TEXAS WATER DEVELOPMENT BOARD

REPORT 81

MAJOR HYDROELECTRIC POWERPLANTS IN TEXAS

Historical and Descriptive Information

By

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TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd.)

FIGURES

TABLE OF CONTENTS (Cont'd.)

DEFINITIONS AND ABBREVIATIONS

Definitions and abbreviations in this list are intended to explain terms as used in this report.

actuator, or governor. A hydraulic (oil) system of control of a steam or hydro turbine, which controls the speed of the prime mover and its power output.

application. A written request to the Texas Water Rights Commission for a permit to appropriate public waters for beneficial use.

average load. The sum of the hourly generation divided by the number of hours designated.

base load. A definite proportion of a power system load allotted to a generating unit or powerplant.

capability. The maximum load which a machine, station, or system can carry under specified conditions for a given time interval.

capacity. The load for which a machine, station, or system is rated.

draft tube. The discharge portion of a water turbine, usually of metal or concrete, which enables water from a turbine to create a partial vacuum.

energy. That which does work. Power efficiently and forcibly exerted. Electrical energy is usually measured in kilowatthours.

exciter. A small direct-current generator, belt driven or direct connected on the main shaft, or a motor-generator set, whose function is to energize the field magnetic poles of an alternating-current generator.

firm power. Power available at all times to meet load requirements.

generator. A rotating electrical machine for converting mechanical energy into electrical current.

gross generation. The total power produced in a power station. (See Net Generation and Plant Use.)

gross head. The difference in elevation, in feet, between still water surface in the reservoir and in the tailrace.

headgate. A hoist operated vertical lift gate installed at the entrance of a penstock or wheelpit to control the flow of water to the turbine.

headwater. Water behind a dam.

hp horsepower. A unit of power equal to 550 foot-pounds per second.

kva kilovolt-ampere (s). A unit of electrical power in alternating-current circuits. (See Power Factor.)

kw kilowatt (s). A unit of electrical power, equal to 1,000 watts or about 1.34 horsepower.

kwhr kilowatthour (s). A unit of work or energy, equal to that expended in 1 hour at a rate of 1 kilowatt.

megawatt. A unit of electrical power, equal to 1,000,000 watts.

megawatthour. A unit of work or energy, equal to that expended in 1 hour at a rate of 1 megawatt.

nameplate rating. The continuous capability of a generator, turbine, motor, etc., under conditions specified by the manufacturer, indicated on the nameplate. Nameplate rating may be greater or less than the demonstrated capability.

net generation. Gross generation less plant use.

normal headwater elevation. The crest of the spillway, top of control gates, or an arbitrarily selected water-surface elevation. Because headwater is subject to variation, daily, monthly, and seasonally, the term "design headwater elevation" is preferable.

normal tailwater elevation. Intended water-surface elevation in the turbine discharge channel. Because the actual tailwater elevations are extremely variable, the term "design tailwater elevation" is preferable.

peak load. The maximum load in a stated period of time.

penstock. A metal, concrete, or wooden pipe carrying water under pressure.

Permit. The specific authorization to make an appropriation of water which is issued by the Texas Water Rights Commission to one whose Application for a Permit has been granted.

plant use. Station service; the electric power used in a powerplant, for lights, heat, fans, motors, pumps, etc. In large plants it is provided for by separate small generators.

power factor. The ratio of true power in kilowatts (kw) to apparent power in kilovolt-amperes (kva) in an alternating-current circuit, expressed as a percentage.

power output. The amount of power or energy delivered from one generator or the total from a power station.

primary energy. Energy available from firm power.

rpm revolutions per minute. A measure of rotating speed.

run-of-river powerplant. A powerplant that uses the flow of the river as it occurs without benefit of storage.

scrollcase. Spiral waterway of converging aperture that delivers water from a penstock to a turbine, or from a pump to a penstock or pipe.

secondary power. Power that is available only part of the time. Secondary power may be interrupted at the discretion of the producer within limits set out in the power contract. Off-peak power is related to this, but is available during certain hours of low system demands.

sediment reserve space. That part of a reservoir capacity allocated for storage of sediment expected to be deposited over a certain period of time.

storage. Water impounded for supply during periods of low river flow.

synchronous. In order for generators to function together they must be "in step" or synchronous in their voltage cycles.

synchronous condenser. An alternating-current generator "on the line" (connected with transmission lines) but at no load, whose field poles are over-excited to boost transmission line voltages.

tailwater. Water in channel or tailbay below a dam.

Tainter (or tainter or taintor). A certain type of gate patented by Mr. Jeremiah Burnham Tainter in 1886. As a descriptive term the "T" is often used as lower case and in some books the spelling is taintor.

turbine (hydraulic). A machine that transforms the potential energy of water into useful work.

watt. One watt is produced when an electric current of 1 ampere flows at an electromotive force of 1 volt.

MAJOR HYDROELECTRIC POWERPLANTS IN TEXAS

Historical and Descriptive Information

INTRODUCTION

Purpose and Scope

This report compiles historical and descriptive information about the major hydroelectric powerplants in Texas, and presents a record of power generation at each plant where available. Records here are current through December 31, 1967.

Descriptions of 25 powerplants are included. Nineteen of these plants were in operation at the end of 1967, two were under construction, and four had been closed. Descriptions of the four closed plants are included because of their historical value.

Many small hydroelectric powerplants, now closed, were of considerable importance to their owners and operators and to the communities they served, but are not detailed in this report. The better known plants were located as follows:

San Marcos River at San Marcos, Alvord, Martindale, Staples, Fentress, Luling, and Ottine.

Guadalupe River at Kerrville, Center Point, Comfort, New Braunfels, Seguin, and Oak Forest.

Comal River at New Braunfels.

Concho River at San Angelo.

Colorado River at Marble Falls.

Llano River at Llano.

San Antonio River near San Antonio.

San Felipe Creek at Del Rio.

Leon River at Belton.

Lampasas River at Lampasas.

The early settlers used water power to operate grain mills, cotton gins, saw mills, water pumps, and other equipment in many locations, but description of these plants is outside the scope of this report. Many of them are described in *The Water Powers of Texas* (Taylor, 1904).

Organization of Report

Descriptions of major hydroelectric powerplants are given chronologically to show their historical development through December 31, 1967. A list of these powerplants by the year construction began follows the introduction. The record of electrical energy generation at each plant, where available, follows the description of the plant. Photographs of some of the plants are included.

Sources of Data

Information on the water right applicable to each hydroelectric powerplant described was obtained from the files of the Texas Water Rights Commission. Records of hydroelectric power generation for the plants operated by the agency named were furnished by the Brazos River Authority; Central Power and Light Company; Guadalupe-Blanco River Authority; International Boundary and Water Commission, United States and Mexico; Lower Colorado River Authority; and the U.S. Army Corps of Engineers. Other information on the powerplants was obtained from the operating agency and from visits of Water Development Board personnel to the plants. Also, the Sabine River Authority of Texas furnished data on the Toledo Bend project which was under construction at end of 1967.

Personnel

This report was prepared under the general direction of John J. Vandertulip, Chief Engineer. The data were compiled and the text was written by F. A. Godfrey and C. L. Dowell under the immediate supervision of S. D. Breeding.

Major hydroelectric powerplants in Texas through December 31, 1967

(Listed in chronological order by year construction was started)

DESCRIP-TION NO.	HYDROELECTRIC POWERPLANT	PAGE NO.	OWNER	RESERVOIR	STREAM	RIVER BASIN	YEAR CONSTRUCTION STARTED	YEAR CONSTRUCTION COMPLETED	GENERATING CAPACITY (KW)
1	Austin	4	City of Austin* do* Lower Colorado River Authority, Lessee*	Lake McDonald Lake Austin do	Colorado do do	Colorado do do	1890 1911 1937	1893 1915 1939	5,227(hp) 6,000(hp) 13,500
2	Cuero[1]/	10	Central Power and Light Company	--	Guadalupe	Guadalupe	1896	1898	1,100
3	Gonzales[2]/	16	do	--	do	do	1925	1925	1,200
4	Dunlap (TP-1)	19	Guadalupe-Blanco River Authority	Lake Dunlap	do	do	1927	1928	3,600
5	McQueeney (TP-3)	22	do	Lake McQueeney	do	do	1927	1928	2,800
6	Nolte (TP-5)	26	do	Lake Nolte	do	do	1927	1927	2,480
7	Devils Lake[3]/	30	Central Power and Light Company	Devils Lake	Devils	Rio Grande	1927	1928	1,800
8	Lake Walk[3]/	34	do	Lake Walk	do	do	1928	1929	1,350
9	H-4 Dam	38	Guadalupe-Blanco River Authority	H-4 Reservoir	Guadalupe	Guadalupe	1929	1931	2,400
10	H-5 Dam	41	do	H-5 Reservoir	do	do	1929	1931	2,400
11	Seguin (TP-4)	44	do	TP-4 Reservoir	do	do	1930	1932	2,400
12	Buchanan	48	Lower Colorado River Authority	Lake Buchanan Authority	Colorado	Colorado	1931	1938	33,750
13	Eagle Pass	53	Central Power and Light Company	Canal	Rio Grande	Rio Grande	1931	1932	9,600
14	Red Bluff	58	Red Bluff Water Power Control District	Red Bluff	Pecos	do	1934	1937	2,300
15	Inks	59	Lower Colorado River Authority	Inks Lake	Colorado	Colorado	1936	1938	12,500
16	Marshall Ford	62	do	Lake Travis	do	do	1937	1942	67,500
17	Morris Sheppard	66	Brazos River Authority	Possum Kingdom	Brazos	Brazos	1938	1941	22,500
18	Denison	70	U.S. Army Corps of Engineers	Lake Texoma	Red	Red	1939	1943	70,000

See footnotes at end of table.

Major hydroelectric powerplants in Texas through December 31, 1967--Continued

DESCRIPTION NO.	HYDROELECTRIC POWERPLANT	PAGE NO.	OWNER	RESERVOIR	STREAM	RIVER BASIN	YEAR CONSTRUCTION STARTED	YEAR CONSTRUCTION COMPLETED	GENERATING CAPACITY (KW)
19	Whitney	74	U.S. Army Corps of Engineers	Whitney	Brazos	Brazos	1947	1951	30,000
20	Granite Shoals	77	Lower Colorado River Authority	Lake Lyndon B. Johnson	Colorado	Colorado	1949	1951	45,000
21	Marble Falls	80	do	Marble Falls Lake	do	do	1949	1951	30,000
22	Falcon	83	International Boundary and Water Commission	International Falcon	Rio Grande	Rio Grande	1950	1954	31,500
23	Sam Rayburn (McGee Bend)	86	U.S. Army Corps of Engineers	Sam Rayburn	Angelina	Neches	1956	1966	52,000
24	Amistad	89	International Boundary and Water Commission	Amistad	Rio Grande	Rio Grande	1963	under construction	80,000
25	Toledo Bend	90	Sabine River Authorities of Texas and Louisiana	Toledo Bend	Sabine	Sabine	1964	under construction	83,000
				Total active generating capacity December 31, 1967.....					436,230 kw

*Same project site. First dam and powerplant destroyed by flood April 7, 1900.
1/ Discontinued October 1965.
2/ Discontinued November 1965.
3/ Discontinued December 1965.

DESCRIPTIONS OF HYDROELECTRIC POWERPLANTS

1. Austin Hydroelectric Powerplant

Location

Austin Hydroelectric Powerplant is at Tom Miller Dam (Lake Austin) on the Colorado River at Austin, Travis County.

Ownership and History of Development

The powerplant is owned by the city of Austin and is operated by the Lower Colorado River Authority under a term lease as one of a series of six hydroelectric powerplants on the Colorado River and is the sixth and lowest in elevation of the series. The other five are Buchanan, Inks, Granite Shoals, Marble Falls, and Marshall Ford Hydroelectric Powerplants. All of these were built and are operated by the Lower Colorado River Authority and are described in this report (Clay, 1948; Dowell and Breeding, 1967).

Lake Buchanan is the upstream project and was the first built (1938) including significant storage to sustain river flow for power generation at the downstream powerplants. Additional storage is provided by Lake Travis. The provision of this upstream storage made feasible the reconstruction of the Austin Dam and Hydroelectric Powerplant.

The present (1968) project was constructed under authority of the water right claimed by the city of Austin under Certified Filing No. 330 filed June 30, 1914, with the State Board of Water Engineers. Prior rights were said to be established before 1890 when the first Austin Dam was started. The prior water rights renewed by this certified filing were for the purposes of furnishing water, lights, and power to the inhabitants of Austin and State institutions; appropriating the flow and underflow and the storm and rainwaters of the Colorado River; and storing the flood and rainwaters of the Colorado River for generating power, for domestic uses, and for general municipal and State purposes. The certified filing further states that water may be diverted from the river or sand beaches at various places along the riverbank for domestic purposes and for general municipal and State uses through certain filtration systems located upon a described "Sandy Beach Reserve."

The history of attempts to develop the water and hydropower resources of the Colorado River of Texas is long, varied, and sometimes tragic. A summary of this history is found in the book *Flood to Faucet,* by Walter E. Long (1956).

Navigation was a primary concern in early days—on a river plagued by floods and log jams which effectively prevented navigation.

A State program was impossible on a State gross budget of $115,372 per annum (1851). Federal aid of $20,000 (1853) was expended to clear the log jams and a period of navigation existed from 1854 to 1860.

The War Between the States practically stopped the navigation program and the log jams built up again. The railroads came to Austin on Christmas Day, 1871, and the railroad era stopped all serious attempts to renew river navigation. But the flood problem remained.

Construction of the Austin Dam and Hydroelectric Powerplant was begun by the city of Austin November 5, 1890, and was completed May 2, 1893, at a cost of over one million dollars. The dam was 60 feet high with a total length of 1,275 feet, with an overflow crest 1,091 feet long, and was said to be the largest masonry dam in the world across a flowing stream (Figure 1). Elevation of overflow crest was 490.0 feet above msl (mean sea level) as described by McDonough (1940). The reservoir formed by the dam was named Lake McDonald in honor of the then mayor of Austin and the dam was known as the Austin Dam until 1937 when its name was changed to the Tom Miller Dam in honor of another Austin mayor. Lake McDonald was one of the first man-made lakes in the nation with a length of over 30 miles. This dam and reservoir provided no effective flood control, however.

The first Austin Hydroelectric Powerplant was designed on an assumption that the minimum flow of the Colorado River at the site would be 1,000 cfs (cubic feet per second). On the basis of this assumed minimum flow, a continuous supply of hydroelectric power amounting to 5,227 hp (horsepower) was to be available for a gross head of 60 feet and net head of 57.5 feet. This expectation of continuous power production was not reached as the river flow was much less than 1,000 cfs many times during the short life of this first Austin Dam (Taylor, 1900).

On April 7, 1900, floodwater destroyed nearly one-half of the Austin Dam and part of the hydroelectric powerplant (Taylor, 1900, p. 42-44).

On September 22, 1911, the city of Austin entered into a contract with William D. Johnson to

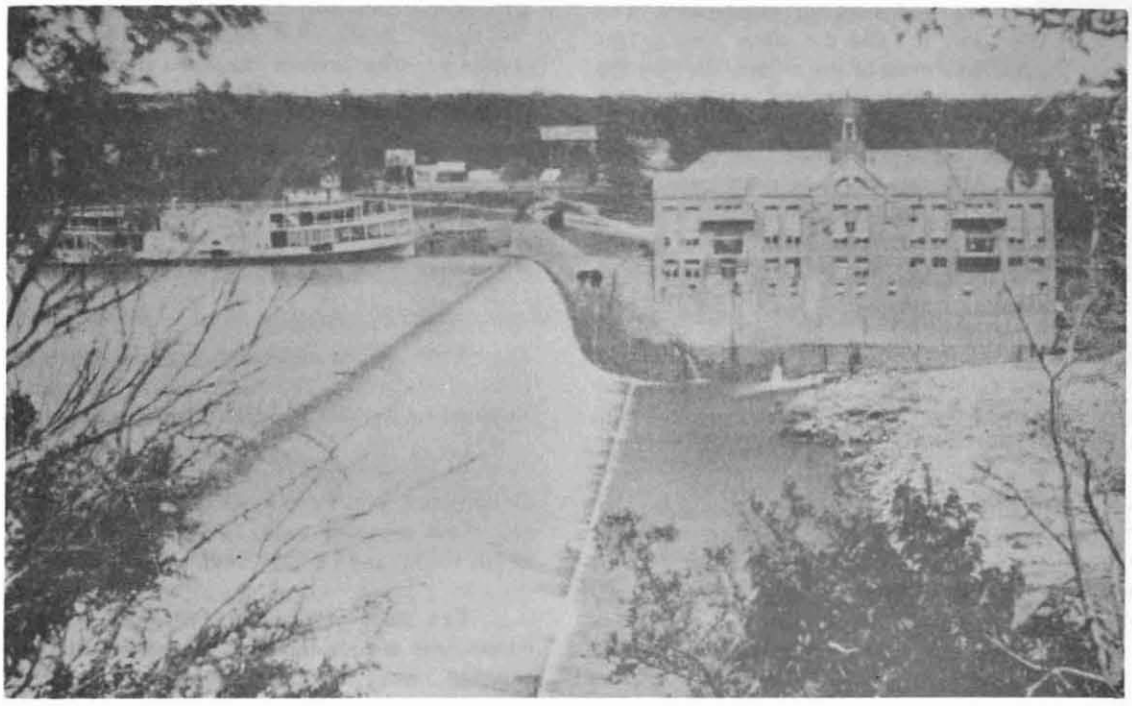

Figure 1.--Austin Dam and Hydroelectric Powerplant before 1900 (Mead, 1917). The excursion boat Ben Hur is in upper left. The dam and powerplant were partly destroyed by flood April 7, 1900.

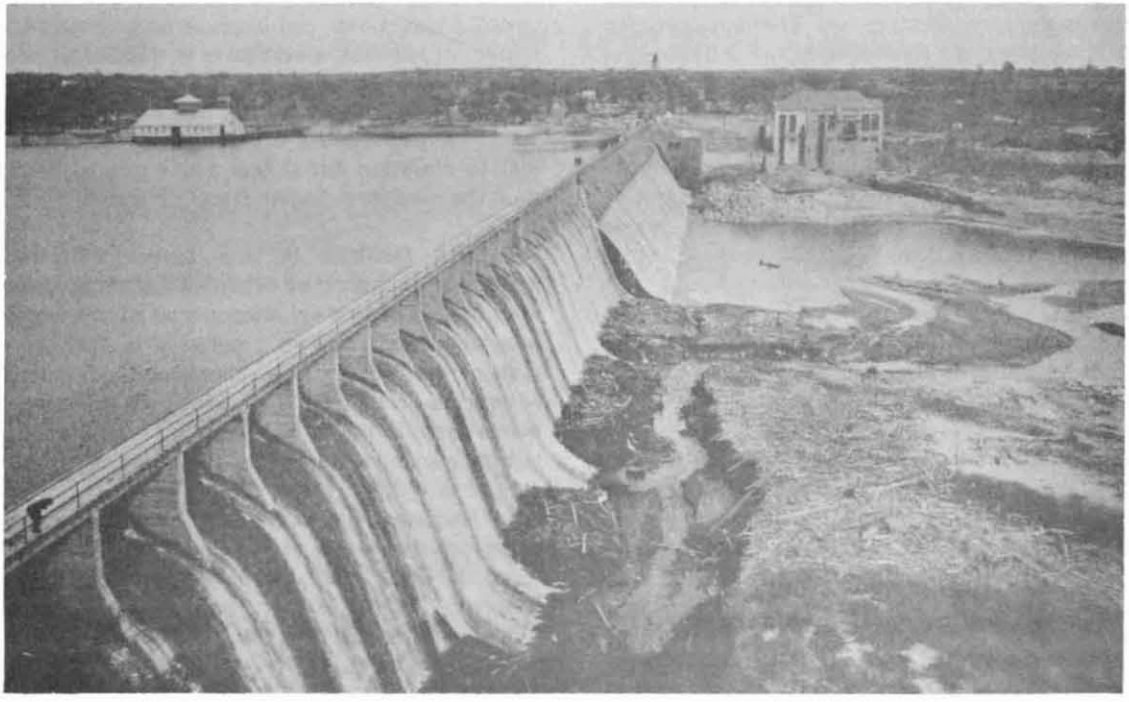

Figure 2.--Austin Dam and Hydroelectric Powerplant in 1915, after reconstruction and before the September 1915 flood (Mead, 1917).

rebuild the dam and hydroelectric powerplant. The reconstructed dam was to raise the water level 5 feet higher than the spillway crest of the original dam by the use of floodgates. In rebuilding the dam about one-half of the old masonry dam was used with automatic wooden floodgates 6 feet high installed on the crest. The rebuilt part of the dam was concrete with crest 9 feet lower than crest of the old dam. Automatic wooden floodgates 15 feet high were installed on top of this concrete section (Mead, 1917). The contract required Johnson also to supply the equipment of the powerplant to include three vertical turbines of not less than 2,400 hp each when operating under a head of 60 feet; three 6,600 volt, 3-phase, 60-cycle electric generators to be directly connected to the 2,400 hp vertical turbines and capable of generating not less than 6,000 hp of electrical energy; and two direct current exciting generators of such capacity that either one shall be able to furnish the necessary full load exciting current for all three of the 3-phase generators (Mead, 1917, p. 58). (The rebuilt powerplant was not accepted by the city of Austin and was never operated to supply power).

Johnson in turn assigned the contract to the City Water Power Company, which sublet it to the William P. Carmichael Company, which started work on the project almost immediately.

Floodwater in 1913 did much damage to the reconstruction contractor's coffer dams on the project. Reconstruction was nearly complete when, in September 1915, a flood destroyed 20 of the large automatic crest gates and most of the small ones. The tailrace at the powerplant was filled with rock, gravel, and debris, effectively plugging the draft tubes. The reconstructed dam and powerplant are shown in Figure 2 before the September 1915 flood.

The contractor and the city of Austin were in controversy over the contractor's failure to complete the contract to the satisfaction of the city and the city's refusal to accept responsibility. Thus came to an end this first effort to rebuild the dam.

The dam was damaged further by the great flood of June 15, 1935, which destroyed most of the remaining gates and gate piers, and part of the concrete ogee spillway.

Reconstruction of the old dam into the present (1968) dam and powerplant was started in 1937 by the Lower Colorado River Authority, and generation of electricity began March 31, 1940. The uncontrolled spillway crest of present dam is 2.8 feet higher than spillway crest of the dam that failed in 1900. The Austin Dam was renamed Tom Miller Dam in 1937 and was dedicated April 6, 1940, just one day less than 40 years after the original dam was destroyed by flood in 1900. The name "Austin Hydroelectric Powerplant" has been continued. The present dam and hydroelectric powerplant are shown in Figure 3.

Physical Description

Two 6,750 kw capacity generators at Austin Hydroelectric Powerplant provide a total capacity of 13,500 kw.

Each of the vertical generators is a 6,750 kw, 3 phase, 60 cycle, 11,500 volt, 200 rpm unit manufactured by the Westinghouse Electric Corporation.

Each of the turbines is a Newport News Shipbuilding and Drydock Company automatic adjustable blade propeller type, 200 rpm unit with a capacity of 10,500 hp at 64.8-foot head.

The two turbines at the Austin Hydroelectric Powerplant are equipped with mechanically automatic-adjusted blades for the purpose of getting the greatest output of power for any gate position. This is obtained by a cam arranged on a wicket gate arm in such a way that a sliding collar on the vertical turbine shaft will move vertically with changes of wicket gate openings on the turbine. The sliding collar carries with it a shaft inside the hollow turbine shaft and is connected to a mechanism that rotates the blades of the turbine runner to the required angle.

Design headwater elevation for the powerplant is at 492.8 feet above msl (crest of uncontrolled spillway); minimum tailwater elevation is at 428.0 feet above msl, giving a gross head of 64.8 feet.

The powerhouse is water sealed (to prevent flooding) to elevation 476.0 feet above msl, which is higher than the maximum known flood stage at this site.

The facilities of the Lower Colorado River Authority, including an extensive system of transmission lines, have become an integral part of the South Texas interconnected system, comprising private power systems as well as large municipal and other public enterprises. The Lower Colorado River Authority powerplants provide power not only for local consumption, but for peaking loads of interconnected systems.

Records of gross monthly generation of electrical energy at the Austin Hydroelectric Powerplant for the years 1943-67 have been furnished by the Lower Colorado River Authority and are given in the table following. Records for the years before 1943 are not available.

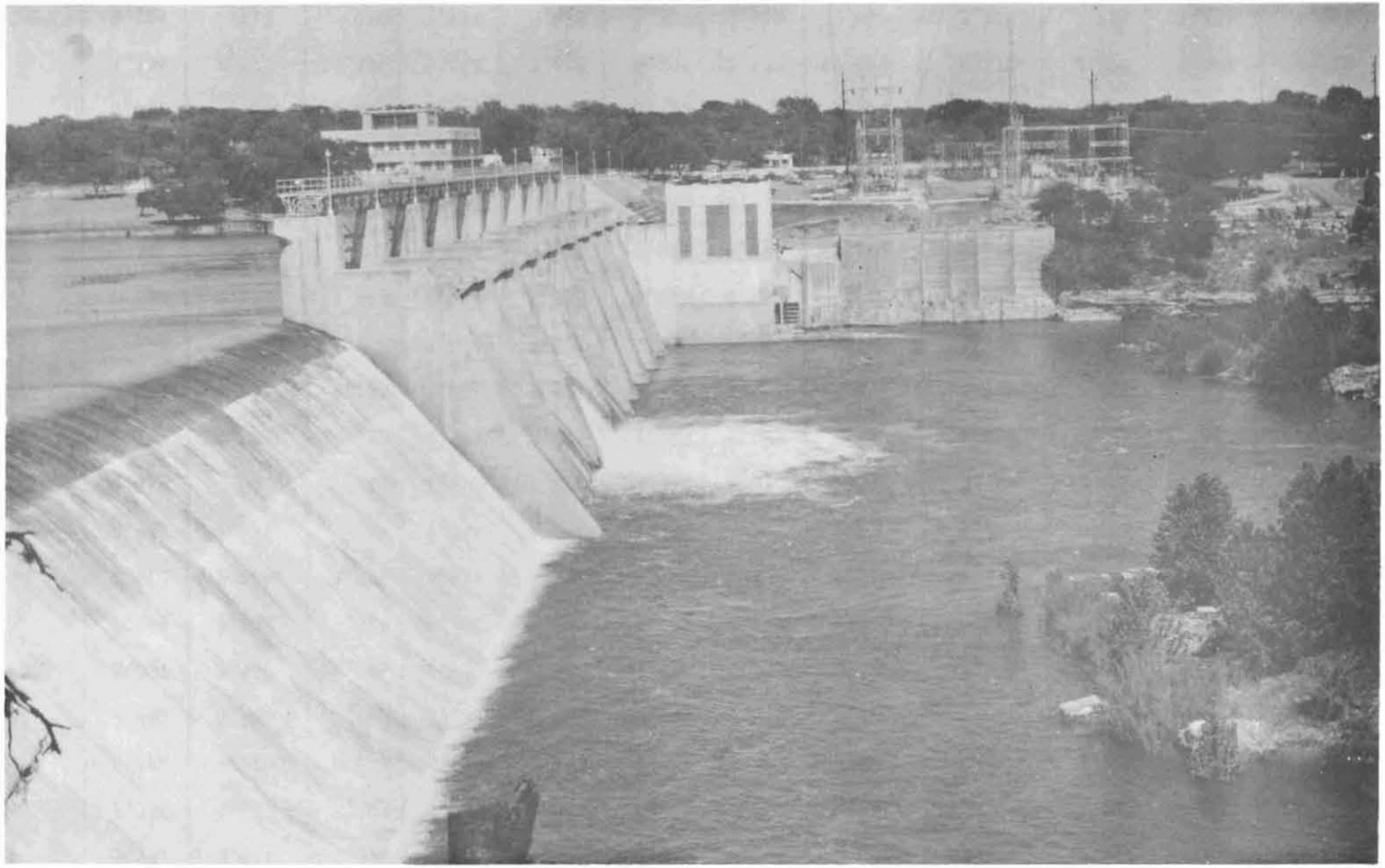

Figure 3.--Tom Miller Dam and Austin Hydroelectric Powerplant after reconstruction in 1939.
Courtesy of Lower Colorado River Authority.

