

PLAINTIFF'S EXHIBIT

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1972 PLANT DESIGN ISSUE

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

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.	Mansfield	Shippingport, PA	Commonwealth Associates, Inc.	1	900	75	6415	3785	1005	1005	
2	Virginia Electric & Power Co.	Yorktown	Hornsbury, 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 N.Y., Inc.	Astoria	New York, NY	Ebasco Services Inc.	6	825	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	1010	
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 ⁵⁴	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	690	76	4985	2600	1007	1007	
11	Illinois Power Co.	Baldwin	Baldwin, IL	Sargent & Lundy	3	632	75	4220	2620	1005	1005	
12	Pyramac Electric Power Co.	Chalk Point	Aquasco, MD	United Engineers & Constructors Inc.	4	600	75	4600	1980	953	953	
13	Gulf States Utilities Co.	Willow Glen	St. Gabriel, LA	Stone & Webster Engineering Corp.	5	580	74	4035	3850	1005	1005	
14	Dallas Power & Light Co.	Monticello	Titus County, TX	Ebasco Services Inc.	1	575	74	4025	2825	1005	1005	
15	Wisconsin Power & Light Co.	Columbia	Portage, WI	Sargent & Lundy	1	527	73	3800	2620	1005	1005	
16	Iowa Public Service Co.	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. Comm'n. of Ontario	Lennox	Kingston, Ont., Canada	Self	1	513	75	3600	2500	1000	1000	
19	Gulf Power Co.	Crist	Pensacola, FL	Southern Services, Inc.	7	500	73	3626	2486	1000	1000	
20	The Hydro-Elec. Pwr. Comm'n. of Ontario	Nanticoke	Port Dover, Ont., Canada	Self	1	500	72	3600	2450	1000	1000	
21	Puerto Rico Water Resources Auth.	South Coast	Guayama, PR	United Engineers & Constructors Inc.	5	450	72	2970	2400	1000	1000	
22	Tampa Electric Co.	Big Bend	Tampa, FL	Stone & Webster Engineering Corp.	3	450	75	3116	2552	1000	1000	
23	Puerto Rico Water Resources Auth.	Aguirre	Guayama, PR	United Engineers & Constructors Inc.	1	450	74	3170	2400	1000	1000	
24	Utah Power & Light Co.	Huntington Canyon	Huntington, UT	Sterns-Roger Corp.	2	440	74	2965	2400	1000	1000	
25	Central Louisiana Electric Co. Inc.	Rodemacher	Vic. of Boyce, LA	Sargent & Lundy	1	430	75	3025	2400	1000	1000	
26	Delmarva Power & Light Co.	Edge Moor	Edge Moor, DE	Bechtel Corp.	5	410	73	2890	2460	1000	1000	
27	Philadelphia Electric Co.	Eddystone	Eddystone, PA	United Engineers & Constructors Inc.	3	400	74	2850	1980	950	950	
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	Sterns-Roger Corp.	1	370	73	2600	1900	1000	1000	
31	Montana Power Co.	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.	1	3161 ⁴	73 ¹⁵	250 ⁹	1350	355	355	
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	950	
35	Public Service Co. of Oklahoma	Comanche	Comanche, OK	Westinghouse Electric Corp.	1	240 ⁶³	73	443 ²⁰	1360	950	950	
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	Tropett 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	1	436	76	3064	2620	1005	1005	
42	East Kentucky Rural Electric Coop.	Charlestown Bottoms	Maysville, KY	Stanley Consultants, Inc.	1	300	76	2300	2610	1005	1005	
43	Blair Electric Power Coop. Inc.	Miller	Palo Pinto, TX	Tropett & Gee, Consulting Engrs.	3	200	75	1550	1977	1005	1005	
44	Taunton Municipal Lighting Plant	Cleary	Taunton, MA	Paul L. Geringer & Associates	9	110 ⁴⁰	73	557	1875	1005	1005	
45	Fremont Dept. of Utilities	Wright	Fremont, NE	Lutz, Gaily & Brain	3	92	76	675	1800	1005	1005	
46	Alexandria Munic. Power & Light Dept.	Hunter	Alexandria, LA	Black & Veatch	4	35	73	718	1350	955	955	
47	Denton Municipal Utilities	Denton	Denton, TX	Black & Veatch	5	65	73	580	1250	955	955	
48	Vero Beach Municipal Power Plant	Vero Beach	Vero Beach, FL	Black & Veatch	4	55	75	505	1350	955	955	

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.
 BJL - 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 - Croft-Reynolds Engineering Co., Inc.
 CUL - Culligan Industrial Systems Div. Culligan USA.
 CV - Copps-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 Odegrmont, 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.
 HDW - 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 - Kuhse, Koop & Kausch-AG.
 LA - The Louis Allis Co., Inc.
 LAW - LA Water Treatment Div. Chromalloy American Co.
 LN - Leeds & Northrup Co.
 LCO - Lodge-Cortrell 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 Pump Div. Dresser Industries Inc.
 RA - Raymond Div. Combustion Engineering, Inc.
 RS - Riley Stoker Corp.
 SIE - Siemens AG.
 STW - Strithers-Wells Corp.
 SWE - Southwestern Engineering Co.
 WE - Westinghouse Electric Corp.
 WM - The Whitlock Manufacturing Co.
 WO - Worthington Co.
 YU - Yuba Heat Transfer Corp.
 ZU - Air Systems Div. Zurn Industries, Inc.

SYMBOLS

ABr - Aluminum bronze
 Ad - Admiralty brass
 Adl - Admiralty, inhibited
 AlB - Aluminum brass
 ANc - Analog computer
 ANT - Antemperator
 BA - Blades 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 - Demineralizing
 DiC - Digital computer
 DiO - 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 flue
 HI - Horizontal mt.
 Hyb - Hybrid
 HyC - Hydraulic cou.
 J - Steam jet eye.
 L - Lignite
 M - Motor
 Man - Monitoring pt.
 MAP - Monitoring, partial control
 MgO - Magnesium oxide

