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Project Summary

EPA Utility FGD Survey January - March 1981

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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. 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 87 systems in operation, 35 systems under construction, and 104 planned systems. Projected 1990 FGD controlled capacity in the U.S. is 108,612 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

This report is prepared quarterly (every 3 months) by PEDCo Environmental, Inc., under contract to the Industrial Environmental Research Laboratory/Research Triangle Park and the Stationary Source Enforcement Division 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 United States at the end of March 1981. Table 2 lists the units that have changed status during the first 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 approximately 833 GW by the end of 1990.[1] (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.[2]) Approximately 370 GW or 44% of the 1990 total will come from coal-fired units. The distribution of power generation sources, both present (December 1979) and future (December 1990) 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 (March 1981) and the future (December 1990) is shown in Table 5.

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 40 to 50 systems representing approximately 20,000 to 25,000 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 F usage and projected usage trends, Ta 6 gives a current (March 1981) an projected (December 1990) breakdo of throwaway product systems ver: salable product systems as a percen the total known commitments to FGD of the end of the first quarter 1981.

Highlights: January - March 1981

The following paragraphs highli FGD system developments during first quarter of 1981.

Arizona Public Service announc that initial FGD operations at Choll commenced in March 1981. The 3 MW (gross) boiler fires pulverized c with an average sulfur content of 0.5 Flue gas flows through an ESP tc double-loop, spray-packed tower (I search-Cottrell design) which uses limestone slurry and treats 36% of t flue gas. The system operated 1 we and was shut down for a beari inspection.

Basin Electric Power Coop announc that a contract was awarded to

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

Status	No. of units	Total controlled capacity, MW*	Equivalent scrubbed capacity, MW†
Operational	87	32,717	29,538
Under construction	35	14,835	14,481
Planned:			
Contract awarded	27	13,796	13,796
Letter of intent	11	8,235	8,235
Requesting/evaluating bids	18	10,191	10,075
Considering only FGD systems	48	28,838	28,850
Total	226	108,612	104,975

**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 systems.*
†The summation of the effective scrubbed flue gas in equivalent MW based on the percent of flue gas scrubbed by the FGD systems.

Table 2. *Summary of Changes—January - March 1981*

	Operational		Under construction		Contract awarded		Letter of intent		Requesting/ eval. bids		Considering FGD		Total	
FGD status report December 31, 1980	No. 84	MW[a] 28,187[b]	No. 34	MW[a] 14,285	No. 30	MW[a] 14,903[b]	No. 10	MW[a] 7,515	No. 16	MW[a] 8,735	No. 49	MW[a] 29,640[b]	No. 223	MW[a] 103,265
Arizona Public Service														
Cholla 4	+1	126	-1	126										
Basin Electric Power Coop														
Antelope Valley 2					+1	440			-1	440				
Cincinnati Gas & Electric														
East Bend 2	+1	650	-1	650										
Colorado Ute Electric Assn.														
Craig 3			+1	447	-1	447								
Iowa Electric Light & Power														
Guthrie Co.									+1	720	-1	720		
Jacksonville Electric Authority														
St. Johns River Power Park 1									+1	600	-1	600		
St. Johns River Power Park 2									+1	600	-1	600		
Kentucky Utilities														
Hancock 1									+1	650	-1	650		
Hancock 2									+1	650	-1	650		
Tennessee Valley Authority														
Widows Creek 7	+1	575	-1	575										
Utah Power & Light														
Hunter 3			+1	400	-1	400								
Hunter 4			+1	400	-1	400								
Washington Water Power														
Creston Coal 2											+1	570	+1	570
Creston Coal 3											+1	570	+1	570
Creston Coal 4											+1	570	+1	570
West Penn Power														
Mitchell 33			+1	300	-1	300								
Total	87	29,538	35	14,481	27	13,796	11	8,235	18	10,075	48	28,850	226	104,975