Gross generation of electrical energy at Austin Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1943	8,591	6,940	6,276	7,937	6,400	6,816	5,984	5,874	2,768	4,343	3,678	4,239	69,846
1944	3,797	3,531	2,975	3,235	5,128	7,644	9,504	8,837	8,178	7,522	4,402	6,143	70,896
1945	5,331	5,567	6,203	6,522	6,901	6,108	9,192	6,721	7,708	6,028	6,554	6,382	79,217
1946	6,192	4,124	4,823	5,136	7,443	6,044	5,851	8,754	7,252	7,249	5,926	6,420	75,214
1947	7,742	6,496	6,067	4,121	5,368	6,643	6,938	6,022	4,378	3,343	3,357	2,715	63,190
1948	3,071	3,368	2,705	2,990	3,998	5,676	6,265	6,286	3,404	2,611	1,907	1,873	44,154
1949	1,965	1,802	3,524	3,168	3,572	5,574	6,270	5,825	4,584	3,749	3,690	3,476	47,199
1950	2,418	2,264	1,936	1,931	4,558	4,562	5,486	4,834	2,431	1,283	1,648	1,947	35,298
1951	2,463	1,621	404	1,834	4,698	4,234	5,766	5,236	1,736	734	475	532	29,733
1952	459	430	463	1,152	2,898	4,845	4,836	4,835	2,368	662	539	572	24,059
1953	2,149	2,487	833	2,550	3,836	5,468	5,482	3,888	1,047	655	421	857	29,673
1954	939	231	1,114	3,051	5,926	6,111	6,447	4,616	1,283	651	598	620	31,587
1955	620	1,022	1,255	2,800	4,875	8,590	7,863	6,159	4,177	5,946	4,792	1,498	49,597
1956	850	1,274	1,363	2,932	6,856	6,074	6,372	4,416	1,500	556	320	360	32,873
1957	344	317	356	2,480	9,371	9,606	10,114	7,444	6,553	8,430	10,821	10,902	76,738
1958	9,888	7,585	11,162	10,678	10,039	10,341	10,619	8,291	4,383	3,631	1,856	744	89,217
1959	2,098	1,739	1,820	4,247	6,828	4,897	6,474	9,638	7,241	9,346	10,220	10,165	74,713
1960	9,059	7,129	8,962	8,719	8,186	8,130	7,873	5,701	3,293	2,752	884	456	71,144
1961	1,206	7,699	10,496	9,288	7,008	6,702	10,171	10,047	6,272	2,206	8,002	8,729	87,826
1962	4,503	553	416	1,111	4,418	5,201	5,725	5,064	2,366	485	1,136	1,699	32,677
1963	1,420	1,600	381	2,924	4,752	5,633	5,367	5,106	3,971	389	0	8	31,551
1964	35	4	0	3,202	4,724	5,045	4,770	3,614	2,959	159	14	30	24,556

Gross generation of electrical energy at Austin Hydroelectric Powerplant, in Megawatthours--Continued

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1965	212	616	164	1,976	6,761	10,518	4,963	4,162	3,475	1,939	4,561	4,488	43,835
1966	1,508	107	338	5,148	9,971	6,098	5,347	3,704	2,974	1,447	1,664	35	38,341
1967	0	425	1,682	5,123	6,220	6,434	4,228	6,197	2,984	224	162	72	33,751
Total	76,860	68,931	75,718	104,255	150,735	162,994	167,907	151,271	99,285	76,340	77,627	74,962	1,286,885
Monthly and annual average 1943-67	3,074	2,757	3,029	4,170	6,029	6,520	6,716	6,051	3,971	3,054	3,105	2,999	51,475
Monthly average in percent of annual average 1943-67	6.0	5.4	5.9	8.1	11.7	12.7	13.0	11.8	7.7	5.9	6.0	5.8	100

2. Cuero Hydroelectric Powerplant

Location

Cuero Hydroelectric Powerplant was on the Guadalupe River 5 miles north of Cuero, DeWitt County.

Ownership and History of Development

The Cuero Hydroelectric Powerplant was shut down October 20, 1965, by owner, the Central Power and Light Company. The story of this plant is included in this report because its operation was typical of many early small run-of-river powerplants.

The following document brings to light many of the problems experienced in the early days of the power business in Texas. O. T. McAlister wrote this history, evidently in 1948. The original document was on the wall of the office at the Cuero Hydroelectric Powerplant of the Central Power and Light Company. H. A. Taylor of Cuero supplied a copy of the document, which reads as follows:

> A stock company was organized by the principle business men of Cuero in the early part of 1891. The purpose of this company was to build a light [plant] to furnish lights to the town of Cuero. This company was given the name of Cuero Light and Power Company. The plant consisted of low pressure boilers fired by wood, of which there was an abundance near the edge of town, a slide valve steam engine, and a Heisler dynamo. This was a series system generating 1100 volts.
>
> This plant was operated in this manner until the early part of 1896 when the Buchel Power and Irrigation Company was organized for the purpose of developing a hydro-electric plant on the Guadalupe River for power and irrigating purposes. The original dam of the Buchel Power and Irrigation Company was constructed at a cost of approximately one hundred thousand dollars. The Cuero Light and Power Company then offered to sell its holdings to the promoters of the Buchel Power and Irrigation Company, but it being old and obsolete, it is said by their manager who is yet living in Cuero [1948], that the Buchel Power and Irrigation Company offered them practically nothing—which was said to be practically what it was worth—and they installed "The Warn", a multiple system. This was the first alternating current that Cuero ever knew.
>
> This gave Cuero some better electric service. In March 1898, the Buchel Power and Irrigation Company energized their lines which were built parallel and on opposite sides of the street to those of the Cuero Light and Power Company. These two companies operated at that time in sharp competition to each other. The Cuero Light and Power Company was then issuing assessments each month to supplement their earnings to pay the operating expenses. This information was given to us by the manager of the Cuero Light and Power Company, and one of the stockholders who is living in Cuero today [1948]. This continued for a period of twelve months when the Cuero Light and Power Company sold its holdings to the Buchel Power and Irrigation Company, at which time the Buchel Power and Irrigation Company [installed] a higher rate which they conceived to be a reasonable rate and one under which they could exist. They also promised to install an auxiliary steam plant to ensure good service when the river was high enough to render it impossible to run the hydro plant. The Buchel Power and Irrigation Company then installed a steam plant with approximately 300 H.P. [horsepower] capacity.
>
> At this time the Buchel Power and Irrigation Company's machinery consisted of two new American Turbine Wheels, with a ten foot working water pressure which gave them approximately 400 H.P., water power, and a steam plant consisting of one Lane Bodly Corliss engine with 300 H.P. capacity.
>
> The first lighting meter contract was signed by the Buchel Power and Irrigation Company in 1900. This was for fifteen C.P. [candlepower] lights or its equivalent, the rate being 15¢ per K.W.H. straight, with a minimum of $2.50 per month plus 25¢ meter rental. Such contracts must be signed for twelve months. During this year the Buchel Power and Light Company got into the power business and made a contract with the Cuero Cotton Mills to furnish power at $19.00 per H.P., per year consisting of 306 working days. They also made power contracts at ¾¢ per mechanical H.P. At this time the city was served on a flat rate of $2.25 for three-16 C.P. [candlepower] lights. All over three lamps became cheaper, being 25¢ each per month. There was also an agreement that they should burn the lights only until midnight.
>
> In 1903, the penstocks were enlarged, three fifty inch Samson turbines were added to increase the power, also at the same time, two feet were added to the crest of the dam. This added height proved to be a very expensive experiment as the additional fall of water undermined the foundation of the dam and was only stopped at great expense by shipping in stone and filling in the hole.

In 1905 there was a day service during the hot summer months for a circuit that ran up town during the fan season. This was the first twenty-four hours per day service that was ever known in Cuero.

In the spring of 1908, the plant was burned to the water's edge.

When W. M. Ratcliffe and his associates bought the dam site in July 1908 he organized a corporation under the name of Cuero Light and Power Company, and revamped the old plant, starting the plant again on December 28, 1908. This company immediately put in a meter system all over Cuero and from that day on, Cuero has operated on a meter system, twenty-four hours a day. They at that time, made a minimum charge of $1.25 and 25¢ meter rental. This continued under this management until 1914 during which time various power contracts were signed, the lowest having been with the present Guadalupe Valley Cotton Mills, at .0134 per K.W.H. [1.34 cents per K.W.H.]. This rate was in effect for about five years and was raised to .02½ per K.W.H. [2½ cents per K.W.H.] with a rigid fuel clause.

In 1911 this same company installed three fifty-six inch Samson Turbines to replace the American Wheels and at the same time raised the crest of the dam, three feet, three inches, making a total height of the dam fifteen feet, three inches.

In 1914 the property was purchased by the Texas Southern Electric Company, which company built a concrete penstock [wheelpit] at a cost of approximately $30,000.00 and was reorganized as the Texas Gas and Electric Company. This company owned the following properties: Cuero, Memphis, Childress, Claredon, Yorktown, Victoria, Beeville, Kingsville, Bishop, Wharton, Del Rio, Center, and Vernon. On February 24, 1920, the Texas Gas and Electric Company went into the hands of receiver. The receiver immediately raised the rates to 20¢ per K.W.H. and minimum of $2.00. They operated this plant at this rate for about twenty months after which time it was sold under the hammer to Morrison and McCall.

A few weeks after Morrison and McCall had acquired this property and during an extreme high river, a barrage of driftwood, several miles long, landed against the dam and pushed off a section, seven feet-eight inches high which left the water plant without any power. Morrison and McCall then operated their steam plant which, at this time, consisted of one 500 H.P. Bates Corliss Engine, and 450 [horsepower] boiler capacity, and gave Cuero an uninterrupted electric service. Arrangements were quickly made, and a section of reinforced concrete was anchored on top of this masonry, and in less than sixty days the plant was operating better than ever.

Again on April 3, 1922, during another period of high water, the flood water cut around the west end of the dam, opening up a new channel one hundred and twenty-five feet wide.

The present dam was then extended across this new channel, which doubled the length of the dam; thus proportionately increasing its stability and safety. The water-wheels and generating units of the station were replaced by larger and more modern equipment which included three Allis-Chalmers Umbrella Type Generators.

Morrison and McCall operated this property until it was taken over as a subsidiary of Middle West Utilities in July, 1925. This company immediately began to entrench itself more substantially in the larger towns and to spread its wings of high lines [high voltage transmission lines] and distribution systems until it is now hovering and nurturing, by dependable and unlimited electric service, every village and town within anything like a reasonable distance.

Cuero, itself, has grown from a very insignificant series system light plant, until now it is the center of a network of high lines [high voltage lines]. We have a connected load in power and light of 2130.2 K.W. (kw) and are distributing over our lines approximately 200,000 K.W.H. per month. Almost 100% of our people are satisfied with the service that they are getting and are continually complimenting and praising our service. A great percent of them also are satisfied with the rates.

The names of the electric light companies of Cuero have been changed many times. It first operated under the name of Cuero Light and Power Company, then Buchel Power and Irrigation Company, Texas Southern Electric, Texas Gas and Electric Company, Texas Central Power Company, and now Central Power and Light Company.

(Signed) O. T. McAlister (1948)

The electric distribution system of Cuero and surrounding rural area is now owned by the city of

Cuero. Electric requirements are purchased from Lower Colorado River Authority through delivery contracts with Central Power and Light Company.

The Cuero hydroelectric powerplant was typical of early Texas power developments in being a low-head run-of-river installation. The flow of the river at the Cuero plant was partly regulated by releases from Canyon Reservoir near New Braunfels after impoundment of water in that reservoir began June 16, 1964.

A special act of the Texas Legislature granted the Cuero Light and Power Company (now owned by the Central Power and Light Company) a 50-year lease effective January 1, 1914, to all water rights in and to the Guadalupe River, in DeWitt County, belonging to the State of Texas. The lease was granted "provided the Company will not construct a greater number of dams in said river than is sufficient to generate 1,800 horsepower."

The Cuero plant, because of its small capacity, was shut down October 20, 1965, by the Central Power and Light Company, which became owner of the plant under that name when the company was formed from Texas Central Power Company on June 11, 1926.

At the time of shutdown, the capacity of the Cuero plant was 1,100 kw. This capacity was so small compared to the system capacity that it was no longer economical to operate the powerplant.

Physical Description

Each of the three vertical generators was a 375 kw, 3 phase, 60 cycle, 2,300 volt, 200 rpm unit manufactured by Allis-Chalmers Manufacturing Company (Figure 4). Each of the three vertical turbines manufactured by Allis-Chalmers Manufacturing Company was a fixed blade, propeller type, 200 rpm unit with a capacity of 550 hp at 15-foot head. The turbines were controlled by Allis-Chalmers governors. The turbines were located in an open wheelpit with the flow of water from the forebay controlled by headgates protected by trashracks.

The design gross head at the Cuero plant was 15 feet, and the design water discharge per unit was 360 cfs.

Records of gross monthly generation of electrical energy at the Cuero Hydroelectric Powerplant for the period January 1929 to October 1965 have been furnished by the Central Power and Light Company and are given in the table following. Records for years before 1929 are not available.

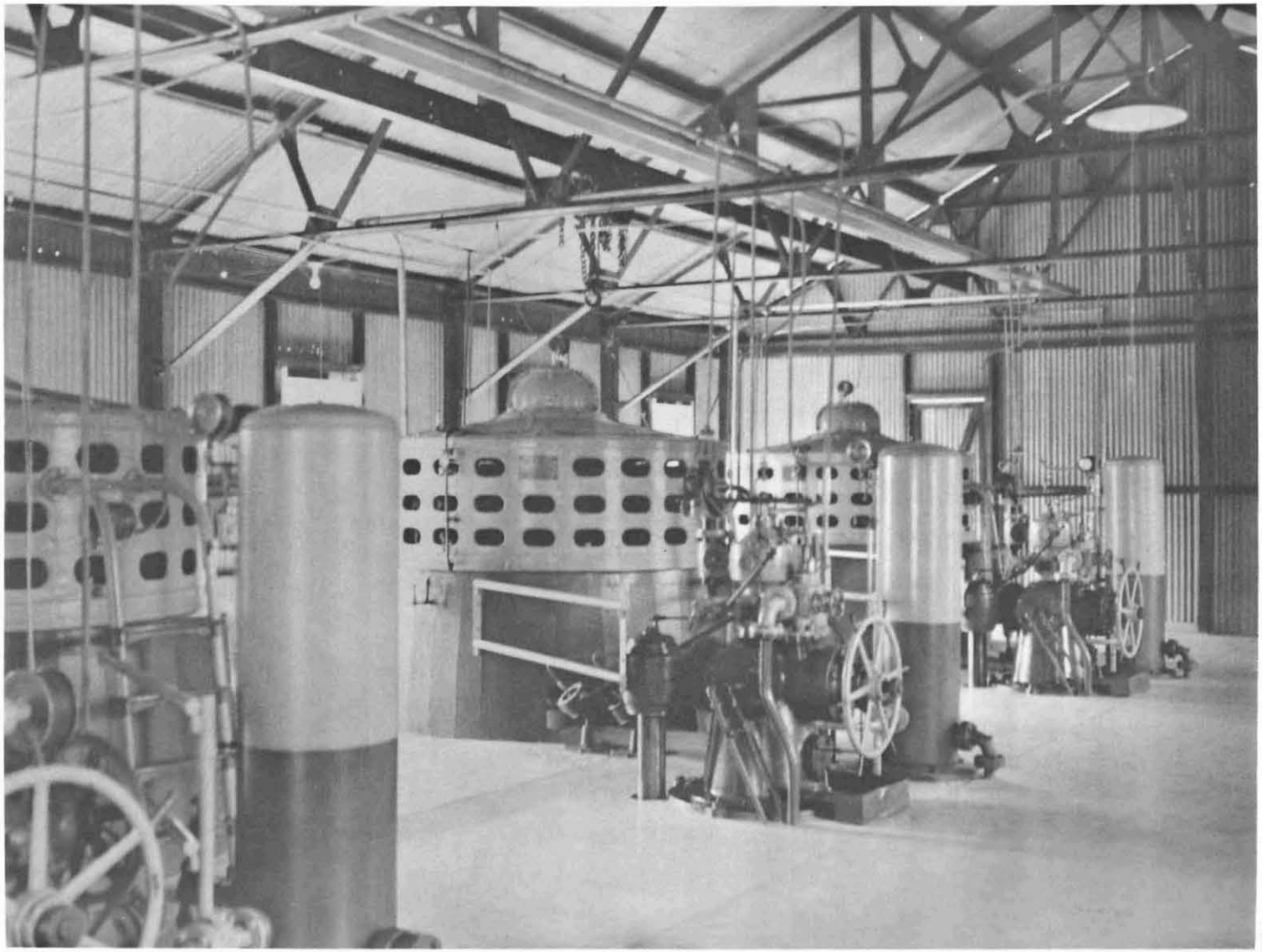

Figure 4.--Cuero Hydroelectric Powerplant, June 1964.

Gross generation of electrical energy at Cuero Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1929	310	284	256	320	342	342	470	463	305	214	356	336	3,998
1930	346	351	295	315	375	438	382	240	197	393	397	383	4,112
1931	377	504	433	596	474	569	459	378	248	268	280	346	4,932
1932	397	424	524	470	446	371	432	480	448	482	399	373	5,246
1933	510	494	417	439	384	410	243	325	336	282	263	255	4,358
1934	383	518	360	540	443	326	219	321	233	231	281	340	4,195
1935	327	340	313	350	252	228	535	549	420	460	543	454	4,771
1936	520	496	472	431	386	413	105	510	442	332	562	555	5,224
1937	595	602	446	574	486	442	490	350	311	319	336	388	5,339
1938	344	505	510	444	207	551	450	382	330	286	333	333	4,675
1939	394	371	310	319	365	291	300	224	199	251	279	272	3,582
1940	287	327	304	410	360	413	387	213	182	225	283	218	3,609
1941	509	424	372	448	71	254	479	547	513	543	524	477	5,161
1942	454	453	374	400	523	520	362	442	400	441	572	582	5,532
1943	580	534	436	530	405	519	400	358	376	346	329	344	5,157
1944	471	523	426	585	522	408	558	421	489	454	444	502	5,803
1945	488	474	452	403	592	576	490	390	350	509	419	451	5,594
1946	499	498	448	576	545	543	445	332	384	429	455	520	5,674
1947	460	551	504	556	586	509	463	374	356	304	322	355	5,340
1948	346	386	351	307	358	257	383	183	202	220	222	229	3,443
1949	261	315	374	364	432	509	371	348	302	276	382	373	4,307
1950	368	423	320	367	390	382	307	212	201	199	196	219	3,584

Gross generation of electrical energy at Cuero Hydroelectric Powerplant, in Megawatthours--Continued

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1951	235	240	211	284	277	332	172	101	134	136	159	178	2,459
1952	177	187	173	244	217	334	240	93	201	388	300	412	2,966
1953	458	418	338	310	365	202	165	130	343	245	336	353	3,663
1954	325	277	203	223	251	146	58	32	44	41	98	110	1,808
1955	148	210	174	144	179	218	97	82	45	25	28	91	1,441
1956	94	119	66	50	78	6	3	3	2	0	2	102	525
1957	36	128	300	230	373	373	336	158	119	315	383	552	3,303
1958	402	369	404	537	412	531	526	371	384	560	518	567	5,581
1959	536	492	528	378	490	412	481	368	315	429	498	510	5,437
1960	568	537	547	509	453	290	522	480	488	245	332	456	5,427
1961	360	302	533	571	519	345	507	484	368	437	407	543	5,377
1962	430	380	388	397	349	372	246	133	311	328	308	398	4,040
1963	342	326	333	348	262	187	154	85	99	128	230	244	2,738
1964	244	348	389	302	222	254	134	108	267	384	373	280	3,305
1965	248	154	396	405	195	265	280	106	105	65	--	--	2,219
Total	13,830	14,284	13,689	14,674	13,586	13,538	12,651	10,775	10,449	11,190	12,149	13,101	153,916
Monthly and annual average 1929-64	377	393	369	396	372	369	344	296	287	309	338	364	4,214
Monthly average in percent of annual average 1929-64	9.0	9.3	8.8	9.4	8.8	8.8	8.2	7.0	6.8	7.3	8.0	8.6	100

3. Gonzales Hydroelectric Powerplant

Location

Gonzales Hydroelectric Powerplant was on the Guadalupe River at Gonzales, Gonzales County, 1.5 miles downstream from the mouth of San Marcos River.

Ownership and History of Development

The first Gonzales hydroelectric plant was built in 1891-92, with a dam providing a head of 9 feet to two 60-inch, one 66-inch, and one 72-inch turbine. A total of 400 hp was developed and used for a cotton gin, gristmill, electric-light plant, and the pumps for the water system. This dam was washed out and a larger concrete dam was constructed at the same site in 1914-17. The new dam provided a gross head of about 15 feet for the turbines.

Texas Central Power Company (now the Central Power and Light Company) acquired the plant from Spooner and Lewis in 1925, constructed a new building, turbine pits, and other facilities, and installed modern turbines and generators for hydroelectric power production. Central Power and Light Company is the owner of water rights of Certified Filing No. 571. The plant was shut down by the owner in November 1965 because of its small capacity.

The Gonzales plant operated on the natural flow of the river until impoundment of water in Canyon Reservoir began June 16, 1964. After that date, the flow of the river was partly regulated by releases from Canyon Reservoir.

Physical Description

Each of the three vertical generators was a 400 kw, 3 phase, 60 cycle, 2,300 volt, 200 rpm unit manufactured by Westinghouse Electric Corporation.

Each of the three vertical turbines was an H. P. Leffel Company, Francis type, 200 rpm unit with a capacity of 500 hp at 15-foot head. The turbines were controlled by Woodward governors.

Records of gross monthly generation of electrical energy at the Gonzales Hydroelectric Powerplant for the period January 1929 to November 1965 have been furnished by the Central Power and Light Company and are given in the table following. Records of generation prior to 1929 are not available.

Gross generation of electrical energy at Gonzales Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1929	275	251	242	309	321	233	475	435	347	277	325	302	3,792
1930	301	230	262	282	348	384	334	205	179	336	345	335	3,541
1931	346	458	444	445	290	540	484	369	289	239	271	371	4,546
1932	383	412	526	431	462	348	412	444	408	443	370	355	4,994
1933	493	453	401	420	360	390	236	310	321	268	254	239	4,145
1934	338	490	361	488	387	308	218	288	210	189	244	240	3,761
1935	242	318	266	283	301	271	478	467	403	433	453	406	4,321
1936	474	440	413	388	361	424	215	514	399	338	526	547	5,039
1937	550	554	423	533	431	408	462	330	298	313	363	415	5,080
1938	538	548	538	475	337	578	444	407	373	328	355	355	5,276
1939	412	385	336	337	369	298	301	265	228	272	297	280	3,780
1940	314	329	309	399	374	426	412	275	236	220	284	323	3,899
1941	561	454	428	400	150	399	516	576	525	547	524	472	5,552
1942	468	454	378	435	553	507	376	423	386	413	543	585	5,521
1943	584	515	435	520	405	499	406	360	394	352	344	352	5,166
1944	468	565	428	566	505	390	541	421	473	467	440	480	5,744
1945	529	447	409	394	560	592	466	402	368	526	458	490	5,541
1946	549	569	493	556	518	520	433	352	388	403	458	505	5,744
1947	462	559	535	544	552	490	427	368	303	288	310	335	5,173
1948	341	357	334	300	312	253	364	160	207	226	225	232	3,311
1949	258	303	361	367	446	480	366	331	291	250	371	338	4,162
1950	339	402	314	346	396	372	294	196	209	211	190	211	3,480

Gross generation of electrical energy at Gonzales Hydroelectric Powerplant, in Megawatthours--Continued

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1951	227	231	201	270	259	310	161	102	138	138	134	149	2,349
1952	172	175	160	231	196	312	180	94	193	349	270	403	2,735
1953	465	394	309	288	329	165	147	110	328	238	306	316	3,395
1954	292	255	186	182	208	72	59	38	30	49	109	122	1,602
1955	146	188	155	125	173	171	98	68	43	38	35	83	1,323
1956	96	106	67	43	64	14	12	15	7	1	16	65	506
1957	35	102	229	206	375	375	294	149	129	318	385	507	3,104
1958	432	360	369	382	382	476	476	333	373	529	470	538	5,120
1959	514	455	509	429	524	373	471	57	298	436	442	485	4,993
1960	553	511	517	470	452	286	489	429	451	266	340	376	5,145
1961	407	266	483	506	469	322	468	432	352	382	363	406	4,856
1962	385	347	354	358	314	336	229	139	133	413	257	329	3,594
1963	298	284	235	307	246	160	124	69	89	131	177	202	2,372
1964	209	286	318	265	198	212	125	100	209	309	383	149	2,763
1965	248	269	478	439	294	407	415	220	189	188	165	--	3,312
Total	13,709	13,722	13,254	13,719	13,221	13,101	12,408	10,253	10,197	11,020	11,817	12,316	148,737
Monthly and annual average 1929-64	374	374	355	369	359	352	333	279	278	301	324	342	4,040
Monthly average in percent of annual average 1929-64	9.2	9.3	8.8	9.1	8.9	8.7	8.2	6.9	6.9	7.5	8.0	8.5	100

4. Dunlap (TP-1) Hydroelectric Powerplant

Location

Dunlap (TP-1) Hydroelectric Powerplant is about 2 miles below TP-1 Dam (Lake Dunlap) on the Guadalupe River and 7 miles northwest of Seguin, Guadalupe County.

Ownership and History of Development

The project is one of six hydroelectric powerplants that are owned and operated by the Guadalupe-Blanco River Authority on the Guadalupe River. These powerplants are Dunlap (TP-1), McQueeney (TP-3), Seguin (TP-4), Nolte (TP-5), H-4 Dam, and H-5 Dam.

The powerplants were authorized by the following water rights from the State Board of Water Engineers: Permit No. 21 (Application No. 21), dated July 25, 1914, which granted an appropriation not to exceed 1,300 cfs, continuously, from the Guadalupe River, for the purpose of hydroelectric power development, to the Guadalupe Water Power Company (now owned by the Guadalupe-Blanco River Authority); and Permit No. 1096 (Application No. 1163), dated June 12, 1929, which granted an appropriation not to exceed 941,200 acre-feet of water per annum for power development purposes to the Hunt Development Company (now owned by the Guadalupe-Blanco River Authority).

Construction of TP-1 Dam began in 1927 and was completed in 1928, with impoundment of water and generation of power beginning at that time.

The output from this and the other five plants is sold to Central Power and Light Company and delivered through necessary switches and transformers to the high voltage transmission system supplying power to the area.

At the end of December 1967, this plant was in the process of conversion to complete automatic operation. The control center and necessary equipment are located in the office building of the Guadalupe-Blanco River Authority in Seguin.

Physical Description

Two 1,800 kw generating units at Dunlap (TP-1) Hydroelectric Powerplant provide a total generating capacity of 3,600 kw.

Each of the two vertical generators is a 1,800 kw, 3 phase, 60 cycle, 2,400 volt, 180 rpm unit with a direct connected exciter. The generators and control equipment were furnished by the General Electric Company.

Each of the two vertical turbines is a James Leffel and Company, 180 rpm, Francis type, with a capacity of 2,800 hp at 46.0-foot head.

At this plant, each turbine is installed in an open wheelpit equipped with trashracks and headgates.

Water discharged from the Dunlap Hydroelectric Powerplant is subsequently used by downstream plants, each plant storing water during low-flow periods for use during the time of peak power requirements. Maximum water discharge per unit at full load is 625 cfs.

An intake structure at the dam controls flow to the 2-mile long diversion canal to the powerhouse. Additional powerhead is gained by the use of this canal.

Forebay water level is at elevation 573 feet above msl. Tailwater elevation is 527 feet above msl. Gross head for the turbine is 46 feet. One-foot high flashboards provide additional head.

The Dunlap powerplant was a run-of-river plant until June 16, 1964, when storage began in Canyon Reservoir near New Braunfels. After that date, the flow of the river was partly regulated by releases from Canyon Reservoir. Water releases from Lake Dunlap are controlled by the operation of the turbines while generating power, and by spillway gates.

Records of gross monthly generation of electrical energy at the Dunlap (TP-1) Hydroelectric Powerplant for the years 1929-67 have been furnished by the Guadalupe-Blanco River Authority and are given in the table following.

