United States
Environmental Protection
Agency

Industrial Environmental Research
Laboratory
Research Triangle Park NC 27711

Research and Development

EPA-600/S7-82-058 June 1983

EPA

Project Summary

EPA Utility FGS Survey October-December 1981

This report, generated by a computerized data base system, presents a survey of operational and planned domestic utility flue gas desulfurization (FGD) systems, operational domestic particle scrubbers, and Japanese coal-fired utility boiler FGD installations. It summarizes information contributed by the utility industry, system and equipment suppliers, system designers, research organizations, and regulatory agencies. It presents data on system design, fuel characteristics, operating history, and actual performance. Unit by unit dependability parameters are included, and problems and solutions associated with the boilers, scrubbers, and FGD systems are discussed.

The domestic FGD systems are tabulated alphabetically by development status (operational, under construction, or in the planning stages), utility company, system supplier, process, waste disposal practice, and regulatory class. FGD system economic data, definitions, and a glossary of terms are appended to the report. Current data for domestic FGD systems show 94 systems in operation, 40 systems under construction, and 88 planned systems. Projected 1999 FGD controlled capacity in the U.S. is 107,351 MW.

This Project Summary was developed by EPA's Industrial Environmental Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The FGD survey report is prepared quarterly for EPA's Industrial Environmental Research Laboratory, Research Triangle Park, NC. The information in this report is generated by a computerized data base system known as the Flue Gas Desulfurization Information System (FGDIS). The FGDIS structure diagram, Figure 1, shows the informational areas the system addresses and some representative data items contained in each. The design information contained in the FGDIS encompasses the entire emission control system and the power generating unit to which it is applied. Performance data for operational FGD systems include monthly dependability parameters, service time, and descriptions of operational problems and solutions.

Aside from its use in generating the survey report, the FGDIS is available for remote terminal access. Because the survey report is now available only through purchase from the National Technical Information Service (NTIS), the data base represents a more immediate method for users to examine the data acquired under the survey program. Access to the FGDIS also enables users to obtain additional data that are too specific for inclusion in the quarterly report. Direct access to the data base allows statistical analyses of the data (e.g., averages, maxima, minima, and standard deviations of various parameters), the use of simple mathe-

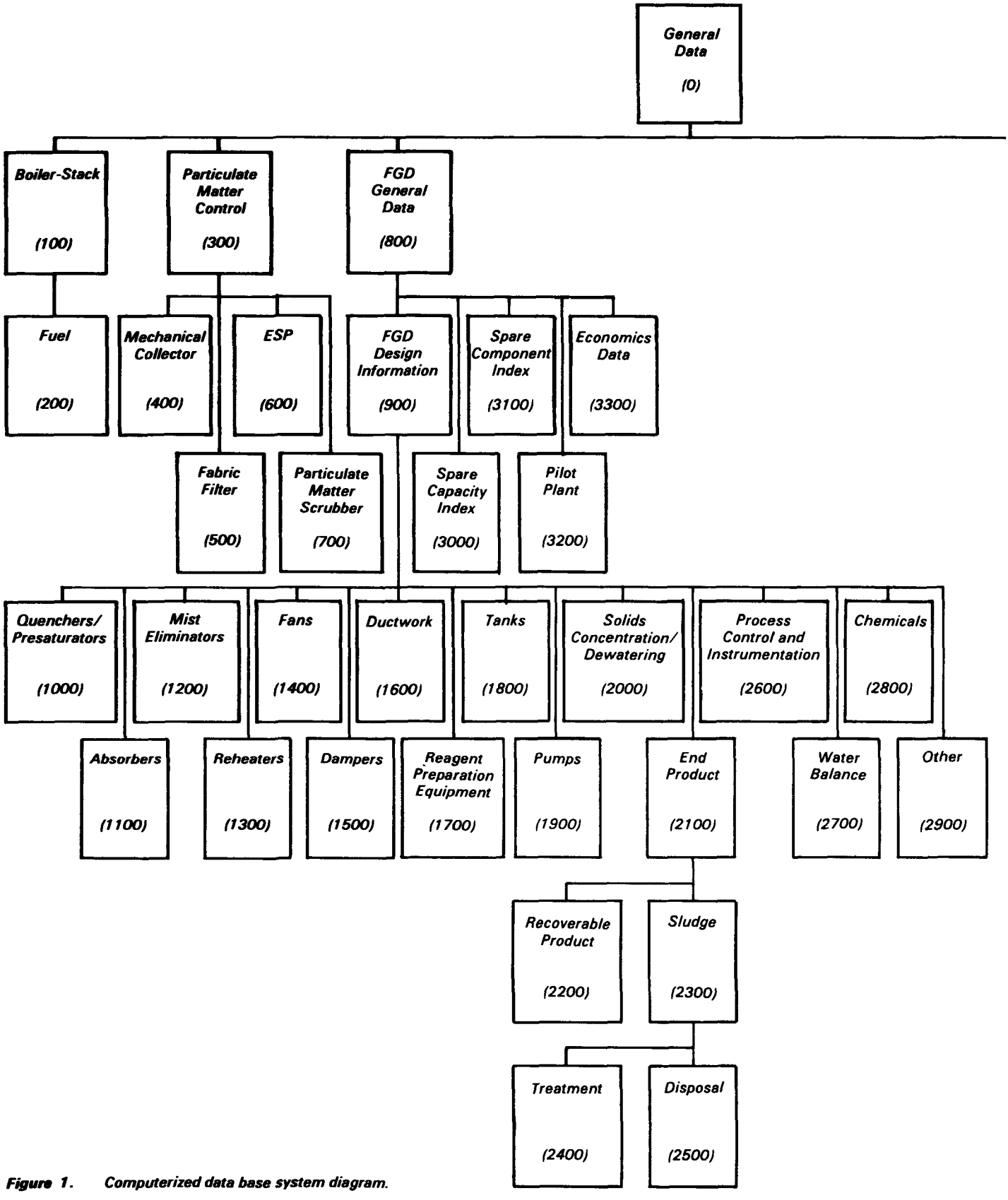
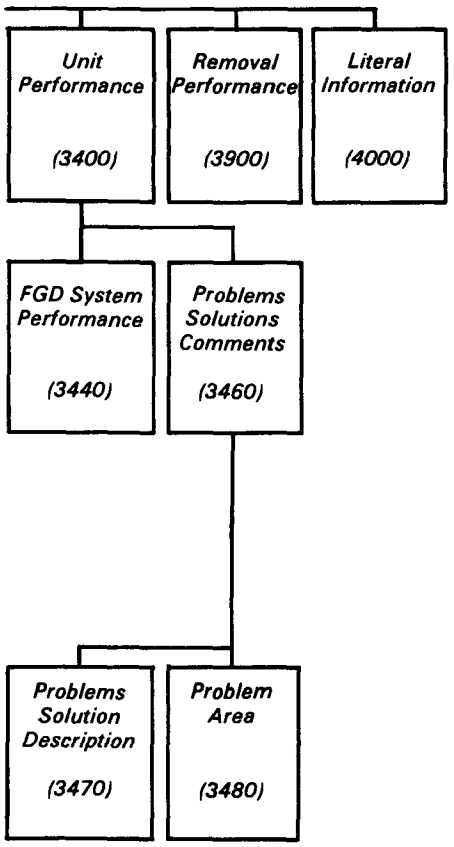