plants and general list power in 1973

PROJECT	BOILERS										FURNACE					FORCED-DRAFT FANS									
	Surface 1000 sq ft										Burners					Pulverizers					Drive				
	Boiler and waterwall	Superheater	Reheater	Economizer	Air heaters	Pressure, in H ₂ O	Volume, 1000 cu ft	Combustion rate, 1000 Btu/hr cu ft	Type	Number per boiler	Type	Manufacturer	Number per boiler	Capacity of each, ton/hr	Manufacturer	Number per boiler	Capacity of each, 1000 cfm	Wheel type	Flow control	Manufacturer	Type	Number per boiler	Hp each	Manufacturer	
Art, TB	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
Art, TB	72	133	222	276	249	0.1	363	20.5	BD, DB	32	CE	N	N	N	N	2	880	BC	V	WE	M	2	4500	GE	2
Art, TB	72	133	222	276	249	0.1	363	20.5	BD, DB	32	CE	N	N	N	N	2	880	BC	V	WE	M	2	4500	GE	3
Art	47	143	156	344	687	0.1	467	NAV	BD, DB	36	NAV	CE	N	N	N	2	1075	BC	V, D	APC	M	2	6000	EE	4
Art, GR	65	113	111	60	496	0.2	271	NAV	BD	10	CV	BW	N	N	N	2	522	BC	NAV	BF	M	2	6000	GE	5
Art, D	84	64	206	263	687	1.8	480	14.6	Prd, DB	36	CE	FW	6	60	FW	2	1000	BA	V	WE	M	2	7000	EE	6
Art, GR	39	226	54	50	1815	0.1	469	15	BD	28	PC	BW	7	50	BW	2	1062	BA	V	GF	M	2	2500	AC	7
Art, D	50	82	31	532	NAV	200	NAV	60, DB	24	HF	RS	6	23	RS	1	721	BA	V, D	AS	M	1	2320	WE	8	
Art, GR	50	77	31	532	NAV	241	28	BD	30	HF	FO, RS	N	N	N	2	825	BA	V	WE	M	2	3000	NAV	9	
Art, TB	NAV	119	50	230	972	0.1	540	12.5	60, DB	56	TB	CE	7	72	RA	2	679	BA	V	WE	M	2	NAV	NAV	10
Art, TB	77	100	48	363	749	0.5	516	10.8	BD	24	TB	CE	6	66	RA	3	380	BA	V	WE	M	3	1500	NAV	11
Art, TB	NAV	79	44	301	153	NAV	253	NAV	60	32	TB	CE	N	N	N	2	763	BA	V	AS	M	2	4000	WE	12
Art, GR	NAV	NAV	NAV	NAV	402	35.8	NAV	25.4	Prd, DB	26	NAV	CE	N	N	N	2	650	NAV	V, D	CE	M	2	5000	EM	13
Art, TB	56	116	135	65	695	0.15	512	11.1	BD, DB	64	NAV	CE	8	72	CE	2	455	BA	V	WE	M	2	1250	WE	14
Art, TB	71	82	46	190	748	0.3	421	12.2	BD, ST	24	TB	CE	6	69	CE	2	462	BA	V	WE	M	2	1750	LA	15
Art, 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
Art, GR	90	111	97	91	321	0.1	268	16.2	BD, ST	10	CV	BW	N	N	N	2	607	NAV	V	NAV	M	2	8000	NAV	17
Art, TB	26	160	21	135	402	0.15	157	30.7	BD	32	CE	N	N	N	N	2	534	NAV	V	NOV	M	2	2300	NAV	18
Art, 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	1450	WE	19
Art, GR	51	123	108	151	464	0.1	251	19.9	BD, DB	40	CE	N	N	N	N	2	528	BA	V	HAP	M	2	1450	SIE	20
Art, TB, WS	32	115	151	100	369	0.15	240	16.5	BD, DB	16	TB	CE	N	N	N	2	559	NAV	V	WE	M	2	1750	AC	21
Art, D	32	101	73	71	378	1.3	243	17.5	Prd	24	TE	CE	N	N	N	2	2286	BA	NAV	WE	M	2	4500	EM	22
Art, TB, WS	32	100	160	88	369	0.15	240	17.4	BD, DB	16	TE	CE	N	N	N	2	559	NAV	V	WE	M	2	1750	AC	23
Art, TB	NAV	117	45	240	229	0.1	315	12.1	BD	20	TB	CE	5	44	RA	2	665	BC	V	WE	M	2	2250	GE	24
Art, TB	18	90	30	68	302	37	115	NAV	Prd	24	CE	BW	N	N	N	2	470	BA	V	WE	M	2	5000	WE	25
Art, GR	44	146	40	74	350	0.1	137	27.5	BD	28	CE	BW	N	N	N	2	408	BA	V	WE	M	2	2000	WE	26
Art, TB	30	43	23	238	101	0.1	159	26.5	BD, DB	16	TB	CE	N	N	N	2	476	BA	V	WE	M	2	2000	WE	27
Art, GR	71	61	89	146	295	0.5	231	14.9	BD	16	TB	CE	N	N	N	2	333	BA	V	NAV	M	2	1500	NAV	28
Art, GR	52	117	79	54	582	0.1	270	13.9	BD	24	HF	RS	3	64.8	RS	2	1161	NAV	V, D	NAV	M	2	1750	NAV	29
Art, TB	88	56	101	129	444	11.6	290	12	Prd	16	NAV	FD	4	50	FW	2	1000	V	WE	M	2	4000	GE	30	
Art, 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
Art, D	91	29	NAV	NAV	NAV	NAV	NAV	NAV	BD, DB	24	HF	RS	6	25.5	RS	2	272	BA	V	ZU	M	2	1250	NAV	32
Art, WS	36	28	29	58	142	19.5	87	35	Prd	24	NAV	BW	N	N	N	2	415	BA	V, D	WE	M	2	4000	GE	33
Art, TB	22	33	17	104	278	17	94	26.5	Prd	16	CE	N	N	N	N	2	314	NAV	H, V	APC	M	2	2250	WE	34
Art, EA	25	27	15	53	135	27	71	26.5	Prd, DB	6	NAV	CE	N	N	N	2	230	BC	V	WE	M	2	900	WE	35
Art, TB	25	27	15	53	135	27	71	26.5	Prd, DB	12	TB	CE	N	N	N	2	302	BA	V	WE	M	2	900	WE	36
Art, TB	17	26	10	53	167	12.5	44	33.3	Prd	8	HF	PEC, RS	N	N	N	1	302	BA	V	AS	M	1	3000	WE	37
Art	50	136	69	95	1131	NAV	404	12.1	BD	12	Cy	BW	NAV	N	N	2	530	BA	D	WE	M	2	8000	AC	40
Art	NAV	54	62	221	343	30	162	NAV	Prd	16	TB	CE	N	N	N	2	488	BA	V	WE	M	2	4000	GE	41
Art	38	134	54	57	NAV	NAV	210	NAV	NAV	24	NAV	BW	8	21.5	BY	2	NAV	NAV	S	NAV	M	2	1500	NAV	42
Art	29	33	15	80	321	12	76	28	Prd	9	HF	RS, PEC	N	N	N	2	252	NAV	V	BF	M	2	1500	NAV	43
Art	46	13	21	70	N	11.8	27	31	Prd	9	HF	RS	N	N	N	151	NAV	NAV	NAV	NAV	M	2	1500	NAV	44
Art	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	
Art	10	9	N	N	87	20	33.3	21	Prd	6	NAV	CE	N	N	N	1	260	BA	H, V, D	AS	M	1	2000	WE	46
Art	30	7	N	N	66	20	23	33.8	Prd	6	NAV	CE	N	N	N	1	708	BA	D	APC	M	1	800	AC	47
Art	22	5	N	N	54	15	22.5	26.2	Prd	6	NAV	FO	N	N	N	1	173	BA	H, V	GF	M	1	1750	WE	48