Gross generation of electrical energy at Dunlap (TP-1) Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1929	821	647	773	909	1,189	1,566	1,617	874	739	714	746	814	11,409
1930	775	709	759	707	1,560	1,328	863	639	581	1,432	1,043	1,112	11,508
1931	1,528	1,995	2,198	1,984	2,169	1,644	1,490	1,215	921	898	948	1,059	18,049
1932	1,383	1,330	1,729	1,347	1,500	992	100	0	1,185	1,462	1,159	1,285	13,472
1933	1,602	1,263	1,388	1,190	1,271	985	898	870	833	814	797	844	12,755
1934	1,135	1,031	1,379	1,505	1,056	755	867	774	691	682	761	855	11,491
1935	832	965	874	820	1,825	1,636	2,070	1,598	2,000	1,929	1,487	1,705	17,741
1936	1,533	1,274	1,390	1,172	1,558	1,724	2,294	1,643	1,735	2,291	2,078	2,061	20,753
1937	1,964	1,660	2,036	1,638	1,328	1,794	1,277	974	922	1,015	955	1,439	17,002
1938	1,843	1,818	1,641	1,705	2,185	1,465	1,136	974	901	893	869	929	16,359
1939	1,036	851	922	868	877	714	906	796	666	971	772	807	10,186
1940	825	836	976	1,291	1,290	1,394	1,132	799	689	747	1,102	1,756	12,837
1941	1,419	2,056	2,436	2,266	2,571	1,992	2,114	1,537	1,525	1,876	1,429	1,357	22,578
1942	1,259	1,108	1,147	1,686	2,146	1,378	1,366	1,017	1,782	2,075	1,874	1,751	18,589
1943	1,546	1,236	1,320	1,319	1,198	1,484	1,276	953	1,038	966	882	966	14,184
1944	1,442	1,547	2,341	1,855	2,295	2,073	1,573	1,234	1,617	1,362	1,281	1,990	20,610
1945	2,196	2,356	2,603	2,471	1,952	1,524	1,349	1,094	1,011	1,760	1,203	1,497	21,016
1946	1,536	1,566	1,958	1,528	1,861	1,588	1,127	948	1,538	2,065	2,328	2,298	20,341
1947	2,258	2,322	2,192	1,974	1,915	1,477	1,266	1,122	934	903	889	967	18,219
1948	926	900	943	849	887	899	863	614	619	708	632	683	9,523
1949	744	843	1,324	1,425	1,801	1,236	939	986	837	984	860	897	12,876
1950	900	1,022	942	954	1,087	964	813	608	618	618	588	640	9,754

Gross generation of electrical energy at Dunlap (TP-1) Hydroelectric Powerplant, in Megawatthours--Continued

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1951	639	599	710	677	908	864	472	384	412	419	443	514	7,041
1952	515	462	512	745	851	912	447	309	1,181	768	718	1,217	8,637
1953	1,320	829	804	729	575	353	359	326	1,091	785	699	838	8,708
1954	685	528	485	427	570	301	224	163	155	249	324	320	4,431
1955	383	454	359	265	565	298	411	182	128	137	145	245	3,572
1956	251	256	185	96	73	10	9	7	24	0	43	122	1,076
1957	121	162	539	1,035	1,964	1,835	791	381	357	1,799	2,320	2,169	13,973
1958	2,581	2,342	2,701	2,371	2,556	2,027	1,622	1,093	1,183	1,761	2,315	1,867	24,419
1959	1,655	1,532	1,582	1,755	1,516	1,310	1,506	1,099	920	1,921	1,498	1,481	17,775
1960	1,805	1,738	1,588	1,577	1,455	1,195	1,276	1,898	1,407	1,418	2,564	2,612	20,533
1961	2,743	2,423	2,697	2,009	1,520	1,644	1,696	1,315	1,090	1,189	1,215	1,180	20,721
1962	1,103	965	1,008	1,031	961	1,033	661	476	694	775	787	931	10,425
1963	836	770	822	976	723	507	439	324	335	451	630	632	7,445
1964	640	879	1,054	804	625	700	436	381	686	1,312	1,206	800	9,523
1965	821	1,116	1,343	1,146	1,736	1,610	1,439	886	1,053	1,072	1,134	1,234	14,590
1966	1,547	1,559	1,735	1,571	1,381	1,542	1,331	1,059	1,390	1,384	1,104	861	16,464
1967	846	704	758	699	608	357	356	400	1,148	1,693	1,997	1,425	10,991
Total	47,994	46,653	52,153	49,376	54,108	47,110	40,811	31,952	37,136	44,298	43,825	46,160	541,576
Monthly and annual average 1929-67	1,231	1,196	1,337	1,266	1,387	1,208	1,046	819	952	1,136	1,124	1,184	13,886
Monthly average in percent of annual average 1929-67	8.9	8.6	9.6	9.1	10.0	8.7	7.5	5.9	6.9	8.2	8.1	8.5	100

5. McQueeney (TP-3) Hydroelectric Powerplant

Location

McQueeney (TP-3) Hydroelectric Powerplant is at Abbott Dam (Lake McQueeney) on the Guadalupe River 5 miles northwest of Seguin, Guadalupe County.

Ownership and History of Development

The project is one of six hydroelectric powerplants being operated by the Guadalupe-Blanco River Authority on the Guadalupe River. These powerplants are Dunlap (TP-1), McQueeney (TP-3), Seguin (TP-4), Nolte (TP-5), H-4 Dam, and H-5 Dam.

The powerplants were authorized by the following water rights from the State Board of Water Engineers: Permit No. 21 (Application No. 21), dated July 25, 1914, which granted to the Guadalupe Water Power Company (now owned by the Guadalupe-Blanco River Authority) an appropriation not to exceed 1,300 cfs, continuously, from the Guadalupe River, for the purpose of hydroelectric power development; and Permit No. 1096 (Application No. 1163), dated June 12, 1929, which granted to the Hunt Development Company (now owned by the Guadalupe-Blanco River Authority) an appropriation not to exceed 941,200 acre-feet of water per annum for power development purposes.

Construction of Abbott Dam began in 1927 and was completed in 1928, with impoundment of water and beginning of power generation occurring at that time.

The output from this and the other five plants is sold to Central Power and Light Company and delivered through necessary switches and transformers to the high voltage transmission system supplying power to the area.

At the end of December 1967, this plant was in the process of conversion to complete automatic operation. The control center and necessary equipment is located in the office building of the Guadalupe-Blanco River Authority in Seguin.

Physical Description

Two 1,400 kw generating units at McQueeney (TP-3) powerplant give a total capacity of 2,800 kw (Figure 5).

Each of the two vertical generators is a 1,400 kw, 3 phase, 60 cycle, 2,400 volt, 164 rpm unit with a direct connected exciter. The generators and control equipment were furnished by the General Electric Company.

Each of the two vertical turbines is a James Leffel and Company, 164 rpm, Francis type, with a capacity of 2,200 hp at 31.0-foot head. Each unit is controlled by a Woodward governor.

At this plant, each turbine is installed in an open wheelpit equipped with trashracks and headgates.

Forebay water level is at elevation 528.7 feet above msl and tailwater is at elevation 497.7 feet above msl, giving gross head of 31.0 feet.

Maximum water discharge per unit at full load is 650 cfs.

Water release is controlled by operation of the turbines and by spillway gates. McQueeney was a run-of-river plant until June 16, 1964, when storage began in Canyon Reservoir near New Braunfels. After that date, the flow of the river was partly regulated by releases from Canyon Reservoir. Water discharged through the McQueeney plant is stored by the downstream powerplants during low-flow periods for use during the time of peak power requirements.

Records of gross monthly generation of electrical energy at the McQueeney (TP-3) Hydroelectric Powerplant for the years 1929-67 have been furnished by the Guadalupe-Blanco River Authority and are given in the table following.

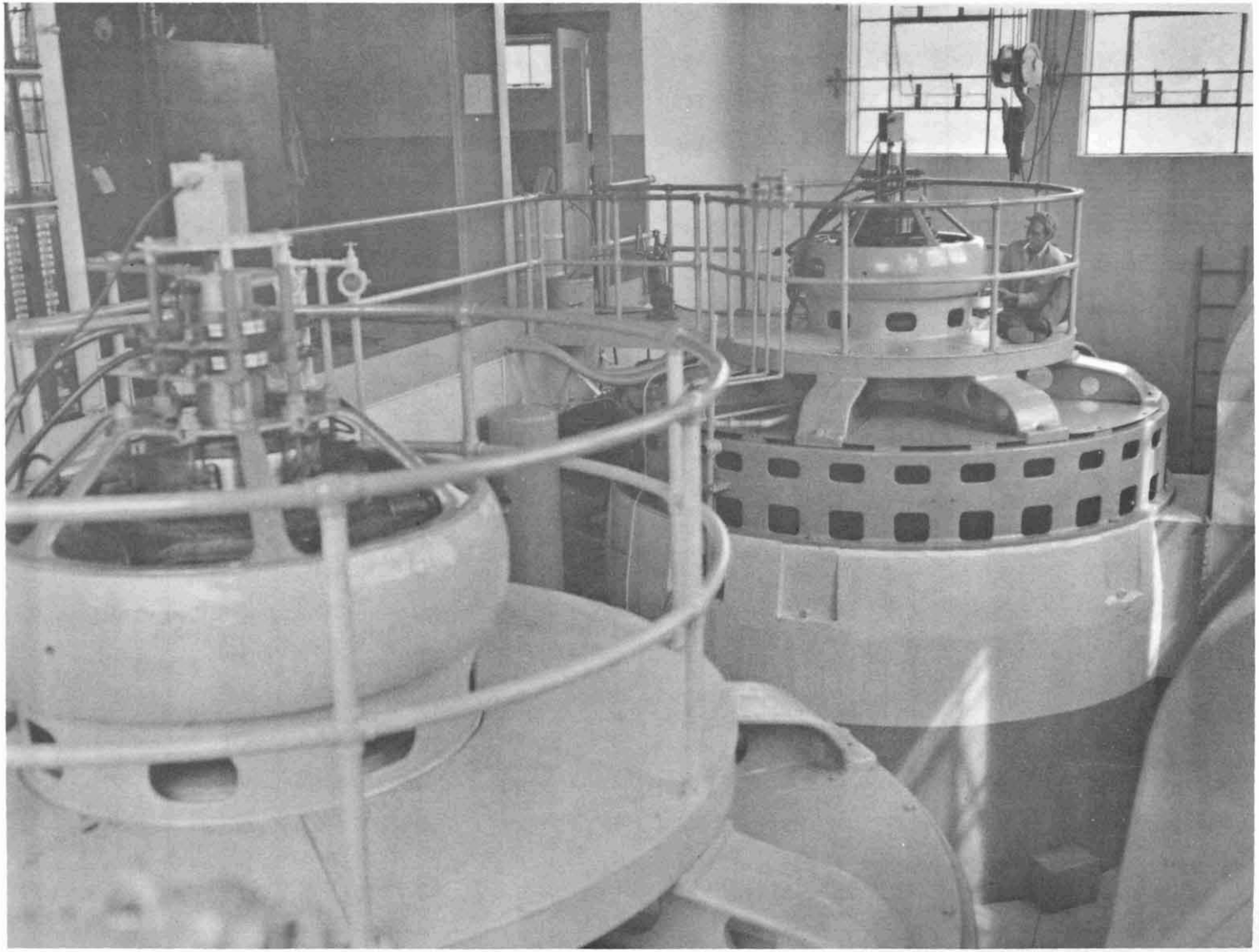

Figure 5.--Two 1,400 kw generators at McQueeney (TP-3) Hydroelectric Powerplant.

Gross generation of electrical energy at McQueeney (TP-3) Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1929	462	354	444	554	768	957	1,087	526	476	398	428	459	6,913
1930	433	398	409	369	1,011	822	475	328	286	919	637	689	6,776
1931	956	1,238	1,371	1,269	1,417	1,081	1,075	819	621	606	627	706	11,786
1932	919	880	1,175	881	990	643	1,359	864	872	976	774	855	11,188
1933	1,052	833	909	785	836	648	585	566	562	549	530	551	8,406
1934	739	673	880	965	696	505	574	413	467	469	509	581	7,571
1935	563	645	572	548	1,078	1,074	1,354	1,034	1,193	1,259	975	1,132	11,427
1936	1,014	840	922	778	921	1,150	1,330	1,082	1,068	1,459	1,440	1,390	13,394
1937	1,304	1,091	1,349	1,073	860	1,182	858	677	633	693	662	967	11,349
1938	1,299	1,246	1,099	1,169	1,494	990	775	668	630	598	596	643	11,207
1939	705	581	627	585	600	479	608	534	454	649	526	546	6,894
1940	556	561	650	855	855	926	763	523	453	487	755	1,056	8,440
1941	938	1,253	1,290	1,384	1,166	1,481	1,307	1,000	970	1,203	946	903	13,841
1942	837	734	756	1,065	1,338	903	892	682	1,145	1,295	1,253	1,166	12,066
1943	1,034	818	877	867	773	969	835	610	684	633	586	645	9,331
1944	958	1,023	1,590	1,213	1,454	1,313	1,040	801	1,038	890	860	1,333	13,513
1945	1,302	1,123	1,202	1,231	1,298	1,014	890	722	666	1,118	794	1,000	12,360
1946	1,039	1,028	1,282	1,044	1,242	1,075	748	645	981	1,354	1,245	1,340	13,023
1947	1,377	1,154	1,408	1,272	1,271	988	843	742	605	594	602	657	11,513
1948	631	609	642	569	586	592	573	403	412	478	432	468	6,395
1949	512	586	915	983	1,213	834	644	669	562	683	591	619	8,811
1950	612	692	635	655	735	641	546	406	419	421	405	440	6,607

Gross generation of electrical energy at McQueeney (TP-3) Hydroelectric Powerplant, in Megawatthours--Continued

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1951	442	415	489	461	611	577	302	250	273	279	296	343	4,738
1952	340	306	339	489	510	593	292	197	759	521	483	827	5,656
1953	874	563	543	519	390	242	239	225	720	532	471	563	5,881
1954	469	362	337	299	384	203	149	108	104	171	221	220	3,027
1955	262	315	258	186	376	204	275	120	89	96	104	173	2,458
1956	178	179	133	72	54	12	8	10	19	4	30	112	811
1957	91	127	377	651	1,280	1,157	509	249	550	1,060	1,254	1,342	8,647
1958	1,723	1,549	1,826	1,550	1,662	1,361	1,059	713	1,064	1,377	1,566	1,248	16,698
1959	1,107	1,029	1,055	1,180	1,019	872	998	723	606q	1,238	957	971	11,755
1960	1,193	1,144	1,058	1,038	960	790	889	1,249	934	1,189	1,703	1,754	13,901
1961	1,840	1,632	1,789	1,323	1,001	1,080	1,120	859	722	788	817	799	13,770
1962	756	659	688	705	652	687	439	320	477	523	531	630	7,067
1963	575	529	557	658	502	344	439	210	218	299	427	427	5,185
1964	433	592	708	536	413	463	269	243	461	855	861	526	6,360
1965	539	779	900	775	1,161	1,074	951	592	696	726	765	875	9,833
1966	1,023	1,030	1,135	1,031	912	1,004	869	701	909	904	724	573	10,815
1967	563	474	509	461	401	226	225	259	774	1,116	1,313	936	7,257
Total	31,650	30,044	33,705	32,048	34,890	31,156	28,193	21,842	24,572	29,409	28,696	30,465	356,670
Monthly and annual average 1929-67	811	770	864	822	895	799	723	560	630	754	736	781	9,145
Monthly average in percent of annual average 1929-67	8.9	8.4	9.5	9.0	9.8	8.7	7.9	6.1	6.9	8.2	8.1	8.5	100

6. Nolte (TP-5) Hydroelectric Powerplant

Location

Nolte (TP-5) Hydroelectric Powerplant is about 2.5 miles (channel distance) below TP-5 Dam (Lake Nolte) on the Guadalupe River, and 3 miles southeast of Seguin, Guadalupe County.

Ownership and History of Development

The project is one of six hydroelectric powerplants being operated by the Guadalupe-Blanco River Authority on the Guadalupe River. These powerplants are Dunlap (TP-1), McQueeney (TP-3), Seguin (TP-4), Nolte (TP-5), H-4 Dam, and H-5 Dam.

The powerplants were authorized by the following water rights from the State Board of Water Engineers: Permit No. 21 (Application No. 21), dated July 25, 1914, which granted an appropriation to the Guadalupe Water Power Company (now owned by the Guadalupe-Blanco River Authority) of not more than 1,300 cfs, continuously, from the Guadalupe River, for hydroelectric power development; and Permit No. 1096 (Application No. 1163), dated June 12, 1929, which granted an appropriation to the Hunt Development Company (now owned by the Guadalupe-Blanco River Authority) of not more than 941,200 acre-feet of water per annum for hydroelectric power development.

Construction began early in 1927 and was completed in November 1927, with impoundment of water and generation of power beginning at that time (Figure 6).

The output from this and the other five plants is sold to Central Power and Light Company and delivered through necessary switches and transformers to the high voltage transmission system supplying power to the area.

At the end of December 1967, this plant was in the process of conversion to complete automatic operation. The control center and necessary equipment are located at the office building of the Guadalupe-Blanco River Authority in Seguin.

Physical Description

Two 1,240 kw generating units at Nolte (TP-5) Hydroelectric Powerplant provide a total capacity of 2,480 kw (Figure 7).

Each of the two vertical generators is a 1,240 kw, 3 phase, 60 cycle, 2,400 volt, 150 rpm unit with a direct connected exciter. The generators and control equipment were furnished by the General Electric Company.

Each of the two vertical turbines is a James Leffel and Company, 150 rpm, Francis type, with a capacity of 1,950 hp at 27.0-foot head. Each unit is controlled by a Woodward governor. At this plant, each turbine is installed in an open wheelpit equipped with trashracks and headgates.

Water releases from Lake Nolte are controlled by the operation of the turbines while generating power, and by spillway gates. Water discharged from upstream plants may be stored during periods when the power load is light and used during the time of peak power requirements. Maximum water discharge per unit at full load is 650 cfs.

An intake structure on the left bank of the dam controls flow to the 1.5-mile long diversion canal to the powerhouse. Additional power head is gained by the use of this canal.

Design headwater elevation (without flashboards) is at elevation 457.6 feet above msl and the tailwater elevation is at 430.6 feet above msl, giving a gross head of 27.0 feet. Two-foot high flashboards can be added for 2 feet more head.

The Nolte plant was a run-of-river plant until June 16, 1964, when impoundment of water began in Canyon Reservoir near New Braunfels. After that date, the river flow was partly regulated by releases from Canyon Reservoir.

Records of gross monthly power generation at the Nolte Plant for the years 1929-67 were furnished by the Guadalupe-Blanco River Authority and are given in the table following.

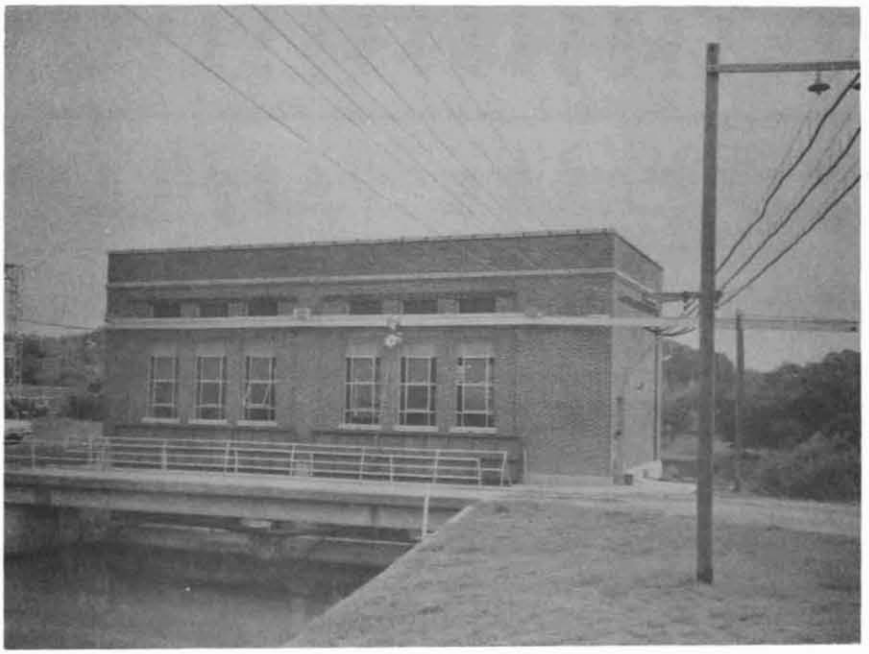

Figure 6.--Nolte (TP-5) Hydroelectric Powerplant.

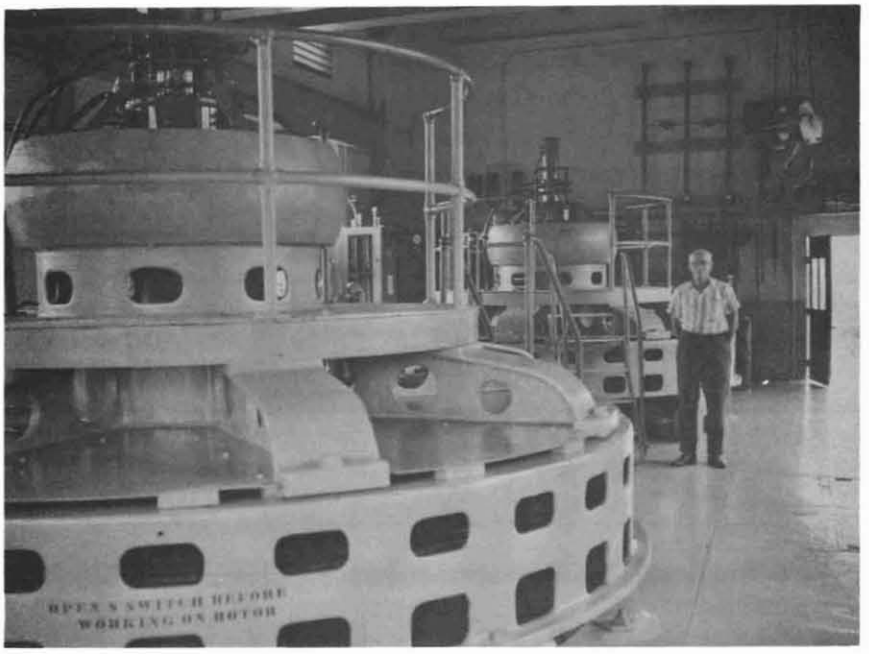

Figure 7.--Two 1,240 kw generators at Nolte (TP-5) Hydroelectric Powerplant.

Gross generation of electrical energy at Nolte (TP-5) Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1929	435	333	399	494	508	752	866	463	397	377	384	413	5,821
1930	392	371	389	360	847	705	440	315	281	746	551	583	5,980
1931	841	1,145	1,227	1,021	1,167	863	849	619	450	458	478	561	9,679
1932	756	686	914	698	794	495	684	663	668	732	595	670	8,355
1933	845	668	749	606	662	502	382	361	379	340	341	365	6,200
1934	588	552	725	818	521	288	348	299	252	227	322	392	5,332
1935	382	499	406	370	889	948	1,062	791	950	979	761	899	8,936
1936	798	677	738	613	734	876	1,032	833	751	997	1,077	1,085	10,211
1937	1,022	840	1,058	852	860	932	665	489	444	506	484	788	8,940
1938	1,077	1,014	915	917	987	799	589	479	443	393	417	467	8,497
1939	539	424	455	413	407	281	396	321	249	448	351	383	4,667
1940	392	416	481	695	672	730	578	322	268	312	604	879	6,349
1941	767	929	1,076	869	939	1,041	1,860	800	794	1,006	760	726	11,567
1942	670	602	592	920	1,164	738	719	529	913	1,134	1,009	934	9,924
1943	831	659	699	696	634	801	682	469	594	483	450	494	7,492
1944	807	856	1,381	1,006	1,214	1,187	835	654	877	740	686	1,125	11,368
1945	1,042	925	1,000	1,015	1,065	809	703	547	490	926	639	819	9,980
1946	840	845	1,065	844	1,044	910	588	510	832	1,178	1,017	1,136	10,809
1947	1,248	968	1,219	1,045	1,071	810	682	601	463	456	460	508	9,531
1948	489	479	493	435	450	446	428	252	273	350	320	357	4,772
1949	403	484	783	845	1,040	700	525	513	449	573	488	509	7,312
1950	506	579	517	545	596	527	422	258	279	277	268	301	5,075

Gross generation of electrical energy at Nolte (TP-5) Hydroelectric Powerplant, in Megawatthours--Continued

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1951	312	298	364	332	477	451	172	124	159	149	174	232	3,244
1952	236	217	239	379	385	473	188	103	608	409	366	650	4,253
1953	692	441	413	401	283	142	133	136	585	422	372	445	4,465
1954	360	273	246	202	297	116	73	38	42	85	117	119	1,968
1955	159	234	185	113	266	131	176	56	36	39	52	96	1,543
1956	95	96	66	26	24	0	0	0	1	0	30	32	370
1957	32	73	286	492	1,076	932	395	161	425	858	1,018	1,108	6,856
1958	1,474	1,290	1,563	1,302	1,329	1,112	830	554	849	1,136	1,268	980	13,687
1959	869	814	829	947	817	683	826	577	476	951	749	781	9,319
1960	947	901	830	827	752	603	709	997	721	714	1,401	1,498	10,900
1961	1,596	1,382	1,511	1,063	797	862	934	692	577	637	651	643	11,345
1962	607	528	547	571	504	545	312	215	344	399	406	472	5,450
1963	431	405	426	509	384	251	196	128	137	210	341	340	3,758
1964	350	484	579	431	317	366	194	186	378	700	692	427	5,104
1965	454	684	732	636	926	841	740	462	541	593	618	731	7,958
1966	855	868	966	883	775	842	700	570	736	735	595	467	8,992
1967	455	382	412	367	305	150	116	155	617	920	1,049	772	5,700
Total	25,594	24,321	27,475	25,558	27,979	24,640	22,029	16,242	18,728	22,595	22,361	24,187	281,709
Monthly and annual average 1929-67	656	624	705	655	717	632	565	417	480	579	573	620	7,223
Monthly average in percent of annual average 1929-67	9.1	8.6	9.8	9.1	9.9	8.8	7.8	5.8	66.6	8.0	7.9	8.6	100

7. Devils Lake Hydroelectric Powerplant

Location

Devils Lake Hydroelectric Powerplant was at Devils Lake Dam on the Devils River in the Rio Grande basin, 16 miles northwest of Del Rio, Val Verde County.

Ownership and History of Development

The powerplant was built, owned, and operated by Central Power and Light Company. The plant was shut down by owner December 20, 1965, because of approaching inundation by Amistad Reservoir on the Rio Grande.

The project was authorized by Permit No. 1049 (Application No. 1125), dated November 2, 1927, granted by the State Board of Water Engineers to James C. Kennedy and subsequently transferred to the Central Power and Light Company. The permit authorized the use of water for hydroelectric power development at a rate not to exceed 550 cfs. The usual flow of Devils River is less than this amount most of the time.

In the 1920's, the Central Power and Light Company decided to develop the power potential of the Devils River, and built two dams and two powerplants: the Devils Lake project completed in 1928 and the Lake Walk project completed in 1929.

Construction of the Devils Lake Dam was begun in 1927 and was completed in December 1928, with impoundment of water and power generation beginning at that time.

The Devils River, a tributary of the Rio Grande, has perennial streamflow in its lower reaches. The Devils Lake plant used the total flow of the river except during flood runoff. Although the Devils River watershed is in an area of relatively light annual rainfall, extremely large floods have occurred, notably in 1932, 1948, and 1954. Each of these floods damaged the powerplant.

Physical Description

The Devils Lake Hydroelectric Powerplant had one 1,800 kw generating unit. The generator was connected to the transmission system supplying the area with electric service.

The vertical generator with a direct connected exciter was a 1,800 kw, 3 phase, 60 cycle, 2,300 volt, 180 rpm unit manufactured by the Westinghouse Electric Corporation.

The vertical turbine was an S. Morgan Smith, 180 rpm, Francis type unit with a capacity of 2,520 hp at 42.25-foot head. The unit was controlled by a Woodward governor.

Forebay design water level was at elevation 1,042.25 feet above msl. Design tailwater elevation was 1,000.0 feet above msl. Gross head for the turbine was 42.25 feet. During the early period of operation, 5-foot-high wood flash boards were installed on the dam to increase the operating head. Due to frequent destruction by floodwater these flash boards were not used during the later period of operation.

The only outlet from Devils Lake was a penstock to the turbine, controlled by headgate operated from a platform upstream from the powerhouse. This plant discharged water into Lake Walk immediately downstream and the Lake Walk plant regulated the required downstream flow.

Figure 8 is a view of the dam and the plant on December 15, 1964. The powerhouse was rebuilt shortly after being partly destroyed by the 1932 flood. Figure 9 is a view of the interior of the powerplant.

Records of gross monthly power generation at the Devils Lake plant for the years 1930-65 were furnished by the Central Power and Light Company and are given in the table following.