Figure 1. *Computerized data base system diagram.*



matical functions, capability for virtually unlimited data cross-referencing, and data tabulation to fit individual informational needs. Requests for further information concerning the FGDIS and periodic FGDIS training seminars should be directed to Michael Melia or Noreen Bruck, PEDCo Environmental, Inc. (513/782-4700), or EPA's Project Officer, Norman Kaplan, IERL-RTP (919/541-2556). Information concerning access to the FGDIS can be obtained from Walter Finch, NTIS, 5285 Port Royal Road, Springfield, Virginia 22161 (703/487-4808). Custom searches of FGDIS data can also be arranged through Finch.

Executive Summary

Table 1 summarizes the status of FGD systems in the U.S. at the end of December 1981. Table 2 lists the units that changed status during the fourth quarter 1981, and Table 3 shows the performance of operating units during this period. The units included in the figures presented in Table 1 are identified in Table 4, and categorical FGD system cost data are presented in Table 5.

Current projections indicate that the total power generating capacity of the U.S. electric utility industry will be about 831 GW by the end of 1999. (This value reflects the annual loss resulting from the retirement of older units, which is considered to be 0.4% of the average generating capacity at the end of each year.[1,2]) Approximately 373 GW or 45% of the 1999 total will come from coal-fired units. The distribution of power generation sources, both present (December 1980) and future (December 1999) is shown in Table 6.[1]

Table 1. *Number and Total Capacity of FGD Systems*

Status	No. of units	Total controlled capacity, MW [a]	Equivalent scrubbed capacity, MW [b]
Operational	94	35,931	32,683
Under construction	40	17,386	16,666
Planned:			
Contract awarded	17	10,035	9,819
Letter of intent	10	7,643	7,585
Requesting/evaluating bids	10	5,630	5,630
Considering only FGD systems	51	30,726	30,398
TOTAL	222	107,351	102,781

[a] *The summation of the gross unit capacities (MW) brought into compliance with FGD systems regardless of the percent of the flue gas scrubbed by the FGD system(s).*
[b] *The summation of the effective scrubbed flue gas in equivalent MW based on the percent of flue gas scrubbed by the FGD system(s).*

Table 2. *Summary of Changes October - December 1981*

	Operational		Under construction		Contract awarded		Letter of intent		Requesting/ eval. bids		Considering FGD		Total	
FGD status report	No.	MW [a]	No.	MW [a]	No.	MW [a]	No.	MW [a]	No.	MW [a]	No.	MW [a]	No.	MW [a]
September 31, 1981	92	31,892 [b]	42	17,457	16	9,169	11	8,235	10	5,630	51	30,398	222	102,781 [b]
East Kentucky Power J.K. Smith 1					+1	650	-1	650						
Louisville Gas & Electric Mill Creek 2	+1	350	-1	350										
Hoosier Energy Merom 2	+1	441	-1	441										
Total	94	32,683	40	16,666	17	9,819	10	7,585	10	5,630	51	30,398	222	102,781

[a] *Equivalent scrubbed capacity.*
[b] *This value was modified slightly due to a MW correction.*

Table 3. *Performance of Operational Units October-December 1981*

Plant	FGD system capacity, MW[a]	Flue gas % scrubbed	FGD capacity on line during period MW[a,b]	No information for this period, MW[a]	Shut down throughout period, MW[a]	October 1981 Dependability %[c,e] AVL	OPR	REL	UTL	November 1981 Dependability %[c,e] AVL	OPR	REL	UTL	December 1981 Dependability %[c,e] AVL	OPR	REL	UTL
Alabama Electric																	
Tombigbee 2	179	70	179			17	52	52	9	41	79	79	36	100	54	54	54
Tombigbee 3	179	70	179			97	58	58	57	99	76	76	59	96	52	52	52
Arizona Electric Power																	
Apache 2	98	50	98			100	100	100	42	65	64	65	64				
Apache 3	98	50	98			96	98	96	96	100	100	89	89				
Arizona Public Service																	
Cholla 1	119	100		119													
Cholla 2	264	100		264													
Cholla 4	126	33		126													
Four Corners 1	175	100		175													
Four Corners 2	175	100		175													
Four Corners 3	229	100		229													
Basin Electric Power																	
Laramie River 1	570	100	570			100			0	100	63	100	59	100	78	100	78
Laramie River 2	570	100	570			100	96	100	95	100	98	100	98	100	93	100	75
Big Rivers Electric																	
Green 1	242	100	242			75	98	98	75	96	95	95	95	99	98	97	98
Green 2	242	100	242			76	96	96	73	63	87	87	45	100	98	98	87
Central Illinois Light																	
Duck Creek 1	416	100	416			0			0	31	79	91	26	80	82	83	69
Central Illinois Public Service																	
Newton 1	617	100	617			100	0	0	0	98	69	85	69	100	85	100	82
Cincinnati Gas & Electric																	
East Bend 2	650	100	650														
Colorado Ute Electric																	
Craig 1	410	90	410			14	14	14	14	80	80	80	80	84	84	84	84
Craig 2	410	90	410			100	99	99	99	21	47	52	21	69	69	70	68
Columbus & Southern Ohio Electric																	
Conesville 5	411	100	411			100	0	0	0	27	0	0	0	84	82	86	77
Conesville 6	411	100	411			100	0	0	0	27	0	0	0	88	83	93	66
Commonwealth Edison																	
Powerton 51	450	100	450						0								32
Cooperative Power Association																	
Coal Creek 1	327	60	327				54		15		57		47		60		45
Coal Creek 2	327	60	327				76		76		67		67		67		67
Delmarva Power & Light																	
Delaware City 1	60	100	60			30	57	71	23	70	70	70	70	73	68	68	59
Delaware City 2	60	100	60			100	100	100	100	89	89	89	89	99	99	99	99
Delaware City 3	60	100	60			78	86	86	78	42	89	89	42	95	95	95	95
Duquesne Light																	
Elrama 1-4	510	100	510			95	77	94	77	100	77	100	77	100	60	100	60
Phillips 1-6	408	100	408			85	59	83	59	74	41	72	41	73	49	73	49
Hoosier Energy																	
Merom 2	441	90	441														

(continued)