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

Table 3. Performance of Operational Units—January - March 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]	January 1981 Dependability %[c,a]				February 1981 Dependability %[c,a]				March 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	63	100	63	100	11	100	11	100	54	100	44
Apache 3	98	50	98			100	53	100	46	100	27	100	27	79	24	53	24
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 Coop																	
Laramie River 1	570	100	570			100	95	100	92	100	95	100	85	100	99	100	97
Big Rivers Electric																	
Green 1	242	100	242														
Green 2	242	100	242														
Central Illinois Light																	
Duck Creek 1	416	100	416			93	92	96	92	91	92	99	90	87	84	88	80
Central Illinois Public Service																	
Newton 1	617	100	617			99	90	100	90	100	95	100	95	90	67	100	62
Cincinnati Gas & Electric																	
East Bend 2	650	100	650														
Colorado Ute Electric Association																	
Craig 1	410	90	410			40	48	48	38	9	8	9	7	12	12	12	12
Craig 2	410	90	410			79	78	78	78	66	66	66	66	52	53	54	52
Columbus & Southern Ohio Electric																	
Conesville 5	411	100	411			91	86	85	77	94	92	92	86	4	20	26	1
Conesville 6	411	100	411			98	92	92	92	92	85	85	78	75	97	99	59
Commonwealth Edison																	
Powerton 51	450	100			450				0				0				0
Cooperative Power Association																	
Coal Creek 1	327	60	327			100	44		44	83	53		43	47	61		29
Coal Creek 2	327	60	327			100	57		57	100	57		56	55	55		31
Delmarva Power & Light																	
Delaware City 1	60	100	60			90	90	90	90	86	84	84	76	96	96	96	95
Delaware City 2	60	100	60			93	93	93	93	96	96	96	96	58	89	89	58
Delaware City 3	60	100	60			64	64	64	64	88	88	88	88	81	83	83	83
Duquesne Light																	
Elrama 1-4	510	100	510			100	75	77	75	97	82	82	82				
Phillips 1-6	408	100	408			70	69	95	69	96	69	73	69				
Gulf Power																	
Scholz 1	20	N/A[d]	20														
Indianapolis Power & Light																	
Petersburg 3	532	100		532													
Kansas City Power & Light																	
Hawthorn 3	90	100	90			100	100	100	74	85	100	67	30	52	100	100	52
Hawthorn 4	90	100	90			100	100	100	67	5	100	5	5	86	100	100	62
La Cygne 1	820	100	820			87	100	83	68	99	100	99	66	97	96	97	81
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			81	81	81	81	0	0		0	100	100	100	39
Cane Run 5	200	100	200			100	100	100	89	82	77	77	59	100	46	46	43
Cane Run 6	299	100	299			86	83	83	80	100	100	100	72	100	34	34	28