- Jointly owned with Texas Electric Service Co and Texas Power & Light Co
- 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
- Primary, 53,000 sq ft; secondary, 411,000
- Opposed firing - 24 burners in front wall, 16 in rear wall
- pH control; morpholine injection
- Single-cylinder turbine
- Data are for the main feedpump. There are also two 35% capacity pumps, each with 5300-hp motor drives manufactured by SIE
- Base-load, indoor unit unless otherwise specified
- Variable-pitch fan blades
- Axial-flow fan
- Units are Imperial gpm
- Units are feet
- 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. 12
- Gas turbines will be installed in 1973, the steam turbine in 1974
- Jointly owned with Wisconsin Public Service Corp and Madison Gas & Electric Co
- Jointly owned with Iowa Power & Light Co, Iowa Southern Utilities Co and Iowa Illinois Gas and Electric Co
- Control firing rate
- Also dampers
- Gross rating
- pH control; ammonia injection
- Primary steam source, main unit crossover; secondary steam source, main steam
- High-pressure/low-pressure
- Gross heat rate at 100% load with exhaust pressure of 1.5 in. Hg abs
- Performance fuel
- Wide-range mechanical burners
- pH control; cyclohexylamine injection
- Applies to data logger
- 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
- Units are 1000 Btu/gal
- Peaking/cycling unit
- Outdoor unit
- Condensing unit
- DsO, 136,000 Btu/gal; RsO, 145,000 Btu/gal; G, 1030 Btu/cu ft
- DsO, 0.16; RsO, 0.3; G, 0.3
- Data are for the main feedpumps. Two standby pumps, manufactured by BJ, have
- H, V for flow control. Each is driven by a 10,000-hp motor manufactured by GE
- pH control; hydrazine injection
- 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
- Twin-shell unit with arsenical-copper tubes in the condensing section and CuN tubes in the air-removal section
- Assumes valves wide open, 5% overpressure and 1 in. Hg abs vacuum in the main unit
- Primary steam source, second reheater; secondary steam source, first reheater and auxiliary boiler
- Turbine heat rate
- Primary steam source, main turbine bleed; secondary steam source, main steam
- DsO, 19,547 Btu/lb; G, 1000 Btu/cu ft
- In DsO
- Excess-air control
- Semi-outdoor unit
- DsO, 19,500 Btu/lb; RsO, 18,400 Btu/lb; G, 1000 Btu/cu ft
- Assumes natural-gas firing and turbine exhausting at 1.5 in. Hg abs