Table 3. *(Continued)*

Plant	FGD system capacity, MW[a]	Flue gas % scrubbed	FGD capacity on line during period MW[a,b]	No information for this period, MW[a]	Shut down throughout period, MW[a]	October 1981 Dependability %[c,e] AVL	OPR	REL	UTL	November 1981 Dependability %[c,e] AVL	OPR	REL	UTL	December 1981 Dependability %[c,e] AVL	OPR	REL	UTL
Indianapolis Power & Light																	
Petersburg 3	532	100		532													
Kansas City Power & Light																	
Hawthorn 3	90	100		90													
Hawthorn 4	90	100		90													
La Cygne 1	874	100	874			51	98	98	35	94	100	92	72				
Kansas Power & Light																	
Jeffrey 1	540	75	540														
Jeffrey 2	490	70	490														
Lawrence 4	125	100	125														
Lawrence 5	420	100	420														
Kentucky Utilities																	
Green River 1-3	64	100			64	100			0	100			0	100			0
Louisville Gas & Electric																	
Cane Run 4	188	100	188			65	93	93	65	99	100	100	99	65	100	100	65
Cane Run 5	200	100	200			93	100	100	58	89	100	100	57	99	99	99	99
Cane Run 6	299	100			299	100			0	100			0	100			0
Mill Creek 1	358	100	358			40	41	41	40	37	40	40	37	26	29	29	26
Mill Creek 2	350	100	350											100	75	75	100
Mill Creek 3	427	100	427			41	90	90	41	32	37	37	32	41	43	43	41
Paddy's Run 6	72	100			72	100			0	100			0	100			0
Minnesota Power & Light																	
Clay Boswell 4	475	85	475			100	95	100	95	94	96	100	73	100	90	100	90
Minnkota Power																	
Milton R. Young 2	185	42	185			100	100	100	66	100	98	99	89	100	100	100	100
Monongahela Power																	
Pleasants 1	668	100		668													
Pleasants 2	668	100		668													
Montana Power																	
Colstrip 1	360	100	360			98				93				97			
Colstrip 2	360	100	360			98				93				96			
Montana-Dakota Utilities																	
Coyote 1	440	100		440													
Nevada Power																	
Reid Gardner 1	125	100	125			0			0	95	78	61	9	100	96	96	100
Reid Gardner 2	125	100	125			100	99	99	86	100	100	100	47	95	74	69	56
Reid Gardner 3	125	100	125			100	99	99	94	98	98	98	98	99	98	97	49
Northern Indiana Public Service																	
Dean H. Mitchell 11	115	99			115	100	0		0	100	0		0	100	0		0
Northern States Power																	
Riverside 6-7	110	100		110													
Sherburne 1	740	100	740			100	100	100	92	100	100	100	95	100	100	100	100
Sherburne 2	740	100	740			100	100	100	100	100	100	100	100	100	100	100	100
Pacific Power & Light																	
Jim Bridger 4	550	100		550													

(continued)

Table 3. *(Continued)*

Plant	FGD system capacity, MW[a]	Flue gas % scrubbed	FGD capacity on line during period MW[a,b]	No information for this period, MW[a]	Shut down throughout period, MW[a]	October 1981 Dependability %[c,e] AVL	OPR	REL	UTL	November 1981 Dependability %[c,e] AVL	OPR	REL	UTL	December 1981 Dependability %[c,e] AVL	OPR	REL	UTL
Pennsylvania Power																	
Bruce Mansfield 1	917	100	917			100				98				99			
Bruce Mansfield 2	917	100	917			98				94				95			
Bruce Mansfield 3	917	100	917			99				100				100			
Public Service of New Mexico																	
San Juan 1	361	100	361			100	96	100	96	100	95	100	81	99	78	100	25
San Juan 2	350	100	350			65	62	67	45	93	71	90	59	95	89	95	89
San Juan 3	534	100	534			98	84	97	62	94	90	93	89	100	92	98	89
Salt River Project																	
Coronado 1	280	80	280														
Coronado 2	280	80	280														
San Miguel Electric																	
San Miguel 1	400	100	400														
Sikeston Board of Municipal Utilities																	
Sikeston 1	235	100	235														
South Carolina Public Service																	
Winyah 2	140	50	140			32	71	72	30	82	88	88	82	81	82	81	65
Winyah 3	280	100	280			96	96	97	96	96	94	95	84	97	97	97	97
Winyah 4	280	100	280							52	53	54	52				
South Mississippi Electric Power																	
R.D. Morrow, Sr. 1	124	62	124			75	99	99	72	100	99	99	98	100	100	100	100
R.D. Morrow, Sr. 2	124	62	124			100	100	100	100	32	99	99	32	100	99	99	94
Southern Illinois Power																	
Marion 4	173	100		173													
Southern Indiana Gas & Electric																	
A.B. Brown 1	265	100	265			98	94	94	84	93	91	91	91	98	63	63	38
Springfield City Utilities																	
Southwest 1	194	100	194			47	87	98	45	0			0	78	82	96	66
Springfield Water, Light & Power																	
Dallman 3	185	90	185			94	68	84	53								
St. Joe Zinc																	
G.F. Weaton 1	60	100	60			12	12	12	12	55	55	55	55	1	1	1	1
Tennessee Valley Authority																	
Shawnee 10A	10	N/A[d]		10													
Shawnee 10B	10	N/A[d]		10													
Widows Creek 7	575	100	575														
Widows Creek 8	550	100	550														
Texas Power & Light																	
Sandow 4	382	70		382													

(continued)

Table 3. *(Continued)*

Plant	FGD system capacity, MW[a]	Flue gas % scrubbed	FGD capacity on line during period MW[a,b]	No information for this period, MW[a]	Shut down throughout period, MW[a]	October 1981 Dependability %[c,e] AVL OPR REL UTL	November 1981 Dependability %[c,e] AVL OPR REL UTL	December 1981 Dependability %[c,e] AVL OPR REL UTL
Texas Utilities								
Martin Lake 1	595	75		595				
Martin Lake 2	595	75		595				
Martin Lake 3	595	75		595				
Monticello 3	800	100		800				
Utah Power & Light								
Hunter 1	360	90		360				
Hunter 2	360	90		360				
Huntington 1	366	85		366				
Naughton 3	330	100		330				
TOTAL	32,683		23,321	8,812	550			

[a] Equivalent scrubbed capacity.
[b] This category includes the flue gas capacity being handled by the FGD system at least part of the time during the report period.
[c] The percent figures listed are average values for all system scrubbing trains during the period.
[d] Flue gas % scrubbed for prototype and demonstration units is not applicable unless the system is designed to bring a unit into compliance with SO_2 emission standard.
[e] Availability, operability, reliability, and utilization as defined in Appendix C of this report.