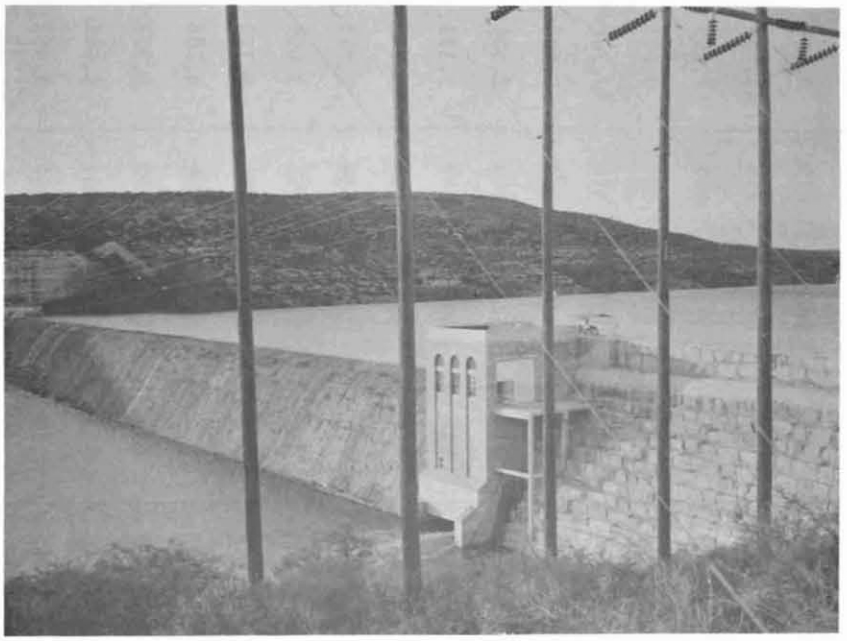

Figure 8.--Devils Lake Dam and Hydroelectric Powerplant, December 15, 1964. Note masonry construction.

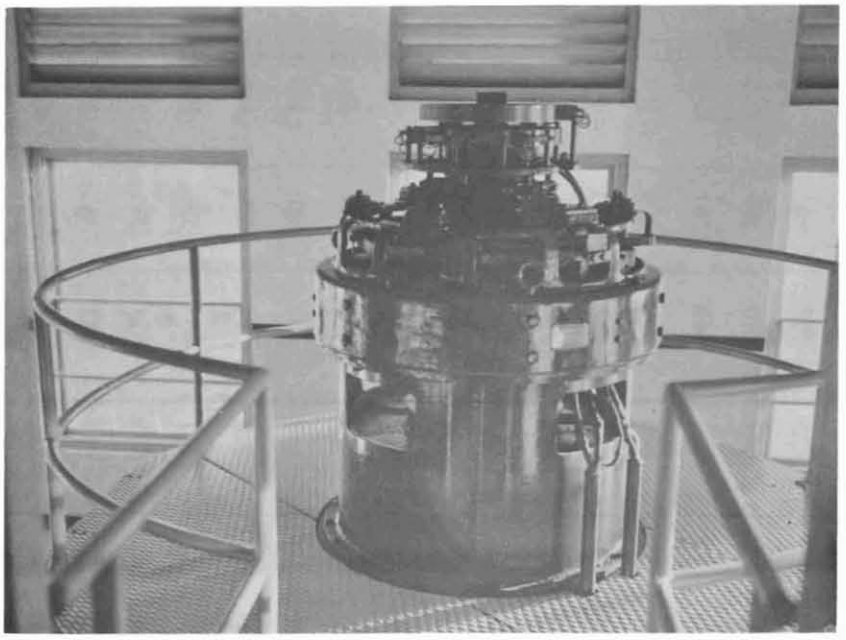

Figure 9.--Direct connected exciter mounted above the generator at Devils Lake Hydroelectric Powerplant.

Gross generation of electrical energy at Devils Lake Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1930	545	525	415	587	189	529	591	438	399	887	1,158	1,118	7,381
1931	1,086	1,225	931	924	1,093	1,282	1,168	1,086	952	899	909	854	12,409
1932	808	752	621	607	702	596	722	646	163	768	1,060	1,029	8,474
1933	1,062	1,070	966	1,059	1,006	1,050	938	885	833	820	778	719	11,186
1934	726	662	561	654	598	780	610	589	632	536	518	480	7,355
1935	485	474	382	504	623	636	963	957	1,007	1,045	1,076	1,031	9,183
1936	1,051	1,028	925	911	899	1,020	1,028	988	963	1,040	998	910	11,761
1937	890	850	719	738	672	765	575	576	581	575	586	567	8,094
1938	661	701	571	595	558	526	529	940	780	715	726	703	8,005
1939	714	672	583	600	682	665	593	605	530	534	606	549	7,333
1940	558	536	468	664	654	692	657	708	654	551	568	508	7,218
1941	487	482	412	470	689	629	604	556	596	779	725	634	7,063
1942	618	574	480	560	491	478	484	512	883	807	913	854	7,654
1943	828	725	609	658	657	884	712	620	655	613	574	590	8,125
1944	617	545	559	516	503	574	436	406	728	652	558	494	6,588
1945	491	451	383	928	354	333	412	364	337	690	672	562	5,977
1946	522	441	355	409	421	464	600	422	416	647	503	461	5,661
1947	546	505	412	404	425	372	354	374	462	389	386	354	4,983
1948	321	319	276	267	374	314	0	87	776	709	700	621	4,764
1949	578	540	802	729	1,026	992	889	1,017	1,032	819	0	0	8,424
1950	0	802	679	666	590	579	682	686	614	668	587	527	7,080
1951	491	447	368	380	383	437	287	308	297	292	332	302	4,324

Gross generation of electrical energy at Devils Lake Hydroelectric Powerplant, in Megawatthours--Continued

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1952	300	287	253	273	237	406	263	245	244	232	247	250	3,237
1953	246	242	237	216	204	191	182	211	396	354	331	300	3,110
1954	302	276	228	429	587	700	21	841	930	827	703	659	6,503
1955	591	462	445	382	393	327	463	526	534	808	646	611	6,188
1956	535	414	373	306	271	226	207	238	235	289	263	266	3,623
1957	255	236	260	419	956	1,027	984	918	871	969	939	863	8,697
1958	854	757	975	823	827	854	1,020	953	968	1,045	1,025	1,044	11,145
1959	1,033	913	909	837	922	806	910	856	706	958	866	799	10,515
1960	760	664	660	580	576	517	609	673	589	670	669	637	7,604
1961	638	563	548	458	427	685	914	864	751	762	699	674	7,983
1962	601	482	469	487	438	546	509	436	522	666	632	579	6,367
1963	504	421	394	346	534	508	422	368	333	329	304	303	4,766
1964	321	379	253	276	252	228	205	203	414	1,043	977	926	5,477
1965	848	683	686	615	512	494	497	439	327	467	412	242	6,222
Total	21,873	21,105	19,167	20,277	20,725	22,112	21,049	21,541	22,110	24,854	23,646	22,020	260,479
Monthly and annual average 1930-65	608	586	532	563	576	614	585	598	614	690	657	612	7,235
Monthly average in percent of annual average 1930-65	8.4	8.1	7.3	7.8	8.0	8.5	8.1	8.3	8.5	9.5	9.1	8.4	100

8. Lake Walk Hydroelectric Powerplant

Location

Lake Walk Hydroelectric Powerplant was at Lake Walk Dam on the Devils River in the Rio Grande basin, 11 miles northwest of Del Rio, Val Verde County.

Ownership and History of Development

The powerplant was owned and operated by the Central Power and Light Company. The plant was shut down by owner December 17, 1965, because of approaching inundation by Amistad Reservoir on the Rio Grande. The project was named in honor of Sam H. Walk, long time local manager at Del Rio for the Central Power and Light Company.

The project was authorized by Permit No. 1077 (Application No. 1149), dated September 17, 1928, granted by the State Board of Water Engineers to James C. Kennedy and subsequently transferred to the Central Power and Light Company. The permit authorized the use of water at a rate not to exceed 550 cfs for the purpose of hydroelectric power development. The rate of flow of Devils River is less than 550 cfs most of the time.

The project was started in December 1928, and was completed in May 1929. Impoundment of water began with closure of Lake Walk Dam in May 1929, and the generation of power started May 17, 1929. The powerplant was damaged by large floods in 1932, 1948, and 1954.

Physical Description

One 1,350 kw generating unit was installed at Lake Walk Hydroelectric Powerplant. The turbine used the total flow of the river except during flood runoff. The supply of water to this lake was partly regulated by the operation of the Devils Lake Hydroelectric Powerplant upstream. The plant was connected to the transmission system supplying the area with electric service. The S. Morgan Smith turbine in this plant was the first automatic adjustable blade turbine installed in the United States, and was still giving good service at the time the plant was closed (Dowell, 1929; Dowell and Breeding, 1967). The turbine will be on display at Amistad Dam along with a model of that project and interesting rocks and Indian relics discovered during construction of Amistad Dam. (The display will be in a museum to be operated by the National Park Service.)

The adjustable blade settings vary directly and automatically with gate-opening, resulting in high efficiency at all loads. The main shaft is bored out to permit a small shaft, which also has a vertical movement, to rotate with it. The lower end of this shaft connects by levers to the runner blades, rotating them as it moves up or down. The upper end of the shaft connects to a piston in a Servo-motor operated by oil pressure and is in synchronism with the Servo-motor controlling the gate opening. This causes the blade angle to vary with each change of gate opening.

This generating unit was automatically controlled by a system of relays stopping and starting the unit when any one of a series of events, such as low water, overload, over-voltage, under-voltage, or heating of bearings, might take place.

The vertical generator was a 1,350 kw, 3 phase, 60 cycle, 2,300 volt, 277 rpm unit with a direct connected exciter manufactured by the Westinghouse Electric Corporation.

The vertical turbine was an S. Morgan Smith automatic adjustable blade Kaplan type, 277 rpm, with a capacity of 1,900 hp at 33.0-foot head. The unit was controlled by a Woodward governor.

The operating tailwater elevation was 968.0 feet above msl. Gross head for the turbine was 33.0 feet.

Figure 10 is a view of the Lake Walk Hydroelectric Powerplant and Dam, December 1964.

Records of gross monthly generation of hydroelectric power at the Lake Walk Plant for the years 1930-65 were furnished by the Central Power and Light Company and are given in the table following.

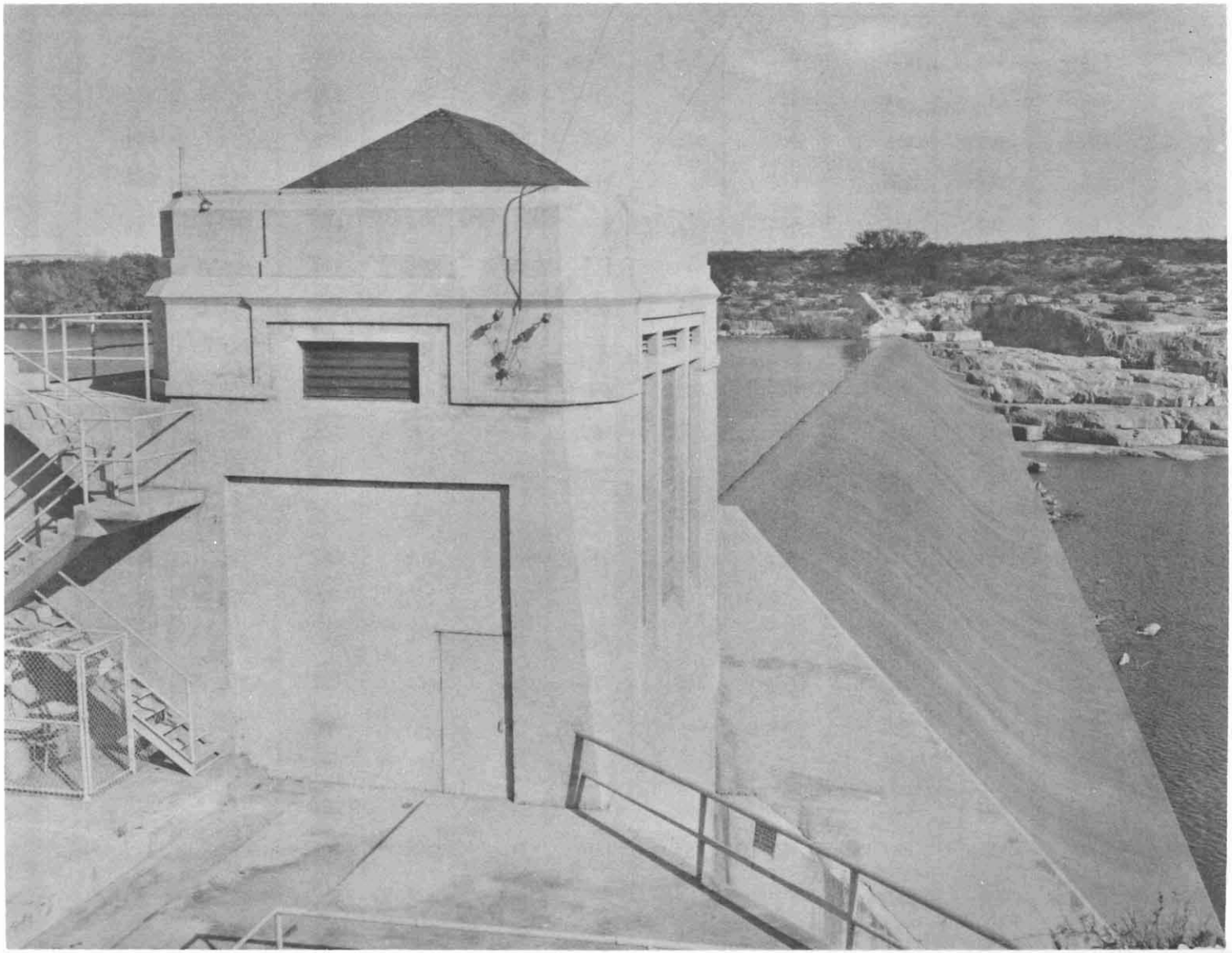

Figure 10.--Lake Walk Hydroelectric Powerplant and Dam, December 1964.

Gross generation of electrical energy at Lake Walk Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1930	369	338	290	500	145	410	445	356	257	737	945	830	5,622
1931	797	943	693	697	894	976	873	802	721	691	691	647	9,425
1932	602	568	449	436	515	413	552	486	123	358	1,108	1,035	6,645
1933	1,073	1,037	893	924	844	898	768	739	708	696	636	578	9,794
1934	583	525	440	531	463	656	484	450	529	427	407	366	5,861
1935	375	362	283	406	544	786	797	830	906	1,000	1,034	986	8,309
1936	955	896	789	767	782	912	959	827	876	957	822	734	10,276
1937	716	698	634	631	547	712	510	460	476	469	379	460	6,692
1938	580	630	500	490	478	414	462	830	675	618	630	593	6,900
1939	612	557	458	478	593	556	468	506	412	411	502	440	5,993
1940	451	411	341	545	552	579	536	590	521	427	430	379	5,762
1941	368	367	314	399	590	497	511	425	491	693	622	525	5,802
1942	499	456	372	430	428	384	367	413	778	719	771	691	6,308
1943	524	444	511	532	543	769	589	520	524	482	437	465	6,340
1944	489	428	445	391	322	0	0	244	616	540	444	396	4,315
1945	420	377	309	335	269	252	316	274	255	609	566	435	4,417
1946	413	340	274	350	334	375	472	316	308	553	387	353	4,475
1947	443	391	323	310	339	280	270	296	371	285	291	278	3,877
1948	248	239	211	180	271	234	0	313	598	547	561	486	3,888
1949	429	417	621	564	820	788	726	806	848	816	859	752	8,446
1950	754	666	525	524	466	414	530	515	471	513	442	382	6,202
1951	368	329	255	274	280	324	192	180	168	171	216	198	2,955

Gross generation of electrical energy at Lake Walk Hydroelectric Powerplant, in Megawatthours--Continued

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1952	171	172	147	166	96	224	143	115	132	116	135	142	1,759
1953	133	129	155	103	93	78	65	104	303	245	213	190	1,811
1954	185	150	126	315	424	561	15	40	321	605	529	492	3,763
1955	429	316	298	242	264	194	313	376	390	614	465	431	4,332
1956	374	264	238	190	158	117	94	100	106	141	130	124	2,036
1957	119	118	141	277	794	766	760	713	678	752	731	650	6,499
1958	653	574	737	637	650	640	772	744	727	748	742	768	8,392
1959	790	692	725	645	731	629	701	692	568	778	692	663	8,306
1960	635	543	564	501	447	377	455	512	454	496	149	286	5,419
1961	478	431	395	330	311	518	726	695	613	630	565	544	6,236
1962	495	435	390	375	192	414	364	306	386	510	458	411	4,736
1963	335	279	260	230	382	353	280	260	239	231	215	212	3,276
1964	203	309	216	231	201	176	142	143	306	755	737	726	4,145
1965	656	563	541	458	526	644	583	558	502	498	449	245	6,223
Total	17,724	16,394	14,863	15,394	16,288	17,320	16,240	16,536	17,357	19,838	19,390	17,893	205,237
Monthly and annual average 1930-65	492	455	413	428	453	481	451	459	482	551	539	497	5,701
Monthly average in percent of annual average 1930-65	8.6	8.0	7.2	7.5	7.9	8.4	7.9	8.1	8.5	9.7	9.5	8.7	100

9. H-4 Dam Hydroelectric Powerplant

Location

H-4 Dam Hydroelectric Powerplant is at H-4 Dam (H-4 Reservoir) on the Guadalupe River, 4 miles southeast of Belmont, Gonzales County.

Ownership and History of Development

The project is one of six hydroelectric powerplants being operated by the Guadalupe-Blanco River Authority on the Guadalupe River. These powerplants are Dunlap (TP-1), McQueeney (TP-3), Seguin (TP-4), Nolte (TP-5), H-4 Dam, and H-5 Dam.

The powerplants were authorized by the following water rights from the State Board of Water Engineers: Permit No. 21 (Application No. 21), dated July 25, 1914, which granted an appropriation not to exceed 1,300 cfs, continuously, from the Guadalupe River, for the purpose of hydroelectric power development, to the Guadalupe Water Power Company (now owned by the Guadalupe-Blanco River Authority); and Permit No. 1096 (Application No. 1163), dated June 12, 1929, which granted an appropriation not to exceed 941,200 acre-feet of water per annum for power development purposes to the Hunt Development Company (now owned by the Guadalupe-Blanco River Authority).

Construction of the project was begun in 1929 and completed in August 1931, with impoundment of water and generation of power beginning at that time. The output from this and the other five plants is sold to Central Power and Light Company and delivered through necessary switches and transformers to the high voltage transmission system supplying power to the area.

At the end of December 1967, this plant was in the process of conversion to complete automatic operation. The control center and necessary equipment are located in the office building of the Guadalupe-Blanco River Authority in Seguin.

Physical Description

The one vertical generator is a 2,400 kw, 3 phase, 60 cycle, 2,400 volt, 180 rpm unit with a direct connected exciter. The generator and control equipment were furnished by the General Electric Company.

The one vertical turbine is an S. Morgan Smith, 180 rpm, Kaplan propeller type with a capacity of 3,800 hp at 27.0-foot head. The unit is controlled by a Woodward governor.

At this plant, the turbine is installed in an open wheelpit equipped with trashracks and headgates.

Headwater elevation (crest of the spillway with bear trap gates raised) is elevation 331.0 feet above msl and the tailwater elevation is 304.0 feet above msl, giving a gross head for the turbine of 27.0 feet.

Maximum water discharge through the plant at full load is 1,300 cfs. Water release is controlled by operation of the turbine while generating power, and by spillway gates.

Water discharged from the powerplant is subsequently used by H-5 Hydroelectric Powerplant. Some water is stored during periods of low river flow for use during the time of peak power requirements.

The H-4 plant was a run-of-river plant until June 16, 1964, when impoundment of water began in Canyon Reservoir near New Braunfels. After that date, the river flow was partly regulated by releases from Canyon Reservoir.

Records of gross monthly power generation at the H-4 plant for the years 1935-67 were furnished by the Guadalupe-Blanco River Authority and are given in the table following. Records before 1935 are not available.

Gross generation of electrical energy at H-4 Dam Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1935	550	661	430	521	833	991	1,149	1,012	1,070	1,145	927	1,017	10,306
1936	961	857	815	712	697	1,142	1,058	1,031	908	1,178	1,400	1,168	11,927
1937	1,129	1,060	1,103	1,005	756	1,049	686	522	550	550	573	763	9,746
1938	1,088	1,279	904	1,002	1,310	953	646	577	545	484	540	541	9,869
1939	626	575	511	513	518	432	516	437	380	477	511	437	5,933
1940	491	511	508	756	659	787	724	269	373	358	674	949	7,059
1941	939	1,247	1,250	1,460	957	1,399	1,250	885	816	1,007	757	752	12,719
1942	723	707	601	938	1,315	912	759	626	921	748	663	976	9,889
1943	950	818	686	827	622	921	673	552	583	537	499	546	8,214
1944	726	942	1,246	1,182	1,216	1,282	916	554	996	748	743	1,095	11,646
1945	1,175	1,448	1,350	1,450	1,133	889	710	563	559	1,015	720	844	11,856
1946	871	852	1,040	1,023	1,048	1,070	666	494	944	1,282	1,329	1,279	11,898
1947	1,387	1,504	1,103	1,160	1,145	882	816	607	589	468	318	556	10,535
1948	489	582	531	468	506	376	650	300	343	379	375	380	5,379
1949	440	487	792	793	1,115	780	592	546	485	528	671	465	7,694
1950	567	673	526	630	629	662	460	322	337	336	290	372	5,804
1951	396	404	342	491	454	608	236	157	194	195	247	250	3,974
1952	300	300	287	407	354	686	244	146	481	519	405	699	4,828
1953	815	583	455	453	463	196	176	157	684	417	536	492	5,427
1954	410	368	276	268	347	198	98	51	38	87	162	198	2,501
1955	216	302	236	142	303	192	179	84	37	46	50	164	1,951
1956	145	155	106	37	56	9	20	6	0	0	0	86	620

Gross generation of electrical energy at H-4 Dam Hydroelectric Powerplant, in Megawatthours--Continued

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1957	28	121	413	515	1,141	1,036	426	180	450	992	1,360	1,240	7,902
1958	1,412	1,154	1,445	1,308	1,308	1,098	900	571	809	1,172	1,277	1,009	13,463
1959	903	818	758	992	857	620	903	607	471	970	794	772	9,465
1960	920	877	843	824	801	554	771	953	622	761	1,386	1,433	10,745
1961	1,536	1,251	1,475	1,093	824	845	1,021	753	631	706	739	707	11,581
1962	666	583	599	626	548	585	356	247	412	436	459	537	6,054
1963	490	482	483	547	428	258	202	125	147	218	392	370	4,142
1964	391	534	639	449	313	378	189	168	432	728	739	466	5,426
1965	547	782	761	682	925	886	751	481	564	656	668	840	8,543
1966	876	921	1,014	915	857	862	721	487	756	772	638	513	9,332
1967	504	424	453	396	338	173	165	197	647	951	1,092	850	6,190
Total	23,667	24,262	23,981	24,585	24,776	23,711	19,629	14,667	17,774	20,866	21,934	22,766	262,618
Monthly and annual average 1935-67	717	735	727	745	751	718	595	444	539	632	665	690	7,958
Monthly average in percent of annual average 1935-67	9.0	9.2	9.1	9.4	9.4	9.0	7.5	5.6	6.8	7.9	8.4	8.7	100

10. H-5 Dam Hydroelectric Powerplant

Location

H-5 Dam Hydroelectric Powerplant is at H-5 Dam on the Guadalupe River, upstream from the San Marcos River, and 4 miles southwest of Gonzales, Gonzales County.

Ownership and History of Development

The project is one of six hydroelectric powerplants being operated by the Guadalupe-Blanco River Authority on the Guadalupe River. These powerplants are Dunlap (TP-1), McQueeney (TP-3), Seguin (TP-4), Nolte (TP-5), H-4 Dam, and H-5 Dam.

The powerplants were authorized by the following water rights from the State Board of Water Engineers: Permit No. 21 (Application No. 21), dated July 25, 1914, which granted an appropriation not to exceed 1,300 cfs, continuously, from the Guadalupe River for the purpose of hydroelectric power development, to the Guadalupe Water Power Company (now owned by the Guadalupe-Blanco River Authority); and Permit No. 1096 (Application No. 1163), dated June 12, 1929, which granted an appropriation not to exceed 941,200 acre-feet of water per annum for power development purposes to the Hunt Development Company (now owned by the Guadalupe-Blanco River Authority).

Construction began the latter part of 1929. Generation of power began in October 1931. Part of the earthen section of the dam was destroyed by a flood in July 1932.

The output from this and the other five plants is sold to Central Power and Light Company and delivered through necessary switches and transformers to the high voltage transmission system supplying power to the area.

At the end of December 1967, this plant was in the process of conversion to complete automatic operation. The control center and necessary equipment are located in the office building of the Guadalupe-Blanco River Authority in Seguin.

Physical Description

The one vertical generator is a 2,400 kw, 3 phase, 60 cycle, 2,400 volt, 180 rpm unit with a direct connected exciter. The generator and control equipment were furnished by the General Electric Company.

The one vertical turbine is an S. Morgan Smith, 180 rpm, Kaplan propeller type, with a capacity of 3,700 hp at 29.0-foot head. The unit is controlled by a Woodward governor.

At this plant, the turbine is installed in an open wheelpit equipped with trashrack and headgate.

Headwater elevation (crest elevation with gates closed) is 290.9 feet above msl and the tailwater elevation is 261.9 feet above msl, giving a gross head of 29.0 feet.

Maximum water discharge through the plant at full load is 1,300 cfs. Some water is stored during periods of low streamflow for use during the time of peak power requirements.

The H-5 plant was a run-of-river plant until June 16, 1964, when impoundment of water began in Canyon Reservoir near New Braunfels. After that date, the river flow was partly regulated by releases from Canyon Reservoir.

Records of gross monthly power generation at the H-5 plant for the years 1935-67 were furnished by the Guadalupe-Blanco River Authority and are given in the table following. Records before 1935 are not available.

Gross generation of electrical energy at H-5 Dam Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1935	561	676	450	539	817	977	1,136	977	991	1,085	895	936	10,040
1936	902	795	747	690	671	1,035	983	1,012	875	1,075	1,367	1,150	11,302
1937	1,196	1,044	1,055	1,024	742	965	772	550	543	472	587	722	9,582
1938	1,039	1,215	896	979	1,168	970	646	582	547	482	531	529	9,584
1939	613	563	489	484	514	412	482	397	342	458	477	429	5,660
1940	467	493	491	735	626	763	709	357	353	349	658	904	6,905
1941	956	1,200	1,193	1,421	767	1,323	1,245	907	834	882	856	745	12,329
1942	703	695	589	935	1,293	905	749	630	903	1,118	1,140	979	10,640
1943	972	815	671	822	616	936	657	557	588	527	514	546	8,221
1944	718	994	1,180	1,171	1,183	1,190	919	556	970	779	728	1,080	11,469
1945	1,192	1,404	1,281	1,344	1,120	888	706	536	508	996	691	816	11,392
1946	848	850	991	1,003	1,037	1,070	620	432	836	1,155	1,282	1,260	11,385
1947	1,347	1,485	1,210	956	1,171	890	821	587	554	449	500	513	10,483
1948	541	573	530	462	512	376	660	275	315	358	364	376	5,342
1949	432	479	751	603	1,087	810	599	538	492	500	676	553	7,520
1950	518	670	520	631	627	619	432	288	302	213	316	364	5,500
1951	372	396	335	484	442	594	221	128	188	177	240	250	3,827
1952	296	295	278	400	349	706	240	126	554	543	422	723	4,932
1953	862	603	467	462	464	203	165	136	679	417	546	482	5,486
1954	417	364	271	262	330	191	76	42	37	43	148	207	2,388
1955	222	338	262	166	323	213	163	84	50	37	37	114	2,009
1956	143	155	99	30	47	24	13	36	4	0	0	44	595

Gross generation of electrical energy at H-5 Dam Hydroelectric Powerplant, in Megawatthours--Continued

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1957	16	134	457	538	1,226	1,048	417	160	373	931	1,378	1,314	7,992
1958	1,389	1,124	1,379	1,349	1,250	1,117	462	576	815	1,210	1,317	1,072	13,060
1959	960	886	927	1,052	804	670	936	620	495	973	827	821	9,971
1960	988	923	865	829	803	515	817	988	828	708	1,361	1,410	11,035
1961	1,522	1,162	1,480	1,122	848	816	1,054	780	536	730	752	727	11,529
1962	690	609	626	655	566	594	353	231	426	444	475	566	6,235
1963	513	508	503	562	429	248	191	100	129	208	396	386	4,173
1964	412	571	688	500	342	376	188	151	448	750	769	490	5,685
1965	570	720	793	570	897	858	794	483	579	694	718	853	8,529
1966	920	970	1,079	962	917	897	739	550	751	779	656	526	9,746
1967	524	434	467	404	341	166	154	192	643	1,016	1,085	892	6,318
Total	23,641	24,143	24,020	24,146	24,329	23,365	19,119	14,565	17,489	20,558	22,709	22,780	260,864
Monthly and annual average 1935-67	716	732	728	732	737	709	579	441	530	623	688	690	7,905
Monthly average in percent of annual average 1935-67	9.1	9.3	9.2	9.3	9.3	8.9	7.3	5.6	6.7	7.9	8.7	8.7	100

11. Seguin (TP-4) Hydroelectric Powerplant

Location

Seguin (TP-4) Hydroelectric Powerplant is at TP-4 Dam on the Guadalupe River, 3 miles southwest of Seguin, Guadalupe County.