Fossil-fired Central Stations

New peaking/cycling plant

Each project listing covers four pages

PROJECT	INDUCED DRAFT FANS						TURBINE			CONDENSER			FEEDWATER			CONTROLS							
	Number per boiler	Capacity of each, 1000 cfm	Flow control	Manufacturer	Drive		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 manufacturer, makeup/condensate	Combustion (Mtr)	Feedwater (Mtr)	Clean-draft TV (Mtr)		
					Type	Number per boiler																Hp each	Manufacturer
1	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	O	AS	M	4	6000	AC	1.5	7	6	GE	483	1	AIB	IR	J	De	Pdx ²⁷	HCC	HCC	OP	
3	4	694	O	AS	M	4	6000	AC	1.5	7	6	GE	NAV	1				NAV/NAV	HCC	HCC	OP		
4	3	1190	O	APC	M	3	7000	EE	2	7	4	WE	356	1	ABr	IR	Ro	De	NAV	GE,FO	GE	NAV	
5	2	326	HvC	BF	M	2	5000	GE	3.5	7	6	GE	450	1	SSt	WE	J	De	De	BM	BM	OP	
6	N								1.5	7	4	GE	360 ³⁹	1		WO	Ro	So	De ²¹	HCC	HCC	OP	
7	2	1408	V	GF	M	2	5500	AC	1.5	7	4	WE	301	1	Adl,CuN	FW	Ro	De	De ^{21,37}	BM	BM	OP	
8	1	1088	V	AS	M	1	4750	WE	2.5	7	4	GE ³²	365	1	SSt	NAV	Ro	De	De ²¹	HCC	HCC	NAV	
9	2	1630	V	WE	M	2	7000	NAV	3	5	4	ACP	295	1	CuN	DL	Ro	De	SF ⁶	HCC	HCC	NAV	
10	4	665	O	GF	M	4	NAV	NAV	1.5	NAV	4	GE	332	1	SSt	FW	Ro	De	NAV	NAV	NAV	NAV	
11	3	770	HvC	WE	M	3	4000	NAV	1.5	7	4	GE	310	1	SSt,CuN	IR	Ro	De	De	LN	LN	N	
12	4	1210	HvC,D	NAV	M	4	7000	WE	4	4	4	GE	414	2	CuN	IR	RP	De	SF ²¹	BM	BM	NAV	
13	N								2	7	2	WE	242	1	CuN	IR	Ro	De	De,SF	WE	WE	OP	
14	2	1241	O	APC	M	2	4000	WE	2.5	7	4	WE ³²	210	1	SSt	FW	Ro	De	Pdx ²¹	LN	LN	N	
15	2	999	HvC	BF	M	2	6900	WE	1	7	4	GE	250	2	Ad	WE	Ro	De	De ^{21,25}	F	F	N	
16	2	328	S	AS	M	2	5000	GE	1.5	7	2	GE	460	2	SSt	IR	Ro	De	De ⁶	NAV	NAV	NAV	
17	2	1000	HvC	NAV	M	2	7000	NAV	1.5	7	4	WE	300	1	SSt,Ad	WE	Ro	De	De ²⁷	LN	LN	N	
18	2	743	V	KKK	M	2	3500	NAV	1.5	7	4	GE	160	1	Ad	FW	J	De	De	F	F	OP	
19	N								3.5	7	2	WE	230	2	Ad,CuN	BLH	Ro	De	Pdx ⁶	BM	BM	OP	
20	2	800	V	HAP	M	2	3000	BRP	1.5	7	4	CAP	163	1	Ad	MLW	Ro	De	De ⁹	3M	3M	OP	
21	2	879	V	WE	M	2	4500	GE	2	7	2	GE ³²	248	1	Ad	BLH	Ro,J	De	De	GE	GE	OP	
22	N								2	6	2	GE	143	1	SSt	IR	Ro	De	De ²⁷	NAV	NAV	NAV	
23	2	390	V	WE	M	2	4500	GE	2.5	7	2	BB ³²	248	1	Ad	3LH	Ro,J	De	De	NAV	NAV	NAV	
24	2	1105	O	WE	M	2	4500	GE	3.5	6	2	GE	171	2	SSt,Adl	SWE	J	De	NAV	BM	BM	OP	
25	N								1	7	2	GE ⁴⁷	238	2	SSt,Adl	IR	Ro	De	De ^{21,6}	F	F	DP	
26	2	625	O	WE	M	2	4500	WE	2	7	2	WE	218	1	Adl	DL	Ro	De	N	BM	BM	OP	
27	2	754	O	AS	M	2	6000	WE	2	3	1	WE	178	1	Adl	IR	J	De	NAV	LN	LN	OP	
28	2	489	O	NAV	M	2	3500	NAV	1.6	7	4	GE	130	1	NAV	IR	Ro	De	De ²¹	GE	GE	NAV	
29	4	NAV	NAV	NAV	NAV	NAV	NAV	NAV	3.5	8	2	GE	212	1	SSt,Adl	DL	Ro	De	NAV	LN	LN	N	
30	N								2.3	6	2	WE	165	2	Adl	DL	J	De	NAV	FO	HCC	OP	
31	2	NAV	O	NAV	M	2	NAV	NAV	3.5	6	2	GE	144	2	SSt,Adl	DL	J	De	NAV	NAV	NAV	NAV	
32	N								3.5	2	2	GE	79	2	Adl,CuN	IR	NAV	De	NAV	NAV	NAV	N	
33	2	413	O	ZU	M	2	2250	NAV	2	6	2	GE	148	1	Adl	DL	Ro	De	De	NAV	NAV	NAV	
34	N								1.5	3	2	WE	103	1	CuN	WE	Ro	De	NAV	BM	BM	OP	
35	N								NAV	1	1	WE ⁷	98	2	Adl	WE	J	De	N	WE	WE	N	
36	N								2.3	6	2	WE	143	2	SSt	WE	J	De	NAV	LN	LN	NAV	
37	N								1	8	2	WE	96	2	Ad	IR	Ro	De	NAV	NAV	NAV	NAV	
38	2		V	AS	M	2	2000	GE	1.5	6	2	GE	30	2	CuN	DL	J	De	NAV	BM	BM	N	
39	N								2	6	2	GE	60	1	SSt,Adl	MS	Ro	So,Eva	N	FO	F	N	
MUNICIPAL AND COOPERATIVE INSTALLATIONS																							
40	2	1026	O	ZU	M	2	6000	AC	1.5	7	2	BB	160	1	SSt	MS	Ro	De	NAV	NAV	NAV	NAV	
41	N								2.5	7	2	WE	170	1	Adl	NAV	Ro	De	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	
43	N								3.5	6	2	WE	80	1	SSt,Adl	NAV	Ro	De	NAV	NAV	NAV	N	
44	N								2	2	2	GE	68	2	SSt	IR	Ro,J	De	NAV	NAV	NAV	N	
45	1	1012	O	NAV	M	2	52	NAV	2.5	6	2	GE	60	2	Ad	SWE	J	De	NAV	NAV	NAV	OP	
46	N								3.5	5	2	GE ⁷	55	2	SSt	SWE	Ro	De	N	BM	BM	N	
47	N								2	3	1	GE ⁷	50	2	SSt,Ad	DL	Ro	De	De	BM	BM	N	
48	N								2.5	5	1	GE ⁷	31	1	CuN	MS	Ro	De	NAV	NAV	NAV	N	

