



Project Summary

EPA Utility FGD Survey April — June 1981

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The 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 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 88 systems in operation, 40 systems under construction, and 99 planned systems. Projected 1999 FGD controlled capacity in the U.S. is 108,857 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).

This report is prepared quarterly by PEDCo Environmental, Inc., under contract to the Industrial Environmental Research Laboratory/Research Triangle Park of the U.S. Environmental Protection Agency. It is generated by a computerized data base system, the structure of which is illustrated in Figure 1 (see pages 6 and 7).

Table 1 summarizes the status of FGD systems in the U.S. at the end of June 1981. Table 2 lists the units that have changed status during the second quarter 1981, and Table 3 shows the performance of operating units during this period.

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 1999.¹ (This value reflects the annual loss resulting from the retirement of older units; i.e., about 0.4 percent of the average generating capacity at the end of each year.²) Approximately 373 GW (45 percent 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 4.¹

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 (June 1981) and the future (December 1999) is shown in Table 5.

In light of the revised New Source Performance Standards, actual FGD



Table 1. Number and Total Capacity of FGD Systems

Status	No. of units	Total controlled capacity, MW ^a	Equivalent scrubbed capacity, MW ^b
Operational	88	33,357	30,158
Under construction	40	16,106	15,887
Planned:			
Contract awarded	21	11,815	11,815
Letter of intent	11	8,235	8,235
Requesting/evaluating bids	19	10,456	10,340
Considering only FGD systems	48	28,888	28,850
Total	227	108,857	105,285

^aThe 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).

^bThe summation of the effective scrubbed flue gas in equivalent MW based on the percent of flue gas scrubbed by the FGD system(s).

control is expected to be greater than that reflected by the figures above. For example, about 50 to 60 systems representing approximately 29,000 to 31,000 MW of generating capacity presently fall into the uncommitted category. These are systems that cannot be included in the committed group at this time because information regarding their status is not ready for public release.

In an effort to show general FGD usage and projected usage trends, Table 6 gives a current (June 1981) and projected (December 1999) breakdown of throwaway product systems versus salable product systems as a percentage of the total known commitments to FGD by the end of the second quarter 1999.

Table 2. Summary of Changes April - June 1981

FGD status report March 31, 1981	Operational		Under construction		Contract awarded		Letter of intent		Requesting/eval bids		Considering FGD		Total	
	No.	MW ^a	No.	MW ^a	No.	MW ^a	No.	MW ^a	No.	MW ^a	No.	MW ^a	No.	MW ^a
Big Rivers Electric D.B. Wilson 1			+1	440	-1	440								
Deseret Gen. & Trans. Moon Lake 1			+1	410	-1	410								
Gulf Power Scholz 1	-1	20											-1	20
Marquette Board of Light & Power Shiras 3			+1	44	-1	44								
Montana-Dakota Utilities Coyote 1	+1	440	-1	440										
Muscatine Power & Water Muscatine 9			+1	166	-1	166								
Northern Indiana Pub. Service Schahfer 17			+1	421	-1	421								
Pacific Power & Light Jim Bridger 2A			+1	100									+1	100
Sikeston Bd. of Municipal Utilities Sikeston 1	+1	235	-1	235										
South Carolina Public Service Cross 2			+1	500	-1	500								
Southern Indiana Gas & Elec. A.B. Brown 2									+1	265			+1	265
Total	88	30,158	40	15,887	21	11,815	11	8,235	19	10,340	48	28,850	227	105,285

^aEquivalent scrubbed capacity

^bThis value was modified slightly due to a MW correction

Table 3. Performance of Operational Units April - June 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	April 1981 Dependability % ^{c,a}				May 1981 Dependability % ^{c,a}				June 1981 Dependability % ^{c,a}			
						AVL	OPR	REL	UTL	AVL	OPR	REL	UTL	AVL	OPR	REL	UTL
Alabama Electric Tombigbee 2	179	70		179													
Tombigbee 3	179	70		179													
Arizona Electric Power Apache 2	98	50	98			100	100	100	100	100	100	100	100	100	100	100	100
Apache 3	98	50	98			100	75	100	36	100	87	100	87	100	87	100	87