Ownership and History of Development

The project is one of six hydroelectric powerplants being operated by the Guadalupe-Blanco River Authority on the Guadalupe River. These powerplants are Dunlap (TP-1), McQueeney (TP-3), Seguin (TP-4), Nolte (TP-5), H-4 Dam, and H-5 Dam.

The powerplants were authorized by the following water rights from the State Board of Water Engineers: Permit No. 21 (Application No. 21), dated July 25, 1914, which granted an appropriation not to exceed 1,300 cfs, continuously, from the Guadalupe River, for the purpose of hydroelectric power development, to the Guadalupe Water Power Company (now owned by the Guadalupe-Blanco River Authority); and Permit No. 1096 (Application No. 1163), dated June 12, 1929, which granted an appropriation not to exceed 941,200 acre-feet of water per annum for power development purposes to the Hunt Development Company (now owned by the Guadalupe-Blanco River Authority).

Construction began in 1930. Generation of power began in March 1932. The output from this and the other five plants is sold to Central Power and Light Company and delivered through necessary switches and transformers to the high voltage transmission system supplying power to the area.

At the end of December 1967, this plant was in the process of conversion to complete automatic operation. The control center and necessary equipment are located in the office building of the Guadalupe-Blanco River Authority in Seguin.

Physical Description

An exterior view of the Seguin (TP-4) Hydroelectric Powerplant and Dam is shown in Figure 11. The one vertical generator is a 2,400 kw, 3 phase, 60 cycle, 2,300 volt, 180 rpm unit with a direct connected exciter (Figure 12). The generator and control equipment were furnished by the General Electric Company.

The one vertical turbine is an S. Morgan Smith, 180 rpm, Kaplan propeller type, with a capacity of 3,750 hp at 29.0-foot head. The unit is controlled by a Woodward governor.

At this plant, the turbine is installed in an open wheelpit equipped with trashracks and headgates.

Forebay water level is 497.4 feet above msl and the tailwater elevation is 468.4 feet above msl giving a gross head of 29.0 feet.

Maximum water discharge through the turbine at full load is 1,300 cfs. The plant stores some water during low-flow periods for use during the time of peak power requirements. Water releases are subsequently used by the downstream powerplants.

The Seguin plant was a run-of-river plant until June 16, 1964, when impoundment of water began in Canyon Reservoir near New Braunfels. After that date, the river flow was partly regulated by releases from Canyon Reservoir.

Records of gross monthly power generation at the Seguin plant for the years 1935-67 were furnished by the Guadalupe-Blanco River Authority and are given in the table following. Records before 1935 are not available.

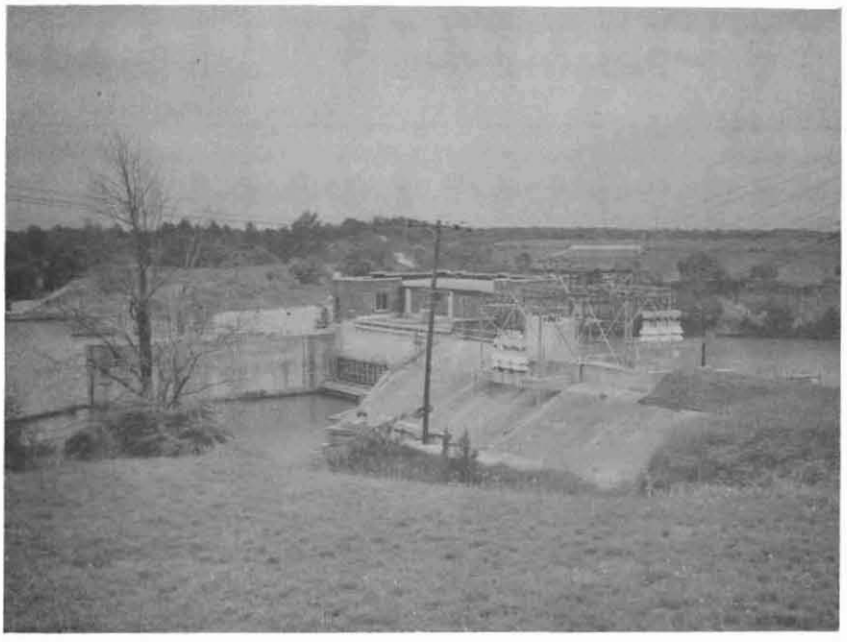

Figure 11.--Seguin (TP-4) Hydroelectric Powerplant and Dam.

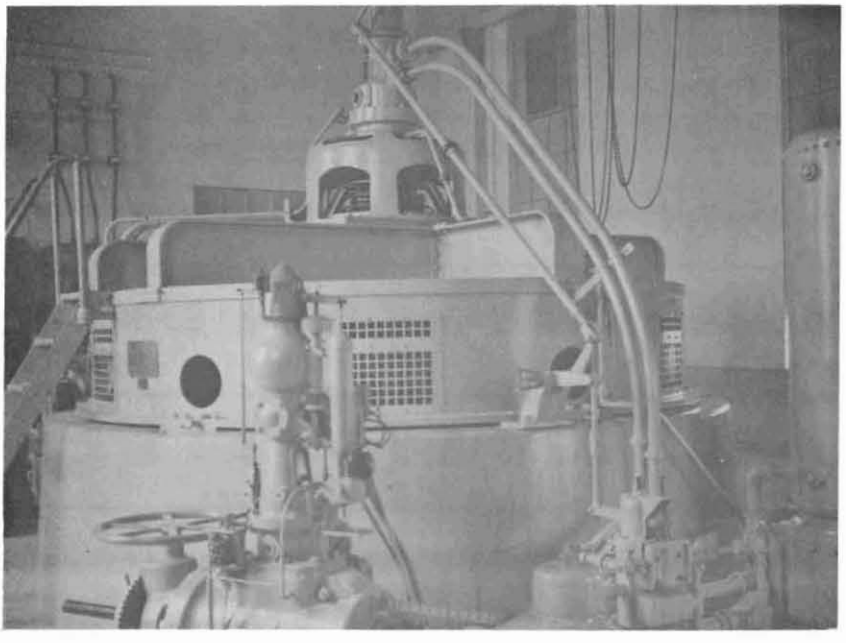

Figure 12.--The 2,400 kw generator at Seguin (TP-4) Hydroelectric Powerplant.

Gross generation of electrical energy at Seguin (TP-4) Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1935	484	589	486	472	1,079	1,146	1,256	959	1,150	1,179	920	1,053	10,773
1936	929	778	845	707	823	1,036	1,286	983	967	1,280	1,310	1,254	12,198
1937	1,170	980	1,233	984	776	1,094	556	591	536	609	575	861	9,965
1938	1,164	1,109	996	1,048	1,319	910	682	574	535	504	494	541	9,876
1939	607	487	514	486	488	370	482	426	334	549	397	416	5,556
1940	451	473	550	775	747	831	662	401	357	394	674	1,017	7,332
1941	855	1,230	1,368	1,301	1,328	1,342	1,267	882	742	1,121	840	800	13,076
1942	741	652	667	1,022	1,314	796	797	579	1,049	1,264	1,061	1,044	10,986
1943	928	729	766	782	702	873	359	526	612	545	476	546	7,844
1944	884	954	1,519	1,102	1,374	1,285	921	695	980	825	770	1,238	12,547
1945	1,262	1,261	1,377	1,359	1,178	901	790	619	567	1,051	698	895	11,958
1946	881	937	1,170	920	1,123	974	638	225	639	1,310	1,322	1,348	11,487
1947	1,398	1,281	1,356	1,179	1,189	882	760	677	532	513	522	573	10,862
1948	487	540	546	485	499	519	505	366	375	404	318	301	5,345
1949	399	478	820	899	1,110	736	538	536	448	540	489	520	7,513
1950	512	594	525	552	616	555	430	267	290	284	248	318	5,191
1951	322	309	368	344	492	467	217	155	208	212	239	251	3,584
1952	281	252	278	411	444	498	211	126	671	391	361	712	4,636
1953	741	449	418	411	302	167	163	161	618	439	331	464	4,664
1954	337	281	257	228	303	124	88	56	58	109	154	148	2,143
1955	190	242	189	128	291	147	207	74	51	57	66	115	1,757
1956	117	118	87	43	32	5	5	4	9	1	3	88	512

Gross generation of electrical energy at Seguin (TP-4) Hydroelectric Powerplant, in Megawatthours--Continued

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1957	58	99	338	614	1,220	1,094	403	186	497	1,018	1,311	1,276	8,114
1958	1,634	1,385	1,712	1,367	1,501	1,204	900	560	912	1,237	1,386	1,071	14,869
1959	933	549	498	1,006	870	730	860	585	483	1,078	801	839	9.232
1960	1,036	978	900	877	791	640	730	1,075	779	1,043	1,546	1,628	12,023
1961	1,718	1,508	1,646	1,150	856	944	979	722	608	653	687	661	12,132
1962	624	537	549	578	500	540	332	244	390	432	410	511	5,647
1963	452	423	429	539	392	269	223	162	98	247	351	350	3,935
1964	364	502	597	424	329	389	220	205	415	758	742	477	5,422
1965	477	733	802	675	1,042	945	811	476	575	606	643	790	8.575
1966	926	941	1,041	936	819	898	736	584	794	790	624	457	9,546
1967	445	376	414	374	332	180	181	215	699	1,026	1,190	853	6,285
Total	23,807	22,754	25,261	24,178	26,181	23,491	19,195	14,896	17,978	22,469	21,959	23,416	265,585
Monthly and annual average 1935-67	721	690	765	733	793	712	582	451	545	681	665	710	8,048
Monthly average in percent of annual average 1935-67	9.0	8.6	9.5	9.1	9.8	8.8	7.2	5.6	6.8	8.5	8.3	8.8	100

12. Buchanan Hydroelectric Powerplant

Location

Buchanan Hydroelectric Powerplant is at Buchanan Dam (Lake Buchanan) on the Colorado River, 11 miles west of Burnet, Burnet County.

Ownership and History of Development

The powerplant is owned and operated by the Lower Colorado River Authority as one of a series of six hydroelectric powerplants on the Colorado River. The other five are Inks, Granite Shoals, Marble Falls, Marshall Ford, and Austin Hydroelectric Powerplants. All of these are described in this report.

The project was authorized by Permit No. 1259 (Application No. 1345), dated May 25, 1938, granted by the State Board of Water Engineers to the Lower Colorado River Authority. This permit authorizes an annual appropriation of 1,391,530 acre-feet of water for domestic, municipal, industrial, irrigation, mining, and hydroelectric power uses.

Several other water rights that are included in Permit No. 1259 recognize earlier water rights of the Lower Colorado River Authority (Dowell and Breeding, 1967).

The project was started by the Samuel Insull interests in April 1931 under the name Central Texas Hydro-Electric Company. Work was stopped April 20, 1932, because of financial difficulties. Construction was resumed by the Lower Colorado River Authority in 1935 and was completed in 1938. Deliberate impoundment of water in Lake Buchanan began May 20, 1937. The flood of July 1938 filled the reservoir for the first time, resulting in a large floodflow discharge from the reservoir. The first electric generating unit was placed in operation in January 1938.

Buchanan Hydroelectric Powerplant is upstream of five other projects. Water released through the powerplant is subsequently used for generation of power at Inks, Granite Shoals, Marble Falls, Marshall Ford, and Austin Hydroelectric Powerplants.

Physical Description

Each of the three vertical generators is an 11,250 kw, 3 phase, 60 cycle, 7,200 volt, 171.4 rpm unit manufactured by Westinghouse Electric Corporation.

Two of the three vertical turbines are Newport News Shipbuilding and Drydock Company, Francis type, 171.4 rpm units, with capacities of 17,300 hp at 131-foot head. The third turbine, installed in 1950, is an I. P. Morris Division of Baldwin Manufacturing Company unit with the same characteristics as the first two. All three turbines are controlled by Woodward cabinet type governors located on the generator floor level.

A 12-foot diameter steel penstock connects from the lake to each turbine. Each penstock is equipped with a fixed-wheel type headgate. The number three penstock has a wye and butterfly-type valve for controlling the flow from the pump-back unit described below. The original plant design in 1932 called for valves in each penstock, which were on order at the time construction stopped. When a butterfly-type valve was needed in 1950 for this pump installation, S. Morgan Smith Company, the low bidder, found one of these unfinished 1932 cast iron valve bodies in stock. So, the valve finally arrived at the place of original intent 18 years late.

The centerline of the turbine wheels is at elevation 896.5 feet above msl. These units, therefore, can be operated as synchronous condensers with the turbine blades above tailwater. Maximum lake elevation is 1,020.5 feet above msl (crest elevation of uncontrolled spillway) and tailwater elevation is 889.0 feet above msl, providing a maximum gross head of 131.5 feet.

Buchanan Hydroelectric Powerplant has a pump-back unit, placed in operation in May 1950, by which turbine discharge into the tailrace or Inks Lake is in part pumped back to Lake Buchanan. Pumping takes place during off-peak hours of system electrical requirements. The water is then used for power generation during system peaks. A ratio of about 1.8 kwhr off-peak power at Buchanan will pump water back to the lake to generate 1.0 kwhr of peak power, depending on the operating head. Expressed in amount of water, using the pump for 8 hours each day for a year is equivalent to about 10 feet of water in Lake Buchanan. The pump-back unit is an 84 inch, vertical 163.7 rpm Worthington Corporation centrifugal pump with a capacity of 840 cfs, driven by a direct-connected 13,450 hp Westinghouse Electric Corporation vertical motor. To start the unit, electrical connection is made to one of the generator units and both are brought to synchronous speed, then connected to the transmission system. The motor load is then transferred from the generator to the system and the generator shut down. This prevents a surge on the system that would be created by starting such a large motor.

The operating center is located off the generator room and contains the necessary controls for the three generators and the pump motor. The Inks generating unit, 4 miles downstream, is also controlled from this center. The control wires are contained in a cable suspended from poles along the transmission power line.

The Buchanan Hydroelectric Powerplant, transformer station, and part of the downstream side of Buchanan Dam are shown in Figure 13. Two generators and the pump motor in the plant are shown in Figure 14.

Records of gross monthly hydroelectric power generated at the Buchanan plant for the years 1943-67 were furnished by the Lower Colorado River Authority and are given in the table following. Records of power generation before 1943 are not available.

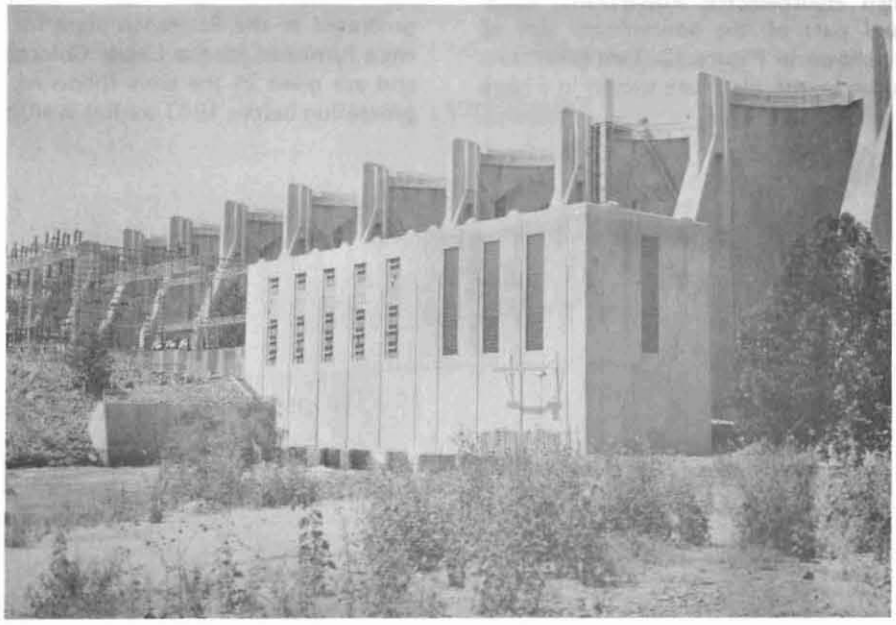

Figure 13.--Buchanan Hydroelectric Powerplant, transformer station, and downstream side of Buchanan Dam. Courtesy of Lower Colorado River Authority.

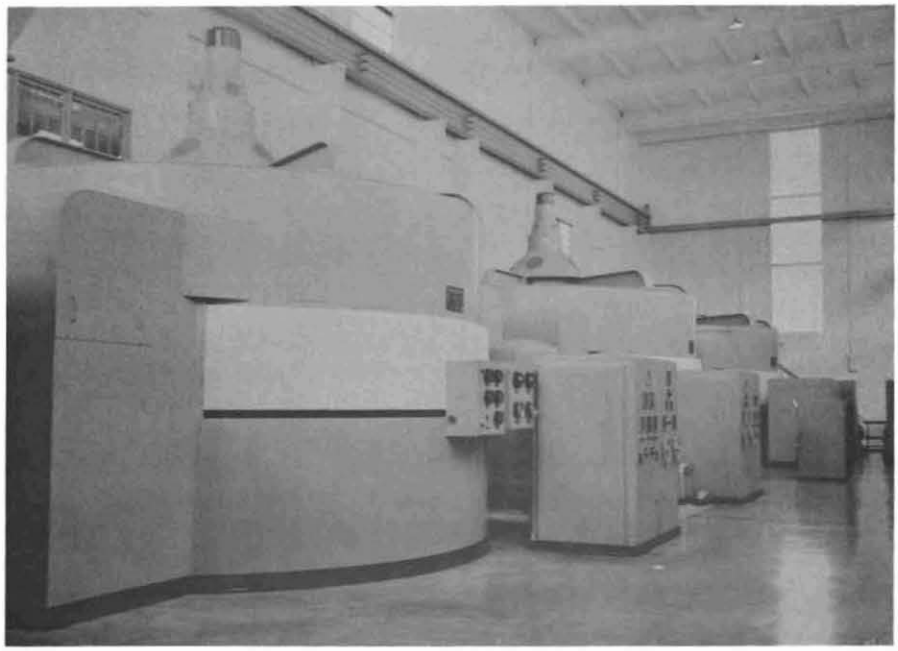

Figure 14.--Two 11,250 kw generators and the pump motor at Buchanan Hydroelectric Powerplant.

Gross generation of electrical energy at Buchanan Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1943	3,955	7,296	9,175	7,311	4,955	6,290	2,707	2,396	855	3,288	4,021	5,047	57,296
1944	2,401	2,243	8,360	5,492	11,616	11,512	6,070	9,677	8,154	4,252	5,351	1,965	77,093
1945	3,287	2,664	4,167	2,135	3,704	5,003	12,809	7,309	4,751	2,673	4,086	6,500	59,088
1946	6,477	8,591	9,814	8,148	1,121	3,295	8,590	5,744	3,292	5,364	6,960	5,881	73,277
1947	1,546	1,352	4,482	3,461	1,960	4,056	5,929	5,423	5,443	6,779	5,970	4,479	50,880
1948	3,535	4,978	4,514	4,114	2,728	4,228	5,676	6,039	4,883	2,544	1,854	3,927	49,020
1949	3,266	2,431	116	2,263	15,315	10,083	8,474	6,173	7,394	3,975	4,431	252	64,173
1950	0	0	3,425	3,355	2,795	5,432	3,183	4,714	3,227	1,773	3,897	2,069	33,870
1951	2,304	3,384	1,231	2,873	9,086	12,432	10,862	13,837	7,744	3,192	1,956	979	69,880
1952	1,478	2,292	413	649	2,205	5,462	9,831	9,149	1,676	1,773	2,513	2,289	39,730
1953	2,995	3,246	1,271	1,665	1,417	4,432	1,407	2,382	5,484	4,763	2,036	2,410	33,508
1954	3,109	1,213	1,534	2,011	21,781	10,699	8,198	3,155	2,255	2,846	1,549	1,659	60,009
1955	3,330	913	1,857	2,821	8,413	19,387	16,560	11,944	6,294	11,769	6,065	2,896	92,249
1956	3,554	1,200	1,092	2,066	18,494	7,825	3,291	2,863	4,141	2,284	1,261	2,430	50,501
1957	3,226	4,019	1,751	3,685	25,811	19,387	6,342	12,482	4,123	15,730	11,718	8,438	116,712
1958	11,258	7,734	9,958	9,058	11,807	10,357	11,334	3,532	2,459	736	2,421	5,227	85,881
1959	3,943	383	759	1,249	1,647	2,443	17,900	11,915	3,357	17,337	7,128	8,010	76,071
1960	11,620	11,133	6,166	7,824	6,246	10,456	6,277	4,912	2,811	760	315	1,471	69,991
1961	1,128	386	7,701	6,338	6,138	12,505	11,575	10,354	8,129	9,286	5,936	7,306	86,782
1962	7,322	2,083	657	353	1,136	1,779	5,185	7,225	9,345	13,516	1,154	299	50,054
1963	8,015	10,294	4,591	13,182	18,436	21,350	21,971	21,753	15,056	2,494	3,612	5,903	146,657
1964	1,573	2,132	1,041	2,325	7,566	7,502	4,784	3,540	2,986	1	276	821	34,547

Gross generation of electrical energy at Buchanan Hydroelectric Powerplant, in Megawatthours--Continued

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1965	270	47	108	64	16,631	10,416	1,907	5,919	1,754	0	518	963	38,597
1966	1,375	1,405	1,147	3,811	11,352	4,527	4,913	2,178	9,970	4,897	0	981	46,556
1967	494	3,135	3,784	16	982	5,319	7,418	6,896	5,529	1,614	353	819	36,359
Total	91,461	84,554	89,114	96,269	213,342	216,177	203,193	181,511	131,112	123,646	85,381	83,021	1,598,781
Monthly and annual average 1943-67	3,658	3,382	3,565	3,851	8,534	8,647	8,128	7,260	5,244	4,945	3,415	3,321	63,951
Monthly average in percent of annual average 1943-67	5.7	5.3	5.6	6.0	13.4	13.5	12.7	11.4	8.2	7.7	5.3	5.2	100

13. Eagle Pass Hydroelectric Powerplant

Location

Eagle Pass Hydroelectric Powerplant is in the Rio Grande basin in Maverick County on the Maverick County Canal about 10 miles upstream from Eagle Pass, Maverick County.

Ownership and History of Development

The plant is owned and operated by the Central Power and Light Company.

Water used for generating electric power is purchased from the Maverick County Water Control and Improvement District No. 1 which was granted Permit No. 1086 (Application No. 1160) dated October 8, 1928, by the State Board of Water Engineers for the purpose of hydroelectric power development. The district has a separate permit for irrigation water.

This combined irrigation and power development is known generally as the Eagle Pass Project. Its history began in 1895 when surveys were made and feasibility was determined. Significant progress was not made until 1927 when a bond issue of $4,800,000 was voted for financing construction of an irrigation system. Later, power development was added to the project through a contract between the district and Central Power and Light Company to supply water for power generation at the Eagle Pass Hydroelectric Powerplant. This further development required a larger canal with a capacity of 1,500 cfs for transporting water to the powerplant site and for irrigation along its 31.5-mile length from the district's point of diversion in Kinney County to the powerplant in Maverick County. An additional bond issue of $1,600,000 was necessary to finance the enlarged canal project (Dowell, 1932).

Construction of the powerplant was started in 1931 and completed in April 1932. Generation of power began April 11, 1932, but the plant was shut down in September 1932 because of flood damage to the canal that diverted water from the Rio Grande. The powerplant returned to operation March 19, 1937.

Physical Description

A special feature of this project is that no dam is required to divert water from the Rio Grande. Instead, a channel was cut in the riverbed of the Rio Grande 10 feet below normal low water to divert flow to the main Maverick County Canal by gravity. The flow to the canal is controlled by three gates installed in a concrete intake structure.

Eagle Pass Hydroelectric Powerplant is at the end of a high ridge on the bank of the Rio Grande. The district delivers water at the end of their 31.5-mile main canal at a control structure. (A smaller canal of 350 cfs capacity continues from this point to supply water for irrigation.)

From the control structure, Central Power and Light Company constructed a canal 1,370 feet long with a capacity of 1,500 cfs to a concrete headworks structure. This structure provides transition from the canal to three 11-foot diameter penstocks with vertical headgates and hoisting equipment for control of water to the turbines in the powerhouse. In addition, there is a taintor gate 12 feet wide by 12 feet high to control the flow to a concrete chute discharging to a weir structure and on to the Rio Grande. This spillway is necessary to prevent buildup and surges in the canal in case of sudden interruption to plant operation.

The water level in the powerplant canal at the headworks is at elevation 796.0 feet above msl, which is 83 feet above the normal river level in the tailrace channel. The operating tailrace elevation is 715.0 feet above msl, giving a gross head of 81.0 feet with three units operating and normal river conditions.

Three 3,200 kw generating units at Eagle Pass Hydroelectric Powerplant provide a total capacity of 9,600 kw. The power is delivered through necessary switches and transformers to the high voltage transmission system supplying the local area, interconnected plants, and service areas of Central Power and Light Company.

Each of the three vertical generators is a 3,200 kw, 3 phase, 60 cycle, 6,900 volt, 225 rpm unit with a direct connected exciter. The generators, switchboard, and control equipment were furnished by the Westinghouse Electric Corporation.

Each of the three vertical turbines is a James Leffel and Company, 225 rpm, Francis type, with capacity of 4,500 hp at 81.0-foot head. Each unit is controlled by a Woodward governor.

As the contract is based on amount of water used, the turbines were tested using the Gibson method to measure the flow and calibrate the Simplex indicating and recording meters. These meters use the differential pressure of Winter-Kennedy taps installed in the scroll-case calibrated to read cfs. In addition, the electric output of each generator is recorded each hour.

An exterior view of the Eagle Pass plant is given in Figure 15. The interior view, Figure 16, shows the three generators with exciters and Woodward governors.

Records of gross monthly generation of hydroelectric power at the Eagle Pass plant were furnished by the Central Power and Light Company. These records for the period March 1937 to December 1967 are given in the table following.

Figure 15.--Eagle Pass Hydroelectric Powerplant. The Rio Grande at flood stage is in background, September 23, 1964.

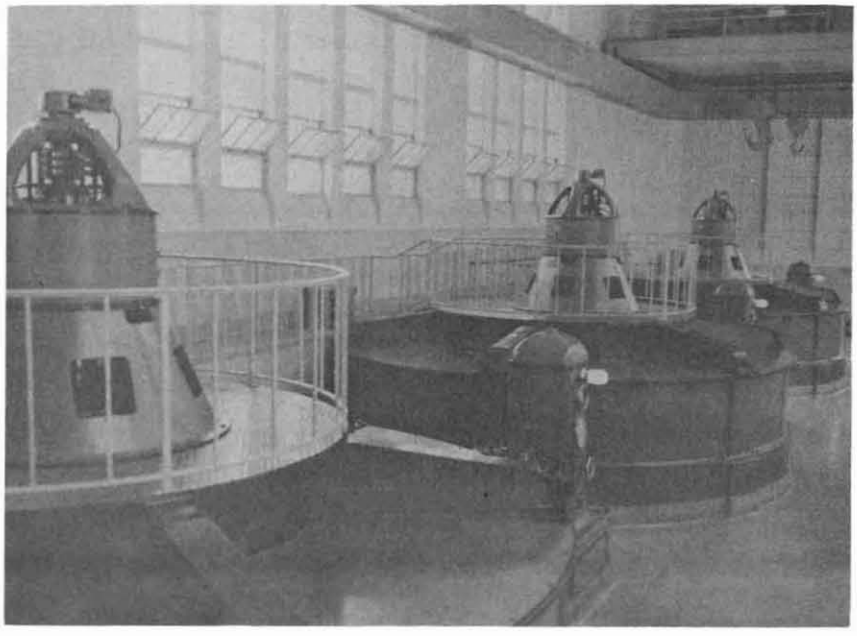

Figure 16.--Three 3,200 kw generators with Woodward governors at Eagle Pass Hydroelectric Powerplant.

