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Power

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Environmental management • Plant electric systems • Heating and cooling for process and comfort • Mechnical transmission and lubrication • Engines, turbines, generators • Air, gas and liquid handling • Instrumentation and control • Steam generation

1972 PLANT DESIGN ISSUE

Including □ Power Environmental Awards
Annual Plant Design Report □ 1972 Equipment Roundup

Fossil-fired Central Stations

Preengineered combined-cyc

PROJECT	COMPANY	PLANT NAME	LOCATION	CONSULTING ENGINEER	Unit number	Unit capacity, MW	Year of first commercial operation	BOILERS			
								Steam flow, 1000 lb/hr	Superheater outlet pressure, psig	Superheater outlet temp, F	Reheat temp, F
1	Pennsylvania Power Co[1]	Mansfield	Shippingport, PA	*Commonwealth Associates, Inc*	1	900	75	6415	3785	1005	1005
2	Virginia Electric & Power Co	Yorktown	Hornsbyville, VA	Brown & Root, Inc	3	345	74	5841	2600	1005	1005
3	Virginia Electric & Power Co	Possum Point	*Dumfries, VA*	*Brown & Root, Inc*	5	845	76	5841	2600	1005	1005
4	Consolidated Edison Co of NY, Inc	Astoria	New York, NY	Ebasco Services Inc	6	826	74	5864	2450	1005	1005
5	Commonwealth Edison Co	Powerton	*Pekin, IL*	Sargent & Lundy	5	818	NAv	5037	2620	1005	1005
6	Appalachian Power Co	Amos	*St. Albans, WV*	American Elec Power Service Corp	2	800	72	5280	3700	1010	....[8]
7	Detroit Edison Co	Monroe	Monroe, MI	Self	2	750	72	5718	3800	1000	1000
8	Carolina Power & Light Co	*Roxboro*	Roxboro, NC	NAv	4	720	76	5170[56]	2610	1005	1005
9	Consumers Power Co	Karn	Essexville, MI	Commonwealth Associates, Inc	4	690	75	4650	1890	955	955
10	Northern States Power Co	*Sherburne County*	Becker, MN	Black & Veatch	1	680	76	4985	2640	1007	1005
11	*Illinois Power Co*	Baldwin	Baldwin, IL	Sargent & Lundy	3	632	75	4220	2620	1005	1005
12	Potomac Electric Power Co	Chalk Point	Aquasco, MD	United Engineers & Constructors Inc	4	600	75	4600	1980	953	952
13	*Gulf States Utilities Co*	Willow Glen	St. Gabriel, LA	Stone & Webster Engineering Corp	5	580	74	4035	3850	1005	1000
14	Dallas Power & Light Co[2]	Monticello	Titus County, TX	Ebasco Services Inc	1	575	74	4025	3825	1005	1005
15	*Wisconsin Power & Light Co*[16]	Columbia	Portage, WI	Sargent & Lundy	1	527	73	3800	2620	1005	1005
16	Iowa Public Service Co[17]	Neal	Sioux City, IA	Ebasco Services Inc	3	520	76	3805	2620	1005	1005
17	Northern Indiana Public Service Co	Kankakee	Wheatfield, IN	Sargent & Lundy	14	520	75	3230	3635	1005	1005
18	The Hydro-Elec Pwr Commn of Ontario	Lennox	Kingston, Ont., Canada	Self	1	513	75	3600	2500	1000	1005
19	Gulf Power Co	Crist	Pensacola, FL	Southern Services, Inc	7	500	73	3626	2486	1000	1005
20	The Hydro-Elec Pwr Commn of Ontario	Nanticoke	Port Dover, Ont., Canada	Self	1	500	72	3600	2450	1000	1005
21	Puerto Rico Water Resources Auth	South Coast	Guayanilla, PR	United Engineers & Constructors Inc	5	450	72	2970	2400	1000	1005
22	Tampa Electric Co	Big Bend	Tampa, FL	*Stone & Webster Engineering Corp*	3	450	75	3116	2552	1000	1005
23	Puerto Rico Water Resources Auth	Aguirre	Guavama PR	United Engineers & Constructors Inc	1	450	74	3170	2400	1000	1005
24	Utah Power & Light Co	Huntington Canyon	*Huntington, UT*	Sterns-Roger Corp	2	440	74	2965	2400	1000	1005
25	Central Louisiana Electric Co Inc	Rodemacher	Vic of Boyce, LA	Sargent & Lundy	1	430	75	3025	2400	1000	1005
26	Delmarva Power & Light Co	Edge Moor	Edge Moor, DE	Bechtel Corp	5	410	73	2890	2460	1000	1005
27	Philadelphia Electric Co	Eddystone	Eddystone, PA	United Engineers & Constructors Inc	3	400	74	2850	1980	950	955
28	Long Island Lighting Co	Northport	Northport, NY	Ebasco Services Inc	4	380	75	2550	2640	1005	1005
29	*Central Illinois Light Co*	Duck Creek	Vic of Canton, IL	Commonwealth Associates, Inc	1	370	76	3000	2600	1005	1005
30	Public Service Co of New Mexico	San Juan	Waterflow, NM	Stearns-Roger Corp	1	370	73	2600	1900	1000	1005
31	Montana Power Co[1]	Colstrip	Colstrip, MT	Bechtel Corp	1	350	75	2520	2597	1005	1005
32	Jersey Central Power & Light Co	Gilbert	Milford, NJ	Burns and Roe, Inc	...	316[14]	73[15]	2506[5]	1350	955	N
33	South Carolina Public Service Auth	Georgetown	Georgetown, SC	Burns and Roe, Inc	1	303	74	2100	2400	1005	1005
34	San Diego Gas & Electric Co	Encina	Carlsbad, CA	Pioneer Service & Engineering Co	4	300	73	2050	1890	950	955
35	Public Service Co of Oklahoma	Comanche	Lawton, OK	*Westinghouse Electric Corp.*	1	240[63]	73	443[66]	1360	950	N
36	Southwestern Public Service Co	Jones	Lubbock, TX	*Self*	2	235	74	1783	1940	1005	1005
37	Central Illinois Public Service	Meredosia	Meredosia, IL	Sargent & Lundy	4	195	75	1425	2500	1005	1005
38	Atlantic City Electric Co	England	Beesleys Point, NJ	*United Engineers & Constructors Inc*	3	160	74	1260	1940	1005	1005
39	West Texas Utilities Co	Fort Phantom	Abilene, TX	Tippett and Gee, Consulting Engrs	1	146	74	1059	1865	1005	1005
	MUNICIPAL AND COOPERATIVE INSTALLATIONS										
40	Basin Electric Power Coop	Olds	*Stanton, ND*	*Burns and Roe, Inc*	2	450	75	3050	2640	1005	1005
41	San Antonio Public Service Board	Sommers	Elmendorf, TX	Black & Veatch	3	436	76	3054	2620	1005	1005
42	East Kentucky Rural Electric Coop	*Charlestown Bottoms*	*Maysville, KY*	Stanley Consultants, Inc	1	300	76	2300	2610	1005	1005
43	Brazos Electric Power Coop, Inc	Miller	Palo Pinto, TX	Tippett & Gee, Consulting Engrs	3	200	75	1550	1977	1005	1005
44	Taunton Municipal Lighting Plant	*Cleary*	Taunton, MA	Paul L Geiringer & Associates	9	110[50]	73	557	1875	1005	1005
45	*Fremont Dept of Utilities*	*Wright*	Fremont, NE	Lutz, Daily & Brain	8	92	76	675	1800	1005	1005
46	Alexandria Munic Power & Light Dept	Hunter	Alexandria, LA	Black & Veatch	4	85	73	718	1350	955	N
47	*Denton Municipal Utilities*	Denton	Denton, TX	Black & Veatch	5	65	73	580	1250	955	N
48	Vero Beach Municipal Power Plant	Vero Beach	Vero Beach, FL	Black & Veatch	4	55	75	505	1350	955	N

MANUFACTURERS

AC - Allis-Chalmers Manufacturing Co
ACP - Allis-Chalmers Power Systems, Inc
APC - The Air Preheater Co, Inc
AS - American Standard, Inc
BB - Brown Boveri Corp
BF - Buffalo Forge Co
BJ - Byron-Jackson Pumps, Div Borg-Warner Corp
BLH - Baldwin-Hamilton Co
BM - Bailey Meter Co
BPC - Bingham Pump Co
BRP - Bruce Peebles & Co, Ltd
BU - Buell Engineering Co, Inc
BW - Babcock & Wilcox Co
BWL - Babcock & Wilcox Ltd
CAP - C A Parsons, Ltd
CE - Combustion Engineering, Inc
CES - Combustion Engrg Superheater Co, Ltd
CHH - Chicago Heater Co
CIR - Canadian Ingersoll-Rand Co Ltd
COC - Cochrane Div, Crane Co
CRL - Croll-Reynolds Engineering Co, Inc
CUL - Culligan Industrial Systems Div, Culligan USA
CV - Copes-Vulcan, Inc
DL - DeLaval Turbine Inc
DP - Diamond Power Specialty Corp
EAI - Electronics Associates, Inc
EE - English Electric Co Ltd
EL - Ecodyne Ltd
EM - Electric Machinery Manufacturing Co
F - The Foxboro Co
FIS - Fischer & Porter Co
FO - Forney Engineering Co
FW - Foster Wheeler Corp
GDI - Gulf Degremont, Inc
GE - General Electric Co
GF - The Green Fuel Economizer Co
GW - The Graver Water Conditioning Co
HAP - James Howden & Parsons of Canada Ltd
HCC - Computer and Instrumentation Div, Westinghouse Electric Corp
HOW - Howell Instruments, Inc
HT - Hungerford & Terry, Inc
IBM - International Business Machines Corp
IN - Infilco Products Co
IR - Ingersoll-Rand Co
IW - Illinois Water Treatment Co
JOY - Joy Manufacturing Co
KKK - Kuhale, Kopp & Kausch-AG
LA - The Louis Allis Co, Inc
LAW - LA/Water Treatment Div, Chromalloy American Co
LN - Leeds & Northrup Co
LOD - Lodge-Cottrell Ltd
MLW - MLW Worthington Ltd
MR - Milton Roy Co
MS - Maryland Shipbuilding & Drydock Co
NOV - Novenco Inc
PEC - Peabody Engineering Corp
PM - The Permutit Co
PP - Pacific Pumps Div, Dresser Industries Inc
RA - Raymond Div, Combustion Engineering, Inc
RS - Riley Stoker Corp
SIE - Siemens AG
STW - Struthers-Wells Corp
SWE - Southwestern Engineering Co
WE - Westinghouse Electric Corp
WM - The Whitlock Manufacturing Co
WO - Worthington Corp
YU - Yuba Heat Transfer Corp
ZU - Air Systems Div, Zurn Industries, Inc