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	April 1981 Dependability % ^{c,e}				May 1981 Dependability % ^{c,e}				June 1981 Dependability % ^{c,e}			
						AVL	OPR	REL	UTL	AVL	OPR	REL	UTL	AVL	OPR	REL	UTL
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	97	100	97	100	96	100	86				
Big Rivers Electric																	
Green 1	242	100	242			100			61	85			79	95			95
Green 2	242	100	242			100			100	93			92	96			96
Central Illinois Light																	
Duck Creek 1	416	100	416			38	28	29	24	70	68	71	67	71	63	70	54
Central Illinois Public Service																	
Newton 1	617	100	617			100	95	100	95	100	88	98	81	100	92	100	91
Cincinnati Gas & Electric																	
East Bend 2	650	100	650														
Colorado Ute Electric																	
Craig 1	410	90	410			21	35	27	21	0	0	0	0	0	0	0	0
Craig 2	410	90		410		0	0	0	0	0	0	0	0	0	0	0	0
Columbus & Southern Ohio Electric																	
Conesville 5	411	100	411			97	82	87	63	100	100	100	95	99	100	100	97
Conesville 6	411	100	411			51	98	100	33	100	100	100	83	99	100	100	90
Commonwealth Edison																	
Powerton 51	450	100	450						0				0				0
Cooperative Power																	
Coal Creek 1	327	60	327			100	71	100	71	100	50	100	50	100	39	100	36
Coal Creek 2	327	60	327			100			0	100			0	100	28	100	11
Delmarva Power & Light																	
Delaware City 1	60	100	60			74	83	83	74	98	98	98	98	100	100	100	100
Delaware City 2	60	100	60			64	84	84	64	98	98	98	98	76	76	76	76
Delaware City 3	60	100	60			93	93	93	93	76	76	76	76	100	100	100	100
Duquesne Light																	
Elrama 1-4	510	100	510			100	93	100	93	97	79	95	79				
Phillips 1-6	408	100	408			73	70	73	70	71	66	71	66				
Indianapolis Power & Light																	
Petersburg 3	532	100	532														
Kansas City Power & Light																	
Hawthorn 3	90	100	90			100	100	100	69	100	100	100	31	100	100	100	55
Hawthorn 4	90	100	90			81	100	72	49	96	100	96	86	100	100	100	95
La Cygne 1	820	100		820													
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			100			0	100			0	84	80	80	80
Cane Run 5	200	100	200			100	100	100	51	100	100	100	96	100	0	0	0
Cane Run 6	299	100	299			95	98	98	82	98	97	97	96	89	100	100	26
Mill Creek 1	358	100	358			40	25	25	8	47	61	61	22	56	40	40	27
Mill Creek 3	427	100	427			33	33	33	33	34	38	38	34	35	35	35	35
Paddy's Run 6	72	100		72		100			0	100			0	100			0
Minnesota Power & Light																	
Clay Boswell 4	475	85	475			100	81	100	76	96	64	100	58	100	86	100	86
Minnkota Power & Light																	
Milton R. Young 2	185	42	185			3	5	6	3	65	73	75	65	72	66	68	53
Monogahela Power																	
Pleasants 1	618	100		618													
Pleasants 2	618	100		618													