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]	January 1981 Dependability %[c,e]				February 1981 Dependability %[c,e]				March 1981 Dependability %[c,e]			
						AVL	OPR	REL	UTL	AVL	OPR	REL	UTL	AVL	OPR	REL	U
Mill Creek 1	358	100	358			51	46	46	42	52	52	52	52	39	36	36	
Mill Creek 3	442	100	442			0	0		0	0	0		0	1	1	1	
Paddy's Run 6	72	100			72	100			0	100			0	100			
Minnesota Power & Light																	
Clay Boswell 4	475	85	475			100	95	100	95	100	82	100	81	100	92	100	
Minnkota Power & Light																	
Milton R. Young 2	185	42	185			84	94	100	84	95	100	100	95	88	95	100	
Monongahela Power																	
Pleasants 1	618	100	618														
Pleasants 2	618	100	618														
Montana Power																	
Colstrip 1	360	100	360			96				97							
Colstrip 2	360	100	360			98				97							
Nevada Power																	
Reid Gardner 1	125	100	125			85	85	85	85	43	54	54	43	76	73	73	
Reid Gardner 2	125	100	125			97	96	97	84	93	90	89	75	100	98	98	
Reid Gardner 3	125	100	125			99	99	99	99	100	100	100	100	89	67	67	
Northern Indiana Public Service																	
Dean H. Mitchell 11	115	99			115	100	0		0	100	0		0	100	0		
Northern States Power																	
Riverside 6,7	110	N/A[d]	110														
Sherburne 1	740	91	740			100	100	100	100	100	100	100	95	100	100	100	1
Sherburne 2	740	91	740			100	100	100	100	100	100	100	99	100	100	100	1
Pacific Power & Light																	
Jim Bridger 4	550	100		550													
Pennsylvania Power																	
Bruce Mansfield 1	917	100	917														
Bruce Mansfield 2	917	100	917														
Bruce Mansfield 3	917	100	917														
Public Service Co. of New Mexico																	
San Juan 1	361	100	361			100	99	100	97	98	92	96	84	100	66	82	
San Juan 2	350	100	350			97	76	98	76	96	31	99	25	94	82	94	
San Juan 3	534	100	534			100	90	98	55	81	80	80	75	98	97	98	
Salt River Project																	
Coronado 1	280	80	280														
Coronado 2	280	80	280														
South Carolina Public Service Authority																	
Winyah 2	140	50	140			99	99	99	99	97	97	97	97	100	100	100	1
Winyah 3	280	100	280			66	80	80	66	86	88	88	82	85	100	100	
South Mississippi Electric																	
R.D Morrow, Sr. 1	124	62	124			100			0	100	92	100	12	86	80	80	
R.D. Morrow, Sr. 2	124	62	124			89	98	98	87	100	100	100	86	86	87	87	
Southern Illinois Power Coop																	
Marion 4	173	100	173			59	50	53	49	67	67	67	67	65	72	75	
Southern Indiana Gas & Electric																	
A.B Brown 1	265	100	265			99	99	99	99	99	99	99	99	94	86	88	
Springfield City Utilities																	
Southwest 1	194	100	194			58	54	71	54	46	43	46	43				
Springfield Water, Light, & Power																	
Dallman 3	205	100	205			100	58	58	58	50	48	95	40	50	46	46	
St Joe Zinc																	
G F. Weaton 1	60	N/A[d]			60	0	0		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														

ıle 3. *Concluded*

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]	January 1981 Dependability %[c,e] AVL	OPR	REL	UTL	February 1981 Dependability %[c,e] AVL	OPR	REL	UTL	March 1981 Dependability %[c,e] AVL	OPR	REL	UTL
'artin Lake 3	595	75	595														
'onticello 3	800	100	800														
ıh Power & Light																	
unter 1	360	90	360				100		93		100		95		100		31
unter 2	360	90	360				100		89		100		96		100		99
untington 1	366	86	366				100		96		100		100		100		94
otal	29,538		25,825	2,402	1,311												

ıivalent scrubbed capacity

s category includes the flue gas capacity being handled by the FGD system at least part of the time during the report period

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

e 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.

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

nufacturing/Niro Atomizer for a e/spray drying FGD system to be talled at Antelope Valley 2. The 440 V (gross) unit will fire lignite with an ırage sulfur content of 0.68%. Operaıs are scheduled to commence in ober 1985.

he limestone FGD system operated Laramie River 1 of Basin Electric ver achieved 100% availability for first quarter of 1981. The system ırated for the 3 month period with no jor problems reported.

he dual-alkali scrubbing system talled at Newton 1 of Central Illinois ılic Service achieved availabilities of %, 100%, and 90% during January, ruary, and March, respectively. No ıjor FGD-related problems were ıorted during the three months.

nitial operation of the FGD system at st Bend 2 of Cincinnati Gas and ıctric commenced in March 1981. e unit fires pulverized coal with an ırage sulfur content of 3.0%. A hote ESP is followed by three lime FGD ıdules, supplied by Babcock and lcox. The stabilized sludge from this ısed water loop system is disposed of an on-site landfill. The system erated in a shakedown/debugging ase during March.