SYMBOLS

ABr - Aluminum bronze
Ad - Admiralty brass
Adi - Admiralty, inhibited
AlB - Aluminum brass
AnC - Analog computer
Att - Attemperator
BA - Bladed airfoil
Bal - Balanced
BC - Backward-curved blades
BD - Balanced draft
C - Coal, bituminous
Cir - Circular
Cr - Crude oil
CuN - Copper/nickel
Cy - Cyclone
D - Damper
DB - Dry bottom
De - Demineralizatic
DiC - Digital computa
DsO - Distillate oil
EA - Excess air
Eva - Evaporator
Fs - Fuel in storage
Fub - Fuel at burner
G - Gas
GR - Flue-gas recirc
Gt - Gas tempering
H2 - Hydrogen
H2O - Water
HF - Horizontal flat
HI - Horizontal int
Hyb - Hybrid
HyC - Hydraulic cou
J - Steam jet ejec
L - Lignite
M - Motor
MAn - Monitoring a
MAP - Monitoring, a partial contro
MgO - Magnesium o

Reheat control	BOILERS: Surface, 1000 sq ft: Boiler and waterwalls	Superheater	Reheater	Economizer	Air heater	Pressure, in H2O	Volume, 1000 cu ft	Combustion rate, 1000 Btu/hr cu ft	FURNACE: Type	Burners: Number per boiler	Burners: Type	Burners: Manufacturer	Pulverizers: Number per boiler	Pulverizers: Capacity of each, ton/hr	Pulverizers: Manufacturer	FORCED DRAFT FANS: Number per boiler	Capacity of each, 1000 cfm	Wheel type	Flow control	Manufacturer	Drive: Type	Drive: Number per boiler	Drive: Hp each	Drive: Manufacturer	PROJECT
An[19]	111	156	199	236	1022	-0 1	734	10 8	BD	32	HI	FW	8	55	FW	2	1250	BA	V	NAv	M	2	NAv	NAv	1
An,TB	72	133	222	276	249	0 1	383	20 5	BD,DB	32	. [26]	CE	N			2	880	BC	V	WE	M	2	4500	GE	2
An,TB	72	133	222	376	249	-0 1	383	20 5	BD DB	32	. [26]	CE	N	.		2	880	BC	V	WE	M	2	4500	GE	3
An	47	143	158	344	687	Bal	467	NAv	BD,DB	36	NAv	FO	N			2	1075	BC	V,D	APC	M	2	6000	EE	4
An,GR	65	113	111	60	496	0 2	271	NAv	BD	10	Cy	BW	N		.	2	522	BC	NAv	BF	M	2	6000	GE	5
An,D	84	64	..[20]	236	687	18	480	14 6	Prd,DB	36	Cir	FW	6	60	FW	2	1000	BA	V	WE	M	2	7000	EE	6
An,GR	39	226	206	283	1815	-0 1	469	15	BD	28	PC	BW	7	50	BW	2	1062	BA	V	GF	M	2	2500	AC	7
An,D	50	82	54	50	443	NAv	200	NAv	BD,DB	24	HF	RS	6	23	RS	1	721	BA	V,D	AS	M	1	2320	WE	8
An,GR	52	77	31	532	N	Bal	241	28	BD	30	HF	FO,RS	N			2	825	BA	V	WE	M	2	3000	NAv	9
An,TB	NAv	119	50	230	972	0 1	540	12 5	BD,DB	56	TB	CE	7	72	RA	2	679	BA	V	WE	M	2	NAv	NAv	10
TB	77	100	48	363	748	-0 5	516	10 8	BD	24	TB	CE	6	66	RA	3	380	BA	V	WE	M	3	1500	NAv	11
An,TB	NAv	79	44	301	153	NAv	253	NAv	BD	32	TB	CE	N		...	2	763	BA	V	AS	M	2	4000	WE	12
An,GR	NAv	NAv	NAv	NAv	402	35 8	NAv	25 4	Prd,DB	20	NAv	CE	N			2	650	NAv	V,D	CE	M	2	5000	EM	13
WS,TB	56	116	135	65	695	0 15	512	11 1	Bal,DB	64	NAv	CE	8	72	CE	2	455	BA	V	WE	M	2	1250	WE	14
TB	71	82	46	190	748	-0 3	421	12 2	Bal,ST	24	TB	CE	6	69	CE	2	462	BA	V	WE	M	2	1750	LA	15
An,D	30	79	119	185	755	0 1	334	15	BD,DB	24	HI	FW	6	48	FW	2	575	BA	V,D	AS	M	2	3500	GE	16
An,GR	90	111	97	95	321	-0.1	268	16 2	Bal,ST	10	Cy	BW	N	..	...	2	607	NAv	V	NAv	M	2	8000	NAv	17
An,TB	26	160	27	135	402	-0 15	157	30 7	Bal	32	.	CE	N	.		2	534	[11]	[10]	NOV		...	2300	NAv	18
An,D	26	38	113	154	44	20	282	16 8	Prd	24	HI	FW	6	32.9	FW	2	545	BA	S,V	AS	M	2	. [29]	WE	19
GR,Gt	51	123	108	151	464[4]	0 1	251	19.9	BD,DB	40[5]	Cir	.	5		BWL	2	528	.	V	HAP	.	..	1450	SIE	20
GR,TB,WS	32	115	151	100	369	0 15	240	16 5	Bal,DB	16	TB	CE	N	...	.	2	559	NAv	V	WE	M	2	1750	AC	21
D	53	101	73	71	370	13 4	243	17.5	Prd	24	..	PEC	N		...	2	2286	BA	NAv	WE	M	2	4500	EM	22
GR,TB,WS	32	100	160	88	369	0 15	240	17 4	BD,DB	16	TE	CE	N	.	...	2	559	NAv	V	WE	M	2	1750	AC	23
An,TB	NAv	117	45	240	229	-0 1	319	12 1	BD	20	TB	CE	5	44	RA	2	665	BC	V	WE	M	2	2250	GE	24
EA	18	90	30	68	302	37	115	NAv	Prd	24	Cir	BW	N	...	....	2	470	BA	V	WE	M	2	5000	WE	25
An,GR	44	146	40	74	350	0 1	137	27.5	BD	28	Cir	BW	N	....	.	2	408	BA	V	WE	M	2	2000	WE	26
TB	30	43	23	238	101[62]	Bal	159	26.5	BD,DB	16	TB	CE	N	....	..	2	476	BA	V	WE	M	2	2000	WE	27
GR	71	61	89	146	295	-0 5	231	14.9	BD	16	TB	CE	N	...	.	2	333	BA	V	NAv	M	2	1500	NAv	28
GR	52	117	79	54	582	Bal	270	13.9	BD	24	HF	RS	3	64.8	RS	2	1161	NAv	V,D	NAv	M	2	1750	NAv	29
An	88.	58	101	129	444	11.6	290	12	Prd	16	NAv	FO	4	50	FW	2	1000	.	V	WE	M	2	4000	GE	30
TB,WS	45	59	29	153	250	-0.1	236	14.3	BD,DB	20	TB	CE	5	53	RA	2	626	BA	V,D	WE	M	2	2500	WE	31
	91[65]	29[65]	N	71[65]	N			..	..	8	..	.	...	...	...	N	..	.	....	.	...	..	.	.	32
An,D	40	NAv	NAv	41	243	-0 3	175	15.9	BD,DB	24	HF	RS	6	25.5	RS	2	272	BA	V	ZU	M	2	1250	NAv	33
GR,WS	36	28	29	58	142	19 5	87	35	Prd	24	NAv	BW	N	....	.	2	415	BA	V,D	WE	M	2	4000	GE	34
	174[66]	67[66]	N	268[66]	0		...	...	.	NAv	...	..	N	..	..	N		.	...	....	...	...	....	..	35
TB	22	33	17	104	278	17	94	..	Prd	16	....	CE	N	...	..	2	314	NAv	HyC	APC		...	..	.	36
An,EA	25	47	13	53	135	27	71	26 5	Prd,DB	8	NAv	FO	N	..	..	2	230	BC	V	WE	M	2	2250	WE	37
GR,TB	9	27	9	72	86	-0.1	58 4	29	Bal,DB	12	TB	CE	N	...	....	2	.. [60]	BA	V	WE	M	2	900	WE	38
WS	17	26	10	53	167	12 5	44	33 3	Prd	6	HF	PEC,RS	N	..	...	1	302	BA	V	AS	M	1	3000	WE	39
An	50	136	69	95	1131	NAv	404	12.1	BD	12	Cy	BW	NAv	....	...	2	530	BA	D	WE	M	2	8000	AC	40
An	NAv	54	62	221	343	30	162	NAv	Prd	16	TB	CE	N	..	.	2	488	BA	V	WE	M	2	4000	GE	41
... [46]	36	134	54	57	N	Bal	210	NAv	NAv	24	NAv	BW	8	21.5	BW	2	NAv	NAv	S	NAv	M	2	1500	NAv	42
GR	23	33	15	80	321	12	76	28	Prd	9	HF	RS,PEC	N	.	.	2	252	NAv	V	BF	M	2	1500	NAv	43
An	48	13	21	70	N	11.8	27	31	Prd	9	HF	RS	N	.	....	1[51]	NAv	NAv	NAv	NAv	M	.	..	.	44
GR	24	42	13	10	89	13.2	NAv	NAv	BD	9	NAv	BW	3	48	BW	1	931	....	V	NAv	M	1	750	NAv	45
N	10	9	N	N	87	20	33.3	27	Prd	6	.	CE	N	....	.	1	260	BA	HyC,D	AS	M	1	2000	WE	46
WS	30	7	N	N	68	20	23	33.8	Prd	6	NAv	CE	N	....	..	1	208	BA	D	APC	M	1	800	AC	47
N	22	9	N	N	54	15	22.5	26 2	Prd	6	NAv	FO	N	....	..	1	173	BA	HyC	GF	M	1	1750	WE	48

