Industrial Classification code reported by the respondent was raised to a higher level, to 3-digit, etc., where the 4-digit detail could allow for the identification of the respondent. Further, geographic detail was also collapsed for the same reason.

In several cases, a given industrial designation and geographical class did not have a sufficient number of cases to meet the dominant rule established for public disclosure. In these instances, geographical classes with the same industrial designation were combined until the dominant rules were satisfied. The establishment and combustors in a combined region are identified as being located in all the geographical classes that were combined. (For the tables in this report, unless otherwise indicated, any establishment or combustor in a combined region is listed in the "other" category.)

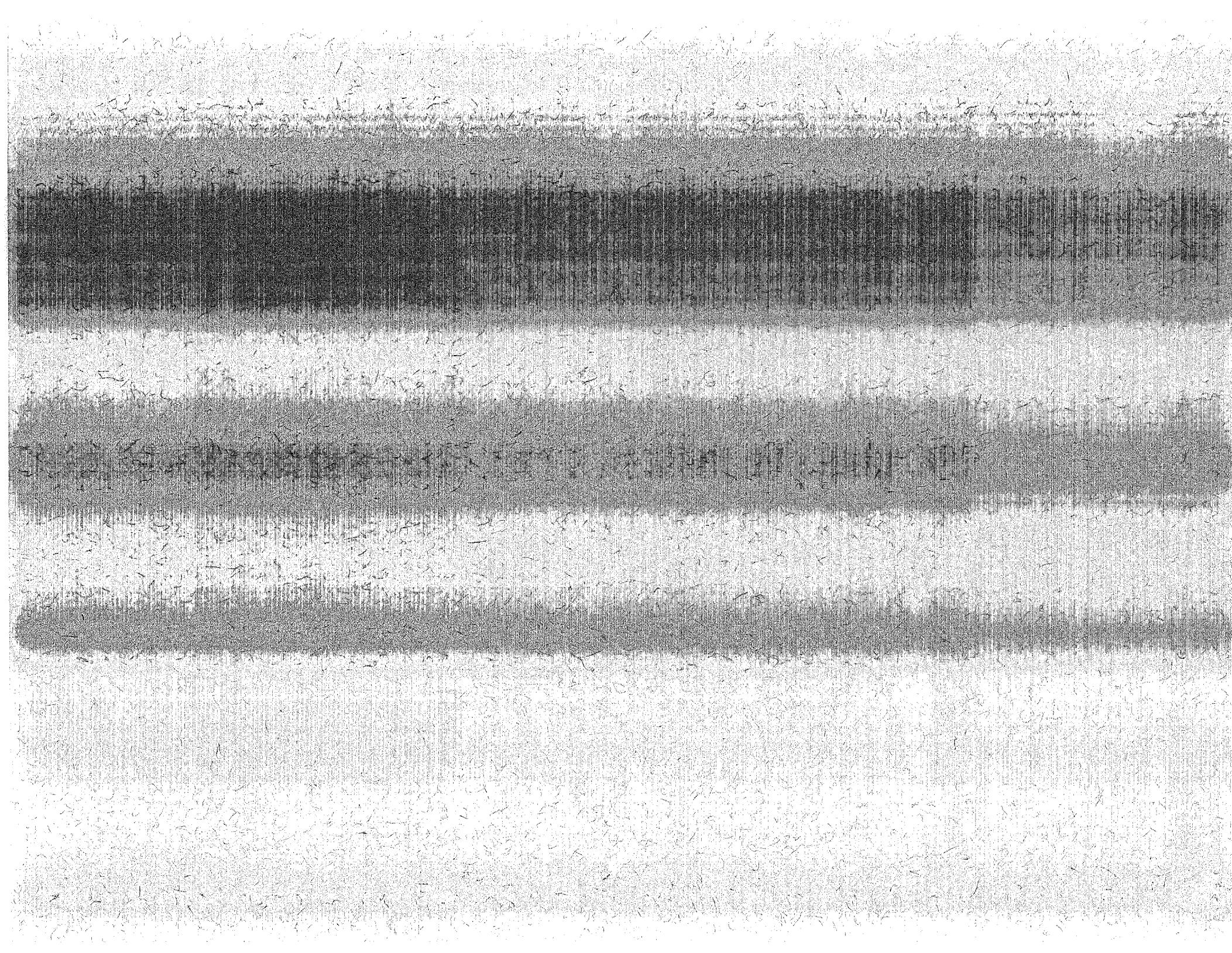
Third, upper limits for the Btu value of all fuels, electricity and steam consumed, produced, purchased or transferred onsite, or sold or transferred off-site were established. The values reported in the data file for items reported above that limit are the mean value for all values reported above the upper limit for the particular item.

Fourth, all values below the upper limit mentioned above, were inoculated with normally distributed random error. The minimum error was  $\pm 5$  percent of the originally reported value and the maximum is  $\pm 40$  percent. All values on a given report received the same amount of error so that the original proportions are preserved. The probabilities of the error ranges are as follows:

Ranges of Error (Percent)	Probability
05%	0.3820
05% - 10%	0.2996
10% - 15%	0.1836
15% - 20%	0.0880
20% - 25%	0.0332
25% - 30%	0.0098
30% - 40%	0.0036

In a few cases, this error inoculation resulted in values which exceed the upper limit described above. In order to maintain the consistency of the inoculation procedures, the inoculation values were reported even though they exceeded the upper limit established for raw data.





**Energy Information Administration  
Forrestal Building  
Washington, D.C. 20585**

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