Gross generation of electrical energy at Eagle Pass Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1937	--	--	97	379	790	1,521	1,180	1,771	1,068	930	1,040	745	9,521
1938	782	752	606	650	805	1,309	1,477	968	598	556	789	870	10,162
1939	921	974	811	1,073	1,139	1,247	1,211	1,296	1,138	1,099	736	970	12,615
1940	905	1,090	1,080	1,033	1,052	1,032	1,132	1,388	1,132	1,467	867	941	13,119
1941	1,023	1,095	1,076	1,716	1,432	1,199	1,344	1,436	1,229	1,416	1,630	1,588	16,184
1942	1,239	1,244	1,092	913	1,793	1,805	1,029	1,573	1,436	1,549	1,708	1,542	16,923
1943	1,515	1,808	1,974	1,509	1,607	1,996	1,815	2,359	1,653	2,176	2,041	1,976	22,429
1944	1,985	1,865	1,570	1,489	1,368	1,998	1,270	1,564	1,775	2,035	1,829	2,023	20,771
1945	2,182	2,249	1,886	2,055	1,547	1,618	1,597	1,702	1,273	1,788	1,861	1,768	21,526
1946	1,961	1,893	1,655	1,495	1,691	1,527	1,619	817	1,192	1,622	1,799	1,656	18,927
1947	1,934	1,899	1,623	1,364	1,604	956	842	686	1,178	766	904	1,031	14,787
1948	988	1,207	852	435	702	1,312	987	1,763	3,183	3,024	3,167	3,181	20,801
1949	3,578	3,606	3,777	3,769	4,145	3,930	3,666	4,518	4,674	4,524	4,751	4,328	49,266
1950	4,516	4,446	3,853	4,128	4,142	4,689	4,105	4,512	4,290	4,367	3,846	3,759	50,653
1951	4,277	4,332	3,891	3,540	3,164	4,564	2,879	3,770	3,715	2,854	3,401	2,966	43,353
1952	2,921	2,517	1,817	1,434	1,757	3,273	3,425	2,057	718	803	1,448	2,001	24,171
1953	2,269	1,680	1,910	333	81	0	548	2,194	4,355	2,117	2,329	2,176	19,992
1954	2,335	2,448	995	2,081	3,029	3,920	344	1,986	3,955	4,081	3,381	3,409	31,964
1955	3,210	2,515	1,903	858	1,859	1,151	2,100	2,939	2,755	2,776	2,854	2,960	27,880
1956	3,041	2,354	1,457	854	852	580	492	1,090	2,020	1,518	1,582	2,096	17,936
1957	2,592	2,424	2,558	1,968	3,014	2,885	1,570	2,227	2,956	4,120	3,940	3,960	34,214
1958	4,319	3,799	3,863	2,614	3,388	2,896	3,035	3,382	3,434	3,456	3,915	3,956	42,057

Gross generation of electrical energy at Eagle Pass Hydroelectric Powerplant, in Megawatthours--Continued

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1959	3,978	3,683	3,257	3,275	3,947	3,524	3,901	3,889	3,791	4,077	4,011	3,717	45,050
1960	3,708	3,831	3,580	2,803	3,212	2,231	3,368	3,985	3,529	3,726	4,162	4,418	42,544
1961	4.510	4,146	3,693	2,757	3,504	3,703	3,905	4,148	3,817	4,122	3,830	3,914	46,049
1962	3,888	3,302	3,286	3,078	2,639	3,359	3,481	2,768	3,742	4,124	3,851	4,137	41,655
1963	3,901	3,141	2,516	2,436	3,822	3,349	2,832	3,548	3,890	3,515	3,513	3,837	40,300
1964	3,335	3,280	2,834	1,949	2,322	2,912	1,450	2,943	2,954	4,644	3,750	3,913	36,286
1965	3,301	3,527	3,125	3,040	2,880	3,370	1,925	2,655	3,450	4,022	3,703	4,673	39,671
1966	4,363	3,504	2,812	2,503	4,473	3,247	2,724	3,816	4,752	4,136	3,460	3,747	43,537
1967	3,770	3,048	2,979	3,038	1,316	2,155	2,898	3,039	4,071	4,124	3,924	3,874	38,236
Total	83,247	77,659	68,428	60,569	69,076	73,258	64,151	76,789	83,714	85,534	84,022	86,132	912,579
Monthly and annual average 1938-67	2,775	2,589	2,278	2,006	2,276	2,391	2,099	2,501	2,755	2,820	2,766	2,846	30,102
Monthly average in percent of annual average 1938-67	9.2	8.6	7.6	6.7	7.6	7.9	7.0	8.3	9.1	9.4	9.2	9.4	100

14. Red Bluff Hydroelectric Powerplant

Location

Red Bluff Hydroelectric Powerplant is at Red Bluff Dam (Red Bluff Reservoir) on the Pecos River in the Rio Grande basin, 5 miles north of Orla, Reeves County.

Ownership and History of Development

The powerplant is owned and operated by the Red Bluff Water Power Control District under the authority of Permit No. 1217 (Application No. 1295), dated January 15, 1934, granted by the State Board of Water Engineers to the district. The permit authorized the construction of a reservoir and annual use of 300,000 acre-feet of water for hydroelectric power generation and irrigation of 145,000 acres of land in Reeves, Loving, Ward, and Pecos Counties.

Irrigation along the Pecos River downstream from the New Mexico-Texas state line was begun in the middle 1870's. By 1914, consideration was being given to constructing a reservoir. This culminated in the Red Bluff Project and, in 1933, construction was approved as a project of the U.S. Public Works Administration. Actual construction began in November 1934 and was completed in September 1936. Power generation began June 6, 1937.

Physical Description

Number one vertical generator is a 1,000 kw, 3 phase, 60 cycle, 2,400 volt, 360 rpm unit. Number two vertical generator is a 1,300 kw, 3 phase, 60 cycle, 2,400 volt, 277 rpm unit. Both generators were manufactured by the General Electric Company.

Both of the turbines are S. Morgan Smith Company vertical, Francis type. Number one unit has a capacity of 1,200 hp at 60-foot head and operates with a speed of 360 rpm. Number two unit has a capacity of 1,600 hp at 60-foot head and operates at a speed of 277 rpm.

Water is supplied to turbine number one by a 5.5-foot diameter steel penstock and to turbine number two by a 6.5-foot diameter steel penstock. A butterfly valve is installed on each penstock.

Irrigation releases from Red Bluff Reservoir normally are discharged through the operation of the hydroelectric powerplant. During much of the time, however, the water supply has been limited and generation curtailed. The bypass valves are used when the water requirement is small. No releases are made solely for power generation. The electric output of the plant is used at Grand Falls for local distribution to supplement generation by diesel engine generating units.

Records of generation of hydroelectric power at this plant are not available.

15. Inks Hydroelectric Powerplant

Location

Inks Hydroelectric Powerplant is at Inks Dam (Inks Lake) on the Colorado River, 4 miles below Buchanan Dam, and 10 miles west of Burnet, Burnet County.

Ownership and History of Development

The powerplant is owned and operated by the Lower Colorado River Authority as the second of a series of six hydroelectric powerplants on the Colorado River. The other five are Buchanan, Granite Shoals, Marble Falls, Marshall Ford, and Austin Hydroelectric Powerplants. All of these are described in this report.

The project was authorized by Permit No. 1259A (Application No. 1345), dated May 25, 1938, granted by the State Board of Water Engineers to the Lower Colorado River Authority. This permit authorizes an annual appropriation of 1,391,530 acre-feet of water for hydroelectric power production.

Several other water rights included in Permit No. 1259A recognize earlier water rights of the Lower Colorado River Authority. These are described in Texas Water Development Board Report 48 (Dowell and Breeding, 1967).

Not long after work had been resumed on Buchanan Dam in 1935, a smaller dam was started at the Arnold site about 4 miles downstream from Buchanan (Clay, 1948). This new dam is known as the Inks Dam in memory of Roy B. Inks, one of the originators of the Lower Colorado River Authority. It is designed primarily as a power dam. Construction of the Inks project was begun in 1936 and was completed in June 1938. Impoundment of water in Inks Lake began at that time. The power unit began operation in June 1938.

Physical Description

The one 12,500 kw generating unit at Inks Hydroelectric Powerplant is operated by remote control from Buchanan Hydroelectric Powerplant. Output is coordinated with the discharge from that plant.

The vertical generator is a 12,500 kw, 3 phase, 60 cycle, 6,900 volt, 112.5 rpm unit manufactured by General Electric Company.

The vertical turbine is an S. Morgan Smith Francis type 112.5 rpm unit with a capacity of 19,700 hp at 63.5-foot head.

Design headwater elevation at Inks plant is 888.0 feet above msl and the tailwater is 824.5 feet above msl, giving a gross head of 63.5 feet for the turbine. Centerline of the turbine is at elevation 834.0 feet above msl.

Records of gross monthly hydroelectric power generated at the Inks plant for the years 1943-67 were furnished by the Lower Colorado River Authority and are given in the table following. Records of power generation before 1943 are not available.

Gross generation of electrical energy at Inks Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1943	1,840	3,482	4,437	3,700	2,558	3,264	1,364	1,235	4,795	1,660	2,145	2,762	33,242
1944	1,383	1,336	4,521	2,969	6,416	5,768	3,098	5,060	4,236	2,231	2,821	1,161	41,000
1945	1,812	1,436	2,154	1,202	1,725	2,401	5,837	3,466	2,302	1,159	1,947	3,219	28,660
1946	3,273	4,348	4,916	4,276	594	1,694	4,551	3,116	1,746	2,786	3,733	3,292	38,325
1947	1,005	751	2,458	1,876	900	1,985	2,890	2,728	2,829	3,623	3,268	2,418	26,731
1948	1,863	2,742	2,580	2,443	1,574	2,470	2,996	3,188	2,497	1,351	951	2,143	26,798
1949	1,811	1,432	269	775	7,544	4,932	4,041	2,997	3,680	1,976	2,235	299	31,991
1950	43	14	1,409	1,662	1,598	2,666	1,438	2,299	1,516	459	1,212	487	14,803
1951	0	931	355	1,233	4,680	6,089	5,301	7,453	4,231	1,386	377	43	32,079
1952	190	640	44	389	1,332	2,880	5,401	5,664	870	520	905	407	19,242
1953	934	1,085	160	458	521	2,156	698	1,199	2,672	2,167	1,010	1,028	14,088
1954	1,467	603	758	975	6,834	4,681	3,909	1,494	920	710	6	37	22,394
1955	716	429	109	792	3,205	6,568	7,203	5,625	2,449	5,406	2,823	1,433	36,758
1956	1,673	210	232	817	7,694	3,091	1,582	1,419	2,075	665	629	642	20,729
1957	998	1,344	343	1,228	7,832	7,111	3,032	6,051	2,031	5,321	5,517	3,931	44,739
1958	5,227	3,675	4,493	4,245	5,444	4,855	5,365	1,775	1,299	362	1,167	2,624	40,531
1959	1,981	297	465	681	863	1,253	7,682	5,353	1,598	5,818	2,028	2,403	30,422
1960	5,272	5,174	2,939	3,803	3,009	5,049	3,274	1,851	1,255	430	266	907	33,229
1961	679	243	3,606	3,011	2,882	5,017	5,258	4,647	3,748	4,412	2,817	3,561	39,881
1962	3,646	1,379	1	246	619	956	2,679	3,865	5,111	7,374	672	214	26,762
1963	410	1,015	4	198	10	12	457	681	302	2	7	807	3,905
1964	159	427	598	1,285	4,005	4,012	4,468	2,197	1,918	43	166	16	19,294

Gross generation of electrical energy at Inks Hydroelectric Powerplant, in Megawatthours--Continued

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1965	0	0	0	40	5,081	4,875	920	2,782	902	96	428	164	15,288
1966	101	162	62	1,380	4,360	2,207	2,347	1,101	4,543	2,253	0	531	19,047
1967	226	949	1,684	51	569	2,496	3,584	3,397	2,779	853	254	435	17,277
Total	36,709	34,104	38,597	39,735	81,849	88,488	89,375	80,643	62.304	53,063	37,384	34,964	677,215
Monthly and annual average 1943-67	1,468	1,364	1,544	1,589	3,274	3.540	3,575	3,226	2,492	2,123	1,495	1,399	27,089
Monthly average in percent of annual average 1943-67	5.4	5.0	5.7	5.9	12.1	13.1	13.2	11.9	9.2	7.8	5.5	5.2	100

16. Marshall Ford Hydroelectric Powerplant

Location

Marshall Ford Hydroelectric Powerplant is at Mansfield Dam (Lake Travis) on the Colorado River, 12 miles northwest of Austin, Travis County.

Ownership and History of Development

The powerplant is owned and operated by the Lower Colorado River Authority as one of a series of six hydroelectric powerplants on the Colorado River. The other five are Buchanan, Inks, Granite Shoals, Marble Falls, and Austin Hydroelectric Powerplants. All of these are described in this report. The dam was built by the U.S. Bureau of Reclamation. The Lower Colorado River Authority built the power facility. The Marshall Ford plant is the fifth hydroelectric powerplant downstream from Lake Buchanan.

The project was authorized by Permit No. 1260 (Application No. 1346), dated May 25, 1938, granted by the State Board of Water Engineers to the Lower Colorado River Authority. The permit grants the right to appropriate 1,500,000 acre-feet of water annually for municipal, irrigation, mining, recreation, and hydroelectric power purposes.

Several other water rights included in Permit No. 1260 recognize earlier water rights of the Lower Colorado River Authority (Dowell and Breeding, 1967).

Construction began in March 1937, following plans for a dam much lower than the existing dam. First stages of the low dam were completed in July 1939. On May 10, 1939, Congress approved more money, and a contract was awarded to the same builder for additional foundation and a higher dam. The present structure was completed May 17, 1942. Deliberate impoundment began on September 9, 1940. The first generating unit was placed in operation January 27, 1941. On February 21, 1941, the dam was named Mansfield Dam in honor of Congressman J. J. Mansfield, who had been of much help in the project. The powerplant, however, has kept the name Marshall Ford.

Physical Description

Three 22,500 kw generating units at Marshall Ford Hydroelectric Powerplant provide a total capacity for the powerplant of 67,500 kw. Due to higher operating head than originally designed, the units can be overloaded for peak power requirements to 29,000 kw each.

Each of the three vertical generators is a 22,500 kw, 3 phase, 60 cycle, 13,800 volt, 144 rpm unit, manufactured by General Electric Company (Figure 17).

Each of the three vertical turbines is an I. P. Morris Company, Francis type, 144 rpm unit, with the capacity varying with the operating head. Each of the units is controlled by a Woodward cabinet type governor.

A 16-foot diameter steel penstock connects from the lake to each turbine. Each penstock is equipped with a fixed-wheel type headgate.

The operating room is on the top floor and contains the necessary controls for the generators and transmission line circuits.

The elevation of the water in the forebay of the powerplant at maximum power storage space is 681.1 feet above msl. The tailbay elevation is 495.0 feet above msl, giving a gross head of 186.1 feet. The crest of the uncontrolled spillway of the dam is at 714.1 feet above msl, and the capacity above 681.1 feet above msl is reserved for flood control. In special cases where danger of flooding downstream is not present, the water in storage between elevation 681.1 and 691.1 feet above msl may be released by operating the turbines to generate power instead of discharging the water through flood gates.

Records of gross monthly hydroelectric power generated at the Marshall Ford plant for the years 1943-67 were furnished by the Lower Colorado River Authority and are given in the table following. Records of power generation before 1943 are not available.

Figure 17.--Three 22,500 kw generators at Marshall Ford Hydroelectric Powerplant.
Courtesy of Lower Colorado River Authority.

Gross generation of electrical energy at Marshall Ford Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1943	23,954	18,804	16,926	20,961	16,359	17,928	15,710	14,786	6,625	10,276	8,714	10,288	181,331
1944	8,781	8,198	6,660	7,975	13,657	22,257	29,250	25,870	23,902	20,976	11,134	15,310	193,970
1945	13,107	13,880	16,053	15,808	18,229	16,099	29,638	29,689	18,706	14,221	16,649	16,157	218,236
1946	15,565	9,961	11,919	13,349	18,845	15,673	16,344	24,132	19,138	18,654	13,489	15,326	192,395
1947	18,177	16,256	15,056	10,137	13,478	16,498	17,370	14,351	10,825	7,982	7,755	6,236	154,121
1948	6,964	7,573	5,574	7,670	8,912	13,219	16,371	15,966	8,444	6,341	4,835	4,584	106,453
1949	4,766	4,249	8,253	6,919	9,044	16,955	17,030	15,196	12,504	9,896	9,327	8,772	122,911
1950	6,129	5,460	4,978	4,513	10,674	13,573	13,596	11,496	5,877	3,568	4,290	4,634	88,788
1951	5,616	3,518	904	4,073	9,683	8,655	11,407	10,798	4,157	2,386	1,319	1,019	63,535
1952	1,013	945	996	2,420	6,200	10,061	10,408	10,383	6,297	1,836	1,219	1,441	53,219
1953	5,260	5,439	3,833	7,517	10,525	15,561	15,570	10,217	2,392	1,495	978	1,796	80,583
1954	422	739	6,163	7,972	17,094	16,929	18,829	13,243	3,596	1,195	2,138	2,349	90,669
1955	2,007	3,355	4,001	7,523	13,546	36,783	26,196	18,834	15,446	19,626	13,964	4,352	165,633
1956	2,356	1,711	6,413	8,009	20,578	18,499	19,177	12,382	4,380	1,905	910	1,077	97,397
1957	1,267	941	1,018	11,110	51,892	50,310	42,873	22,149	17,633	34,540	51,902	40,458	326,093
1958	27,954	26,637	53,182	37,170	31,604	38,566	38,874	23,750	10,760	8,417	4,249	2,081	303,244
1959	4,754	8,224	5,233	11,458	18,868	13,841	18,509	28,422	20,048	45,528	40,546	29,129	244,560
1960	24,831	24,879	30,094	25,279	22,931	23,105	22,289	15,568	9,295	7,197	2,287	0	207,755
1961	487	32,463	30,673	26,846	19,065	18,533	31,298	31,046	17,712	5,724	22,193	23,743	259,783
1962	10,065	3,367	1,052	2,420	11,448	13,485	15,079	13,485	5,957	1,067	2,410	3,810	83,645
1963	3,540	2,018	3,622	7,821	12,723	14,965	13,504	12,198	8,408	1,055	96	30	79,980
1964	54	0	1	7,179	10,482	11,407	10,085	7,589	5,802	480	0	14	53,093

Gross generation of electrical energy at Marshall Ford Hydroelectric Powerplant, in Megawatthours--Continued

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1965	0	13	0	4,655	28,570	53,305	14,816	11,488	9,308	4,862	12,321	9,082	148,420
1966	5.041	2,003	215	16,385	45,444	17,999	15,301	9,593	7,814	4,047	4,449	206	128,497
1967	0	203	5,010	16,404	16,770	17,387	11,324	16,605	7,322	437	0	0	91,462
Total	192,110	200,836	237,829	291,573	456,621	511,593	490,848	419,236	262,348	233,711	237,174	201,894	3,735,773
Monthly and annual average 1943-67	7,684	8,033	9,513	11,663	18,265	20,464	19,643	16,769	10,494	9,349	9,487	8,076	149,431
Monthly average in percent of annual average 1943-67	5.1	5.4	6.4	7.8	12.2	13.7	13.1	11.2	7.0	6.3	6.4	5.4	100

17. Morris Sheppard Hydroelectric Powerplant

(Also known as Possum Kingdom)

Location

Morris Sheppard Hydroelectric Powerplant is at Morris Sheppard Dam (Possum Kingdom Reservoir) on the Brazos River in Palo Pinto County, 11 miles southwest of Graford and 18 miles northeast from Mineral Wells.

Ownership and History of Development

The project is owned and operated by the Brazos River Authority. It was authorized by Permit No. 1262 (Application No. 1351), dated May 9, 1938, and granted by the State Board of Water Engineers to the Brazos River Authority. The permit authorizes an appropriation of 1,500,000 acre-feet of water annually for municipal, industrial, mining, irrigation, recreation, and power generation uses.

Construction of the dam was started May 29, 1938. The dam was completed and deliberate storage was begun March 21, 1941. Power generation began April 17, 1941.

This project was built in 1938 with the help of $4,500,000 from the U.S. Public Works Administration. Total cost of the project was $9,000,000. Officially, the dam and reservoir are both named for the late U.S. Senator Morris Sheppard. Locally, the more familiar name is Possum Kingdom. Figure 18 is an aerial view of the dam and powerplant.

Physical Description

The powerplant building is a concrete structure housing two hydroelectric units with a total capacity of 22,500 kw. The operating room is on the top floor and contains the switchboard, relays, instruments, and other equipment for controlling the units and flow of electricity to the transmission system. The power generated is sold to the Brazos River Transmission Electric Cooperative, Inc., for use in its service area.

Each of the two vertical generators is an 11,250 kw, 3 phase, 60 cycle, 6,900 volt, 171.4 rpm unit furnished by the General Electric Company.

Each of the two vertical turbines is an Allis-Chalmers Manufacturing Company, 171.4 rpm, Francis type, with a capacity of 17,000 hp at 125-foot head.

Two 12-foot diameter penstocks made of steel imbedded in concrete convey water from the reservoir to the turbines. Headgates are installed at the intake structure to stop the flow of water to the penstocks when necessary.

Forebay water level with full reservoir is at elevation 1,000.0 feet above msl. The tailwater elevation is 875.0 feet above msl, giving a gross head for the turbine of 125 feet.

Records of gross monthly generation of electrical energy at the Morris Sheppard Hydroelectric Powerplant for the period May 1942 to December 1967 have been furnished by the Brazos River Authority and are given in the table following.

Figure 18.--Morris Sheppard Dam and Hydroelectric Powerplant (also known as Possum Kingdom). Courtesy of Brazos River Authority.

Gross generation of electrical energy at Morris Sheppard Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1942	--	--	--	--	329	415	790	681	498	597	466	465	4,241
1943	3,720	6,655	7,454	7,081	3,227	4,215	5,060	3,555	704	292	73	55	42,091
1944	532	342	230	151	670	1,112	1,138	2,151	562	1,646	1,596	1,913	12,043
1945	1,842	1.810	2,077	1,789	2,467	3,568	3,445	3,650	1,486	906	701	1.369	25,110
1946	5,010	874	459	1,298	982	1,116	3,506	3,988	5,351	12.263	5,698	5,015	45,560
1947	4,892	2,365	1,082	1,621	5,601	7,105	4,342	3,453	3,106	1,491	941	1,565	37,564
1948	2,106	2,127	1,539	2,410	1,169	3,052	4,212	5,356	2,194	830	931	897	26,823
1949	1,148	1,179	635	368	6,593	14,430	4,573	6,553	6,182	6,257	2.723	1,584	52,225
1950	799	919	1,477	916	4,093	6,985	10,935	10,357	12,924	4,575	1,580	2,185	57,745
1951	4,144	2,040	372	2,050	1,486	4,161	8,250	6.479	3,129	1,652	940	897	35,600
1952	1,438	275	154	526	235	3,223	4,150	3,257	118	17	8	98	13,499
1953	13	0	28	64	221	1,580	3,182	3,221	4,104	4,189	5,106	2,093	23,801
1954	1,286	904	1,367	3,933	15,677	10,726	5,746	4,694	987	480	111	33	45,944
1955	1,199	336	197	366	4,004	11,980	4,886	3,561	5,027	9,461	1,939	745	43,701
1956	3,175	3,965	4,780	2,705	4,683	1,906	6,555	3,122	216	129	475	806	32,517
1957	1,478	1,246	524	2,773	17,766	16,348	3,285	2,960	1,906	7,700	8,753	4,490	69,229
1958	2,887	2,064	405	1,332	11,638	3,788	8,762	4,005	1,649	3,622	1,793	1,068	43,013
1959	1,191	284	287	410	1,171	5,995	9,991	1,004	1,071	6,799	1,559	1,668	31,430
1960	2,514	4,272	698	1,501	2,100	1,014	9,148	2,523	2,151	8,887	5,646	4,676	45,130
1961	2,977	1,934	3,834	3,868	1,046	10,941	16,257	7,811	5,531	2,837	1,013	1,929	59,978
1962	2,391	1,880	1,777	636	201	6,067	6,386	8,590	12,030	4,528	4,321	5,836	54,643
1963	4,441	2,037	464	272	4,679	17,342	6,175	3,572	1,234	200	29	285	40,730

Gross generation of electrical energy at Morris Sheppard Hydroelectric Powerplant, in Megawatthours--Continued

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1964	745	371	548	301	147	2,300	4,450	2,742	1,033	306	414	198	13,555
1965	964	680	490	779	8,047	2,438	2,928	2,471	2,717	1,898	1,621	1,298	26,331
1966	1,392	590	2,030	3,846	7,095	780	3,545	1,972	17,722	3,697	0	1,824	44,493
1967	542	374	257	2,288	420	6,204	9,586	3,056	1,706	624	1,764	458	27,279
Total	52,826	39,523	33,165	43,284	105,747	148,791	151,283	104,784	95,338	85,883	50,201	43,450	954,275
Monthly and annual average 1943-67	2,113	1,581	1,327	1,731	4,217	5,935	6,020	4,164	3,794	3,411	1,989	1,719	38,001
Monthly average in percent of annual average 1943-67	5.6	4.2	3.5	4.5	11.1	15.6	15.8	11.0	10.0	9.0	5.2	4.5	100

18. Denison Hydroelectric Powerplant

Location

Denison Hydroelectric Powerplant is at Denison Dam (Lake Texoma) on the Red River between Grayson County, Texas, and Bryan County, Oklahoma, 5 miles northwest of Denison, Texas.

Ownership and History of Development

The project is owned by the U.S. Government and was built and put in operation by the U.S. Army Corps of Engineers, Denison District, in 1943. Following World War II, the Denison District was deactivated and the Denison project became part of the Tulsa District. It was authorized by the Flood Control Act of June 28, 1938, for flood control, power generation, water conservation, and recreational purposes. Public Law 868, Seventy-Sixth Congress, Third Session, designates the beneficial uses for the project.

Construction started in 1939 and was completed in 1943, with deliberate impoundment in Lake Texoma beginning October 31, 1943.

The first unit of the Denison Hydroelectric Powerplant was placed in service June 10, 1944, and started commercial power production July 17, 1944, on an emergency basis at reduced head, due to the shortage of electric power caused by World War II industrial requirements. The reservoir was filled in March 1945, and operation changed from emergency to normal. The second unit was placed in service September 15, 1949, and commercial production began September 19, 1949.

Power generated by unit one is sold to the Texas Power and Light Company and distributed by its system control center in Dallas. The output of unit two is sold to electric cooperatives and utility companies in Oklahoma, by the Southwestern Power Administration, the marketing agency for federal power in this area. Power distribution is controlled from the operating center of the Public Service Company of Oklahoma at Tulsa, Oklahoma. Generation is normally during the hours of peak power requirement of the two systems.

Physical Description

Two gate controlled penstocks, each 20 feet in diameter, carry the water from Lake Texoma to two 56,000 hp turbines. (Three additional penstocks are installed for future use.) These turbines are direct connected to 35,000 kw generators giving a total capacity of 70,000 kw.

Each of the two vertical generators is a 35,000 kw, 3 phase, 60 cycle, 13,800 volt, 90 rpm unit manufactured by Westinghouse Electric Corporation.

Each of the two vertical turbines is an S. Morgan Smith Company, Francis type, 90 rpm unit with a capacity of 56,000 hp at 102.5-foot net head. The turbines are controlled by governors manufactured by Woodward Governor Company.

Electric service for the powerhouse and project area is provided by two 600 kw hydroelectric units completely isolated from the main power system.

The powerhouse contains equipment necessary for the plant operation located at various floor levels. The operating room with switchboard, relays, recording instruments, and other control equipment is located in the south end of the powerhouse overlooking the generator floor area.

At top of power storage at elevation 617.0 feet above msl, the reservoir capacity is 2,722,000 acre-feet, and at bottom of power pool at elevation 590.0 feet above msl, the power head and sediment storage capacity is 1,049,000 acre-feet. This gives a storage capacity of 1,673,000 acre-feet for the production of hydroelectric power. (Elevation of top of power storage was raised to 617.50 feet above msl early in 1968.)