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	April 1981 Dependability % ^{c,*}				May 1981 Dependability % ^{c,*}				June 1981 Dependability % ^{c,*}			
						AVL	OPR	REL	UTL	AVL	OPR	REL	UTL	AVL	OPR	REL	UTL
Montana Power																	
Colstrip 1	360	100		360													
Colstrip 2	360	100		360													
Montana-Dakota Utilities																	
Coyote 1	440	100	440														
Nevada Power																	
Reid Gardner 1	125	100	125			96	99	99	96	88	67	67	27	94	90	93	81
Reid Gardner 2	125	100	125			100	95	95	7	96	96	96	94	91	89	89	76
Reid Gardner 3	125	100	125			100	100	100	94	98	98	98	96	100	100	100	100
Northern Indiana Public Service																	
Dean H. Mitchell II	115	99			115	100	0		0	100	0		0	100	0		0
Northern States Power																	
Riverside 6-7	110	N/A ^d	110														
Sherburne 1	740	91		740													
Sherburne 2	740	91		740													
Pacific Power & Light																	
Jim Bridger 4	550	100		550													
Pennsylvania Power																	
Bruce Mansfield 1	917	100	917											100			
Bruce Mansfield 2	917	100	917											100			
Bruce Mansfield 3	917	100	917											98			
Public Service Co. of New Mexico																	
San Juan 1	361	100	361			100	99	100	89	100	100	100	100	65	45	51	39
San Juan 2	350	100	350			78	62	66	47	98	84	96	64	63	42	47	42
San Juan 3	534	100	534			20	74	100	20	8	37	37	6	71	56	56	28
Salt River Project																	
Coronado 1	280	80		280													
Coronado 2	280	80		280													
Sikeston Brd. of Municipal Utilities																	
Sikeston 1	235	100	235														
South Carolina Public Service																	
Winyah 2	140	50	140														
Winyah 3	280	100	280														
South Mississippi Electric																	
R D Morrow, Sr. 1	124	62	124			50	94	34	26	0			0	91	91	91	91
R.D. Morrow, Sr. 2	124	62	124			100	98	100	87	100	99	100	93	98	97	97	97
Southern Illinois Power																	
Marion 4	173	100	173			81	71	83	62	84	84	96	84	68	68	72	68
Southern Indiana Gas & Electric																	
A.B. Brown 1	265	100	265			100	0		0	88	81	82	51	100	99	99	97
Springfield City Utilities																	
Southwest 1	194	100	194			61	80	81	59	44	74	91	31	78	75	84	61
Springfield Water, Light & Power																	
Dallman 3	185	90	185			0	0		0	40	19	19	15				
St. Joe Zinc																	
G F Weston 1	60	N/A ^d	60			11	11	11	11	0	0		0	0	0		0
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														
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														

Table 3. (continued)

Plant	FGD system capacity, MW ^a	Flue gas % scrubbed	FGD capacity on line during period, MW ^b	No information for this period, MW ^c	Shut down throughout period, MW ^d	April 1981 Dependability % ^{e*}				May 1981 Dependability % ^{e*}				June 1981 Dependability % ^{e*}			
						AVL	OPR	REL	UTL	AVL	OPR	REL	UTL	AVL	OPR	REL	UTL
Utah Power & Light																	
Hunter 1	360	90	360				100		65		100		90		100		89
Hunter 2	360	90	360				100		100		100		63		100		91
Huntington 1	366	85	366				100		35		100		4		100		78
Total	30,158		20,560	8,387	1,211												

^aEquivalent scrubbed capacity.

^bThis category includes the flue gas capacity being handled by the FGD systems at least part of the time during the report period

^cThe percent figures listed are average values for all system scrubbing trains during the period

^dFlue gas % scrubbed for prototype and demonstration units is not applicable unless the system is designed to bring a unit into compliance with SO₂ emission standard

^eAvailability, operability, reliability, and utilization as defined in Appendix C of the full report

Table 4. 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 5. FGD Controlled Generating Capacity: Present and Future

	Coal-fired generating capacity controlled by FGD, %	Total generating capacity controlled by FGD, %
June 1981*	11.9	5.4
December 1999	28.2	13.1

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

Highlights: April - June 1981

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

The limestone FGD systems on Apache 2 and 3 of Arizona Electric Power achieved 100 percent availabilities during the second quarter 1981. Both systems operated during the 3-month period with no major problems reported.

The Laramie River limestone FGD system of Basin Electric Power achieved 100 percent availability for April and May. No major operational problems were encountered during this period. Information for June was not made available.

Big Rivers Electric announced that, during the second quarter 1981, construction started on D.B. Wilson 1 in Centertown, KY. The 440-MW (gross) unit will consist of a wet limestone FGD system, supplied by Pullman Kellogg, for SO₂ control. The unit is scheduled to commence operations in 1984.

Central Illinois Public Service reported that the dual alkali FGD system installed

on Newton 1 achieved 100 percent availability during the second quarter 1981. The utility reported no major problems during this period.

Columbus and Southern Ohio Electric reported that the lime FGD system installed on Conesville 5 achieved monthly availabilities of 97, 100, and 99 percent during the second quarter 1981. No major operational problems were reported during the period.

Cooperative Power reported that the Coal Creek 1 and 2 lime/alkaline flyash FGD systems achieved 100 percent availabilities during the second quarter 1981. The utility reported no major problems during the period.

Construction of the Moon Lake 1 wet limestone FGD system of Deseret Generation and Transmission started during the period. The 410-MW (gross) unit will fire a bituminous coal with an average sulfur content of 0.5 percent. The FGD system is supplied by Combustion Engineering and will feature a baghouse, supplied by Ecolaire, to remove particulate matter. Moon Lake 1 is scheduled for service in September 1984.