MANUFACTURERS

AC - Alth Chalmers Manufacturing Co
ACP - Alth 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 Engineering Superheater Co, Ltd
CHM - Chicago Heater Co
CIR - Canadian Ingersoll Rand Co Ltd
COC - Cochrane Div, Crane Co
CRL - Croil Reynolds Engineering Co, Inc
CUL - Culligan Industrial Systems Div, Culligan USA
CV - Copes Vulcan, Inc
DL - DeLaval Turbine Inc
DP - Diamond Power Specialty Corp
EAL - 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 - Foster Engineering Co
FW - Foster Wheeler Corp
GDI - Gulf Development, 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 - Intilco 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 Permunit Co
PP - Pacific Pump 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
Adl - Admiralty, inhibited
AIB - Aluminum brass
Anc - Analog computer
Att - Attenuator
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
DC - Digital computer
DO - 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 interline
Hyb - Hybrid
HvC - 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										PROJECT
Application	Number per boiler	Capacity of each gpm	Discharge pressure psig	Manufacturer	Flow control	Drive		Manufacturer	Number of heater trains	Number of closed heaters per train	Final feedwater temp. F	Manufacturer	Type	Calorific value, 1000 Btu/lb or Btu/cu ft	Design heat rate, Btu/kWh	Maximum sulfur content, %	Combustion additive	Additive introduction	Working fluid	Sootblower							
						Type	Hp (each)													Number of heater trains	Manufacturer						
MAN	2	7900	4696	IR	S	T-11	27 500	DL	2/3/2	3/4/2	546	YU	C	11.9	8400 ²⁴	4.3 ²⁵	No	NAv	Air	CV	1						
MAN	2	13 400	3256	IR	HvC	MIS	24 600	DL	2/1/2	2/3/2	475	YU	Cr	145	8065	1	Yes	NAv	Air	NAv	2						
MAN	2	13 400	3256	IR	HvC	MIS	24 600	DL	2/1/2	2/3/2	475	YU	Cr	145	8065	1	Yes	NAv	Air	NAv	3						
MAN	2	7950	3110	IR	S	T-11	15 700	WE	2	2/5/2	509	SWE	OsO, RsO, G	9.7 12.5	8032	NAv	No	NAv	St	CV	4						
MAN	2	NAv	3530	BJ	S	T-11	17 500	GE	2/1/2	3/4/2	479	CHH, YU	C				No	NAv	St	DP	5						
MAN	1	12 550	4570	DL	S	T-11	34 800	DL	2/1/2	2/4/2	548	WO	C	12	7482 ⁴²	1.5	No	NAv	St	DP	6						
MAN	2	6260	4965	IR	S	T-11	21 500	GE	2/1/2	2/5/2	519	FW	C	12.5	8676	3.5	No	NAv	Air	DP	7						
MAN	1	6700	3472	NAv	S	T-11	15 577	NAv	1	3/5/2	517	NAv	Cr	12	9100	2.5	No	NAv	Air	DP	8						
MAN	1	11 550	7330	PF	S	T-11	17 025	WE	1	0/2/2	362	STW	Cr	14.4	10 400	0.1	No	NAv	Air	DP	9						
MAP	2	NAv	NAv	DL	S	T-11	13 000	GE	1	2/4/2	467	FW, YU	C	8.3	8082	1.2	No	NAv	St	CV	10						
MAP	2	4500	3079	PP	S	T-11	13 500	GE	2	2/4/2	474	YU	C	10.8	NAv	3	No	NAv	St	DP	11						
MAP	2	5550	3500	BJ	S	T-11	8930	GE	1	0/2/2	318	WE	RdO, G	18	8950	0.5	MgO	Fub	St	CV	12						
MAN	1	10 400	6570	DL	S	T-11	NAv	WE	NAv	NAv	504	SWE	RdO, G	NAv	9300	1.7	Yes	Fub	St	DP	13						
MAN	1	9700	4375	DL	S	T-11	31 500	DE	1	2/5/2	501	SWE	L	6.8	9900 ²⁰	0.6	No	NAv	Air	CV	14						
MAN	2	4700	3135	IR	S	T-11	11 429	GE	1/2/2	2/4/2	481	YU	C	8.4	9300	0.6	No	NAv	St	CV	15						
MAN	2	4340	2976	PP	S	T-11	9500	GE	1	2/4/2	493	YU	C	9.2	9900	0.7	No	NAv	St	CV	16						
MAN	2	4075	4563	BJ	S	T-11	11 950	DL	1	2/5/2	488	WE	C, G	11.4 1035	NAv	3.1	No	NAv	Air	CV	17						
MAN	2	6740	7200	CIR	S	T-11	16 200	GE	1	4/4/2	487	MLW, CHH, FW	RdO	18.3	9161	NAv	NAv	St	DP	18							
MAN	2	4800	3056	BJ	S	T-11	9900	WE	2/1/2	4/4/2	481	BLH	C	12	9375	4	No	NAv	St	DP	19						
MAP	1	8034	2743	CIP	S	T	16 800	GE	1		485	FW	C	12.3		3.5	No	NAv	St	CV	20						
MAN	2	4500	3200	DL	Reg	MIS, T	10 000	GE	1	2/5/2	470	YU, BLH, CHH	RdO	17.7	7728	2.9	No	NAv	St	CV	21						
MAN	1	6790	2877	DL	S	T-11	17 474	GE	1	3/3/2	492	CHH, STW	Cr	18	9300	NAv	Yes	Fub	St	CV	22						
MAN	1	9000	2200	DL	S	T-11	15 700	GE	1	2/5/2	489	YU, BLH, CHH	RdO	17.7	7793	2.9	No	NAv	St	CV	23						
MAN	2	3820	3310	DL	S	T-11	7500	GE	1	2/4/2	485	YU	NAv	12.2	NAv	0.5	N	NAv	St	CV	24						
MAN	1	7320	2996	DL	S	T-11	13 838	GE	1	2/4/2	480	YU	NAv	NAv	9550	NAv	NAv	NAv	St	NAv	25						
MAP	1	7600	2950	DL	S	T-11	14 200	WE	1	2/5/2	478	SWE, CHH	RdO, Cr	19.5	7924	0.5	NAv	Fub	Air	DP	26						
MAP	1	6360	2250	DL	S	T-11	11 000	DL	1	0/2/2	353	YU	RdO, Cr	19.19.5	8750	0.3	MgO	Fub	St	CV	27						
MAP	1	6290	3100	IR	HvC	MIS	12 000	NAv	1	2/5/2	NAv	WE	RdO	18.3	9079	NAv	Yes	NAv	Air	CV	28						
MAP	1	7300	3007	NAv	Reg	T-11	14 686	NAv	1	3/5/2	530	WE	C	10.7	9175 ⁴⁰	2.3	No	NAv	Air	DP	29						
MAP	2	3000	2446	DL	HvC	M	6000	GE	NAv	NAv	NAv	NAv	C	9.7	NAv	1.2	No	NAv	Air	OP	30						
MAN	2	3192	6882	PP	S	T-11	7000	GE	1	1/4/2	487	STW	C	8.8	8032	1	No	NAv	St	CV	31						
MAN	2	1430	1800	IR	Reg	M	2000	GE	1	0/1/2	267	WM	OsO, RdO, Cr	Var	8870	0.3	No	NAv	St	CV	32						
MAN	2	2375	3275	AC	Reg	M	5500	AC	1	2/3/2	482	YU	C	11.5	9337	1.4	No	NAv	St	DP	33						
MAN	2	2850	2300	PP	Reg	M	5000	GE	1	0/2/2	359	WE, CHH	RdO, G	18.8 1080	10 000 ⁴⁰	0.5 ⁴⁰	No	NAv	St	DP	34						
AP	1	1095	1430	BPC	Reg	M	1250	WE	1	N/2/2	250	COC	G	1050	9140	N	N	N	N	DP	35						
MAP	2	3090	2089	WO	HvC	M	4500	GE	1	2/3/2	472	YU	G	1000	9940 ²⁰	N	No	NAv	N	DP	36						
MAN	2	1570	2899	PP	HvC	M	3500	AC	1	2/3/2	475	YU	OsO	19.5	9500 ²⁰	0.3	No	NAv	N	DP	37						
MAN	2	1750	2406	DL	Reg	M	3000	WE	1	3/2/2	476	STW, CHH	RdO, Cr	19.19.3	7976	1	MgO	Fub	St	DP	38						
MAN	2	1335	2403	AC	HvC	M	2500	AC	2	3/2/2	464	STW, LAW	G	1096	8155	0	No	NAv	N	DP	39						
MAN	2	3542	3200	DL	S	T-11	7060	DL	2	3/3/2	467	SWE	L	7	10 890	0.8	No	NAv	St	DP	40						
MAP	1	7590	2950	NAv	S	T-11	14 600	WE	1	2/4	485	NAv	OsO, G	11.0	9474	0.145	No	NAv	NAv	DP	41						
MAN	2	NAv	NAv	BJ	S	T	7000	GE	NAv	NAv/NAv	NAv	NAv	C	11.0	7971	3.5	No	NAv	Air	DP	42						
MAN	2	1800	2300	NAv	HvC	M	3500	NAv	1	2/3/2	466	NAv	OsO, RdO, G	18.5	9850 ⁴⁰	1	NAv	Fub	St	DP	43						
MAN	2	1300	5195	IR	Reg	M	2250	NAv	1	N/2	220	NAv	RdO				NAv	St	DP	44							
MAN	2	1530	2500	BJ	Reg	M	3000	GE	1	2/2	380	SWE	C, G	10.3 1000	9500	1	No	NAv	St	DP	45						
MAN	2	890	1500	PP	Reg	M	1250	WE	1	2/2	443	YU	G	1000	NAv	N	No	NAv	N	APC	46						
MAN	2	800	2100	AC	Reg	M	1250	AC	1	2/1	468	SWE	G	1075	9205	N	No	NAv	NAv	DP	47						
MAN	2	NAv	NAv	NAv	M	NAv	NAv	NAv	1	2/2	439	NAv	OsO, G	53	10 800	0.8	Yes	Fs	St	DP	48						