Colorado Ute Electric announced that nstruction of the Craig 3 FGD system gan during the first quarter of 1981. ıe lime/spray-drying system is being ıpplied by Babcock and Wilcox. The i5-MW (gross) unit will fire pulverized ıbbituminous coal with an average ılfur content of 0.45%. A fabric filter ill be used to collect the flyash and the y calcium sulfite/sulfate particulate atter (as well as any unused reagent).

Table 4. *Power Generation Sources; Present and Future*

	Coal	Nuclear	Oil	Hydro	Gas	Other	GW (total)
December 1979	*39%*	*9%*	*25%*	*13%*	*13%*	*1%*	*603*
December 1990	*44%*	*14%*	*20%*	*11%*	*10%*	*1%*	*833*

Startup of the FGD system is expected in April 1983.

Columbus and Southern Ohio Electric reported that the Conesville 5 FGD system achieved availabilities of 91% and 94% for January and February, respectively. The Conesville 6 FGD system achieved availabilities of 98% and 92% for the same period, respectively. No major FGD-related problems were reported for either system during the 2 months. March performance data were not provided.

The 20-MW prototype dual-alkali/limestone test program being conducted by Thyssen/CEA and Arthur D. Little at the Scholz station of Gulf Power was completed on March 28. The program was conducted to determine the feasibility of using limestone rather than lime as the source of calcium for regeneration reactions. The system reportedly achieved SO_2 removal efficiencies of 96% and 97% during February and March, respectively. There are no current plans to continue operation of the prototype.

The Elrama FGD system of Duquesne Light achieved availabilities of 100% for January and 97% for February. With the exception of some absorber module lining repairs during February, no major operational problems were encountered during the 2 months. Information for March was not provided.

Iowa Electric Light and Power announced that a letter of intent was signed with Combustion Engineering for the installation of a wet limestone scrubbing system on Guthrie County 1. The unit is rated at 720 MW (gross) and will fire pulverized subbituminous coal with an average sulfur content of 0.4%. An ESP will provide primary particulate matter control. Operations are scheduled to commence in October 1984.

Jacksonville Electric Authority announced that bids are being requested for wet limestone FGD systems to be installed at Units 1 and 2 at the St.

Table 5. *FGD Controlled Generating Capacity; Present and Future*

	Coal-fired generating capacity controlled by FGD, %	Total generating capacity controlled by FGD, %
*March 1981**	*13.9*	*5.4*
December 1990	*29.6*	*13.0*

**The number of committed FGD systems is as of March 1981; however, the figure used for the total generating capacity and coal-fired generating capacity is based on the available December 1979 figures.*