Duquesne Light reported that the lime FGD system operating at Elrama achieved availabilities of 100 and 97 percent for April and May, respectively. Except for some recycle pump replacements, no major operational problems were reported during the period. Information for June was not made available.

The lime FGD system installed on Hawthorn 3 of Kansas City Power and Light achieved 100 percent availability for April through June.

Marquette Board of Light and Power announced that construction of the lime/spray drying FGD system at the Shiras Station has started. This 44-MW (gross) unit is in Marquette, MI. The system is supplied by General Electric Environmental Services, Inc. and will feature a fabric filter for primary particulate matter control. Operation of Shiras 3 is scheduled for October 1982.

Montana-Dakota Utilities announced that Coyote 1 commenced operation in April 1981. This unit, rated at 440 MW (gross), fires lignite with an average sulfur content of 0.9 percent. The sodium carbonate/spray drying FGD system, supplied by Wheelabrator-Frye/Rockwell International, is designed to remove 70 percent of the SO₂. A fabric filter is used for particulate matter collection.

Muscataine Power and Water announced that construction of Muscatine 9 has started. This 166-MW (gross) unit is in Muscatine, IA, and will fire bituminous coal with an average sulfur content of 3.0 percent. The wet limestone FGD system, supplied by Research-Cottrell, is expected to begin operation in September 1982.

Nevada Power reported that the Reid Gardner 2 FGD system achieved availabilities of 100, 96, and 91 percent for April, May, and June, respectively. The Reid Gardner 3 FGD system achieved