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 - OsO, 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 live unit trains, comprised of 600 cars and 22 locomotives

56 - Total output from two boilers supplying steam to one turbine/generator

Other bit 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 bit makeup

63 - Combined-cycle plant, 20 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-gpm motor-driven pump is available for startup service

73 - Data are for the main feedpumps. 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 bit

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

Gas Turbines

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	GE	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 600 MW of gas-turbine generating sets were 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 stringent 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-Ougrée-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.), Gutehoffnungshütte Sterkrade AG (West Germany) and NV Motorenfabriek 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	625	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	Tw	48.4	1000	80			20	13	
3	Jersey Central Power & Light Co	Holland Twp, NJ	GE	MS 7001	427	BI	No	Dw	44.2	300	80			20	12	
4	Wisconsin Public Service Corp	West Marinette, WI	TP	Twin Pac 19	125	PP	Yes	Dw Spv						8	3	
5	City of Cape Town	Cape Town, South Africa	CW	Mod Pod-40	126	PP	Yes	Dw	40	1000	80			3	2	
6	Florida Power & Light Co	Ft. Lauderdale, FL	TD	ER-224	1249	PP	Yes	Dw	38.0	1000	80	42.7	80	5	3	3
7	Vineland Electric Utility	Vineland, NJ	WE	W-251	148	PP	Yes	Dw Spv	31.1	0	58	33.6	59	20	10	5
8	Consolidated Edison Co of NY, Inc	New York, NY	GE	MS 5001	1645	PP	Yes	Dw	20.1	0	35	21.8	35	10		
9	U.S. Navy Propulsion Test Center	Trenton, NJ	TP	FT4A-11LF	1	MD	No	Dw		27.4	0	30	30.6	30		
10	Freeport Electric Dept.	Freeport, NY	CW	Mod Pod-20		PP	Yes	Dw	20	1000	80			3	2	
11	U.S. Air Force	GU ¹	TP	Power Pac 17	114	PP	Yes	Dw Spv						8	3	
12	Golden Valley Electric Assn, Inc	Fairbanks, AK	GE	MS-5001	146	PP	No	Dw	17.5	1000	80			3		
13	Arabian American Oil Co	Uthmaniyah, Saudi Arabia	GE	MS-5002	244	MD	No	Dw		20.3	0	120		10		
14	Volvo Electric Corp, Inc	Hersey, MI	CBC	Coberra 12543	2	PP	Yes	Dw	11.0	1000	80	12.5	80	3	6	3.5
15	Franklin Municipal Plant	Franklin, LA	TD	EA-113	1	PP	Yes	N	10.2	0	35			7	3	3
16	Michigan Wisconsin Pipe Line Co	Gulf of Mexico	GE	MS-3002	242	GH	No	Spv		13.1	1000	80		10		
17	Union Oil Co of Canada Ltd	Lobo, Ont., Canada	CBC	Coberra 125	541	GH	No	Dw		12.5	1000	30				
18	Kloekner Humboldt-Deutz AG	West Germany ¹	AV	TF 35	4	PP	Yes	N	3.5	0	80	4.2	80	1	1	1
19	Oasis Pipeline Co	TX ¹	IR	GT-40	1932	GH	Yes	Spv		4	0	59	5.5	60	4	4
20	Tennessee Gas Pipeline Co	Paris, IL	ALN	501-K1311	211	GH	Yes	Dw		3.6	0	60		1		
21	Amosac Inc	Libya ¹	SO	CS3000	834	GH	Yes	Dw		3.5	1	59		1		
22	Amoco International, Ltd	Gulf of Suez	SO	MD3000	836	MD	Yes	Dw		3.5	1	59		1		
23	Alberta Government Telephone Comm	Calgary, Alta., Canada	SO	GSE3000	217	SP	Yes	Dw		2.5	0			1		
24	Abu Dhabi Petroleum Co, Ltd	Persian Gulf	SO	GSC3000	3	BI	Yes	Dw		2.4	0	59		1		
25	Petroleos Mexicanos	Mexico ¹	CBC	Coberra 30	5	GH	No	Spv		3	1000	80	4	10		
26	National Iranian Oil Co	Iran ¹	AV	TF 25	3	PD	Yes	N		2	0	80	2.8	30	1	1
27	Combined Construction Co	White Plains, NY	NAT	Viking-SBG	540	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 ¹	Indonesia ¹	NAT	Viking-CBG/T	8	TE	Yes	Dw	1.0	0	59			1		
30	Abu Dhabi Petroleum Co Ltd	Persian Gulf	NAT	Viking-CBG	3	BI	No	Dw	1	0	59			1		
31	Dowell Div, Dow Chemical Co	Mobile, AL	SO	IP1000	10	MD	No	Dw		1.2	0			1		
32	Chevron Oil Co	Ft. Saskatchewan, Alta., Can.	SO	MD1000	550	MD	No	Dw		1.2	0	59		1		
33	Amosac Inc	Libya ¹	SO	CS1200	1053	GH	Yes	Dw		1.2	0	59		1		
34	City of Andover	Andover, MA	SO	GSE1000	152	SP	Yes	Dw	0.9	0	59			1		
35	Pacific Telephone & Telegraph Co	Idaho	SO	KS1000	854	SP	Yes	Dw	0.8	0	59			1		
36	Amoco Canada Petroleum Co	Ft. St. John, Alta., Canada	SO	GSC1000	255	TE	Yes	Dw	0.8	0	59			1		