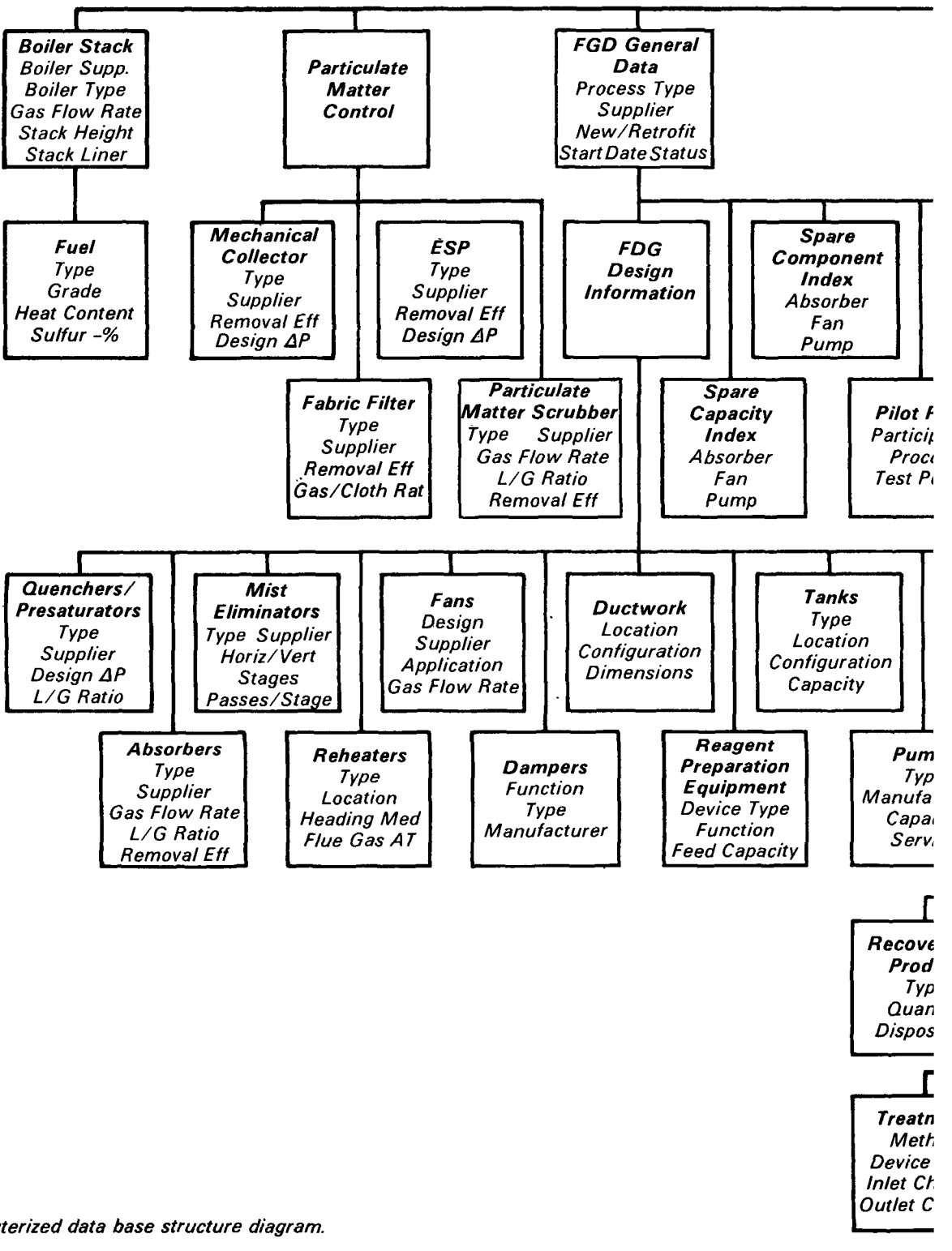