Table 4. *Summary of Operational and Planned Domestic FGD Systems*

Company name/ unit name	Capacity MW (gross)	Fuel % sulfur	FGD process	FGD status	System supplier
Alabama Electric					
Tombigbee 2	255	1.15	Limestone	1	Peabody Process Systems
Tombigbee 3	255	1.15	Limestone	1	Peabody Process Systems
Arizona Electric Power					
Apache 2	195	0.50	Limestone	1	Research-Cottrell
Apache 3	195	0.50	Limestone	1	Research-Cottrell
Arizona Public Service					
Cholla 1	119	0.50	Limestone	1	Research-Cottrell
Cholla 2	264	0.50	Limestone	1	Research-Cottrell
Cholla 4	375	0.50	Limestone	1	Research-Cottrell
Four Corners 1	175	0.75	Lime/alkaline flyash	1	GE Environmental Services
Four Corners 2	175	0.75	Lime/alkaline flyash	1	GE Environmental Services
Four Corners 3	229	0.75	Lime/alkaline flyash	1	GE Environmental Services
Four Corners 4	755	0.75	Lime	2	Babcock & Wilcox
Four Corners 5	755	0.75	Lime	2	Babcock & Wilcox
Associated Electric					
Thomas Hill 3	730	4.80	Limestone	2	Pullman Kellogg
Atlantic City Electric					
Cumberland 1	330	3.25	Process not selected	6	Vendor not selected

[a] FGD Status:
[1] Operational units.
[2] Units under construction.
[3] Planned - contract awarded.
[4] Planned - letter of intent signed.
[5] Planned - requesting/evaluating bids.
[6] Planned - considering only FGD systems.

(continued)

Table 4. *(Continued)*

Company name/ unit name	Capacity MW (gross)	Fuel % sulfur	FGD process	FGD status[a]	System supplier
Basin Electric Power					
Antelope Valley 1	440	0.68	Lime/spray drying	2	Joy Mfg/Niro Atomizer
Antelope Valley 2	440	0.68	Lime/spray drying	2	Joy Mfg/Niro Atomizer
Laramie River 1	570	0.81	Limestone	1	Research-Cottrell
Laramie River 2	570	0.81	Limestone	1	Research-Cottrell
Laramie River 3	570	0.54	Lime/spray drying	2	Babcock & Wilcox
Big Rivers Electric					
D.B. Wilson 1	440		Limestone	2	Pullman Kellogg
D.B. Wilson 2	440		Limestone	3	Pullman Kellogg
Green 1	242	3.75	Lime	1	American Air Filter
Green 2	242	3.75	Lime	1	American Air Filter
Cajun Electric Power					
Chicot 1	562	1.70	Process not selected	6	Vendor not selected
Chicot 2	562	1.70	Process not selected	6	Vendor not selected
Chicot 3	562	1.70	Process not selected	6	Vendor not selected
Chicot 4	562	1.70	Process not selected	6	Vendor not selected
Oxbow 1	540	0.60	Process not selected	5	Vendor not selected
Oxbow 2	540	0.60	Process not selected	6	Vendor not selected
Central Illinois Light					
Duck Creek 1	416	3.66	Limestone	1	Environeering, Riley Stoker
Duck Creek 2	450	3.30	Limestone	6	Vendor not selected
Central Illinois Public Service					
Newton 1	617	2.25	Dual alkali	1	GE Environmental Services
Central Maine Power					
Sears Island 1	600	2.23	Process not selected	6	Vendor not selected
Central Power & Light					
Coleto Creek 2	720	0.39	Process not selected	6	Vendor not selected
Cincinnati Gas & Electric					
East Bend 1	650	4.00	Process not selected	6	Vendor not selected
East Bend 2	650	3.00	Lime	1	Babcock & Wilcox
Colorado Ute Electric					
Craig 1	455	0.45	Limestone	1	Peabody Process Systems
Craig 2	455	0.45	Limestone	1	Peabody Process Systems
Craig 3	447	0.45	Lime/spray drying	2	Babcock & Wilcox
Columbus & Southern Ohio Electric					
Conesville 5	411	4.67	Lime	1	Air Correction Division, UOP
Conesville 6	411	4.67	Lime	1	Air Correction Division, UOP
Poston 5	425		Process not selected	6	Vendor not selected
Poston 6	425	2.50	Process not selected	6	Vendor not selected
Commonwealth Edison					
Powerton 51	450	3.53	Limestone	1	Air Correction Division, UOP

[a]FGD Status:
[1]Operational units.
[2]Units under construction.
[3]Planned - contract awarded.
[4]Planned - letter of intent signed.
[5]Planned - requesting/evaluating bids.
[6]Planned - considering only FGD systems.

(continued)

Table 4. *(Continued)*

Company name/ unit name	Capacity MW (gross)	Fuel % sulfur	FGD process	FGD status[a]	System supplier
Cooperative Power Association					
Coal Creek 1	545	0.63	Lime/alkaline flyash	1	Combustion Engineering
Coal Creek 2	545	0.63	Lime/alkaline flyash	1	Combustion Engineering
Delmarva Power & Light					
Delaware City 1	60	7.00	Wellman Lord	1	Davy McKee
Delaware City 2	60	7.00	Wellman Lord	1	Davy McKee
Delaware City 3	60	7.00	Wellman Lord	1	Davy McKee
Vienna 9	550	2.50	Process not selected	6	Vendor not selected
Deseret Generation & Transmission					
Bonanza 1	410	0.50	Limestone	2	Combustion Engineering
Bonanza 2	410	0.50	Limestone	5	Vendor not selected
Duquesne Light					
Elrama 1-4	510	2.20	Lime	1	GE Environmental Services
Phillips 1-6	408	1.92	Lime	1	GE Environmental Services
East Kentucky Power					
J.K. Smith 1	650	1.50	Lime	4	Babcock & Wilcox
Spurlock 2	500	3.50	Lime	2	Thyssen/CEA
Florida Power & Light					
Martin 3	800		Process not selected	6	Vendor not selected
Martin 4	800		Process not selected	6	Vendor not selected
General Public Utilities					
Coal 1	625	3.50	Process not selected	5	Vendor not selected
Coal 2	625	3.50	Process not selected	6	Vendor not selected
Coal 3	625	3.50	Process not selected	6	Vendor not selected
Coal 4	625	3.50	Process not selected	6	Vendor not selected
Seward 7	690		Process not selected	5	Vendor not selected
Grand Haven Board of Light & Power					
J.B. Sims 3	65	2.75	Lime	2	Babcock & Wilcox
Hoosier Energy					
Merom 1	490	3.50	Limestone	2	Mitsubishi Heavy Industries
Merom 2	490	3.50	Limestone	1	Mitsubishi Heavy Industries
Houston Lighting & Power					
Limestone 1	750	1.08	Limestone	3	Combustion Engineering
Limestone 2	750	1.08	Limestone	3	Combustion Engineering
W.A. Parish 8	600	0.60	Limestone	2	GE Environmental Services
Indianapolis Power & Light					
Patriot 1	650	3.50	Limestone	6	Vendor not selected
Patriot 2	650	3.50	Limestone	6	Vendor not selected
Patriot 3	650	3.50	Limestone	6	Vendor not selected

[a]*FGD Status:*
[1]*Operational units.*
[2]*Units under construction.*
[3]*Planned - contract awarded.*
[4]*Planned - letter of intent signed.*
[5]*Planned - requesting/evaluating bids.*
[6]*Planned - considering only FGD systems.*