Normal tailwater elevation is about 511.0 feet above msl, giving a maximum operating head for the turbine of 106 feet when the lake is at top of the power pool.

Figure 19 is an aerial view of Denison Hydroelectric Powerplant. Figure 20 shows the interior of the powerhouse.

Records of net monthly generation of power at the Denison Hydroelectric Powerplant for the period June 1944 to December 1967 were furnished by the U.S. Army Corps of Engineers. These records are given in the table following.

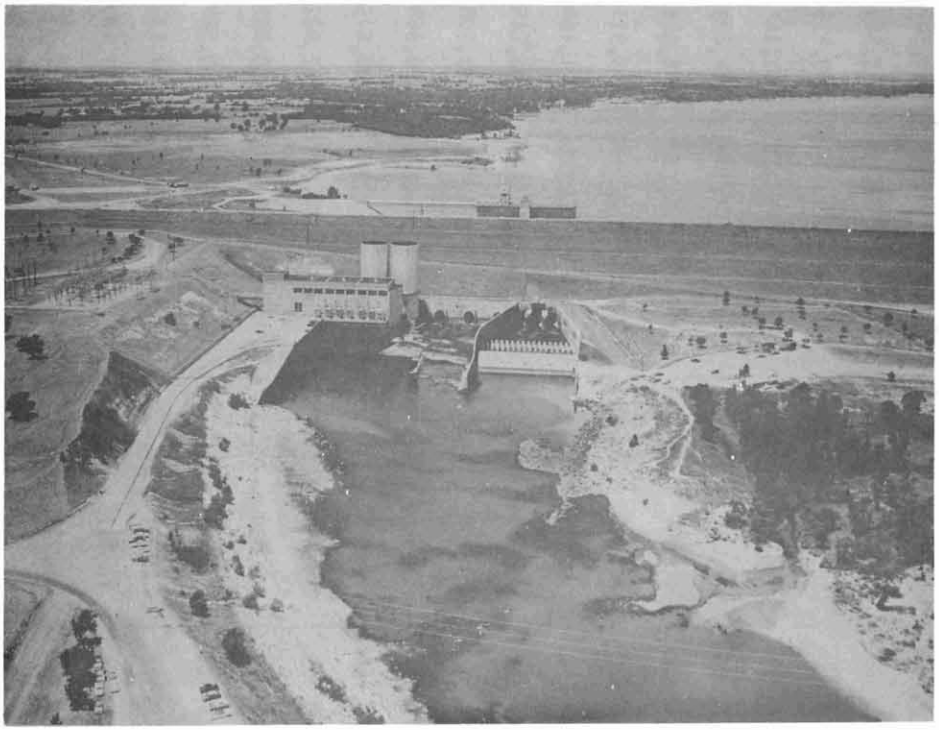

Figure 19.--Denison Dam and Hydroelectric Powerplant.
Courtesy of U.S. Army Corps of Engineers.

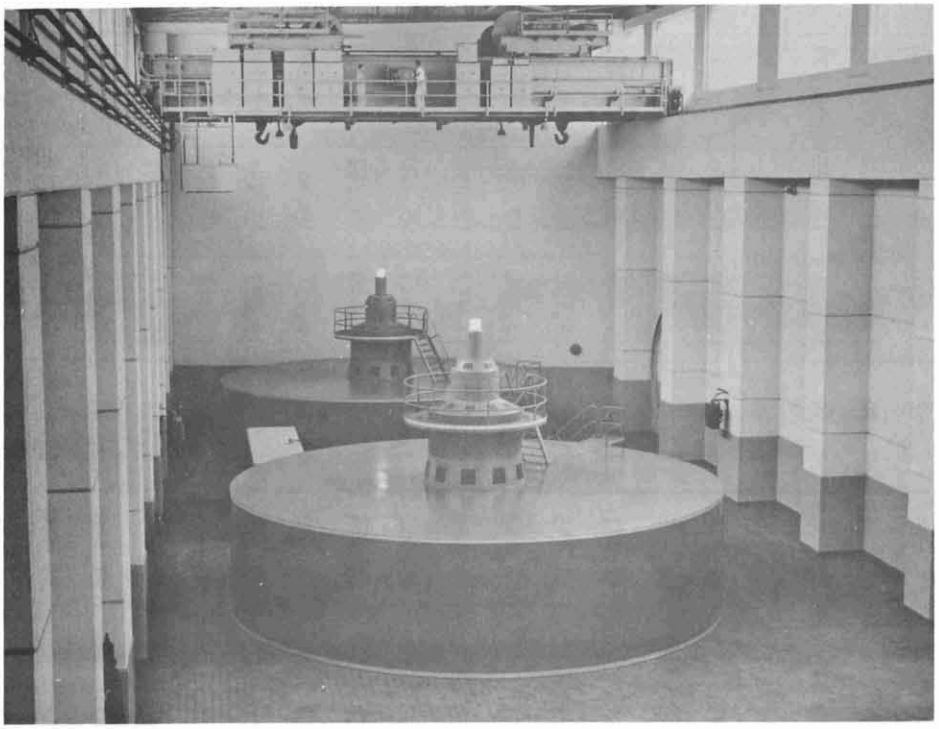

Figure 20.--Two 35,000 kw generators at Denison Hydroelectric Powerplant.
Courtesy of U.S. Army Corps of Engineers.

Net generation of electrical energy at Denison Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1944	--	--	--	--	--	1,021	279	2,025	229	281	245	2,136	6,216
1945	879	1,467	17,061	26,855	27,573	23,438	25,909	27,339	13,917	27,520	11,412	5,391	208,761
1946	22,503	20,430	25,641	21,410	19,571	21,689	21,323	10,988	10,182	16,062	25,261	28,509	243,569
1947	27,799	20,165	10,706	18,396	29,722	28,450	21,825	12,122	11,533	11,000	6,294	11,427	209,439
1948	12,025	11,862	14,343	17,875	14,909	20,753	22,765	13,553	10,548	9,057	10,229	9,322	167,241
1949	11,574	9,500	13,887	10,876	19,048	25,330	11,919	12,255	11,225	13,416	12,475	13,384	164,889
1950	10,998	11,924	7,640	10,215	28,263	30,680	33,944	34,910	31,041	22,429	13,196	13,308	248,548
1951	12,851	13,299	10,229	9,506	22,812	37,061	30,207	14,722	10,858	7,738	6,932	7,706	183,921
1952	11,445	7,320	8,150	13,013	11,615	12,854	12,995	14,618	7,236	10,423	6,122	5,373	121,164
1953	6,048	4,518	2,576	7,086	6,451	8,962	11,251	13,322	11,717	9,588	5,008	10,291	96,818
1954	9,349	9,272	11,857	12,234	39,820	48,720	23,244	15,071	10,708	4,681	8,690	8,662	202,308
1955	1,062	3,714	3,433	5,126	15,979	39,749	18,843	17,031	11,414	38,538	24,602	20,873	200,364
1956	17,444	18,058	10,046	4,352	9,353	6,435	7,220	6,364	6,148	49	111	2,945	88,525
1957	9,502	6,022	6,431	14,861	44,266	40,583	23,130	11,906	13,755	28,672	41,283	26,611	267,022
1958	7,709	20,043	7,837	15,591	37,711	11,138	15,056	12,623	8,090	9,121	9,172	6,800	160,891
1959	10,423	3,246	11,405	9,880	3,248	10,252	19,774	23,423	13,691	20,239	13,218	30,525	169,324
1960	42,256	36,724	20,914	15,004	13,439	17,736	19,663	11,641	9,842	30,790	16,878	27,345	262,232
1961	27,258	10,784	14,739	30,490	10,815	13,558	16,385	12,956	16,772	25,739	24,365	23,621	227,482
1962	16,005	8,205	6,215	10,014	6,376	46,668	23,541	22,528	18,771	22,952	20,674	30,904	232,853
1963	21,431	4,340	6,710	13,223	12,292	13,443	13,804	10,385	5,961	4,846	3,270	4,870	114,575
1964	5,539	5,973	4,853	7,229	7,414	8,433	11,394	10,451	4,652	4,706	3,731	4,259	78,634
1965	9,047	9,147	8,077	9,148	10,535	13,740	17,111	15,675	13,436	10,707	13,582	10,458	140,663

Net generation of electrical energy at Denison Hydroelectric Powerplant, in Megawatthours--Continued

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1966	16,475	9,337	6,630	14,069	29,060	18,009	18,462	11,084	17,604	20,750	12,443	12,377	186,300
1967	7,497	7,899	3,732	5,270	11,248	14,757	13,754	14,587	13,549	10,277	7,585	4,805	114,960
Total	317,119	253,249	233,112	301,723	431,520	513,459	433,798	351,579	282,879	359,581	296,778	321,902	4,096,699
Monthly and annual average 1945-67	13,788	11,011	10,135	13,118	18,762	22,280	18,848	15,198	12,289	15,622	12,893	13,903	177,847
Monthly average in percent of annual average 1945-67	7.8	6.2	5.7	7.4	10.6	12.5	10.6	8.5	6.9	8.8	7.2	7.8	100

19. Whitney Hydroelectric Powerplant

Location

Whitney Hydroelectric Powerplant is at Whitney Dam (Whitney Reservoir) on the Brazos River in Hill and Bosque Counties, 7 miles southwest of Whitney and 38 miles upstream from Waco.

Ownership and History of Development

The project is owned by the U.S. Government and is operated by the U.S. Army Corps of Engineers, Fort Worth District. It was built under authority of the Flood Control Act of August 18, 1941, (Public Law 228, 77th Congress, First Session) and of December 22, 1944, (Public Law 534, 78th Congress, Second Session).

Construction of the project began May 12, 1947. The main dam and spillway were completed in April 1951, and deliberate impoundment in Whitney Reservoir began December 10, 1951. The first of two 15,000 kw generating units was placed in operation June 25, 1953. However, due to lack of water and a permanent power contract, the plant was operated on an emergency contract until June 1, 1955. The Whitney Powerplant, Dam, and switchyard are shown in Figure 21. The generating units and part of Whitney Dam are shown in Figure 22.

The power generated at Whitney Hydroelectric Powerplant is sold to the Brazos Electric Power Cooperative, Inc., by the Southwestern Power Administration, marketing agency for federal power in this area. The power distribution to the service area is controlled from the operating center in Waco. Generation is normally during the hours of peak power requirement of the system.

Physical Description

Two gate controlled penstocks, each 16 feet in diameter, carry the water from Lake Whitney to two 20,700 hp turbines. These turbines are direct connected to 15,000 kw generators giving a total capacity of 30,000 kw.

Each of the two vertical generators is a 15,000 kw, 3 phase, 60 cycle, 13,800 volt, 128.6 rpm unit manufactured by Allis-Chalmers Manufacturing Company.

Each of the two vertical turbines is a Newport News Shipbuilding and Dry Dock Company, Francis type, 128.6 rpm unit, with a capacity of 24,000 hp at 88-foot head. The turbines are controlled by governors manufactured by Woodward Governor Company.

The powerhouse equipment necessary for the plant operation is located at various floor levels. The operating room with switchboard, relays, recording instruments, and other control equipment is at elevation 475.0 and the generator floor elevation is 458.0 feet above msl.

Of the reservoir capacity, 131,700 acre-feet is allocated to the production of hydroelectric power. This regulated discharge through the turbines may be used downstream for agriculture, municipal, and industrial purposes. The maximum elevation of this power storage is 520.0 feet above msl and the normal tailwater elevation is 431.2 feet above msl, giving an operating head for the turbines of 88.8 feet. (Effective January 24, 1968, the power storage elevation was changed from 520.0 to 522.0 feet above msl.)

Records of net monthly generation of electrical energy at the Whitney Hydroelectric Powerplant for the period June 1953 to December 1967 have been furnished by the U.S. Army Corps of Engineers. These records are given in the table following.

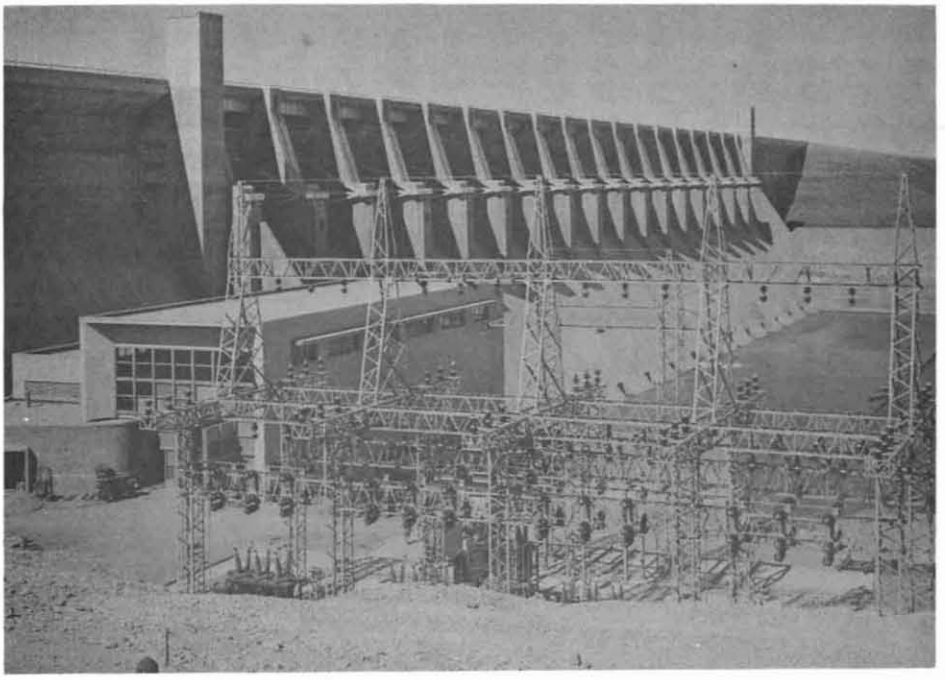

Figure 21.--Whitney Hydroelectric Powerplant, Dam, and switchyard. Courtesy of U.S. Army Corps of Engineers.

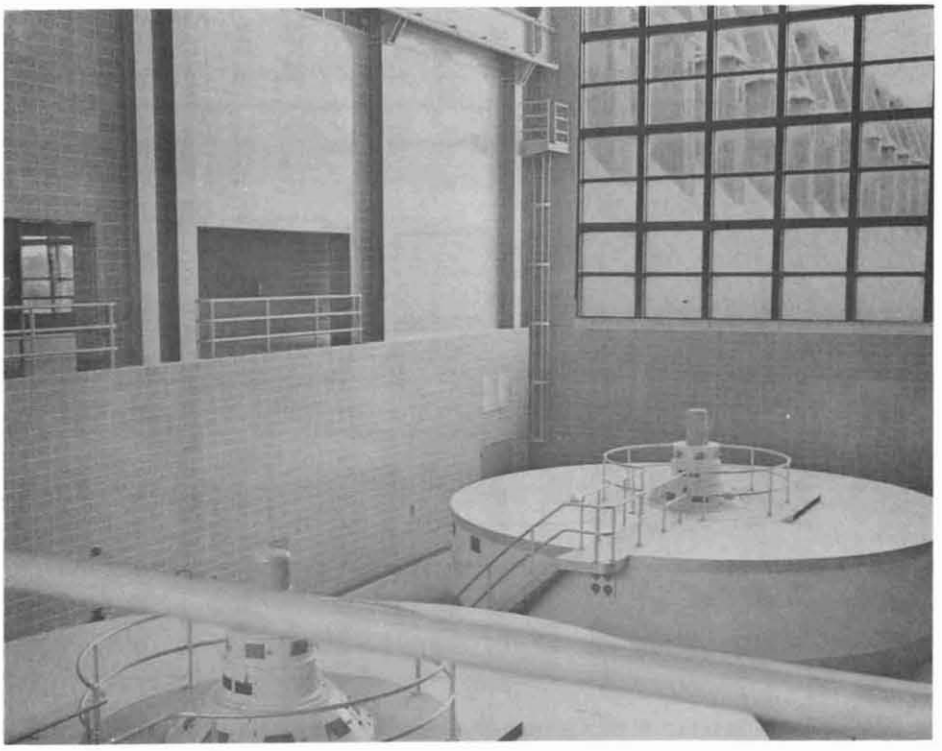

Figure 22.--Two 15,000 kw generators (in foreground) at Whitney Hydroelectric Powerplant. Part of downstream side of Whitney Dam is seen through the window. Courtesy of U.S. Army Corps of Engineers.

Net generation of electrical energy at Whitney Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1953	--	--	--	--	--	367	1,531	1,222	34	33	208	21	3,416
1954	47	42	364	2,506	7,257	6,959	4,725	3,455	1,072	1,139	23	-71	27,518
1955	-72	-60	28	50	4,437	15,330	4,392	2,939	6,350	12,264	1,931	1,788	49,377
1956	2,376	2,404	2,319	2,473	6,904	2,448	6,533	2,922	2,236	2,446	-66	-83	32,912
1957	2,350	2,353	2,433	5,298	22,284	22,446	6,649	2,416	2,476	8,773	10,676	7,330	95,484
1958	6,732	4,403	6,920	6,922	15,119	4,810	9,038	4,128	2,493	2,499	2,517	2,435	68,016
1959	2,398	2,474	2,444	2,311	2,491	2,450	6,952	2,973	2,469	12,692	2,949	5,997	48,600
1960	11,563	8,073	3,680	3,984	5,644	2,457	7,746	2,463	2,465	9,208	7,166	5,461	69,910
1961	10,792	12,359	8,226	3,841	2,464	10,791	17,482	7,419	3,248	8,677	3,048	3,562	91,909
1962	2,334	2,501	2,377	2,496	2,365	8,832	5,297	10,786	13,389	8,793	4,197	5,492	68,859
1963	3,637	2,468	2,492	2,452	5,364	15,939	6,209	2,709	2,447	2,434	1,145	776	48,072
1964	740	760	809	1,126	2,508	2,814	2,870	2,658	1,256	836	1,192	2,430	19,999
1965	2,413	6,907	2,451	2,375	15,106	2,939	2,500	2,289	1,956	2,235	3,294	2,184	46,649
1966	2,450	2,127	2,584	3,193	13,739	3,759	3,196	1,733	16,842	6,187	2,474	2,418	60,702
1967	985	558	565	2,522	2,582	3,812	5,528	5,128	1,400	716	2,845	2,705	29,346
	Note.--Negative figures show station requirements in excess of generation												
Total	48,745	47,369	37,692	41,549	108,264	106,153	90,648	55,240	60,133	78,932	43,599	42,445	760,769
Monthly and annual average 1954-67	3,482	3,384	2,692	2,968	7,733	7,556	6,366	3,858	4,293	5,636	3,099	3,030	54,097
Monthly average in percent of annual average 1954-67	6.4	6.3	5.0	5.5	14.3	14.0	11.8	7.1	7.9	10.4	5.7	5.6	100

20. Granite Shoals Hydroelectric Powerplant

Location

Granite Shoals Hydroelectric Powerplant is at Wirtz (Alvin J.) Dam (Lake Lyndon B. Johnson) on the Colorado River, 4 miles southwest of Marble Falls, Burnet County.

Ownership and History of Development

The powerplant is owned and operated by the Lower Colorado River Authority as one of a series of six hydroelectric powerplants on the Colorado River. The other five are Buchanan, Inks, Marble Falls, Marshall Ford, and Austin Hydroelectric Powerplants. Granite Shoals is the third plant downstream from Lake Buchanan and uses the controlled discharge of water from the Buchanan Hydroelectric Powerplant together with the added flow of the Llano River for power generation.

The project was authorized by Permit No. 953 (Application No. 1023), dated May 15, 1926, granted by the State Board of Water Engineers to the Syndicate Power Company. The permit allocates 1,305,000 acre-feet of water for conservation, irrigation, and power generation uses. The ownership of this permit eventually was vested in the Lower Colorado River Authority (Dowell and Breeding, 1967).

Construction of the project was begun in September 1949 and was completed in November 1951, with deliberate impoundment of water in Lake Lyndon B. Johnson in May 1951. Power generation started June 27, 1951.

Water released from Lake Lyndon B. Johnson through the powerplant is subsequently used for generation of power at Marble Falls, Marshall Ford, and Austin Hydroelectric Powerplants.

Physical Description

Two 22,500 kw generating units at Granite Shoals Hydroelectric Powerplant provide a total capacity of 45,000 kw.

Each of the two vertical generators is a 22,500 kw, 3 phase, 60 cycle, 13,800 volt, 100 rpm unit manufactured by General Electric Company (Figure 23).

Each of the vertical turbines is an I. P. Morris, Francis type, 100 rpm unit, with a capacity of 35,400 hp at the design head of 83.0 feet. The turbines are controlled by Woodward cabinet type governors.

Normal lake elevation is 825.0 feet above msl, and the tailwater varies from no load elevation 738.0 to full load 842.0 feet above msl.

A concrete intake structure guides the flow of water to the penstock and turbine scrollcase. The flow is over a weir section with a taintor gate 29 feet high by 45 feet long for controlling the flow to the penstock.

As the water is taken from near the surface of the lake, a trashrack is installed ahead of the gate.

When these generators are used as synchronous condensers for voltage regulation, the water in the draft tube is depressed below the turbine runner by injection of compressed air.

Records of gross monthly power generation for the Granite Shoals plant through December 1967 were furnished by the Lower Colorado River Authority and are given in the table following.

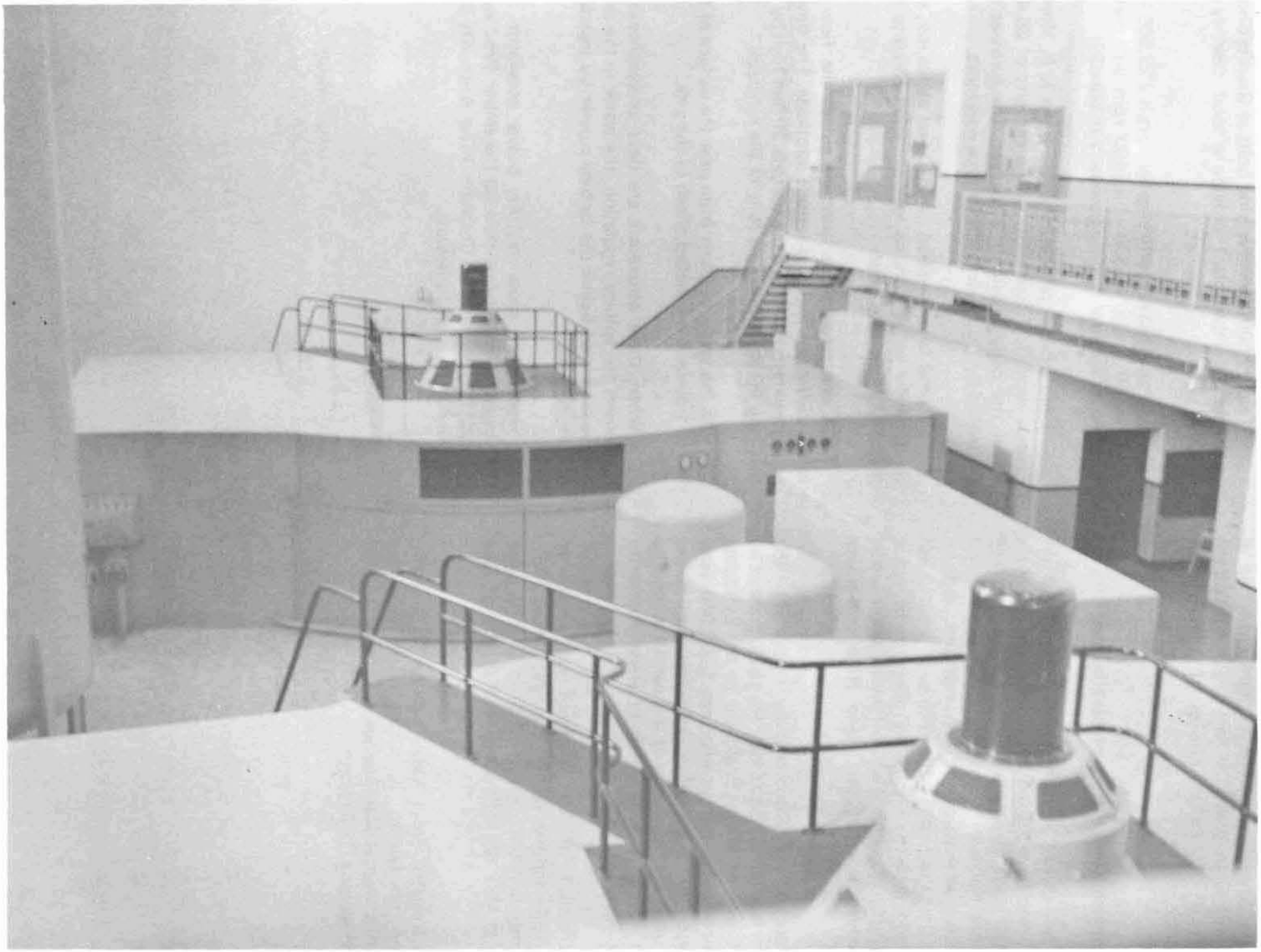

Figure 23.--Two 22,500 kw generators at Granite Shoals Hydroelectric Powerplant. Control room is at upper right.

Gross generation of electrical energy at Granite Shoals Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1951	--	--	--	--	--	141	6,268	7,775	4,361	2,189	862	308	21,904
1952	597	7	124	135	1,911	3,523	8,084	7,954	4,002	234	824	3,541	30,936
1953	2,915	1,734	751	871	4,971	2,509	620	1,571	3,467	3,177	1,470	1,056	25,112
1954	2,236	838	814	1,353	17,644	6,054	4,454	1,483	1,084	837	188	267	37,252
1955	679	1,235	294	670	11,136	16,471	11,435	8,676	8,278	7,576	3,945	1,898	72,293
1956	2,623	179	153	1,034	15,756	4,677	1,470	1,620	2,272	624	1,428	1,004	32,840
1957	1,052	1,292	977	8,530	30,991	17,634	4,638	7,272	2,573	15,346	12,070	7,268	109,643
1958	10,053	12,571	11,056	7,944	10,321	9,770	7,922	2,879	4,473	2,203	2,800	4,697	86,689
1959	3,599	1,079	1,604	2,284	1,863	6,749	13,084	6,862	2,483	17,675	5,185	7,269	69,736
1960	9,821	10,129	5,534	6,990	4,235	6,566	5,258	8,105	2,130	2,090	1,611	5,032	67,501
1961	4,767	6,275	6,607	4,987	4,342	15,615	9,145	7,136	5,628	6,800	4,666	5,643	81,611
1962	5,214	2,890	383	1,356	1,149	1,979	3,314	4,812	6,810	10,443	1,226	632	40,208
1963	1,303	1,425	17	842	226	67	423	660	644	0	1,269	1,344	8,220
1964	755	1,615	1,857	2,105	5,548	5,339	5,257	3,276	9,762	1,658	1,971	706	39,849
1965	683	5,752	1,030	813	17,872	8,000	1,247	3,541	1,706	954	1,224	1,463	44,285
1966	754	856	587	5,478	10,758	2,903	3,480	1,683	10,302	3,620	434	982	41,837
1967	818	3,172	649	206	2,969	3,253	5,197	4,109	3,929	1,731	1,257	942	28,232
Total	47,869	51,049	32,437	45,598	141,692	111,250	91,296	79,414	73,904	77,157	42,430	44,052	838,148
Monthly and annual average 1952-67	2,992	3,191	2,027	2,850	8,856	6,944	5,314	4,477	4,346	4,686	2,598	2,734	51,015
Monthly average in percent of annual average 1952-67	5.9	6.2	4.0	5.6	17.4	13.6	10.4	8.8	8.5	9.2	5.1	5.3	100

21. Marble Falls Hydroelectric Powerplant

Location

Marble Falls Hydroelectric Powerplant is at Starcke (Max) Dam (Marble Falls Lake) on the Colorado River, 1.5 miles southeast of Marble Falls, Burnet County.

Ownership and History of Development

The powerplant is owned and operated by the Lower Colorado River Authority as one of a series of six hydroelectric powerplants on the Colorado River. The other five are Buchanan, Inks, Granite Shoals, Marshall Ford, and Austin Hydroelectric Powerplants. Marble Falls is the fourth plant downstream from Lake Buchanan. It uses the controlled discharge from Buchanan Hydroelectric Powerplant, together with the added flow of the Llano River and further regulation by the Granite Shoals Hydroelectric Powerplant, for power generation. The turbines discharge into Lake Travis.

The project was authorized by Permit No. 998 (Application No. 1022), dated November 4, 1927, granted by the State Board of Water Engineers to Syndicate Power Company. The ownership of the permit later was vested in the Lower Colorado River Authority (Dowell and Breeding, 1967). The permit allocates 1,305,000 acre-feet of water for conservation, irrigation, and power generation.