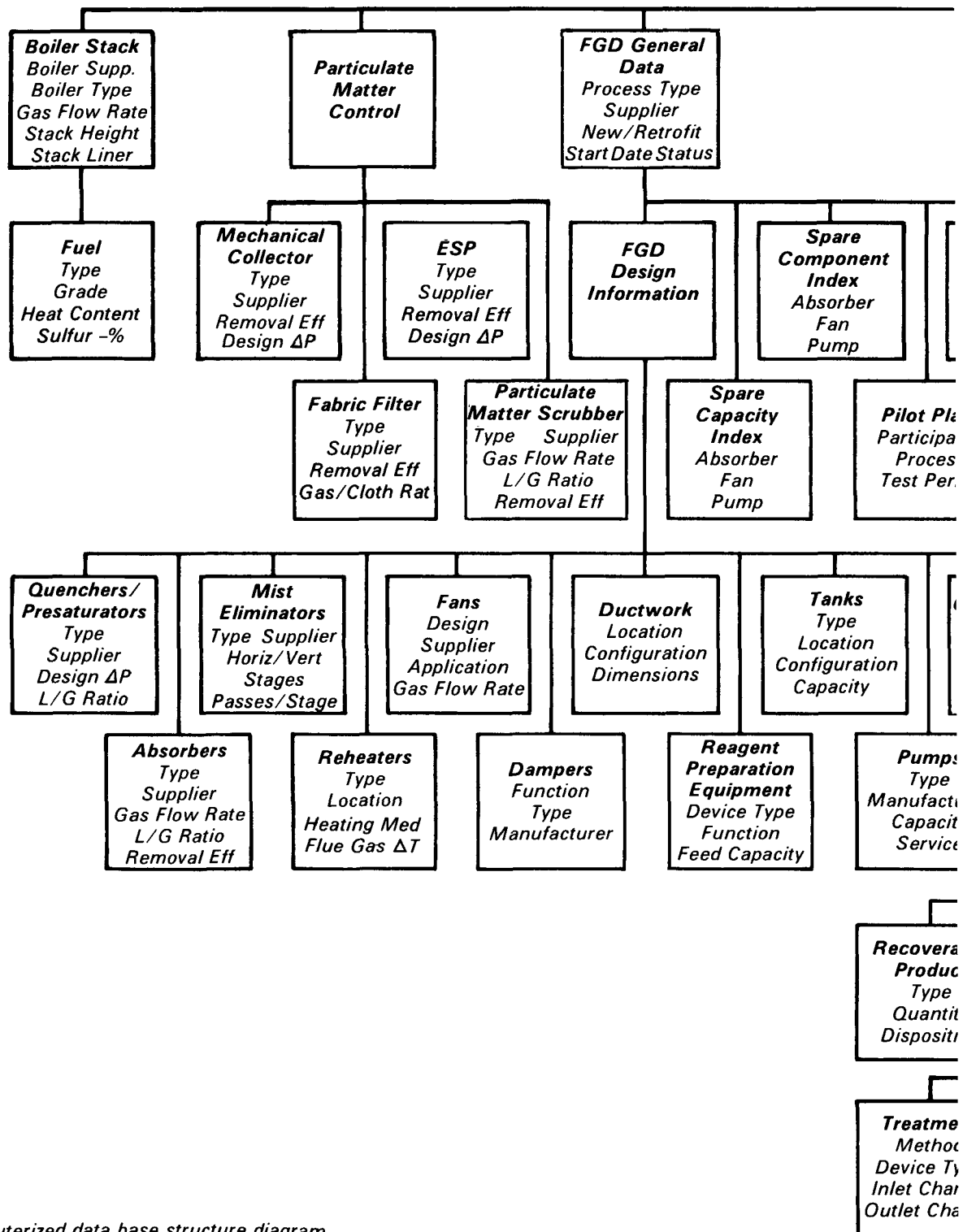
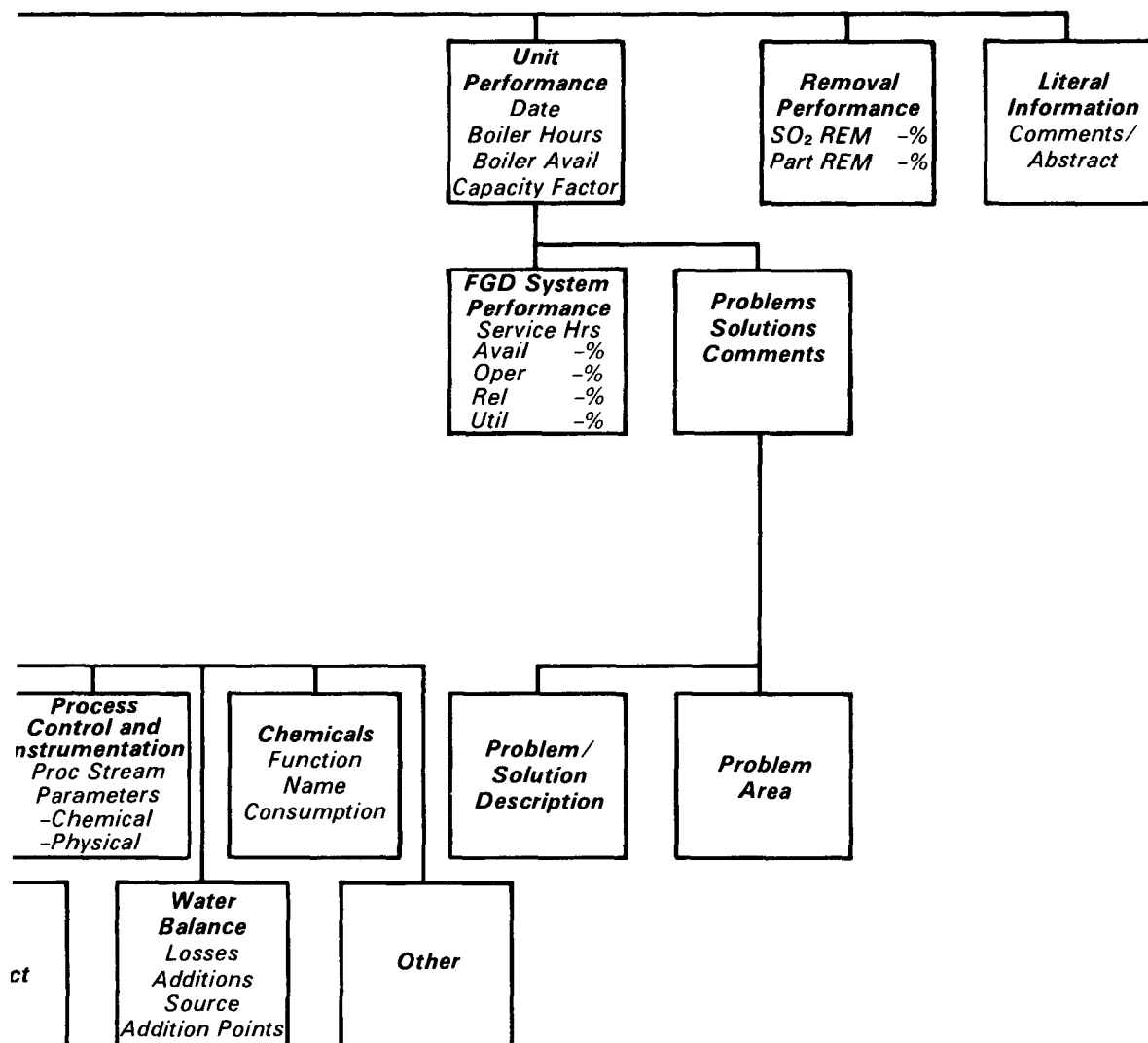