(continued)

Table 4. (Continued)

Company name/ unit name	Capacity MW (gross)	Fuel % sulfur	FGD process	FGD status[a]	System supplier
Petersburg 3	532	3.25	Limestone	1	Air Correction Division, UOP
Petersburg 4	530	3.50	Limestone	2	Research Cottrell
Iowa Electric Light & Power					
Guthrie Co. 1	720	0.40	Limestone	4	Combustion Engineering
Jacksonville Electric Authority					
St. Johns River Power 1	600	2.50	Limestone	5	Vendor not selected
St. Johns River Power 2	600	2.50	Limestone	5	Vendor not selected
Kansas City Power & Light					
Hawthorn 3	90	0.60	Lime	1	Combustion Engineering
Hawthorn 4	90	0.60	Lime	1	Combustion Engineering
La Cygne 1	874	5.39	Limestone	1	Babcock & Wilcox
Kansas Power & Light					
Jeffrey 1	720	0.32	Limestone	1	Combustion Engineering
Jeffrey 2	700	0.30	Limestone	1	Combustion Engineering
Lawrence 4	125	0.55	Limestone	1	Combustion Engineering
Lawrence 5	420	0.55	Limestone	1	Combustion Engineering
Kentucky Utilities					
Green River 1-3	64	4.00	Lime	1	American Air Filter
Hancock 1	708	3.50	Limestone	4	Babcock & Wilcox
Hancock 2	708	3.50	Limestone	6	Vendor not selected
Lakeland Utilities					
McIntosh 3	364	2.56	Limestone	2	Babcock & Wilcox
Lansing Board of Water and Light					
Erickson 2	160		Process not selected	6	Vendor not selected
Los Angeles Department of Water & Power					
Intermountain 1	820	0.79	Lime	6	Vendor not selected
Intermountain 2	820	0.79	Lime	6	Vendor not selected
Intermountain 3	820	0.79	Lime	6	Vendor not selected
Intermountain 4	820	0.79	Lime	6	Vendor not selected
Louisville Gas & Electric					
Cane Run 4	188	3.75	Lime	1	American Air Filter
Cane Run 5	200	3.75	Lime	1	Combustion Engineering
Cane Run 6	299	4.80	Dual alkali	1	Thyssen/CEA
Mill Creek 1	358	3.75	Limestone	1	Combustion Engineering
Mill Creek 2	350	3.75	Lime	1	Combustion Engineering
Mill Creek 3	427	3.75	Lime	1	American Air Filter
Mill Creek 4	495	3.75	Lime	2	American Air Filter
Paddy's Run 6	72	2.50	Lime	1	Combustion Engineering
Trimble County 1	575	4.00	Process not selected	5	Vendor not selected
Trimble County 2	575	4.00	Process not selected	5	Vendor not selected
Lower Colorado River Authority					
Fayette Power Project 3	435	1.70	Limestone	6	Vendor not selected

[a]FGD Status:
[1]Operational units.
[2]Units under construction.
[3]Planned - contract awarded.
[4]Planned - letter of intent signed.
[5]Planned - requesting/evaluating bids.
[6]Planned - considering only FGD systems.

(continued)

Table 4. *(Continued)*

Company name/ unit name	Capacity MW (gross)	Fuel % sulfur	FGD process	FGD status[a]	System supplier
Marquette Board of Light and Power					
Shiras 3	44		Lime/spray drying	2	GE Environmental Services
Michigan South Central Power Agency					
Project 1	55	2.25	Limestone	2	Babcock & Wilcox
Middle South Utilities					
Arkansas Lignite 5	890	0.50	Limestone	4	Combustion Engineering
Arkansas Lignite 6	890	0.50	Limestone	4	Combustion Engineering
Unassigned 1	890	0.50	Limestone	4	Combustion Engineering
Unassigned 2	890	0.50	Limestone	4	Combustion Engineering
Wilton 1	890	0.50	Limestone	4	Combustion Engineering
Wilton 2	890	0.50	Limestone	4	Combustion Engineering
Minnesota Power & Light					
Clay Boswell 4	554	0.94	Lime/alkaline flyash	1	Peabody Process Systems
Minnkota Power					
Milton R. Young 2	440	0.70	Lime/alkaline flyash	1	Thyssen/CEA
Monongahela Power					
Pleasants 1	618	3.00	Lime	1	Babcock & Wilcox
Pleasants 2	618	3.00	Lime	1	Babcock & Wilcox
Montana Power					
Colstrip 1	360	0.77	Lime/alkaline flyash	1	Thyssen/CEA
Colstrip 2	360	0.77	Lime/alkaline flyash	1	Thyssen/CEA
Colstrip 3	700	0.77	Lime/alkaline flyash	2	Thyssen/CEA
Colstrip 4	700	0.77	Lime/alkaline flyash	2	Thyssen/CEA
Montana-Dakota Utilities					
Coyote 1	440	0.87	Sodium carbonate/ spray drying	1	Wheelabrator-Fry/R.I.
Muscatine Power & Water					
Muscatine 9	166	3.21	Limestone	2	Research-Cottrell
Nebraska Public Power District					
Fossil III 1	650	0.36	Process not selected	6	Vendor not selected
Nevada Power					
Harry Allen 1	500		Process not selected	6	Vendor not selected
Harry Allen 2	500		Process not selected	6	Vendor not selected
Harry Allen 3	500		Process not selected	6	Vendor not selected
Harry Allen 4	500		Process not selected	6	Vendor not selected
Reid Gardner 1	125	0.50	Sodium carbonate	1	Thyssen/CEA
Reid Gardner 2	125	0.50	Sodium carbonate	1	Thyssen/CEA
Reid Gardner 3	125	0.50	Sodium carbonate	1	Thyssen/CEA
Reid Gardner 4	250	0.75	Sodium carbonate	4	Thyssen/CEA

[a]*FGD Status:*
[1]*Operational units.*
[2]*Units under construction.*
[3]*Planned - contract awarded.*
[4]*Planned - letter of intent signed.*
[5]*Planned - requesting/evaluating bids.*
[6]*Planned - considering only FGD systems.*

(continued)

Table 4. (Continued)