2 - Jointly owned with Texas Electric Service Co and Texas Power & Light Co
3 - Acting on its own behalf and as agent for Cleveland Electric Illuminating Co, Duquesne Light Co, Ohio Edison Co, Toledo Edison Co and Pennsylvania Power Co
4 - Primary, 53,000 sq ft; secondary, 411,000
5 - Opposed firing – 24 burners in front wall, 16 in rear wall
6 - pH control: morpholine injection
7 - Single-cylinder turbine
8 - Data are for the main feedpump. There are also two 35% capacity pumps, each with 5300-hp motor drives manufactured by SIE
9 - Base-load, indoor unit unless otherwise specified
10 - Variable-pitch fan blades
11 - Axial-flow fan
12 - Units are Imperial gpm
13 - Units are feet
14 - Total output of four gas turbines (rated 47.5 each) and one steam turbine that are packaged together in a preengineered combined-cycle plant. For data on the combustion turbines, see p S•12
15 - Gas turbines will be installed in 1973, the steam turbine in 1974
16 - Jointly owned with Wisconsin Public Service Corp and Madison Gas & Electric Co
17 - Jointly owned with Iowa Power & Light Co, Iowa Southern Utilities Co and Iowa-Illinois Gas and Electric Co
18 - Control firing rate
19 - Also dampers
20 - *Gross rating*
21 - pH control: ammonia injection
22 - Primary steam source, main unit crossover; secondary steam source, main steam
23 - High-pressure/low-pressure
24 - Gross heat rate at 100% load with exhaust pressure of 1.5 in. Hg abs
25 - Performance fuel
26 - Wide-range mechanical burners
27 - pH control: cyclohexylamine injection
28 - Applies to data logger
29 - *Data are for the main feedpump. Standby* pump, manufactured by IR, is rated 5150 gpm at 3272 psig. It is driven by a 10,000-hp motor manufactured by BB
30 - Units are 1000 Btu/gal
31 - Peaking/cycling unit
32 - Outdoor unit
33 - Condensing unit
34 - DsO, 136,000 Btu/gal; RsO, 145,000 Btu/gal; G, 1030 Btu/cu ft
35 - DsO, 0.16; RsO, 0.3; G, 0
36 - *Data are for the main feedpumps.* Two standby pumps, manufactured by BJ, have HyC for flow control. Each is driven by a 10,000-hp motor manufactured by GE
37 - pH control: hydrazine injection
38 - L-p heaters are arranged in a parallel/series circuit. Two trains of two heaters each operate in parallel. Discharge from both trains is combined and flows to two l-p heaters arranged in series. One of these heaters is closed, one is open
39 - *Twin-shell unit with arsenical-copper* tubes in the condensing section and CuN tubes in the air-removal section
40 - Assumes valves wide open, 5% overpressure and 1 in. Hg abs vacuum in the main unit
41 - Primary steam source, second reheater; secondary steam source, first reheater and auxiliary boiler
42 - Turbine heat rate
43 - Primary steam source, main-turbine *bleed; secondary steam source, main steam*
44 - DsO, 19,647 Btu/lb; G, 1000 Btu/cu ft
45 - In DsO
46 - Excess-air control
47 - Semi-outdoor unit
48 - DsO, 19,500 Btu/lb; RsO, 18,400 Btu/lb; G, 1000 Btu/cu ft
49 - Assumes natural-gas firing and turbine exhausting at 1.5 in. Hg abs

Fossil-fired Central Stations

New peaking/cycling plants

This project listing covers four pages

	PROJECT	INDUCED-DRAFT FANS								TURBINE[71]				CONDENSER					FEEDWATER			CONTROLS			
						Drive																			
		Number per boiler	Capacity of each, 1000 cfm	Flow control	Manufacturer	Type	Number per boiler	Hp each	Manufacturer	Exhaust pressure, in. Hg abs	Number of bleed points	Number of exhausts	Manufacturer	Surface area, 1000 sq ft	Number of water passes	Tube material	Manufacturer	Air removal equipment	Makeup treatment	Condensate treatment	Treatment system manufacturers, makeup/condensate	Combustion (Mfr)	Feedwater (Mfr)	Closed-circuit TV (Mfr)	
1		NAv	NAv	NAv	NAv	NAv	NAv	NAv	NAv	1.5	8	6	GE	370	1	Ad	IR	Ro	De	De[21]	NAv/GW	BM	BM	N	
2		4	694	D	AS	M	4	6000	AC	1.5	7	6	GE	483	1	AlB	IR	J	De	Pdx[27]	GW/GW	HCC	HCC	DP	
3		4	694	D	AS	M	4	6000	AC	1.5	7	6	GE	NAv	....	....	....	....	....[57]	....[27]	NAv/NAv	HCC	HCC	DP	
4		3	1190	D	APC	M	3	7000	EE	2	7	4	WE	356	1	ABr	IR	Ro	De	NAv	...MR	GE,FO	GE	NAv	
5		2	326	HyC	BF	M	2	5000	GE	3.5	7	6	GE	450	1	SSt	WE	J	De	De	LAW/LAW	BM	BM	DP	
6		N	....	....	....	....	....	....	....	1.5	7	4	GE	360[39]	1	....[39]	WO	Ro	So	....[21]	PM/PM,CRL	HCC	HCC	DP	
7		2	1408	V	GF	M	2	5500	AC	1.5	7	4	WE	301	1	AdI,CuN	FW	Ro	De	De[21,37]	LAW/LAW	BM	BM	DP	
8		1	1088	V,D	AS	M	1	4750	WE	2.5	7	4	GE[32]	365	1	SSt	NAv	Ro	....[57]	N[27]	NAv/NAv	HCC	HCC	NAv	
9		2	1600	V	WE	M	2	7000	NAv	3	5	4	ACP	295	1	CuN	DL	Ro	De	SF6	COC/GW	HCC	HCC	NAv	
10		4	665	D	GF	M	4	NAv	NAv	1.5	NAv	4	GE	332	1	SSt	FW	Ro	De	NAv	IW/DL	NAv	NAv	NAv	
11		3	770	HyC	WE	M	3	4000	NAv	1.5	7	4	GE	310	1	SSt,CuN	IR	Ro	De	De	LAW/LAW	LN	LN	N	
12		4	1210	HyC,D	NAv	M	4	7000	WE	4	4	4	GE	414	2	CuN	IR	RP	De	SF[21]	NAv/NAv	BM	BM	NAv	
13		N	....	....	....	....	....	....	....	2	7	2	WE	242	1	CuN	IR	Ro	De	De,SF	NAv/NAv	WE	WE	DP	
14		2	1241	D	APC	M	2	4000	WE	2.5	7	4	WE[32]	210	1	SSt	FW	Ro	De	Pdx[21]	PM/GW	LN	LN	N	
15		2	999	HyC	BF	M	2	6900	WE	1	7	4	GE	250	2	Ad	WE	Ro	De	....[75]	NAv/NAv	F	F	N	
16		2	828	S	AS	M	2	6000	GE	1.5	7	2	GE	460	2	SSt	IR	Ro	De	De[6]	NAv/GW	NAv	NAv	NAv	
17		2	1000	HyC	NAv	M	2	7000	NAv	1.5	7	4	WE	300	1	SSt,Ad	WE	Ro	De	De[37]	NAv/NAv	LN	LN	N	
18		2	743	V	KKK	....	....	3500	NAv	1.5	7	4	GE	160	1	Ad	FW	J	De	De	EL	F	F	DP	
19		N	....	....	....	....	....	....	....	3.5	7	2	WE	230	2	Ad,CuN	BLH	Ro	De	Pdx[6]	GDI/GW	BM	BM	DP	
20		2	800	V	HAP	....	....	3000	BRP	1.5	7	4	CAP	163	1	Ad	MLW	Ro	De	....[6]	IN/IN	BM	BM	DP	
21		2	879	V	WE	M	2	4500	GE	2	7	2	GE[32]	248	1	Ad	BLH	Ro,J	De	De	PM/GW	GE	GE	DP	
22		N	....	....	....	....	....	....	....	2	6	2	GE	143	1	SSt	IR	Ro	De	....[27]	COC/NAv	NAv	NAv	NAv	
23		2	890	V	WE	M	2	4500	GE	2.5	7	2	BB[32]	248	1	Ad	BLH	Ro,J	De	De	NAv/COC	GE	GE	DP	
24		2	1105	D	WE	M	2	4500	GE	3.5	6	2	GE	171	2	SSt,AdI	SWE	J	De	NAv	PM/NAv	BM	BM	DP	
25		N	....	....	....	....	....	....	....	1	7	2	GE[47]	238	2	SSt,AdI	IR	Ro	De	....[6]	NAv/NAv	F	F	DP	
26		2	625	D	WE	M	2	4500	WE	2	7	2	WE	218	1	AdI	DL	Ro	De	N	IW/N	BM	BM	DP	
27		2	754	D	AS	M	2	6000	WE	2	3	1	WE	178	1	AdI	IR	J	De	NAv	NAv	LN	LN	DP	
28		2	489	D	NAv	M	2	3500	NAv	1.6	7	4	GE	130	1	NAv	IR	Ro	D	N[21]	NAv/N	GE	GE	NAv	
29		4	NAv	NAv	NAv	NAv	NAv	NAv	NAv	3.5	8	2	GE	212	1	SSt,AdI	DL	Ro	De	De	NAv/NAv	LN	LN	N	
30		N	....	....	....	....	....	....	....	2.3	6	2	WE	165	2	AdI	DL	J	De	NAv	PM/NAv	FO	HCC	DP	
31		2	NAv	D	NAv	M	2	NAv	NAv	3.5	6	2	GE	144	2	SSt,AdI	DL	J	De	....[75]	NAv/NAv	NAv	NAv	NAv	
32		N	....	....	....	....	....	....	....	3.5	2	2	GE	79	2	AdI,CuN	IR	NAv	De	....[75]	NAv/NAv	GE	GE	N	
33		2	413	D	ZU	M	2	2250	NAv	2	6	2	GE	148	1	AdI	DL	Ro	De	De	LAW/LAW	NAv	NAv	No	
34		N	....	....	....	....	....	....	....	1.5	3	2	WE	103	1	CuN	WE	Ro	De	....[27]	NAv/NAv	BM	BM	DP	
35		N	....	....	....	....	....	....	....	NAv	1	1	WE[7]	98	2	AdI	WE	J	De	N	IN/N	WE	WE	N	
36		N	....	....	....	....	....	....	....	2.3	6	2	WE	143	2	SSt	WE	J	De,RO[62]	N[21,37]	PM/N	LN	LN	NAv	
37		N	....	....	....	....	....	....	....	1	8	2	WE	96	2	Ad	IR	Ro	De	De[21]	NAv/NAv	NAv	NAv	NAv	
38		2	....[61]	V	AS	M	2	2000	GE	1.5	6	2	GE	80	2	CuN	DL	J	De	....[37]	IW/NAv	BM	BM	N	
39		N	....	....	....	....	....	....	....	2	6	2	GE	60	1	SSt,AdI	MS	Ro	So,Eva	N	IW,STW/N	FO	F	N	
	MUNICIPAL AND COOPERATIVE INSTALLATIONS																								
40		2	1026	D	ZU	M	2	6000	AC	1.5	7	2	BB	160	1	SSt	MS	Ro	De	NAv	LAW/....	NAv	NAv	N	
41		N	....	....	....	....	....	....	....	2.5	7	2	WE	170	1	AdI	NAv	Ro	De	....[37]	IN/NAv	NAv	NAv	NAv	
42		2	NAv	S	NAv	M	2	2500	NAv	2.5	7	2	GE	165	2	SSt,CuN	WE	Ro	De	De	NAv/NAv	NAv	NAv	N	
43		N	....	....	....	....	....	....	....	3.5	6	2	WE	80	1	SSt,AdI	NAv	Ro	De	NAv	NAv	NAv	NAv	N	
44		N	....	....	....	....	....	....	....	2	2	2	GE	68	2	SSt	IR	Ro,J	De	NAv	NAv/NAv	NAv	NAv	N	
45		1	1012	D	NAv	M	2	[52]	NAv	2.5	6	2	GE	60	2	Ad	SWE	J	De	NAv	HT/....	NAv	NAv	DP	
46		N	....	....	....	....	....	....	....	3.5	5	2	GE[7]	55	2	SSt	SWE	Ro	De	N	CUL/....	BM	BM	N	
47		N	....	....	....	....	....	....	....	2	3	1	GE[7]	50	2	SSt,Ad	DL	Ro	De	De	CUL/....	BM	BM	N	
48		N	....	....	....	....	....	....	....	2.5	5	1	GE[7]	31	1	CuN	MS	Ro	De	....[75]	NAv/NAv	NAv	NAv	N	