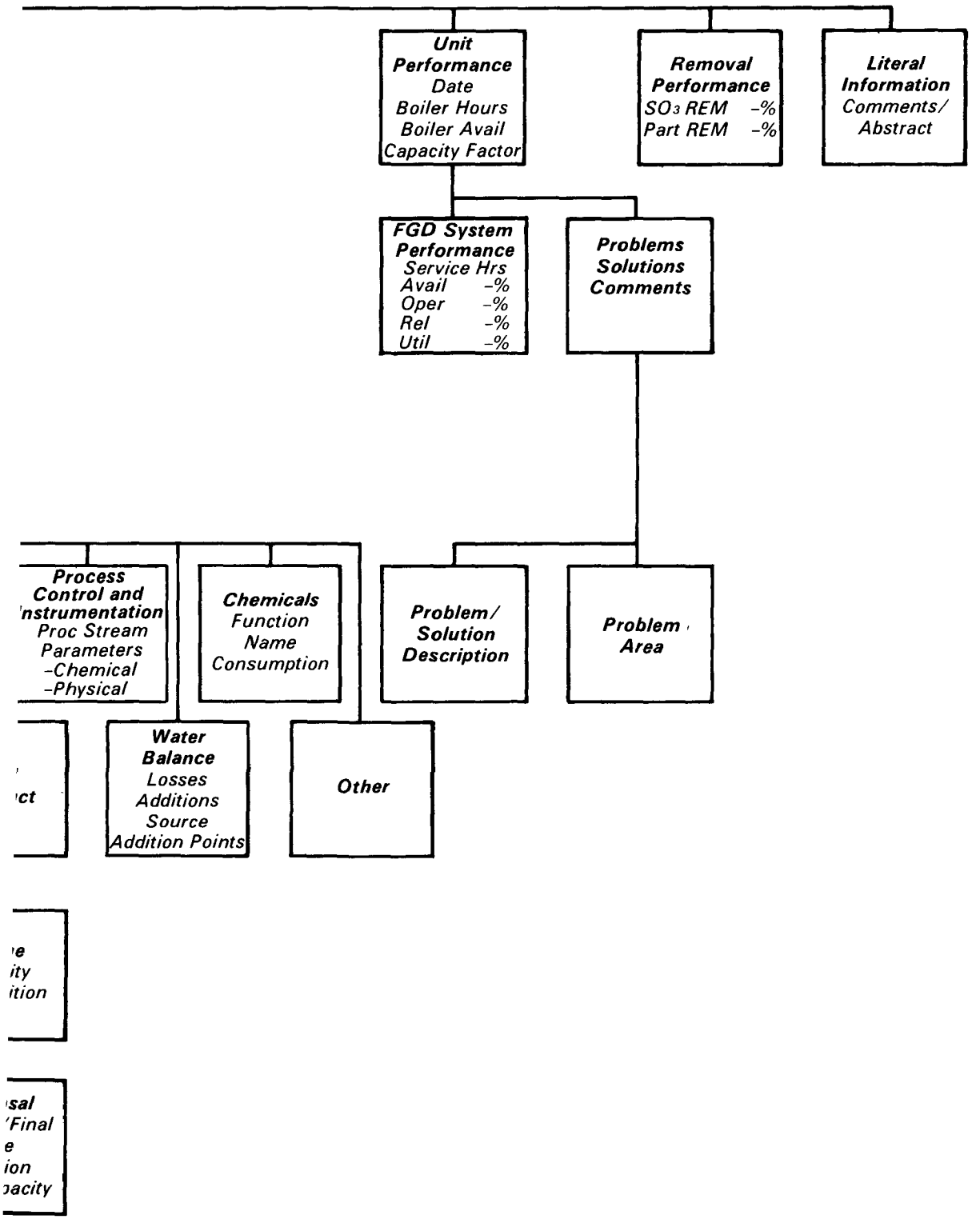