MANUFACTURERS

AKT	AEG-Kanu Turbinenfabrik GmbH
ALN	Detroit Diesel Allison Div, General Motors Corp
ALS	Societe Generale de Constructions Electriques et Mecaniques (ALSTHOM)
AV	Lycorning 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	P 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
BI	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
OsO	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
Rag	Regenerative cycle
Rel	Relative motion between bearing cap and shaft
Rid	Residual oil
Ry	Relay
Sep	Separate
Sk	Stack (mainfold)
Sol	Solid state

SP	Standby power only
SpT	Speed/time
Spv	Supervisory (telemetry)
Te	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

- Various locations
- Independent Indonesian American Petroleum Co
- Exact location not available
- Manufactured in Mannheim, West Germany
- Iranian Electric Power Generation & Transmission Co
- Undisclosed
- Ratio of absolute compressor-discharge pressure to absolute compressor-inlet pressure
- In some gas-turbine packages, turbine driving the external load - compressor, pump or generator 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 external load and gas-generator compressor with the turbine described under the "Gas generator" - Also exhaust silencer
- Also exhaust silencer
- ALN offers five versions of its 501 engine: 501-K5, 501-K13 and 501-K16A burn natural gas; 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 temperature, 13,820 rpm; K13 and K15, also similar in performance (detail in tabulation), use first-stage blades and vanes to permit higher gas temperatures at turbine inlet. Hence, power out about 15% over the K5 and K14 models. K16A performance is comparable to the K13 except it 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, Can (1, K13) and Longville, LA (1, K13); compressor drives: Pacific Telephone & Telegraph Co, Los (2, K15); San Francisco, CA (1, K15) and Oakland, CA (1, K15); generator drives: New York Lo 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 Products

GAS GENERATOR					FREE TURBINE			COMBUSTORS		FUEL		INSTRUMENTATION AND CONTROL										PROJECT		
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 auto manually, under load?	Type of soundproofing	Speed of driven equipment, rpm	Type of control system, liquid mixing	Method of measuring turbine speed	Location of cycle temperature monitor	Saltant power control?	Method of controlling turbine surge	Method of controlling turbine acceleration	Method of measuring turbine vibration	Exhaust temperature control?		Turbine and generator controls	
WE	1	17	4	3600	N	N	N	16	Ac	23	Yes	IS ⁹	3600	Sol/EP	24	BpT,Sk	Yes	Cv	SpT	Bc	Yes	Itg	1	
TD	1	17	5	3600	N	N	N	1	VeC	OsO	Yes	IS ⁹	3600										2	
GE	1	17	3	3600	N	N	N	10	CaC	OsO,GrO	Yes	IS ¹⁰	3600	Sol/EP	29	Te	Yes	Vig	BpT ³⁰	Ref	Yes	Itg	3	
TP	2	7:13,14	1:2:1	22	1	1	2	8	CaC	G,OsO	Yes	IS ⁹	3600	Ry/E ¹⁶	EM	Ti	Yes	Cv	SpT	Ec	Yes	Itg	4	
RR	2	7:5:13	1:1:1		1	1	2	8	Ac	OsO	Yes	IS ⁹	3000	Ry/EH	E	Ti	Yes	Cv	SpT	No	Itg	5		
PW	2	7:8:13	1:2:1	8800/6500 ¹¹	1	1	2	8	CaC	DF	Yes	IS ⁹	3600	Ry/E	35	Ti,Te	Yes	TWS	SpT	Bc	Yes	Itg	6	
WE	1	16	3	4854	N	N	N	8	CaC	23	Yes	IS ⁹	3600	Sol/EP	24	Te/Sk	Yes	Cv	SpT	Rel	Yes	Itg	7	
GE	1	17	2	5100	N	N	10	CaC	OsO	No	IS ¹⁰	3600	Sol/EP	35	Sk	Yes	N	SpT	Bc	Yes	Itg	8		
TP	2	7:8:13	1:2:1	8600,6350 ¹¹	1	1	2	8	CaC	K	No	IS ⁹	3600	Ry/EH	EM	Ti	N	Cv	SpT	Ec	Yes	NAP	9	
RR	2	7:5:13	1:1:1		1	1	2	8	Ac	OsO	Yes	IS ⁹	3600	Ry/EH	E	Ti	Yes	Cv	SpT	No	Itg	10		
TP	2	7:13,14	1:2:1	14	1	1	2	8	CaC	G,OsO,K	Yes	IS ⁹	3600	Ry/E ¹⁶	EM	Ti	Yes	Cv	SpT	Ec	Yes	Itg	11	
GE	1	16	2	5100	N	N	10	CaC	G	No	IS ⁹	3600	Sol/EP	EM	Sk	Yes	N	SpT	Bc	Yes	Itg	12		
RR	1	15	1	5100	1	1	1	12	CaC	DF	Yes	IS ⁹	4670	Sol/EP	EM	Sk	Yes	N	SpT	Bc	Yes	NAP	13	
GE	1	17	2	7650	1	1	1	6	CaC	OF	No	IS ⁹	3600	Ry,Sol/E	E	Te	Yes	Cv,Vig	SpT	Rel	No	Itg	14	
PW	2	7:8:13	1:2:1	8600,6350 ¹¹	1	1	1	8	CaC	OsO	No	IS 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	IS ⁹	6500	Sol/EP	EM	Sk	Yes	N	SpT	Bc	Yes	NAP	16	
RR	1	17	3	7500	1	1	2	8	CaC	G	No	IS 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	OsO	No	IS ⁹	1500	Ry,Sol/E	E	Te	Yes	Cv	SpT	Rel	No	Itg	18	
ALN	1	14	2	13,800	1	1	2	6	CaC	DF	Yes	IS 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	IS 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	IS ⁹	14,300	Ry,Sol/EP	35	Ti,Sk	Yes	Vig		Ts	Yes	NAP	21	
SO	1	11	2	14,300	1	1	1	1	Ac	G	No	IS ⁹	6000	Ry,Sol/EP	35	Ti,Sk	Yes	Vig		Ts	Yes	NAP	22	
SO	1	11	3	14,300	N	N	N	1	Ac	OsO	No	IS ¹⁰		Ry,Sol/EP	35	Ti,Sk	Yes	Cv		Ts	Yes	Itg	23	
SO	1	11	3	14,300	N	N	N	1	Ac	G	No	IS ⁹		Ry,Sol/EP	35	Ti,Sk	Yes	Vig		Ts	Yes	NAP	24	
CBC	1	14	2	11,650	1	1	1	1	Ac	G	No	IS 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	IS ¹⁰	3850	Sol/EP	E		Yes	Cv	SpT		Yes	NAP	26	
KV	1	1	1	17,100	N	N	N	1	Ac	OsO	No	IS ⁹	1800	Ry/E	EM		No	N		39	Bc	No	Itg	27
KV	1	1	1	17,100	N	N	N	1	Ac	DF	No	IS ³⁸	3600	Ry/EH	EM	Te	No	N		39	Bc	No	Itg	28
KV	1	1	1	17,100	N	N	N	1	Ac	OsO	No	IS ³⁸	1800	Ry/EH	EM	Te	No	N		39	Bc	No	Itg	29
KV	1	1	1	17,100				1	Ac	PrG	No	IS ⁹	1800	Ry/EH	EM	Te	No	N		39	Bc	No	Itg	30
SO	1	8	2		1	1	1	1	Ac	OsO	No	IS ⁹						Cv					31	
SO	1	8	2	22,300	1	1	1	1	Ac	G	No	IS ¹⁰	3600	Ry,Sol/EP		Sk	No	Cv			No		32	
SO	1	8	2	22,300	1	1	1	1	Ac	G	No	IS ¹⁰	22,300	Ry,Sol/EP	35	Sk	Yes	Cv			No	NAP	33	
SO	1	8	3	22,300	N	N	N	1	Ac	OsO	No	IS ¹⁰	1800	Ry,E	35	Sk	No	Cv	SpT		Yes	Itg	34	
SO	1	8	3	22,300	N	N	N	1	Ac	OsO	No	IS ⁹	1200	Ry,E	35	Sk	No	Cv	SpT		Yes	Itg	35	
SO	1	8	3	22,300	N	N	N	1	Ac	G	No	IS ¹⁰		Ry,Sol/EP	35	Sk		Cv				Yes	Itg	36