MANUFACTURERS

AC - Allis-Chalmers Manufacturing Co
ACP - Allis Chalmers Power Systems, Inc
APC - The Air Preheater Co, Inc
AS - American Standard, Inc
BB - Brown Boveri Corp
BF - Buffalo Forge Co
BJ - Byron-Jackson Pumps, Div Borg-Warner Corp
BLH - Baldwin-Hamilton Co
BM - Bailey Meter Co
BPC - Bingham Pump Co
BRP - Bruce Peebles & Co, Ltd
BU - Buell Engineering Co, Inc
BW - Babcock & Wilcox Co
BWL - Babcock & Wilcox Ltd
CAP - C A Parsons, Ltd
CE - Combustion Engineering, Inc
CES - Combustion Engrg Superheater Co, Ltd
CHH - Chicago Heater Co
CIR - Canadian Ingersoll-Rand Co Ltd
COC - Cochrane Div, Crane Co
CRL - Croll-Reynolds Engineering Co, Inc
CUL - Culligan Industrial Systems Div, Culligan USA
CV - Copes-Vulcan, Inc
DL - DeLaval Turbine Inc
DP - Diamond Power Specialty Corp
EAI - Electronics Associates, Inc
EE - English Electric Co Ltd
EL - Ecodyne Ltd
EM - Electric Machinery Manufacturing Co
F - The Foxboro Co
FIS - Fischer & Porter Co
FO - Forney Engineering Co
FW - Foster Wheeler Corp
GDI - Gulf Degremont, Inc
GE - General Electric Co
GF - The Green Fuel Economizer Co
GW - The Graver Water Conditioning Co
HAP - James Howden & Parsons of Canada Ltd
HCC - Computer and Instrumentation Div, Westinghouse Electric Corp
HOW - Howell Instruments, Inc
HT - Hungerford & Terry, Inc
IBM - International Business Machines Corp
IN - Infilco Products Co
IR - Ingersoll-Rand Co
IW - Illinois Water Treatment Co
JOY - Joy Manufacturing Co
KKK - Kuhnle, Kopp & Kausch AG
LA - The Louis Allis Co, Inc
LAW - LA/Water Treatment Div, Chromalloy American Co
LN - Leeds & Northrup Co
LOD - Lodge-Cottrell Ltd
MLW - MLW-Worthington Ltd
MR - Milton Roy Co
MS - Maryland Shipbuilding & Drydock Co
NOV - Novenco Inc
PEC - Peabody Engineering Corp
PM - The Permutit Co
PP - Pacific Pumps Div, Dresser Industries Inc
RA - Raymond Div, Combustion Engineering, Inc
RS - Riley Stoker Corp
SIE - Siemens AG
STW - Struthers-Wells Corp
SWE - Southwestern Engineering Co
WE - Westinghouse Electric Corp
WM - The Whitlock Manufacturing Co
WO - Worthington Corp
YU - Yuba Heat Transfer Corp
ZU - Air Systems Div, Zurn Industries, Inc

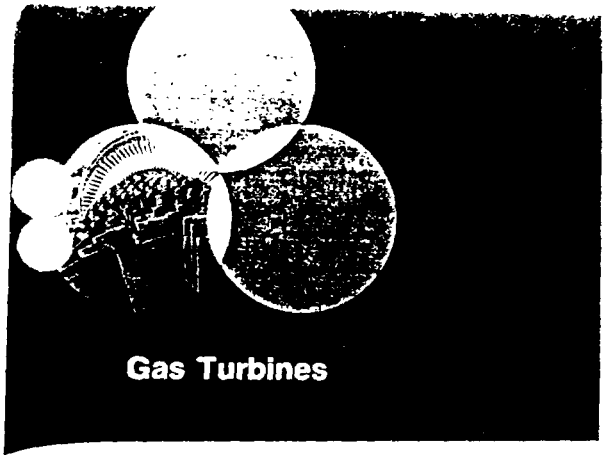
SYMBOLS

ABr - Aluminum bronze
Ad - Admiralty brass
AdI - Admiralty, inhibited
AlB - Aluminum brass
AnC - Analog computer
Att - Attemperator
BA - Bladed airfoil
Bal - Balanced
BC - Backward-curved blades
BD - Balanced draft
C - Coal, bituminous
Cir - Circular
Cr - Crude oil
CuN - Copper/nickel
Cy - Cyclone
D - Damper
DB - Dry bottom
De - Demineralization
DiC - Digital computer
DsO - Distillate oil
EA - Excess air
Eva - Evaporator
Fs - Fuel in storage
Fub - Fuel at burner
G - Gas
GR - Flue-gas recirculation
Gt - Gas tempering
H2 - Hydrogen
H2O - Water
HF - Horizontal flare burner
HI - Horizontal intervane burner
Hyb - Hybrid
HyC - Hydraulic coupling
J - Steam jet ejector
L - Lignite
M - Motor
MAn - Monitoring and analysis
MAP - Monitoring, analysis and partial control
MgO - Magnesium oxide