Construction was begun in November 1949, and was completed in October 1951. Deliberate impoundment of water began in July 1951. Power generation started September 25, 1951.

Physical Description

Two 15,000 kw generating units at Marble Falls Hydroelectric Powerplant provide a total capacity of 30,000 kw.

This plant is operated during the same time period as Granite Shoals and its turbines are rated for the same water requirements as those at Granite Shoals, so there is little change in the lake elevation.

Each of the two vertical generators is a 15,000 kw, 3 phase, 60 cycle, 6,900 volt, 120 rpm unit manufactured by Westinghouse Electric Corporation (Figure 24).

Each of the vertical turbines is an S. Morgan Smith, fixed blade propeller type, 120 rpm unit, with a capacity of 22,500 hp at the design head of 57 feet. The turbines are controlled by Woodward cabinet type governors.

Normal lake elevation is 738.0 feet above msl and the tailwater is about elevation 681.0 feet above msl (unless Lake Travis is above this elevation).

A concrete intake structure guides the flow of water to the penstock and turbine scrollcase. The flow is over a weir section with a taintor gate, 29 feet high by 45 feet long, for controlling the flow to the penstock. As the water is taken from near the surface of the lake, a trashrack is installed ahead of the gate.

Records of gross monthly power generation for the Marble Falls plant through December 1967 were furnished by the Lower Colorado River Authority and are given in the table following.

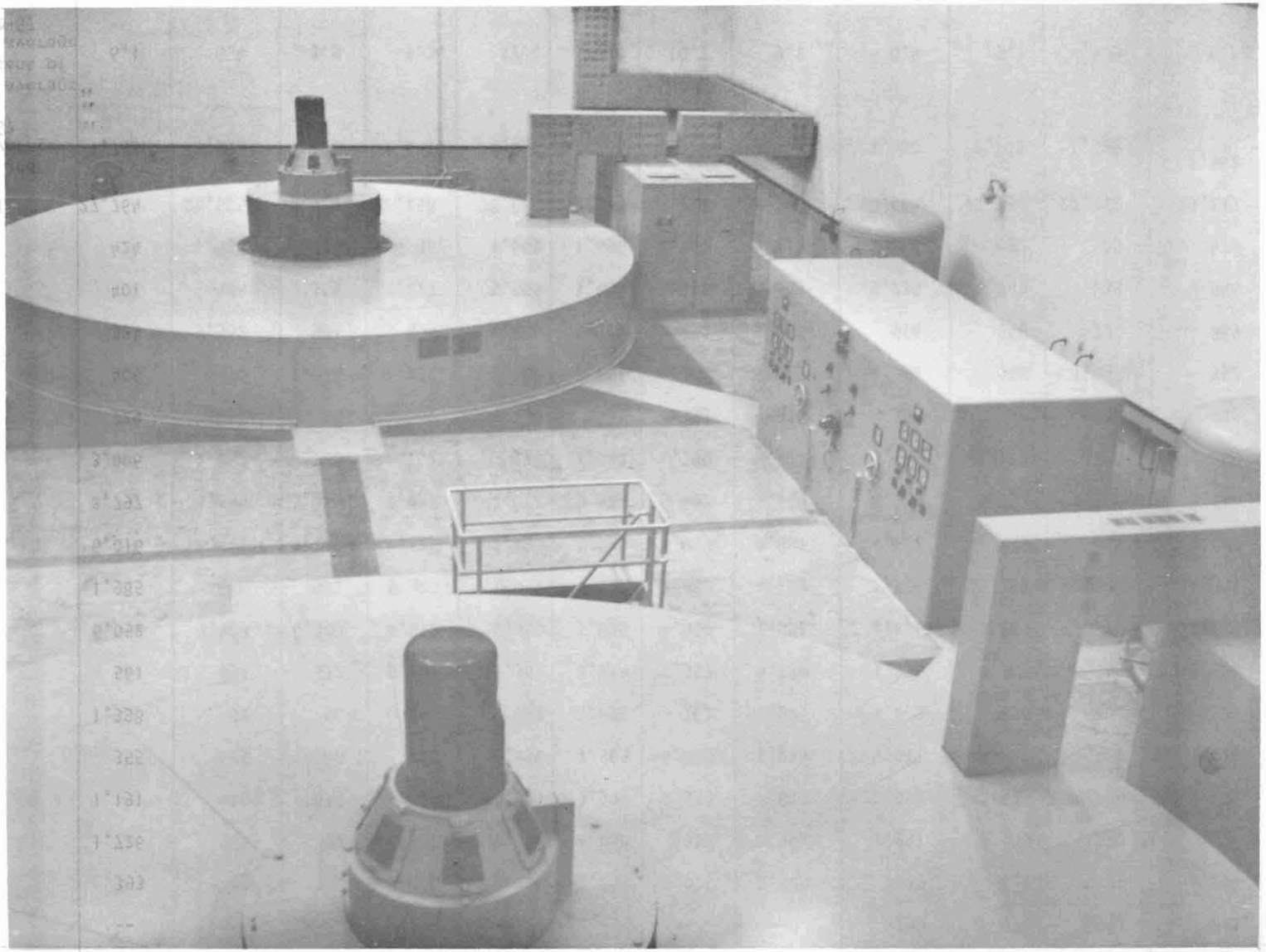

Figure 24.--Two 15,000 kw generators at Marble Falls Hydroelectric Powerplant.

Gross generation of electrical energy at Marble Falls Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1951	--	--	--	--	--	--	--	--	180	871	533	222	1,806
1952	393	19	0	105	1,276	2,243	5,026	5,409	679	124	471	2,274	18,019
1953	1,726	966	397	537	2,964	1,430	325	962	1,947	1,909	270	571	14,004
1954	1,191	410	477	674	10,831	3,507	2,539	817	553	470	70	84	21,623
1955	355	685	140	325	6,676	7,569	6,800	5,244	5,011	4,223	2,166	1,020	40,214
1956	1,398	52	50	553	9,552	2,695	762	921	1,279	335	782	521	18,900
1957	561	691	572	5,102	14,362	8,169	2,557	4,139	1,475	8,656	6,649	3,986	56,919
1958	6,052	7,400	6,209	4,552	5,950	5,629	4,660	1,581	2,476	1,123	1,522	2,639	49,793
1959	1,985	666	902	1,325	1,051	4,237	7,839	4,123	1,376	9,257	2,878	4,561	40,200
1960	6,016	6,041	3,110	4,125	2,499	3,938	3,027	4,891	1,162	1,248	841	2,892	39,790
1961	2,797	3,300	3,825	2,852	2,472	9,423	5,467	4,188	3,247	3,957	2,566	3,124	47,218
1962	3,006	1,662	196	751	578	1,002	1,780	2,524	3,899	6,112	698	355	22,563
1963	729	841	10	482	136	31	193	315	359	0	754	725	4,575
1964	406	910	1,066	1,151	3,098	2,864	2,952	1,727	6,052	965	1,098	352	22,641
1965	324	3,532	521	409	9,886	3,794	632	1,856	916	648	720	869	24,107
1966	401	484	315	3,217	5,956	1,484	1,891	883	5,735	1,840	239	546	22,991
1967	424	1,896	230	96	1,602	1,696	2,761	2,314	2,218	992	665	476	15,370
Total	27,764	29,555	18,020	26,256	78,889	59,711	49,211	41,894	38,564	42,730	22,922	25,217	460,733
Monthly and annual average 1952-67	1,735	1,847	1,126	1,641	4,931	3,732	3,076	2,618	2,400	2,616	1,399	1,562	28,683
Monthly average in percent of annual average 1952-67	6.1	6.4	3.9	5.7	17.2	13.0	10.7	9.1	8.4	9.1	4.9	5.5	100

22. Falcon Hydroelectric Powerplant

Location

Falcon Hydroelectric Powerplant is at Falcon Dam (International Falcon Reservoir) on the Rio Grande, 3 miles west of Falcon Heights, Starr County, Texas.

Ownership and History of Development

The project is owned by the United States and Mexico and is operated by the International Boundary and Water Commission, United States and Mexico.

The Falcon project was authorized by the Water Treaty of 1944 between the United States and Mexico. The project was built by the International Boundary and Water Commission, United States and Mexico, for conservation, irrigation, hydroelectric power, recreation, and flood-control uses. Under the terms of the treaty, the United States receives 58.6 percent of the conservation storage and Mexico receives 41.4 percent.

Plans for the dam and two powerplants, one in the United States and one in Mexico, were approved in the fall of 1949, construction began in 1950, and the dam was completed April 18, 1954. Deliberate impoundment began August 25, 1953, and the project was dedicated in October 1953. Generation of electricity began October 11, 1954. Power generation is divided equally between the United States and the Mexico powerplants. Power from the United States plant is distributed by Central Power and Light Company.

Physical Description

There are two powerplants at Falcon Dam—one on the United States side and one on the Mexico side. Each plant has three 10,500 kw generating units, with provision for a fourth unit when justified. The present total capacity for both plants is 63,000 kw. Each plant has an operating room with all the necessary control equipment. The two plants are interconnected for the transfer of electric energy from one to the other or from an outside supply.

Each of the three vertical generators in each plant is a 10,500 kw, 3 phase, 60 cycle, 6,900 volt, 163.6 rpm unit with a direct connected exciter (Figure 25). The generators and control equipment were furnished by the General Electric Company.

Each of the three vertical turbines is an Allis-Chalmers Manufacturing Company, 163.6 rpm, Francis type, with a capacity of 14,750 hp at 100-foot head. Each turbine is controlled by a Woodward governor.

Four 13-foot diameter steel penstocks (one for future use) are imbedded in the intake structure at the United States plant, with trashracks and provisions for stop logs. The flow to the penstocks is controlled by vertical fixed wheel type gates.

The Mexico powerplant equipment is identical to the United States plant except for penstock arrangement. Here, one 22-foot diameter steel penstock from the reservoir branches into four 13-foot diameter steel penstocks at the power house. The flow to each of the 3 turbines is controlled by butterfly valves.

Forebay water level is at elevation 301.2 feet above msl when reservoir is full to top of winter conservation storage space. No-load tailwater elevation is 175.0 feet above msl; with full load, six units, the tailwater rises to elevation 181.0 feet above msl.

International Falcon Reservoir has a summer storage capacity (April to September) of 2,371,200 acre-feet at a level of 296.4 feet above msl (top of summer conservation storage space). Above this level, there is 909,500 acre-feet of flood control storage capacity. During the winter (October to March), an additional 400,000 acre-feet are allowed for conservation storage, with a corresponding loss of flood-control storage capacity.

Discharges of water from International Falcon Reservoir are made only when required by downstream demands for water or to release water in flood-control storage. No discharge is made for power generation alone.

Power generation is divided between the two powerplants on a basis of water demands downstream. Meters record the flow in cubic feet per second and also convert it to acre-feet. Each powerplant is equipped with two valve-controlled low-flow outlets for water releases when the turbines are not operating.

Records of gross monthly power generation at the United States Falcon Hydroelectric Powerplant were furnished by the International Boundary and Water Commission, United States and Mexico, through 1967 and are given in the table following.

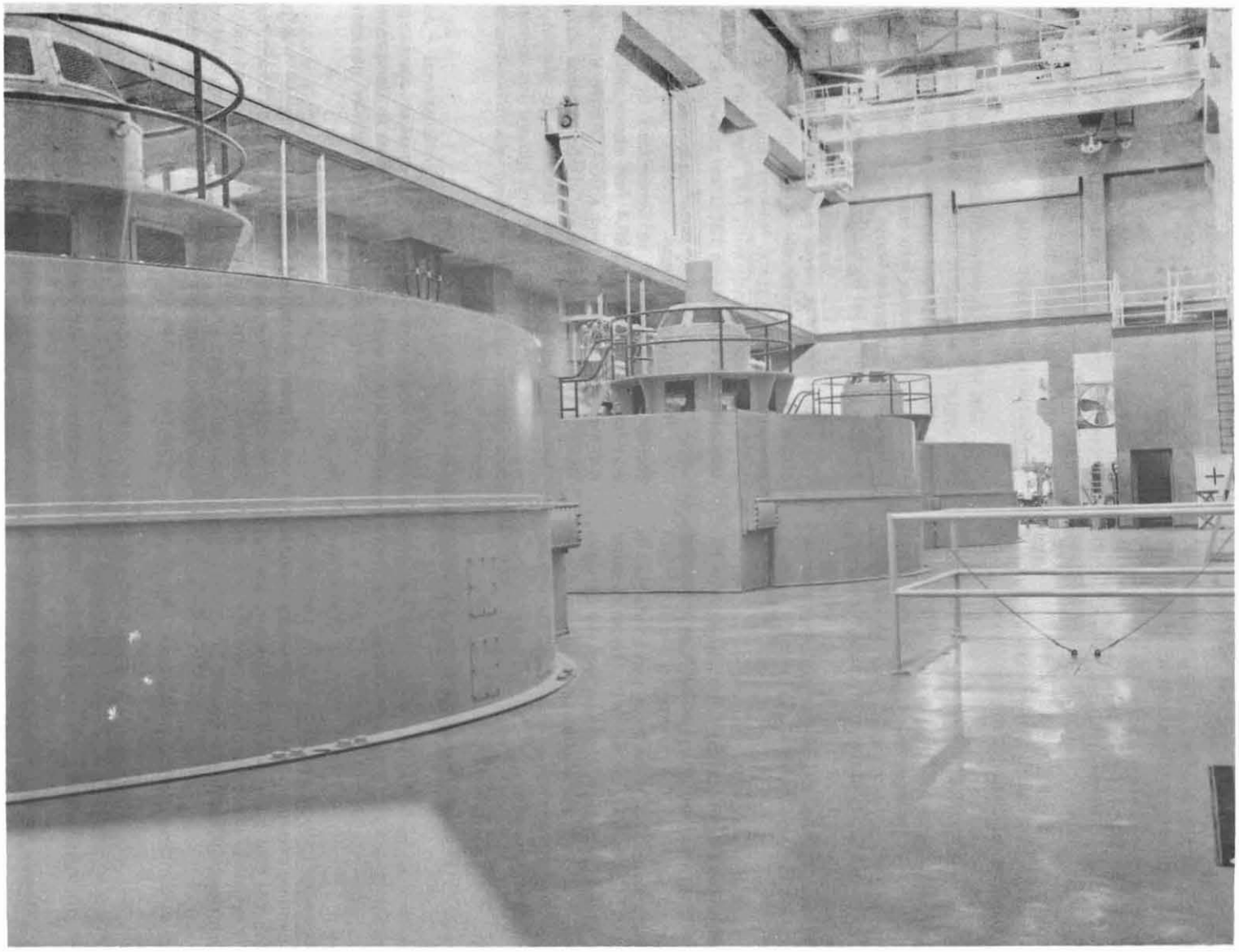

Figure 25.--Three 10,500 kw generators at United States Falcon Hydroelectric Powerplant.

Gross generation of electrical energy at the United States Falcon Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1954	--	--	--	--	--	--	--	--	--	2,528	2,431	7,867	12,826
1955	15,378	10,679	6,535	15,088	18,780	14,630	2,064	9,059	100	183	7,635	7,262	107,393
1956	13,142	13,008	6,557	5,062	7,127	5,943	323	562	1,902	715	809	4,949	60,099
1957	3,410	0	43	504	5,929	6,661	4,938	9,152	6,623	8,716	4,228	5,246	55,450
1958	1,992	620	1,068	10,433	11,346	17,059	3,586	5,907	6,837	27,315	23,438	20,739	130,340
1959	10,635	17,364	17,702	9,178	15,957	12,147	11,176	5,592	12,457	4,672	1,915	6,348	125,143
1960	17,641	12,349	3,236	7,413	12,018	21,092	8,215	4,075	1,855	4,250	1,908	1,609	95,661
1961	3,446	4,484	17,021	12,216	19,516	9,758	6,649	9,483	9,156	4,213	2,468	6,253	104,663
1962	13,875	17,455	3,027	10,564	15,894	14,180	3,187	3,125	1,661	3,243	2,864	2,453	91,528
1963	5,200	8,964	6,799	16,528	1,133	9,651	3,481	4,848	1,275	2,115	958	2,262	63,214
1964	2,453	1,705	4,566	10,743	10,036	4,433	3,318	2,832	1,753	7,060	4,928	5,698	59,525
1965	18,256	6,438	5,620	17,625	16,043	13,369	10,464	3,927	6,602	1,775	1,964	1,998	104,081
1966	2,545	1,999	2,277	4,397	2,383	8,674	7,693	9,692	20,852	3,587	4,631	5,533	74,263
1967	7,439	7,132	7,463	18,374	13,339	8,045	5,861	6,499	15	15,861	388	3,301	93,717
Total	115,412	102,197	81,914	138,125	149,501	145,642	70,955	74,753	71,088	86,233	60,565	81,518	1,177,903
Monthly and annual average 1955-67	8,878	7,861	6,301	10,625	11,500	11,203	5,458	5,750	5,468	6,439	4,472	5,665	89,621
Monthly average in percent of annual average 1955-67	9.9	8.8	7.0	11.9	12.8	12.5	6.1	6.4	6.1	7.2	5.0	6.3	100

23. Sam Rayburn Hydroelectric Powerplant

Location

Sam Rayburn Hydroelectric Powerplant is at Sam Rayburn Dam (Sam Rayburn Reservoir) on the Angelina River in the Neches River basin in Jasper County, 11 miles northwest of Jasper.

Ownership and History of Development

The project is owned by the U.S. Government, and is operated by the U.S. Army Corps of Engineers, Fort Worth District. It formerly was called the McGee Bend project.

The project was authorized by the River and Harbor Act approved March 2, 1945, 79th Congress, First Session, and modified by River and Harbor Act of June 30, 1948, Public Law 858, 80th Congress, Second Session. The Lower Neches Valley Authority paid $3,000,000 toward the construction of Sam Rayburn Dam and has agreed to pay an additional $10,000,000 for water supply benefits at the rate of $200,000 annually for a period of 50 years after completion of project. The first payment was made in December 1965.

Construction started in September 1956 and was completed July 1, 1966. Deliberate impoundment of water began March 29, 1965. Power generation began in September 1965 with limited output during the equipment testing period. Commerical power production began July 1, 1966.

Water released through the hydroelectric powerplant is used for municipal, industrial, and irrigation purposes by the Lower Neches Valley Authority under Permit No. 2124 (Application No. 2298), dated October 13,1964, granted by the Texas Water Commission to the Lower Neches Valley Authority.

The power generated at Sam Rayburn hydroelectric plant is sold to the Sam Rayburn Dam Electric Cooperative, Inc., by the Southwestern Power Administration, marketing agency for federal power in this area. The power is supplied, through the transformers and switch station, to the transmission system of the Gulf States Utility Company. Power distribution to the service area is controlled from the operating center in Beaumont. Generation is normally during the hours of peak power requirement of the system.

Physical Description

The powerhouse and water control structure is located near the right abutment of the dam. This one concrete structure, consisting of the powerhouse, intake structure, outlet works, and roadway, was built on a heavy concrete foundation which rests on a sand formation (Figure 26). Two gates in the intake structure control the flow of water from the reservoir to each turbine scrollcase.

Each of the two vertical generators is a 26,000 kw, 3 phase, 60 cycle, 13,800 volt, 120 rpm unit manufactured by Westinghouse Electric Corporation (Figure 27).

Each of the two vertical turbines is an Allis-Chalmers Manufacturing Company, Kaplan propeller type, 120 rpm unit with a capacity of 41,000 hp at 70-foot head. The turbines are controlled by governors manufactured by Baldwin-Lima-Hamilton Corporation (Pelton Division).

The dam, powerhouse, and switchyard equipment is manually operated from a central control room located at elevation 1,350 feet above msl. The operator has surveillance of the outside areas by wired television.

At the top of the power pool, elevation 164.0 feet above msl, the reservoir has a capacity of 2,852,600 acre-feet with 1,400,600 acre-feet allocated to the production of hydroelectric power with a 15-foot drawdown. The storage below elevation 149.0 feet above msl is for power head and sediment reserve.

With both units operating with full load, the tailwater elevation is about 94.0 feet above msl, giving a gross head of 70.0 feet when the reservoir is at power pool elevation 164.0 feet above msl. Under these conditions, with full head each turbine discharges about 5,650 cfs.

Records of net monthly generation of electrical energy at the Sam Rayburn Hydroelectric Powerplant for the period September 1965 to December 1967 were furnished by the U.S. Army Corps of Engineers. These records are given in the table following.

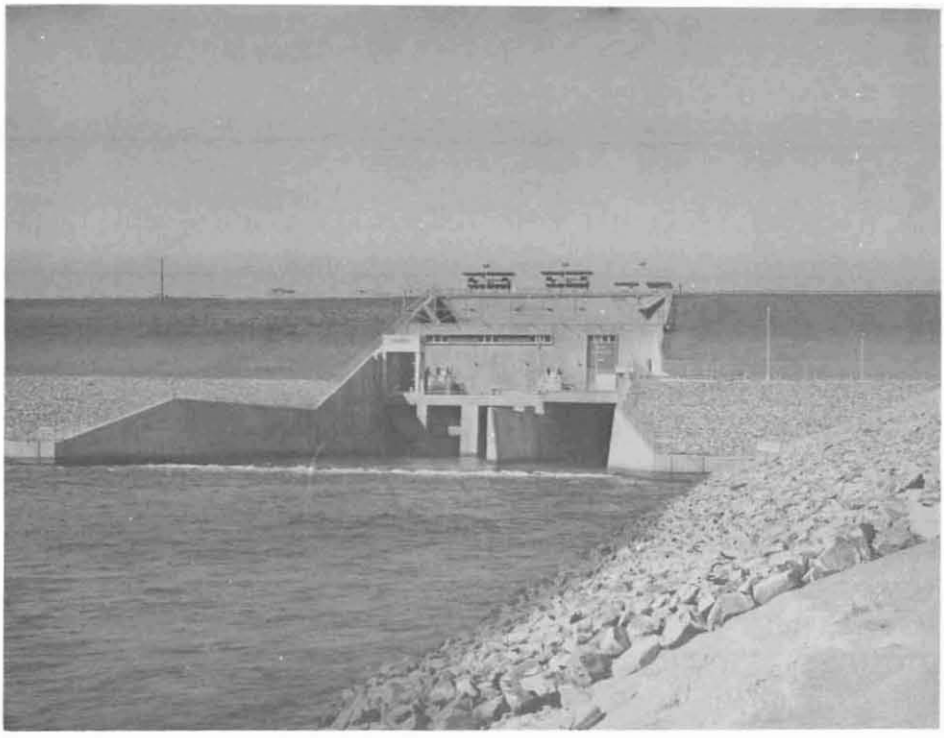

Figure 26.--Sam Rayburn Hydroelectric Powerplant and water control structure. Courtesy of U.S. Army Corps of Engineers.

Figure 27.--Two 26,000 kw generators at Sam Rayburn Hydroelectric Powerplant. Courtesy of U.S. Army Corps of Engineers.

Net generation of electrical energy at Sam Rayburn Hydroelectric Powerplant, in Megawatthours

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
1965	--	--	--	--	--	--	--	--	2	-38	-93	-92	-221
1966	-64	-60	-80	-79	142	263	4,029	3,556	3,158	3,641	3,524	1,803	19,833
1967	909	-113	473	964	534	2,476	2,188	4,330	2,229	1,119	35	756	15,900

Note.--Negative figures show station requirement in excess of generation.

24. Amistad Hydroelectric Powerplants

Location

Two hydroelectric powerplants, one in the United States and the other in Mexico, are proposed at Amistad Dam (Amistad Reservoir) on the Rio Grande in Val Verde County, Texas, and Estado de Coahuila, Mexico, 12 miles northwest of Del Rio, Val Verde County, Texas.

Ownership and History of Development

The dam is under construction. It will be owned by the United States and Mexico, and will be operated by the International Boundary and Water Commission, United States and Mexico. At the end of 1967, penstocks were being installed for an ultimate generating capacity of 80,000 kw at each of the two proposed powerplants, one in the United States and the other in Mexico. However, no construction plans had been made for a powerplant on the United States side at that time.

Agreement with Mexico for joint construction of Amistad Dam by the governments of the United States and of Mexico, in accordance with the provisions of the Water Treaty of 1944, was authorized by the Congress of the United States in Public Law 86-605, July 7, 1960.

Construction of Amistad Dam is handled by the two governments through their respective sections of the International Boundary and Water Commission, United States and Mexico.

The project will provide for water conservation, irrigation, hydroelectric power, flood control, and recreation.

Under terms of the treaty, the United States will get 56.2 percent of the conservation storage and Mexico will get 43.8 percent. Power generation, when developed at two plants at the Amistad Dam, one in the United States and the other in Mexico, will be divided equally between the two countries. Of all the sites studied for possible location of Amistad Dam, the Boundary Commission found the Diablo site (Amistad), one mile below Devils River and 12 miles upstream from the city of Del Rio, to be the most suitable (International Boundary and Water Commission, 1958, p. 59). With a dam at Amistad of the height contemplated, power releases of water at a head of 138 feet or higher can be made 80 percent of the time. With a head of 104 feet or higher, releases can be made 90 percent of the time, for an average of 1,126,000 acre-feet annually (International Boundary and Water Commission, 1958, p. 85).

The International Boundary and Water Commission, in a study of Rio Grande streamflow at the Amistad site covering a 57-year period, indicated there is a water supply sufficient for a hydroelectric generating capacity of 75,000 kw (United States share) during 81 percent of the time studied. Also, that 100,000 kw could be developed 62 percent of the time.

Releases of water at Amistad for production of hydroelectric energy will be subordinate to the releases for domestic and irrigation use. The general plan of operation will be that demands for capacity and energy would be met first to the extent available at the Falcon Hydroelectric Powerplant, with any additional capacity and energy needed being supplied by the Amistad Hydroelectric Powerplant when built (International Boundary and Water Commission, 1958, p. 87).

The preliminary work of relocating highways, railroads, pipelines, and other facilities began in October 1961. The first actual construction at the site began in August 1963 with the drilling and pressure grouting of the rock foundation. Construction of the dam began in January 1965 and is scheduled for completion in March 1969.

25. Toledo Bend Hydroelectric Powerplant

Location

Toledo Bend Hydroelectric Powerplant will be at Toledo Bend Dam (Toledo Bend Reservoir) on the Sabine River in Newton County, Texas, and Sabine Parish, Louisiana, about 14 miles northeast of Burkeville, Texas.

Ownership and History of Development

The project will be owned and operated by the Sabine River Authorities of Texas and Louisiana.

The Texas share of the water to be appropriated from Toledo Bend Reservoir is authorized by Permit No. 1994 (Application No. 2191), dated September 23, 1961, granted by the Board of Water Engineers to the Sabine River Authority of Texas. The permit authorizes a maximum appropriation of 750,000 acre-feet of water annually. Of this, 600,000 acre-feet is for industrial use, 100,000 acre-feet for municipal use, and 50,000 acre-feet for irrigation use. The permittee is authorized to use water for generation of hydroelectric power at a rate of flow not to exceed 16,000 cfs. The use of water for hydroelectric power generation is subordinate to the use of water for municipal, industrial, and irrigation purposes. Power generation will be coordinated with these other requirements to obtain the maximum use of water.

Power production will be sold to electric utility companies serving the area, to supplement steam power generation.

Construction of the project began May 11, 1964, and was 98.6 percent complete at the end of December 1967.

Physical Description

The powerplant will contain two 41,500 kw generating units providing a total capacity of 83,000 kw. The installation of power equipment was nearing completion at the end of December 1967.

Each of the two vertical generators will be a 41,500 kw, 3 phase, 60 cycle, 13,800 volt, 100 rpm unit furnished by Allis-Chalmers Manufacturing Company.

Each of the two vertical turbines will be an English Electric Company, 100 rpm Kaplan propeller type, with a capacity of 58,500 hp at 68-foot head. Each unit will be controlled by a high pressure actuator type governor furnished by Baldwin-Lima-Hamilton Corporation. The turbine runner is shown in Figure 28.

Water to each turbine will be supplied through an intake structure consisting of three reinforced concrete passages. The flow of water will be controlled by electric hoist operated Broome type gates.

Headwater (top of conservation storage space) will be at elevation 172.0 feet above msl. With one unit running, the tailwater will be at elevation 91.0 feet above msl, giving gross head of 81.0 feet. With both units running, the tailwater will be at elevation 102.0 feet above msl, giving a gross head of 70.0 feet.

Figure 28.--Turbine runner being lowered into position at Toledo Bend Hydroelectric Powerplant. Courtesy of Sabine River Authority of Texas.

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