Figure 1. *Computerized data base structure diagram.*


Unit Performance
Date
Boiler Hours
Boiler Avail
Capacity Factor
Removal Performance
SO3 REM -%
Part REM -%
Literal Information
Comments/
Abstract
FGD System Performance
Service Hrs
Avail -%
Oper -%
Rel -%
Util -%
Problems Solutions Comments
Process Control and Instrumentation
Proc Stream
Parameters
-Chemical
-Physical
Chemicals
Function
Name
Consumption
Problem/ Solution Description
Problem Area
Water Balance
Losses
Additions
Source
Addition Points
Other

Johns River Power Park. Each 500-MW (gross) unit will fire pulverized coal with an average sulfur content of 2.5%. Initial operations are scheduled for 1985 and 1987, respectively.

Kentucky Utilities announced that bids are being requested for limestone FGD systems at Hancock 1 and 2. The 708-MW (gross) units will be located in Hawesville, Kentucky, and will fire Western Kentucky coal with an average sulfur content of 3.5%. ESP's will be used to control particulate matter emissions. Operations are scheduled to commence in 1988 and 1994, respectively.

The FGD system at Clay Boswell 4 of Minnesota Power and Light achieved 100% availabilities during January, February, and March. No major problems were reported for the lime/alkaline flyash FGD system during the 3 months.

Montana Power reported that the Colstrip 1 FGD system achieved availabilities of 96% and 97% for January and February, respectively. The Colstrip 2 FGD system achieved availabilities of 98 and 97% for the same 2 months, respectively. No major FGD related problems were reported for either system. March performance data were not provided.

The limestone/alkaline flyash FGD systems installed at Sherburne 1 and 2 of Northern States Power achieved 100% availabilities for the first quarter of 1981. No major operational problems were reported for the 3 months.

San Juan 1 of the Public Service of New Mexico achieved availabilities of 100%, 98%, and 100% during January, February, and March, respectively. San Juan 2 achieved availabilities of 97%, and 94% during the same period, respectively. No major FGD-related problems were reported during the three months.

The limestone FGD system installed at Winyah 2 of South Carolina Public Service achieved availabilities of 99%, 97%, and 100% during the months of January, February, and March, respectively. An expansion joint problem in the quencher discharge pump was the only major problem reported during the 3 months.

The FGD system installed at A.B. Brown 1 of Southern Indiana Gas and Electric achieved availabilities of 99%, 99%, and 94% during January, February, and March, respectively. Some minor pump and vacuum filter problems were reported during the 3 months; however, overall system unavailable time was minimal.

Table 6. Summary of FGD Systems by Process

		Percent of total MW	
		March 1981	December 1990
Throwaway product process			
Wet systems			
Lime		*39.6*	*20.2*
Limestone		*47.4*	*36.2*
Dual alkali		*4.1*	*1.9*
Sodium carbonate		*3.1*	*3.0*
NA[a]		—	*6.3*
°Dry systems			
Lime		*0.4*	*2.9*
Sodium carbonate		—	*0.4*
Salable product process			
Process	*Byproduct*		
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*	*2.4*	*1.2*
Wellman Lord	*Elemental sulfur*	*2.8*	*0.7*
Process undecided		—	*25.5*
	Total	*100.0*	*100.0*

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

Tennessee Valley Authority announced that initial FGD operations at Widows Creek 7 commenced in March 1981. The 575-MW (gross) unit fires pulverized coal with an average sulfur content of 3.7%. The limestone spray tower absorber FGD system is preceded by an ESP and four variable-throat venturies for primary particulate matter control. The system operated in a shakedown/debugging mode throughout March.

Utah Power and Light announced that construction of the FGD systems at Hunter 3 and 4 began in March 1981. The 400-MW (gross) units are being constructed in Castledale, Utah, and will fire pulverized bituminous coal with an average sulfur content of 0.55%. GE Environmental Services, Inc. (formerly Chemico) is supplying the limestone FGD systems which are expected to begin initial operations in 1983 and 1985, respectively.

Washington Water Power announced plans to construct Creston Coal 2, 3, and 4 in Creston, Washington. Each 570-MW (gross) unit will use a limestone FGD system for SO_2 control. Construction at this site is scheduled to commence in 1983, with initial operation of the units currently scheduled for 1987.

West Pennsylvania Power announced that construction of the Mitchell 33 FGD system began in March 1981. This 300-MW (gross) unit is being constructed in Courtney, Pennsylvania, and will fire coal with an average sulfur content of 2.8%. The lime scrubbing process is being supplied by GE Environmental Services, Inc., and is designed for a 95% SO_2 removal efficiency. The system is expected to commence operation in August 1982.

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2. Rittenhouse, R.C. *New Generating Capacity: When, Where, and by Whom.* Power Engineering 82(4):57. April 1978.

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***Norman Kaplan** is the EPA Project Officer (see below).*
The complete report, entitled "EPA Utility FGD Survey, January-March 1981," (Order No. PB 81-225 773; Cost: $23.00, subject to change) will be 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

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