	BOILER FEED PUMPS									FEEDWATER HEATERS				FUEL AND EXHAUST								
							Drive							Fuel						Sootblower		
Application	Number per boiler	Capacity of each, gpm	Discharge pressure, psig	Manufacturer	Flow control	Type	Hp (each)	Manufacturer	Number of heater trains	Number of closed heaters per train	Final feedwater temp, F	Manufacturers	Type	Calorific value, 1000 Btu/lb or Btu/cu ft	Design heat rate, Btu/kWh	Maximum sulfur content, %	Combustion additive	Additive introduction	Working fluid	Manufacturer	PROJECT
MAn	2	7900	4696	IR	S	T	27,500	DL	2/	3/	546	YU	C	11.9	8460	4.3	No		Air	CV	1
MAn		13,400	3256	IR	HyC	MtS	24,600		2/	2/	475	YU	Cr	145	8065	1	Yes	NAv	Air	DP	2
MAn		13,400	3256	IR	HyC	MtS	24,600		2/	2,3/	475	YU	Cr	145	NAv	1	Yes	NAv	Air	NAv	3
MAn	2	7950	3110	IR	S	T	15,700	WE	2	2/	509	SWE	DsO,RsO,G		8075		No		St	CV	4
MAn	2	NAv	3530	BJ	S	T	17,500	GE	2/	3/	479	CHH,YU	C	9.7,12.5	8032	NAv	No		St	DP	5
MAn	1	12,550	4570	DL	S	T	34,800	DL	2/	2/4	548	WO	C	12	7482	1.5	No		St	DP	6
	2	6260	4985	IR	S	T	21,500	GE	2/	2/5	519	FW	C	12.5	8676	3.5	No		Air	DP	7
MAn	1	6700	3427	NAv	S	T	13,577	NAv	2	3/5	517	NAv	C	12	9100	2.5	No		Air	DP	8
MAn	1	11,550	2330	PP	S	T	17,025	WE	1	0/2	362	STW	Cr	19.4	10,400	0.1	No		Air	DP	9
MAP	2	NAv	NAv	DL	S	T	13,000	GE	1	2/4	487	FW,YU		8.3	8082	1.2	No		St	CV	10
MAP	2	4500	3579	PP	S	T	13,500	GE	2	2/4	474	YU	C	10.8	NAv	3	No		St	DP	11
	2	5550	3600	BJ	S	T	8930	GE	1	0/2	318	WE	RsO	18	8950	0.5	MgO	Fub	St	CV	12
	1	10,300	4520	DL	S	T	NAv	WE	NAv	NAv	504	SWE	RsO,G	NAv	9300	0.7	Yes	Fub	St	DP	13
Mon	1	9700	4375	DL	S	T	31,500	DE	1	2/5	501	SWE	L	6.8	9900	0.6	No		Air	CV	14
Mon	2	4700	3135	IR	S	T	11,429	GE	1/2	2/4	481	YU	C	8.4	9300	0.6	No		St	CV	15
MAn	2	4340	2926	PP	S	T	9500	GE	1	2/4	493	YU	C	9.2	9900	0.7	No		St	CV	16
MAn	2	4075	4565	BJ	S	T	11,950	DL	1	2/5	488	WE	C,G	11.4,1035	NAv	3.1	No		Air	CV	17
MAn	1	6740	7200	CIR	S	T	16,200	GE			487	MLW,CHH,FW	RsO	18.3	9161	NAv	NAv		St	DP	18
	2	4800	3050	BJ	S	T	9900	WE	2/	4/4	481	BLH	C	12	9375	4	No		St	DP	19
MAP	1	8034	2743	CIP	S	T	16,800	GE			485	FW	C	12.3		3.5	No		St	CV	20
MAn	2	4500	3200	DL	Reg	MtS,T	10,000	GE	1	2/5	470	YU,BLH,CHH	RsO	17.7	7728	2.9	No	NAv	St	CV	21
MAn	1	6790	7837	PP	S	T	17,474	GE	1	3/3	492	CHH,STW	RsO	18	9300	NAv	Yes	Fub	St	CV	22
MAn	1	9000	3200	DL	S	T	15,700	GE	1	2/5	489	YU,BLH,CHH	Cr	17.7	7793	2.9	No		St	CV	23
MAn	2	3820	2310	DL	S	T	7500	GE	1	2/4	485	YU	C	12.2	NAv	0.5	N		St	CV	24
MAn	1	7320	2996	DL	S	T	13,838	GE	1	2/4	460	YU	NAv	NAv	9550	NAv	NAv		NAv		25
	1	7600	2950	DL	S	T	14,200	WE	1	2/5	478	SWE,CHH		19.5	7924	0.5	NAv		Air	DP	26
MAP	1	6360	2250	DL	S	T	11,000	DL	1	0/2	353	YU	RsO,Cr	19,19.5	8750	0.3	MgO	Fub	St	CV	27
	1	6290	3100	IR	HyC	MtS	12,000	NAv	1	2/5	NAv	WE	RsO	18.3	9079	NAv	Yes		Air	CV	28
	1	7300	3007	NAv	Reg	T	14,686	NAv	1	3/5	530	WE	C	10.7	9175	2.3	No		Air	DP	29
MAP	2	3000	2446	DL	HyC	M	6000	GE	NAv	NAv	NAv	NAv	C	9.7	NAv	1.2	No		Air	DP	30
MAn	2	3192	6882	PP	S	T	7000	GE	1	1/4	487	STW	C	8.8	8032	1	No		St	CV	31
	2	1430	1800	IR	Reg	M	2000	GE	1	0/1	267	WM	DsO,RsO,Cr	Var	8870	0.3	No		St	CV	32
	2	2375	3375	AC	Reg	M	5500	AC	1	2/3	482	YU	C	11.5	9337	1.4	No		St	DP	33
	2	2650	2300	PP	Reg	M	5000	GE	1	0/2	359	WE,CHH	RsO,G	18.8,1080	10,000	0.5	No		St	DP	34
AP	1	1095	1480	BPC	Reg	M	1250	WE	1	N/2	250	COC	G	1050	9140	N	N		N		35
MAP	2	3090	2089	WO	HyC	M	4500	GE	1	2/3	472	YU	G	1000	9940	N	No		N		36
	2	1570	2899	PP	HyC	M	3500	AC	1	2/3	475	YU	DsO	19.5	9500	0.3	No		N		37
	2	1750	2400	DL	Reg	M	3000	WE	1	3/2	476	STW,CHH	RsO,Cr	19,19.3	7976	1	MgO	Fub	St	DP	38
	2	1335	2403	AC	HyC	M	2500	AC	2	3/2	464	STW,LAW	G	1096	8155	0	No		N		39
Mon	2	3542	3200	DL	S	T	7060	DL	2	3/3	467	SWE	L	7	10,890	0.8	No		St	DP	40
MAP	1	7590	2950	NAv	S	T	14,600	WE	1	2/4	485	NAv	DsO,G		9474	0.145	No		NAv	NAv	41
	2	NAv	NAv	BJ		T	7000	GE	NAv	NAv/NAv	NAv	NAv	C	11.0	7971	3.5	No		Air	DP	42
	2	1800	2300	NAv	HyC	M	3500	NAv	1	2/3	466	NAv	DsO,RsO,G		9850	NAv	Yes	Fub	St	DP	43
	2	1300	5195	IR	Reg	M	2250	NAv	1	N/2	220	NAv	RsO	18.5		1	NAv		St	DP	44
	2	1530	2500	BJ	Reg	M	3000	GE	1	2/2	380	SWE	C,G	10.3,1000	9500	1	No		St	DP	45
	2	890	1500	PP	Reg	M	1250	WE	1	2/2	443	YU	G	1000	NAv	N	No		N		46
	2	800	2100	AC	Reg	M	1250	AC	1	2/1	468	SWE	G	1075	9205	N	No		NAv	APC	47
	2	NAv	NAv	NAv	NAv	M	NAv	NAv	1	2/2	439	NAv	DsO,G		10,800	0.8	Yes	Fs	St	DP	48

- ring only
- turbine shaft
- ilable
- il burner
- ed ion exchange
- ized
- ator
- y pump or blower
- osmosis
- ocating pump
- ual oil
- ed control
- ts filters
- ser
- less steel
- ap
- ine
- tangential burners
- ontrol
- ay

- test of footnotes
- -cycle plant; 20 MW is generated
- turbine that will burn DsO at startup and washed RsO during normal operation. For data on the combustion turbine, see page S•12
- 51 - *Standby unit*
- 52 - One motor rated 1250 hp, one 900 hp
- 53 - DsO, 18,984 Btu/lb; G, 1068 Btu/cu ft
- 54 - *Primary steam source*, main-turbine bleed; secondary steam source, main steam and auxiliary boiler
- 55 - *Coal is transported via* five unit trains, comprised of 600 cars and 22 locomotives
- 56 - Total output from two boilers supplying *steam to one turbine/generator*. Other btr data pertain to individual units
- 57 - At 86.6% efficiency
- 58 - *Data are for each of two* 50%-capacity feedpumps. Primary steam source, intermediate-turbine exhaust; secondary *steam source, main steam or auxiliary* boiler. A motor-driven feedpump is provided for startup service
- 59 - *Sub-bituminous coal*
- 60 - One rated 219,500 cfm; one, 162,500
- 61 - One rated 345,000 cfm; one, 262,000
- 62 - *Sewage effluent is* treated for btr makeup
- 63 - Combined-cycle plant; 135 MW is generated by two gas turbines. For data on combustion turbines, see page S•12
- 64 - Based on oil firing
- 65 - Data are for each of four boilers
- 66 - Data are for each of two boilers
- 67 - *Data are for the main* feedpump. Standby pump, manufactured by DL, is rated 3660 gpm at 3001 psig. It is driven by *an 8000-hp motor manufactured* by GE
- 68 - Primary steam source, cold reheat; secondary steam source, main steam
- 69 - *First reheat*, 1025 F; *second* reheat, 1050 F
- 70 - First reheaters,124,000 sq ft; second reheater, 167,000 *sq ft*
- 71 - All tandem-compound, indoor units unless otherwise specified
- 72 - Data are for the *main feedpumps*. A 2800-rpm motor-driven pump is available for startup service
- 73 - Data are for the *main feedpump*. A startup pump, rated at 40% of full capacity, also is installed
- 74 - Compartmented *nozzle*
- 75 - pH control: phosphate injection
- 76 - Primary steam source, main steam; secondary *steam source*, auxiliary btr
- 77 - Data are for the main feedpumps. Standby pump, manufactured by BJ, is rated 3060 gpm at 4573 psig. It is driven by a 12,146-hp motor
- 78 - Steam source: cold reheat only
- 79 - One motor rated 6000 hp, one 1250 hp
- 80 - *Data are for the main feedpump*. Standby pump, manufactured by DL, is rated 4500 gpm. It is driven by a *10,000-hp motor*
- 81 - Data are for the main feedpump. Startup pump, manufactured by DL, is *rated 3180 gpm at 2620 psig. It is* driven by a 5550-hp motor manufactured by AC
- 82 - *Steam-coil air heater*
- 83 - Primary steam source, main-turbine bleed; secondary steam source, *auxiliary boiler*
- 84 - Data are for the main feedpump. Startup pump, manufactured by IR, is *rated 1790 gpm at 2000 psig. Regulator* controls flow; separate 2000-hp turbine is the prime mover
- 85 - *In fuel line*
- 86 - Data are for the main feedpump. Startup pump is rated 3550 gpm *at 2748 psig. It is driven by a* 6000-hp motor
- 87 - Flash evaporation



Company	No. of units	Total power, MW	Mfr	Startup
Pub Service of Oklahoma	1	240	WE	73
Pub Service Elec & Gas Co	1	140	TP	73
Jersey Central Pwr & Light	1	325	GE	74
Ohio Edison Co	1	240	GE	74
Duquesne Light Co	1	270	GE	74
Houston Lighting & Pwr	2	600	GE	74
Louisiana Pwr & Light Co	1	200	GE	74
Pennsylvania Electric Co	1	250	...	74
El Paso Electric Co	1	240	WE	75
So California Edison Co	2	520	WE	75
Central Vermont Pub Service Co	1	275	WE	77

Gas-turbine sales still climbing

Recent surge in combined-cycle orders indicates these units will prove stiff competition for peaking/cycling boilers

By Robert G Schwieger, Associate Editor

The gas-turbine market is stronger than ever and appears to be growing, despite predictions of a few reputable sources that sales would taper off by 1972 and average approximately 2500-3500 MW/yr until about 1980. In fact, about 00 MW of gas-turbine generating sets ere sold in the first half of 1972 alone p S.12-S.15).