Company name/ unit name	Capacity MW (gross)	Fuel % sulfur	FGD process	FGD status[a]	System supplier
New York State Electric & Gas					
Somerset 1	625	2.20	Limestone	4	Peabody Process Systems
Niagara Mohawk Power					
Charles R. Huntley 66	100	1.80	Aqueous carbonate/ spray drying	2	Rockwell International
Northern Indiana Public Service					
Dean H. Mitchell 11	116	3.50	Wellman Lord	1	Davy McKee
Schahfer 17	421	3.20	Dual alkali	2	FMC
Schahfer 18	421	3.20	Dual alkali	3	FMC
Northern States Power					
Metro Coal 1	200	1.00	Lime	6	Vendor not selected
Riverside 6-7	110	1.20	Lime/spray drying	1	Joy Mfg/Niro Atomizer
Sherburne 1	740	0.80	Limestone/alkaline flyash	1	Combustion Engineering
Sherburne 2	740	0.80	Limestone/alkaline flyash	1	Combustion Engineering
Sherburne 3	860	1.00	Lime	6	Vendor not selected
Pacific Gas & Electric					
Montezuma 1	800	0.80	Limestone	6	Vendor not selected
Montezuma 2	800	0.80	Limestone	6	Vendor not selected
Pacific Power & Light					
Jim Bridger 1	550	0.56	Sodium carbonate	6	Vendor not selected
Jim Bridger 2	550	0.56	Sodium carbonate	6	Vendor not selected
Jim Bridger 2A	550	0.56	Lime/sodium carbonate	2	Flakt
Jim Bridger 3	550	0.56	Sodium carbonate	6	Vendor not selected
Jim Bridger 4	550	0.56	Sodium carbonate	1	Air Correction Division, UOP
Pennsylvania Power					
Bruce Mansfield 1	917	3.00	Lime	1	GE Environmental Services
Bruce Mansfield 2	917	3.00	Lime	1	GE Environmental Services
Bruce Mansfield 3	917	3.00	Lime	1	Pullman Kellogg
Philadelphia Electric					
Cromby 1	150	3.00	Magnesium oxide	2	United Engineers
Eddystone 1	240	2.60	Magnesium oxide	2	United Engineers
Eddystone 2	334	2.50	Magnesium oxide	2	United Engineers
Plains Electric G & T					
Plains Escalante 1	233	0.80	Limestone	2	Combustion Engineering
Platte River Power Authority					
Rawhide 1	279	0.25	Lime/spray drying	3	Joy Mfg/Niro Atomizer
Public Service Indiana					
Gibson 5	650	3.30	Limestone	2	Pullman Kellogg
Public Service of New Mexico					
San Juan 1	361	0.80	Wellman Lord	1	Davy McKee
San Juan 2	350	0.80	Wellman Lord	1	Davy McKee

[a]FGD Status:
[1]Operational units.
[2]Units under construction.
[3]Planned - contract awarded.
[4]Planned - letter of intent signed.
[5]Planned - requesting/evaluating bids.
[6]Planned - considering only FGD systems.

(continued)

Table 4. (Continued)

Company name/ unit name	Capacity MW (gross)	Fuel % sulfur	FGD process	FGD status[a]	System supplier
San Juan 3	534	0.80	Wellman Lord	1	Davy McKee
San Juan 4	534	0.80	Wellman Lord	2	Davy McKee
Power Authority of State of New York					
Fossil	700	3.00	Process not selected	6	Vendor not selected
Salt River Project					
Coronado 1	350	0.50	Limestone	1	Pullman Kellogg
Coronado 2	350	0.50	Limestone	1	Pullman Kellogg
Coronado 3	400	0.60	Limestone	6	Vendor not selected
San Miguel Electric					
San Miguel 1	400	1.70	Limestone	1	Babcock & Wilcox
Seminole Electric					
Seminole 1	620	2.75	Limestone	2	Peabody Process Systems
Seminole 2	620	2.75	Limestone	3	Peabody Process Systems
Sikeston Board of Municipal Utilities					
Sikeston 1	235	2.80	Limestone	1	Babcock & Wilcox
South Carolina Public Service					
Cross 1	500	1.80	Limestone	3	Peabody Process Systems
Cross 2	500	1.80	Limestone	2	Peabody Process Systems
Winyah 2	280	1.10	Limestone	1	Babcock & Wilcox
Winyah 3	280	1.10	Limestone	1	Babcock & Wilcox
Winyah 4	280	1.70	Limestone	1	American Air Filter
South Mississippi Electric Power					
R.D. Morrow, Sr. 1	200	1.30	Limestone	1	Environeering, Riley Stoker
R.D. Morrow, Sr. 2	200	1.30	Limestone	1	Environeering, Riley Stoker
Southern Illinois Power					
Marion 4	173	3.75	Limestone	1	Babcock & Wilcox
Southern Indiana Gas & Electric					
A.B. Brown 1	265	3.35	Dual alkali	1	FMC
A.B. Brown 2	265	3.35	Process not selected	5	Vendor not selected
Southwestern Electric Power					
Dolet Hills 1	720	0.70	Limestone	3	Air Correction Division, UOP
Dolet Hills 2	720	0.70	Limestone	6	Vendor not selected
Henry W. Pirkey 1	720	0.80	Limestone	3	Air Correction Division, UOP
Soyland Power					
Soyland 1	500	3.00	Process not selected	6	Vendor not selected
Springfield City Utilities					
Southwest 1	194	3.50	Limestone	1	Air Correction Division, UOP
Springfield Water, Light & Power					
Dallman 3	205	3.30	Limestone	1	Research-Cottrell

[a]FGD Status:
[1]Operational units.
[2]Units under construction.
[3]Planned - contract awarded.
[4]Planned - letter of intent signed.
[5]Planned - requesting/evaluating bids.
[6]Planned - considering only FGD systems.

(continued)

Table 4. (Continued)

Company name/ unit name	Capacity MW (gross)	Fuel % sulfur	FGD process	FGD status[a]	System supplier
St. Joe Zinc					
G.F. Weaton 1	60	2.00	Citrate	1	Morrison & Knudsen/U.S.B.M.
Sunflower Electric					
Holcomb 1	347	0.47	Lime/spray drying	2	Joy Mfg/Niro Atomizer
Tampa Electric					
Big Bend 4	475	2.35	Lime/limestone	3	Research-Cottrell
Tennessee Valley Authority					
Paradise 1	704	4.20	Limestone	2	GE Environmental Services
Paradise 2	704	4.20	Limestone	2	GE Environmental Services
Shawnee 10A	10	2.90	Lime/limestone	1	Air Correction Division, UOP
Shawnee 10B	10	2.90	Lime/limestone	1	GE Environmental Services
Widows Creek 7	575	3.70	Limestone	1	Combustion Engineering
Widows Creek 8	550	3.70	Limestone	1	Tennessee Valley Authority
Texas Municipal Power Agency					
Gibbons Creek 1	443	1.06	Limestone	2	Combustion Engineering
Texas Power & Light					
Sandow 4	545	1.60	Limestone	1	Combustion Engineering
Twin Oaks 1	750	0.70	Limestone	3	GE Environmental Services
Twin Oaks 2	750	0.70	Limestone	3	GE Environmental Services
Texas Utilities					
Forst Grove 1	750	0.80	Process not selected	5	Vendor not selected
Martin Lake 1	793	0.90	Limestone	1	Research-Cottrell
Martin Lake 2	793	0.90	Limestone	1	Research-Cottrell
Martin Lake 3	793	0.90	Limestone	1	Research-Cottrell
Martin Lake 4	750	0.90	Limestone	3	Research-Cottrell
Mill Creek 1	750		Process not selected	6	Vendor not selected
Mill Creek 2	750		Process not selected	6	Vendor not selected
Monticello 3	800	1.50	Limestone	1	GE Environmental Services
Tucson Electric Power					
Springerville 1	370	0.61	Lime/spray drying	3	Joy Mfg/Niro Atomizer
Springerville 2	370	0.61	Lime/spray drying	3	Joy Mfg/Niro Atomizer
United Power Association					
Stanton 1A	60	0.77	Lime/spray drying	2	Research-Cottrell
Utah Power & Light					
Hunter 1	400	0.55	Lime	1	GE Environmental Services
Hunter 2	400	0.55	Lime	1	GE Environmental Services
Hunter 3	400	0.55	Limestone	2	GE Environmental Services
Hunter 4	400	0.55	Limestone	2	GE Environmental Services
Huntington 1	430	0.55	Lime	1	GE Environmental Services
Naughton 3	330	0.55	Sodium carbonate	1	Air Correction Division, UOP
Washington Water Power					
Creston Coal 1	570		Limestone	6	Vendor not selected
Creston Coal 2	570		Limestone	6	Vendor not selected
Creston Coal 3	570		Limestone	6	Vendor not selected
Creston Coal 4	570		Limestone	6	Vendor not selected
West Penn Power					
Mitchell 33	300	2.80	Lime	2	GE Environmental Services
West Texas Utilities					
Oklaunion 1	720	0.34	Process not selected	3	GE Environmental Services
Oklaunion 2	720	0.34	Process not selected	6	Vendor not selected