Figure 1. Computerized data base structure diagram.



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Table 6. Summary of FGD Systems by Process

		Percent of total MW	
		June 1981	December 1999
<u>Throwaway product process</u>			
°Wet systems			
Lime		38.5	21.3
Limestone		47.6	36.1
Dual alkali		3.9	1.9
Sodium carbonate		3.0	3.0
NA ^a		—	5.2
°Dry systems			
Lime		0.4	3.3
Lime/sodium carbonate		—	0.1
Sodium carbonate		1.4	0.4
<u>Salable product process</u>			
°Process	°By-product		
Aqueous carbonate/ spray drying	Elemental sulfur	—	0.1
Citrate	Elemental sulfur	0.2	0.1
Lime	Gypsum	—	0.1
Limestone	Gypsum	—	0.2
Lime/limestone	Gypsum	—	0.5
Magnesium oxide	Sulfuric acid	—	0.7
Wellman Lord	Sulfuric acid	2.3	1.2
Wellman Lord	Elemental sulfur	2.7	0.8
Process undecided		—	25.0
Total		100.0	100.0

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

availabilities of 100, 98, and 100 percent for the same period.

Northern Indiana Public Service announced that construction of Schahfer 17 has started. The 421-MW (gross) unit will fire bituminous coal with an average sulfur content of 3.2 percent. The dual alkali FGD system is supplied by FMC. Primary particulate matter control will be provided by an ESP. Start-up of the unit is scheduled for June 1983.

Pacific Power and Light announced that a demonstration spray drying FGD system is under construction at Jim Bridger 2. The unit fires subbituminous coal with an average sulfur content of 0.5 percent. The dry scrubbing system, supplied by Flakt, will be followed by an ESP for particulate matter collection. The process will be tested using lime and sodium carbonate as separate scrubbing reagents. Operation of the demonstration system is scheduled to start in January 1982.

The Sikeston Board of Municipal Utilities announced that operation of

Sikeston 1 started at the end of the quarter. The 235-MW (gross) unit fires bituminous coal with an average sulfur content of 2.8 percent. Flue gas passes through two parallel ESPs and three parallel 50 percent capacity FGD modules (venturi scrubbers) before exiting through a 450-ft (137 m) stack. Flue gas was first passed through the system on June 30, 1981.

South Carolina Public Service announced that construction of Cross 2 started during the quarter. The 500-MW (gross) unit will fire bituminous coal with an average sulfur content of 1.8 percent. The wet limestone FGD system, supplied by Peabody Process Systems, is scheduled to start operation in January 1984.

The limestone FGD system on South Mississippi Electric Power's R.D. Morrow 2 achieved monthly availabilities of 100, 100, and 98 percent during the second quarter 1981. The utility reported no problems during the period.

Southern Indiana Gas and Electric announced plans to construct a new

unit, A.B. Brown 2, with unit 1 in W Franklin, IN. The 265-MW (gross) unit will fire bituminous coal with an average sulfur content of 3.4 percent. The utility is now requesting/evaluating bids for an FGD system. The unit is scheduled to commence operation in January 1985.

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*. Publication No. DOE/EIA-0095 (80).
2. Berman, Ira M. *New Generation Capacity: When, Where, and Whom*. Power Engineering 85(4), April 1981.

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

The complete report, entitled "EPA Utility FGD Survey, April-June 1981," (Order No. PB 82-115 858; Cost: \$25.50, subject to change) will be available only from:

National Technical Information Service

5285 Port Royal Road

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The EPA Project Officer can be contacted at:

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