K1313, compressor drive; Natural Gas Pipeline Co of
Johnson's Bayou, LA (1, K1313), compressor drive;
disclosed company in Lake Arthur, LA (1, K1313), com-
pressor drive; State University of NY at Stony Brook, NY (2,
K1313), generator drives; Cities Service Gas Co, Saratoga, KS
(K1314) compressor drive; Oasis Pipeline Co, various loca-
tions in Texas (8, K1314), compressor drives
The following companies several models. Depending on the
unit, conditions, elevation, etc., normal power
will fall between 18.7 and 39.35 MW, and peak power
will be between 21.7 and 42.95 MW, gas temperatures at
compressor inlet will be between 1135 and 1250 F;
pressure ratio, between 11.1 and 14.7
Pressure/low pressure
depending on model, low-pressure compressor has either
four or five stages
depending on the model, speed of h-p compressor drive will
be between 8560 and 8750 rpm, speed of l-p compressor
drive will be between 6350 and 6680 rpm
depending on model, analog controls can be electrohydraulic,
pneumatic or electronic
Unit FT4A-11LF was purchased by US Air Force for use
in Vietnam
The Power Pacs purchased during survey period for electric
generation: New England Gas & Electric Assoc, Cambridge,
MA (1 unit, model TP4A 9LF, Ebasco International Corp,
Boulder, Ecuador (1, TP4A-11LF); British Columbia Hydro
Power Auth, Prince Rupert, B.C., Canada (2, TP4C-10F)
Unit TP4A-9DF was purchased by Wisconsin Public Service
Co for electric generation in West Marinette, WI
Unit TP4C-10F was purchased during survey period for electric
generation by Union Electric Co, Wisconsin location in
Wisconsin (1 unit, model TP4A-2C-11LF), Florida Power Corp,
disclosed location (4, TP4C-2C-11LF), Public Service Electric
and Gas Co, undisclosed locations in New Jersey (8, TP4C-2C-11LF);
Portland General Electric Co, undisclosed locations in Oregon
(10, TP4C-2C-11LF); Norcross Public Power Dist, Hebron,
Maine, and Shelton, NE (3, TP4C-2C-11LF), Long Island
Power Co, Glenwood Landing, NY (5, TP4C-2C-11LF);

- 1 Southern California Edison Co, undisclosed location (1), TP4-2C-10F; Wisconsin Public Service Corp, undisclosed location (1), TP4-2C-10F; Wisconsin Power & Light Co, undisclosed location (2), TP4-2C-10F.
- 21 1- Twin Pac series comprises several models. Depending on the ambient conditions, elevation, etc, normal-power ratings will fall between 36.85 and 63.6 MW, and peak-power ratings between 39.8 and 66.5 MW; gas temperature at power-turbine inlet will be between 1130 and 1250 F; pressure ratio, between 11.9 and 16.1.
- 22 1- 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 1- Distillate, residual and crude oils, plus natural and process gases separately or in combination.
- 24 1- Impulse generator.
- 25 1- 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 1- 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 1- 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); Tomarac, Louisiana Power & Light Co (3); Duquesne Light Co (3); Philadelphia Electric Co (3); Ohio Edison Co (2); McPherson Bd of Public Utilities, McPherson, KS (2).
- 28 1- Approximate figures.
- 29 1- Inductor alternator frequency measurement.
- 30 1- Also speed/time ratio.
- 31 1- GT-55.
- 32 1- Variations of this machine ordered as compressor drives by Coastal 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, Moacan, 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); Oass 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, Coynassee Station, TX (2, refrigeration-compressor drive; Oass 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 Variations 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, Ysloskey, LA (1 unit) and San Robin Pipeline Co, Gulf of Mexico (3)