Several years ago, some experts picked the early 1970s as the time for gas-turbine sales to peak. They felt that orders were being placed by utilities solely to fill the generation gap created when nuclear central-station licensing and environmental problems delayed the startup of these plants. However, it now appears many utilities recognize that gas turbines should not be considered merely as a stop-gap measure, but rather as an important part of their system's generation mix. Evidence: orders received by a few manufacturers for open-cycle units with startup dates in 1975 and beyond, and the popularity of preengineered combined-cycle plants (table, above).

At least one manufacturer predicts orders will continue at the current rate of about 6000-7000 MW/yr for another year or two. This period should be followed by a slight dip in sales, assuming large nuclear units come on-line in significant numbers. But then, after utilities have had sufficient time to reassess their generation mix and future requirements, orders are expected to increase and probably exceed levels attained in the early 1970s.

Combined-cycle orders have come on strong after about a six-month lull that followed the first orders announced last year (POWER, October 1971, pp 105-109). Manufacturers are encouraged that these plants will play a major role in midrange generation. Even utilities that do not have gas turbines in their systems are showing considerable interest. Remember that combined cycles were difficult to promote in the early days because the preengineered concept was relatively new, and because some utilities were dissatisfied with the reliability of gas turbines in peaking service.

Several reasons exist for the surge in utility interest:

- High availability of gas turbines can be achieved when these units are operated at relatively constant load for extended periods and when they are maintained in accordance with manufacturers' instructions. Example: the outstanding performance of equipment in pipeline service.
- Some old fossil-fired central stations are not operating as well as expected in cycling service.
- In some cases, it is more economical to order a combined-cycle plant than to invest capital in pollution-control equipment for an older station that might not withstand the rigors of cycling operation.
- There is little operating data to support vendor claims of high reliability for boilers and turbines designed specifically for peaking/cycling service.
- Environmental impact of combined-cycle systems should be less than that of peaking/cycling units because of reduced cooling-water requirements and the utilization of higher quality fuels.
- Construction costs of combined-cycle plants are relatively low because most components are assembled at the factory and shipped in modules to the plant site.

Reducing NO_x from gas turbines

Perhaps one of the biggest problems facing vendors of preengineered combined-cycle systems is the reduction of nitrogen oxides (NO_x) from gas turbines. Although the most strigent NO_x laws in force today can be met by injecting demineralized water into the combustion chamber, this method is expensive. Most gas-turbine manufacturers feel they will be able to offer a combustor that will minimize NO_x without water injection shortly after Environmental Protection Agency determines an acceptable procedure for calculating emissions (POWER, Sept 1972, p 84).

Regarding the survey pages, note that no orders were received by the following companies during the survey period, June 1, 1971 to May 31, 1972: Tokyo Shibaura Electric Co, Ltd–Toshiba (Japan), Siemens AG (Germany), Franco Tosi, SpA (Italy), Société Anonyme Cockerill-Ougree-Providence (Belgium) and Ateliers de Constructions Electriques de Charleroi (Belgium).

Free-world manufacturers of gas turbines for utility and industrial service (larger than 1000 hp) that did not respond to the POWER survey: Auto Diesels Braby Ltd (Great Britain), Dresser Industries, Inc (U S), Gutehoffhungshuette Sterkrade AG (West Germany) and NV Motorenfabnek Thomassen (Netherlands).

PROJECT	COMPANY	EQUIPMENT LOCATION	Manufacturer	Model	Units ordered, 6/1/71-5/31/72	Primary application	Black plant installation?	Method of remote operation	RATING AND CONDITIONS									
									Normal power, MW	Normal power, 1000 hp	Standard elevation, ft	Ambient temp, F	Maximum power, MW	Maximum power, 1000 hp	Ambient temp for max power at std elevation, F	Minutes to reach normal power: Normal startup	Fast startup	Emergency startup
1	Georgia Power Co	GA[1]	WE	W-501	6[25]	PP	No	Dw,Spv	64.4	....	0	59	69	..	59	30	20	10
2	Northern States Power Co	Blue Lake, MN	TD	Mega-Pak[31]	4	PP	No	Dw	48.4	....	1000	80	....	....	....	20	13	....
3	Jersey Central Power & Light Co	Holland Twp, NJ	GE	MS 7001	4[27]	BI	No	Dw	44.2	....	300	80	....	....	....	20	..	12
4	Wisconsin Public Service Corp	West Marinette, WI	TP	Twin-Pac[19]	1[25]	PP	Yes	Dw,Spv	...[21]	....[21]	....[21]	...[21]	....[21]	....[21]	....[21]	8	3	....
5	City of Cape Town	Cape Town, South Africa	CW	Mod Pod-40	1[26]	PP	Yes	Dw	40	....	1000	80	....	....	....	3	2	....
6	Florida Power & Light Co	Ft. Lauderdale, FL	TD	ER-224	12[49]	PP	Yes	Dw	38.0	....	1000	80	42.7	....	80	5	3	3
7	Vineland Electric Utility	Vineland, NJ	WE	W-251	1[48]	PP	Yes	Dw,Spv	31.1	..	0	59	33.6	....	59	20	10	5
8	Consolidated Edison Co of NY, Inc	New York, NY	GE	MS 5001	16[45]	PP	Yes	Spv	20.1	....	0	35	21.8	....	35	10	....	5
9	U.S. Navy Propulsion Test Center	Trenton, NJ	TP	FT4A-11LF	1	MD	No	Dw	....	27.4	0	90	....	30.6	90	....	....	....
10	Freeport Electric Dept	Freeport, NY	CW	Mod Pod-20	....	PP	Yes	Dw	20	....	1000	80	....	....	....	3	2	....
11	U.S. Air Force	GU1	TP	Power Pac[17]	1[18]	PP	Yes	Dw,Spv	...[12]	....[12]	....[12]	....[12]	....[12]	....[12]	....[12]	8	3	....
12	Golden Valley Electric Assn, Inc	Fairbanks, AK	GE	MS-5001	1[46]	PP	No	Dw	17.5	....	1000	80	....	....	....	8	..	....
13	Arabian American Oil Co	Uthmaniyah, Saudi Arabia	GE	MS-5002	2[44]	MD	No	Dw	....	20.3	0	120	....	....	....	10	....	....
14	Wolverine Electric Corp, Inc	Hersey, MI	CBC	Coberra 125[43]	2	PP	Yes	..	11.0	..	1000	80	12.5	....	80	8	6	3.5
15	Franklin Municipal Plant	Franklin, LA	TD	EA-113	1	PP	Yes	N	10.2	....	0	95	....	....	....	7	3	3
16	Michigan Wisconsin Pipe Line Co	Gulf of Mexico	GE	MS-3002	2[42]	Gh	No	Spv	....	13.1	1000	80	....	....	....	10	....	....
17	Union Oil Co of Canada Ltd	Lobo, Ont., Canada	CBC	Coberra 125	5[41]	Gh	No	Dw	....	12.5	1000	30	....	....	....	....	....	....
18	Kloeckner Humboldt-Deutz AG	West Germany[1]	AV	TF 35	4	PP	Yes	N[33]	3.5	....	0	80	4.2	....	80	1	1	1
19	Oasis Pipeline Co	TX[1]	IR	GT-40	1[32]	Gh	Yes	Spv	....	4	0	59	....	5.5	60	4	4	4
20	Tennessee Gas Pipeline Co	Paris, IL	ALN	501-K13[11]	2[11]	Gh	Yes	Dw	....	3.6	0	60	....	....	....	1	....	....
21	Amoseas Inc	Libya[1]	SO	CS3000	8[34]	Gh	Yes	..	....	3.5	0	59	....	....	....	1	....	....
22	Amoco International, Ltd	Gulf of Suez	SO	MO3000	8[36]	MD	Yes	Dw	....	3.5	0	59	....	....	....	1	....	....
23	Alberta Government Telephone Commn	Calgary, Alta., Canada	SO	GSE3000	2[37]	SP	Yes	Dw	2.5	....	....	....	....	....	....	1	....	....
24	Abu Dhabi Petroleum Co, Ltd	Persian Gulf	SO	GSC3000	3	BI	Yes	..	2.4	....	0	59	....	....	....	1	....	....
25	Petroleos Mexicanos	Mexico[1]	CBC	Coberra 30	5	Gh	No	Spv	....	3	1000	80	....	4	30	....	....	....
26	National Iranian Oil Co	Iran[1]	AV	TF 25	3	Pd	Yes	N	....	2	0	80	..	2.8	80	1	1	1
27	Combined Constructors Co	White Plains, NY	NAT	Viking-SBG	5[40]	PP	Yes	N	1.2	....	0	59	....	....	....	1	....	....
28	Chicago Metropolitan Sewage District	Chicago, IL	NAT	Viking-CO	1	TE	No	N	....	1.75	0	59	....	....	....	1	....	....
29	IIAPCO[2]	Indonesia[1]	NAT	Viking-COG/T	8	TE	Yes	Dw	1.0	....	0	59	....	....	....	1	....	....
30	Abu Dhabi Petroleum Co Ltd	Persian Gulf	NAT	Viking-COG	3	BI	No	Dw	1	....	0	59	....	....	....	1	....	....
31	Dowell Div, Dow Chemical Co	Mobile, AL	SO	IPP1000	10	MD	....	Dw	....	1.2	....	....	....	....	....	1	....	....
32	Chevron Oil Co	Ft. Saskatchewan, Alta., Can.	SO	MO1000	5[50]	MD	....	Dw	....	1.2	0	59	....	....	....	1	....	....
33	Amoseas Inc	Libya[1]	SO	CS1200	10[53]	Gh	Yes	..	....	1.2	0	59	....	....	....	1	....	....
34	City of Andover	Andover, MA	SO	GSE1000	1[52]	SP	Yes	Dw	0.9	....	0	59	....	....	....	1	....	....
35	Pacific Telephone & Telegraph Co	[1]	SO	KS1000	8[54]	SP	Yes	....	0.8	....	0	59	....	....	....	1	....	....
36	Amoco Canada Petroleum Co	Ft. St. John, Alta., Canada	SO	GSC1000	2[55]	TE	Yes	Dw	0.8	....	0	59	....	....	....	1	....	....