[a]*FGD Status:*

[1]*Operational units.*
[2]*Units under construction.*
[3]*Planned - contract awarded.*
[4]*Planned - letter of intent signed.*
[5]*Planned - requesting/evaluating bids.*
[6]*Planned - considering only FGD systems.*

Table 5. *Categorical Results of the Reported and Adjusted Capital and Annual Costs for Operational FGD Systems*

	Reported						Adjusted[a]					
	Capital			Annual			Capital			Annual		
	Range, $/kW	Average, $/kW	σ	Range, mills/kWh	Average, mills/kWh	σ	Range, $/kW	Average, $/kW	σ	Range, mills/kWh	Average, mills/kWh	σ
All	23.7-213.6	80.2	44.3	0.1-13.0	2.3	2.8	38.3-282.2	118.8	58.1	1.6-20.8	7.6	4.1
New	23.7-213.6	80.4	46.1	0.1- 5.5	1.7	1.8	38.3-263.9	110.8	48.4	1.6-14.6	6.8	3.2
Retrofit	29.4-157.4	79.7	39.4	0.5-13.0	4.5	4.4	60.4-282.2	139.3	73.8	4.3-20.8	9.7	5.3
Salable	132.8-185.0	153.1	20.6	13.0-13.0	13.0	0.0	254.6-282.2	271.6	12.1	16.7-20.8	18.1	1.9
Throwaway	23.7-213.6	75.8	41.5	0.1-11.3	2.1	2.4	38.3-263.9	110.9	47.6	1.6-17.6	7.0	3.4
Alkaline flyash/lime	43.4-173.8	93.9	44.0	0.4- 5.4	2.1	1.9	52.5-184.4	122.8	51.4	3.0-14.1	7.2	3.8
Alkaline flyash/limestone	49.3- 49.3	49.3	0.0	0.8- 0.8	0.8	0.0	102.6-102.6	102.6	0.0	5.4- 5.4	5.4	0.0
Dual alkali	47.2-174.8	97.8	55.3	1.3- 1.3	1.3	0.0	87.8-263.9	146.7	82.9	5.0-13.9	8.7	3.8
Lime	29.4-213.6	81.8	43.7	0.3-11.3	3.2	2.7	60.4-210.0	116.5	44.2	4.0-17.6	8.1	3.6
Limestone	23.7-170.4	67.9	37.2	0.1- 7.8	1.6	2.2	38.3-194.3	98.9	44.0	1.6-14.6	6.1	3.1
Sodium carbonate	42.9-100.8	69.2	26.6	0.2- 0.5	0.4	0.1	87.1-150.9	110.9	26.4	5.8- 7.4	6.4	0.7
Wellman Lord	132.8-185.0	153.1	20.6	13.0-13.0	13.0	0.0	254.6-282.2	271.6	12.1	16.7-20.8	18.1	1.9

[a] *The adjusted costs were developed in an attempt to establish a common cost basis for FGD systems so that cost comparisons can be made. Reported costs are adjusted by deducting all costs associated with particulate matter control, adjusting sludge disposal site for new and retrofit systems to a common 30-year and 20-year life, and adjusting annual costs to a common 65 percent capacity factor. Both capital and annual costs are escalated to common 1981 dollars. Other cost adjustments are made as well.*

Based on the known commitments to FGD by utilities as presented in Table 1, the percentage of electrical generating capacity controlled by FGD for both the present (December 1981) and the future (December 1999) is shown in Table 7.

In light of the revised New Source Performance Standards, actual FGD control is expected to be greater than what is reflected by the figures above. For example, about 50-60 systems representing approximately 29,000 - 31,000 MW of generating capacity now fall into the uncommitted category. These are systems that cannot be included in the committed group now because information regarding their status is not ready for public release.

To show general FGD usage and projected usage trends, Table 6 gives current (December 1981) and projected (December 1999) breakdowns of throwaway product systems versus salable product systems as a percent of the total known commitments to FGD as of the end of the fourth quarter 1981.

The following paragraphs highlight FGD system developments during the fourth quarter 1981.

Alabama Electric announced that the Tombigbee 3 FGD system achieved availabilities of 97%, 99%, and 96% for October, November, and December, respectively. No major FGD related problems were noted during the 3 months.

Arizona Electric Power reported that the Apache 3 FGD system achieved 96% and 100% availabilities for October and November, respectively. Information for December was not available for this report.

Basin Electric Power reported availabilities of 100% for the Laramie River 1 and 2 FGD systems during October, November, and December. No major FGD-related problems were encountered during this quarter.

Big Rivers Electric reported that the Green 1 FGD system achieved 96% and 99% availabilities for November and December, respectively. Operations at the beginning of the fourth quarter were restricted due to piping and damper problems.

The Newton 1 FGD system of Central Illinois Public Service achieved availabilities of 100%, 98%, and 100% for October, November, and December. No major FGD-related problems were encountered during this quarter.

Delmarva Power & Light announced that the FGD system installed on Delaware 2 achieved availabilities of 100%, 89%, and 99% during the quarter. Some ESP and presaturator problems were noted during the 3 months.

Duquesne Light reported that the FGD system installed at Elrama achieved 95%, 100%, and 100% availabilities for October, November, and December, respectively. During the period the recycle pumps of one of the five modules were replaced. Due to the spare capacity, system operation was not hindered.