MANUFACTURERS

- AKT - AEG-Kanis Turbinenfabrik GmbH
- ALN - Detroit Diesel Allison Div, General Motors Corp
- ALS - Societe Generale de Constructions Electriques et Mecaniques (ALSTHOM)
- AV - Lycoming Div, Avco Corp
- BBS - Brown Boveri-Sulzer Turbomachinery Ltd
- CBC - Cooper-Bessemer Co
- CW - Curtiss-Wright Corp
- FIA - Fiat SpA, Divisione Mare
- GEG - GEC Gas Turbines Ltd
- GE - General Electric Co
- HIT - Hitachi, Ltd
- HS - Hispano-Suiza, Division de la SNECMA
- IR - Ingersoll-Rand Co
- JBE - John Brown Engineering Ltd
- KWU - Kraftwerk Union AG
- KV - A/S Kongsberg Vapenfabrikk
- MHI - Mitsubishi Heavy Industries, Ltd
- NAT - North American Turbine Corp
- NP - Nuovo Pignone SpA
- ORE - Orenda Ltd
- PW - Pratt and Whitney Aircraft Div, United Aircraft Corp
- RR - Rolls-Royce Ltd
- RUS - Ruston Gas Turbines Ltd
- SO - Solar Div of International Harvester Co
- STA - Stal-Laval Turbin AB
- TD - Turbodyne Corp
- TP - Turbo Power and Marine Systems, Inc
- WE - Westinghouse Electric Corp
- WKR - Werkspoor-Amsterdam NV

SYMBOLS

- Ac - Annular combustor
- Acc - Accelerometer
- Bc - Bearing cap
- Bl - Base load
- BpT - Blade-path temperature
- CaC - Canannular combustor
- Cdp - Compressor discharge pressure
- Cmb - Combination, combined cycle
- CrO - Crude oil
- Cv - Compressor bleed valves
- DF - Dual fuel
- DsO - Distillate oil
- Dw - Direct wire
- E - Electronic
- Ec - Engine case
- EH - Electrohydraulic
- EM - Electromagnetic
- EP - Electropneumatic
- G - Natural gas
- Gh - Gas handling
- HoC - Horizontal combustor
- Hy - Hydraulic
- ISi - Inlet silencer
- Itg - Integrated
- K - Kerosene jet A
- MD - Mechanical drive
- N - None
- NAp - Not applicable
- OpC - Open cycle
- Pd - Pump drive
- PP - Peaking power and standby
- ReC - Recovery cycle with exhaust to boiler
- Reg - Regenerative cycle
- Rel - Relative motion between bearing cap and shaft
- RsO - Residual oil
- Ry - Relay
- Sep - Separate
- Sk - Stack (manifold)
- Sol - Solid state
- SP - Standby power only
- SpT - Speed/time
- Spv - Supervisory (telemetry)
- Ts - Turbine exhaust (blade path)
- TE - Total energy
- Ti - Turbine inlet
- Ts - True shaft
- TwS - Twin spool
- VeC - Vertical combustor
- Vig - Variable inlet guide vanes

FOOTNOTES

1 - Various locations
2 - Independent Indonesian American Petroleum Co
3 - Exact location not available
4 - Manufactured in Mannheim, West Germany
5 - Iranian Electric Power Generation & Transmission Co
6 - Undisclosed
7 - Ratio of absolute compressor-discharge pressure to absolute compressor-inlet pressure
8 - In some gas-turbine packages, turbine driving the external load — compressor, pump or generator, for example — is mounted on a shaft separate from the gas-generator's compressor and turbine shaft. This machine is called the free (or power) turbine. Packages without a free turbine develop power for external load and gas-generator compressor with the turbine described under the "Gas generator"
9 - Also exhaust silencer and soundproof building
10 - Also exhaust silencer
11 - ALN offers five versions of its 501 engine: 501-K5, 501-K13 and 501-K16A burn natural gas, 5 501-K16A burn liquid fuel. K5 and K14, similar in performance, have base-load ratings of 3140 the following conditions: ambient temperature, 60 F; elevation, sea level; turbine-inlet tempera turbine speed, 13,820 rpm. K13 and K15, also similar in performance (detail in tabulation), ha first-stage blades and vanes to permit higher gas temperatures at turbine inlet. Hence, power ou about 15% over the K5 and K14 models. K16A performance is comparable to the K13 except which offers additional speed flexibility. Other units sold during 6/1/71-5/31/72 survey period Potomac Telephone Co, Baltimore, MD (2 units, K14), generator drives; Trunkline Gas Co, Co (1, K13) and Longville, LA (1, K13), compressor drives; Pacific Telephone & Telegraph Co, Lo (2, K15), San Francisco, CA (1, K15) and Oakland, CA (1, K15), generator drives; New York T New York, NY (2, K15), generator drives; Warren Petroleum Co, Cameron, LA (1, K13), comp Northern Natural Gas Co, Hugo, MN (1, K13), compressor drive; Kansas-Nebraska Natural Gas Lakin, KS (1, K13) and Scott City, KS (1, K13), generator drives; Coastal States Gas Producing

GAS GENERATOR						FREE TURBINE				COM BUSTORS		FUEL				INSTRUMENTATION AND CONTROL										
Manufacturer	Number of shafts per generator	Number of compressor stages	Number of turbine stages	Turbine speed, rpm	Number of shafts	Number of rotors	Number of stages per rotor	Number	Type	Type	Switch fuel automatically under load?	Type of soundproofing	Speed of driven equipment, rpm	Type of control system logic/analog	Method of measuring turbine speed	Location of cycle temperature monitor	Setpoint power control?	Method of controlling turbine surge	Method of controlling turbine acceleration	Method of measuring turbine vibration	Exhaust temperature control?	Turbine and generator controls	PROJECT
WE	1	17	4	3600	N	N	N	16	Ac	[23]	Yes	ISi[9]	3600	Sol/EP	[24]	BpT,Sk	Yes	Cv	SpT	Bc	Yes	Itg	1
TO	1	17	5	3600	N	N	N	1	VeC	DsO	Yes	ISi[9]	3600										2
GE	1	17	3	3600	N	N	N	10	CaC	DsO,CrO	Yes	ISi[10]	3600	Sol/EH	[29]	Te	Yes	Vig	BpT[30]	Rel	Yes	Itg	3
TP	2	7/[13,14]	1/2[13]	[22]	1	1	2	8	CaC	G,DsO	Yes	ISi[9]	3600	Ry/[16]	EM	Ti	Yes	Cv	SpT	Ec	Yes	Itg	4
RR	2	7/5[13]	1/1[13]		1	1	2	8	Ac	DsO	Yes	ISi[9]	3000	Ry/EH	E	Ti		Cv	SpT	...	No	Itg	5
PW	2	7/8[13]	1/2[13]	8800/6500[13]	1	1	2	8	CaC	DF	Yes	ISi[9]	3600	Ry/E		[35]	Ti,Te	Yes	TwS	SpT	Bc	Yes	Itg	6
WE	1	16	3	4894	N	N	N	8	Ac	[23]	Yes	ISi[9]	3600	Sol/EP		[24]	Te/Sk	Yes	Cv	SpT	Ref	Yes	Itg	7
GE	1	17	2	5100	N	N	N	10	CaC	DsO	No	ISi[10]	3600	Sol/EH		[35]	Sk	Yes	N	SpT	Bc	Yes	Itg	8
TP	2	7/8[13]	1/2[13]	8600/6350[13]	1	1	2	8	CaC	K	No	ISi[9]	3600	Ry/EH	EM	Ti	N	Cv	SpT	Ec	Yes	NAp	9
RR	2	7/5[13]	1/1[13]		1	1	2	8	Ac	DsO	Yes	ISi[9]	3600	Ry/EH	E	Ti		Cv	SpT	....	No	Itg	10
TP	2	7/[13,14]	1/2[13]	[15]	1	1	2	8	CaC	G,DsO,K	Yes	ISi[9]	3600	Ry/[16]	EM	Ti	Yes	Cv	SpT	Ec	Yes	Itg	11
GE	1	16	2	5100	N	N	N	10	CaC	G	No	ISi[9]	3600	Sol/EH	EM	Sk	Yes	N	SpT	Bc	Yes	Itg	12
GE	1	15	1	5100	1	1	1	12	CaC	DF	Yes	ISi[9]	4670	Sol/EH	EM	Sk	Yes	N	SpT	Bc	Yes	NAp	13
RR	1	17	2	7650	1	1	1	8	CaC	DF	No	ISi[9]	3600	Ry,Sol/E	E	Te	Yes	Cv,Vig	SpT	Rel	No	Itg	14
PW	2	7/8[13]	1/2[13]	8600/6350[13]	1	1	1	8	CaC	DsO	No	ISi[9]	3600	Ry/E		[35]	Ti,Te	Yes	TwS	SpT	Bc	Yes	Itg	15
GE	1	15	1	6900	1	1	1	6	CaC	G	No	ISi[9]	6500	Sol/EH	EM	Sk	Yes	N	SpT	Bc	Yes	NAp	16
RR	1	17	3	7500	1	1	2	8	CaC	G	No	ISi[9]	5000	Ry/E	E	Te	Yes	Cv,Vig	SpT	Rel	No	NAp	17
AV	1	8	2	18,000	1	1	2	1	Ac	DsO	No	ISi	1500	Ry,Sol/E	E		Yes	Cv	SpT	....	Yes	Itg	18
ALN	1	14	2	13,800	1	1	2	6	CaC	DF	Yes	ISi[10]	13,800	Sol/EP	EM	Ti	Yes	Cv	SpT	Rel	Yes	NAp	19
ALN	1	14	4	13,820	N	N	N	6	CaC	G	No	ISi[10]	1200	Ry/E		Ti	Yes	Cv	BpT	Acc	No	NAp	20
SO	1	11	2	14,300	1	1	1	1	Ac	G	No	....	14,300	Ry,Sol/....	....[35]	Ti,Sk	Yes	Vig	....	Ts	Yes	NAp	21
SO	1	11	2	14,300	1	1	1	1	Ac	G	No	....	6000	Ry,Sol/....	....[35]	Ti,Sk	Yes	Vig	....	Ts	Yes	NAp	22
SO	1	11	3	14,300	N	N	N	1	Ac	DsO	No	ISi[10]	....	Ry,Sol/....	....[35]	Ti,Sk	Yes	Cv	....	Ts	Yes	Itg	23
SO	1	11	3	14,300	N	N	N	1	Ac	G	No	....	....	Ry,Sol/....	....[35]	Ti,Sk	Yes	Vig	....	Ts	Yes	....	24
CBC	1	14	2	11,650	1	1	1	1	Ac	G	No	ISi[9]	9000	Ry/E	E	Te	Yes	Cv	SpT	Rel	Yes	NAp	25
AV	1	8	1	18,000	1	1	2	1	Ac	DF	No	ISi[10]	3850	Sol/....	E	....	Yes	Cv	SpT	....	Yes	NAp	26
KV	1	1	1	17,100	N	N	N	1	Ac	DsO	No	ISi[9]	1800	Ry/EH	EM	Te	No	N	....[39]	Bc	No	Itg	27
KV	1	1	1	17,100	N	N	N	1	Ac	DF	No	ISi[38]	3600	Ry/EH	EM	Te	No	N	....[39]	Bc	No	Itg	28
KV	1	1	1	17,100	N	N	N	1	Ac	DsO	No	ISi[38]	1800	Ry/EH	EM	Te	No	N	....[39]	Bc	No	Itg	29
KV	1	1	1	17,100	....	....	....	1	Ac	PrG	No	ISi[9]	1800	Ry/EH	EM	Te	No	N	....[39]	Bc	No	Itg	30
SO		8	2		1	1	1	1	Ac	DsO	No	....	....	..../....	....	....		Cv	....	....	....	....	31
SO	1	8	2	22,300	1	1	1	1	Ac	G	No	ISi[10]	3600	Ry,Sol/....	....	Sk	No	Cv	....	....	No	....	32
SO	1	8	2	22,300	1	1	1	1	Ac	G	No	ISi[10]	22,300	Ry,Sol/....	....[35]	Sk	Yes	Cv	....	....	No	NAp	33
SO	1	8	3	22,300	N	N	N	1	Ac	DsO	No	ISi[10]	1800	Ry,E/....	....[35]	Sk	No	Cv	SpT	....	Yes	Itg	34
SO	1	8	3	22,300	N	N	N	1	Ac	DsO	No	ISi[9]	1200	Ry,E/....	....	Sk	No	Cv	SpT	....	Yes	Itg	35
SO	1	8	3	22,300	N	N	N	1	Ac	G	No	ISi[10]	....	Ry,Sol/....	....[35]	Sk	....	Cv	....	....	Yes	Itg	36

K13), compressor drive; Natural Gas Pipeline Co of ica, Johnson's Bayou, LA (1, K13), compressor drive; disclosed company in Lake Arthur, LA (1, K13), com- ssor drive; State University of NY at Stony Brook, NY (2, generator drives, Cities Service Gas Co, Satanta, KS (16A) compressor drive; Oasis Pipeline Co, various loca- in Texas (18, K16A), compressor drives

Pac series comprises several models. Depending on the ambient conditions, elevation, etc, normal-power will fall between 18.7 and 39.35 MW, and peak-power between 21.7 and 42.95 MW; gas temperature at ine inlet will be between 1135 and 1250 F; ure ratio, between 11.1 and 14.7

pressure/los pressure

ding on model, low-pressure compressor has either or nine stages

ding on the model, speed of h-p compressor drive will between 8560 and 8750 rpm; speed of l-p compressor between 6350 and 6690 rpm

ding on model, analog controls can be electrohydraulic, dropneumatic or electronic

el FT4A-11LF was purchased by US Air Force for use Guam

Power Pacs purchased during survey period for electric eration: New England Gas & Electric Assoc, Cambridge, unit, model FT4A-9LF); Ebasco International Corp, quil, Ecuador (1, FT4A-11LF); British Columbia Hydro wer Auth, Prince Rupert, B.C., Canada (2, FT4C-10F)

el TP4-2A-9DF was purchased by Wisconsin Public Service for electric generation in West Marinette, WI

Twin Pacs purchased during survey period for electric eration: Union Electric Co, undisclosed location in souri (1 unit, model TP4-2A-11LF), Florida Power Corp, disclosed location (4, TP4-2C-1LF), Public Service Electric Co, undisclosed locations in New Jersey (8, TP4-2C-1LF); rtland General Electric Co, undisclosed locations in Oregon TP4-2C-1LF); Nebraska Public Power Dist, Hebron, Cook, and Shelton, NE (3, TP4-2C-1LF), Long Island ting Co, Glenwood Landing, NY (5, TP4-2C-1LF); Southern California Edison Co, undisclosed location (1, TP4-2C-1DF); Wisconsin Public Service Corp, undisclosed location (1, TP4-2C-1DF); Wisconsin Power & Light Co, undisclosed location (2, TP4-2C-1DF)

21 - Twin Pac series comprises several models. Depending on the model, ambient conditions, elevation, etc, normal-power rating will fall between 36.85 and 63.6 MW, and peak-power rating between 39.8 and 65.6 MW; gas temperature at power-turbine inlet will be between 1130 and 1250 F; pressure ratio, between 11.9 and 16.1

22 - Depending on model, speed of the high-pressure compressor drive will be between 8380 and 8840 rpm; low-pressure drive, between 6280 and 6700

23 - Distillate, residual and crude oils, plus natural and process gases separately or in combination

24 - Impulse generator

25 - Variations of this machine ordered as generator drives by Northern States Power Co, various locations in Minnesota (6 units) and Public Service Co of Oklahoma, Oklahoma City, OK (2 – in a PACE 260 combined-cycle system)

26 - Variations of this machine ordered as generator drives by British Columbia Hydro & Power Authority, Port Hardy, B.C., Canada (1 unit) and Public Service Electric & Gas Co, Bergen, NJ (1)

27 - Variations of this machine ordered as generator drives by Salt River Project Agricultural Improvement & Power Dist (2 units); Northern States Power Co (4); Omaha Public Power Dist (2); Potomac Electric Power Co (4); Louisiana Power & Light Co (2); Duquesne Light Co (3); Philadelphia Electric Co (3); Ohio Edison Co (2); McPherson Bd of Public Utilities, McPherson, KS (2)

28 - Approximate figure

29 - Inductor alternator frequency measurement

30 - Also speed/time ratio

31 - GT-55

32 - Variations of this machine ordered as compressor drives by Costal States Gas Producing Co, Freer, TX (1 unit); Alberta Gas Trunk Lines Co, Valleyview, Alta., Canada (1); Phillips Petroleum International Investment Co, Bacton, England (3); Tennessee Gas Pipeline Co, Warren, PA (1); and undisclosed company in Rumania (5). Variations ordered as pump drives by National Iranian Oil Co for various undisclosed locations in Iran (8 units)

33 - Mobile trailer installation

34 - Variations of this machine ordered as compressor drives by Colorado Interstate Corp, Mocane, OK (2 units); El Paso Natural Gas Co, Ignacio, NM (1); Humble Oil & Refining Co, locations in Texas (4); Imperial Oil, Ltd, locations in Alta., Canada (5), Mountain Fuel Supply Co, Lark, UT (1); Natural Gas Pipeline Co of America, locations in Texas (4). Oasis Pipeline Co, locations in Texas (4), Shell Oil Co, Gulf of Mexico (1); Union Oil Co of California, Cook Inlet, AK (2)

35 - Magnetic speed pickup

36 - Variations of this machine ordered by Home Oil Co Ltd, Swan Hills, Alta., Canada (2 units), waterflood-pump drive; Mobil Oil Corp, Coyanosa Station, TX (2), refrigeration-compressor drive; Oasis Oil Co of Libya, Inc, various locations in Libya (8), crude-oil-pump drive; Shell Oil Co, undisclosed location in Louisiana (1), waterflood-pump drive; Shell Canada Ltd, various locations in Alta., Canada (2), waterflood-pump drive

37 - Variations of this machine ordered as generator drives by Mountain States Telephone & Telegraph Co, Tucson, AZ (1 unit) and New York Telephone Co, Nassau County, NY (2)

38 - Also soundproof building

39 - Compare maximum fuel flow to compressor discharge pressure

40 - Variation of this machine ordered as generator drives by Santa Clara County, San Jose, CA (2 units)

41 - Variation of this machine ordered as a compressor drive by The Gas Council, Chelmsford, England (4 units)

42 - Variations of this machine ordered as compressor drives by Chattanooga Gas Co, Chattanooga, TN (1 unit) and El Paso Natural Gas Co, undisclosed locations (3). Variations of this machine ordered as pump drives by Tennessee Gas Pipeline Co, Ysclosky, LA (1 unit) and Sea Robin Pipeline Co, Gulf of Mexico (3)