East Kentucky Power announced that a contract has been awarded to Babcock & Wilcox for the installation of a lime FGD system to control SO_2 emissions from J.K. Smith 1. This new unit will be rated at 650 MW (gross) and will fire coal with an average sulfur content of 1.5%. FGD systems start-up is scheduled for August 1987.

The Merom 2 FGD system of Hoosier Energy began initial operations on December 30. Merom 2 is rated at 490 MW (gross) and fires coal with an average sulfur content of 3.50%. The limestone FGD system, supplied by Mitsubishi Heavy Industries, consists of a cold-side ESP upstream of a grid tower absorber. The scrubbed gas is heated by a flue gas bypass before exiting a 700-ft (213.4 m) stack.

Louisville Gas & Electric reported availabilities of 93%, 89%, and 99% for the Cane Run 5 FGD system during October, November, and December, respectively. No major FGD-related problems were encountered during the 3 months.

Initial operations of the Mill Creek 2 FGD system of Louisville Gas & Electric began during December. Mill Creek 2 is rated at 350 MW (gross) and fires coal with an average sulfur content of 3.75%. The lime FGD system, supplied by Combustion Engineering, consists of two absorber modules. Two hot-side ESPs are included for primary particle removal. Availability of the FGD system during December was 100%.

Minnesota Power & Light reported availabilities of 100%, 94%, and 100% for the Clay Boswell 4 FGD system during October, November, and Decem-

ber, respectively. No major FGD-related problems were encountered during the period.

Minnkota Power announced that the FGD system on Milton R. Young 2 achieved 100% availability for October, November and December. No FGD-related problems were reported for the 3 months.

Nevada Power reported that the Reid Gardner 1 FGD system achieved 95% and 100% availabilities for November and December, respectively. The system was not available during October due to scheduled scrubber/boiler overhaul. The Reid Gardner 2 FGD system achieved 100%, 100%, and 95% availabilities for the same 3 months. The Reid Gardner 3 FGD system achieved availabilities of 100%, 98%, and 99% during the 3 months with only minor problems.

The Sherburne 1 and 2 FGD systems of Northern States Power achieved 100% availability during October, November, and December. No FGD-related problems were encountered during the 3 months.

Pennsylvania Power reported availabilities of 100%, 98%, and 99% for the Bruce Mansfield 1 FGD system during October, November, and December, respectively. Bruce Mansfield 2 achieved availabilities of 98%, 94%, and 95% during the same 3 months. Bruce Mansfield 3 achieved availabilities of 99%, 100%, and 100% during the same period. Some minor ID fan problems and general maintenance were encountered.

Public Service Company of New Mexico reported that the San Juan 1 FGD system achieved availabilities of 100%, 100%, and 97% during October, November, and December, respectively. San Juan 2 achieved 93% and 95% availabilities for November and December, respectively. Low availability in October resulted from necessary mist eliminator maintenance. San Juan 3 achieved availabilities of 98%, 94%, and 100% during the same 3 months. Operation of an additional module on San Juan 3 commenced during the period.

South Carolina Public Service reported that the Winyah 3 FGD system achieved availabilites of 96%, 96%, and 97% for October, November, and December, respectively. Some absorber pump problems were reported during the period.

Southern Indiana Gas & Electric reported availabilities of 98%, 93%, and 98% for the A.B. Brown 1 FGD system during October, November, and Decem-

Table 6. *Power Generation Sources: Present and Future*

	Coal	Nuclear	Oil	Hydro	Gas	Other	GW (total)
December 1980	41%	10%	24%	12%	12%	1%	616
December 1999	45%	15%	19%	11%	9%	1%	831

Table 7. *FGD Controlled Generating Capacity: Present and Future*

	Coal-fired generating capacity controlled by FGD, %	Total generating capacity controlled by FGD, %
December 1981[a]	14.2	5.8
December 1999	28.7	12.9

[a] *The number of committed FGD systems is as of December 1981.; however the figure used for the total generating capacity and coal-fired generating capacity is based on the available December 1980 figures.*

Table 8. *Summary of FGD Systems by Process*

		Percent of total MW		
		December 1981	December 1999 (Projected)[b]	December 1999 (Normalized)[c]
Throwaway product process				
°Wet systems				
Lime		38.1	13.0	23.1
Limestone		47.8	31.5	56.0
Dual alkali		3.6	1.2	2.1
Sodium carbonate		3.8	2.7	4.8
NA[a]		-	7.6	-
°Dry systems				
Lime		0.3	4.8	8.5
Lime/sodium carbonate		-	0.1	0.2
Sodium carbonate		1.3	-	-
Salable product process				
°Process	*°Byproduct*			
Aqueous carbonate/ spray drying	*Elemental sulfur*	-	0.1	0.2
Citrate	*Elemental sulfur*	0.2	0.1	0.2
Lime	*Gypsum*	-	0.1	0.2
Limestone	*Gypsum*	-	0.2	0.4
Lime/limestone	*Gypsum*	-	0.7	1.2
Magnesium oxide	*Sulfuric acid*	-	1.0	1.8
Wellman Lord	*Sulfuric acid*	2.3	0.5	0.9
Wellman Lord	*Elemental sulfur*	2.6	0.2	0.4
Process undecided		-	36.2	-
Total		100.0	100.0	100.0

[a] *NA - Not available (these systems are committed to a throwaway product process; however, the actual process is unknown at this time).*

[b] *These values are based solely on information actually reported by utilities. This breakdown could change significantly as specific processes are chosen for plants now in the very early planning stages of development.*

[c] *The effect of those systems listed as "NA" and "process undecided" is removed.*

ber, respectively. Some damper problems were noted throughout the period.

South Mississippi Electric Power reported availabilities of 100% for the R.D. Morrow 1 FGD system during November and December. Low availability for October was due to a scrubber duct inspection.

References

1. U.S. Department of Energy. Energy Information Administration. Office of Coal and Electric Power Statistics. Electric Power Statistics Division. *Inventory of Power Plants in the United States, 1980 Annual.* Publ. No. DOE/EIA-0095 (80).
2. Berman, Ira M. *New Generating Capacity: When, Where, and by Whom.* Power Engineering 85 (4) 72. April 1981.

M. T. Melia and N. G. Bruck are with PEDCo Environmental, Inc., Cincinnati, OH 45246.

***Norman Kaplan** is the EPA Project Officer (see below).*

The complete report consists of two volumes, entitled "EPA Utility FGD Survey, October-December 1981:"

"Volume I. Categorical Summaries of FGD Systems," (Order No. PB 83-168 054; Cost: $29.50, subject to change)

"Volume II. Design and Performance Data for Operational FGD Systems," (Order No. PB 83-168 062; Cost: $59.50, subject to change)

The above documents are available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

The EPA Project Officer can be contacted at:

Industrial Environmental Research Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

Cincinnati OH 45268

Environmental
Protection
Agency
EPA-335

iness
Private Use, $300

PS 0000329
U S ENVIR PROTECTION AGENCY
REGION 5 LIBRARY
230 S DEARBORN STREET
CHICAGO IL 60604