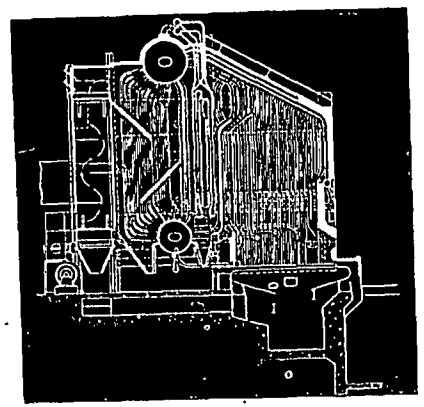
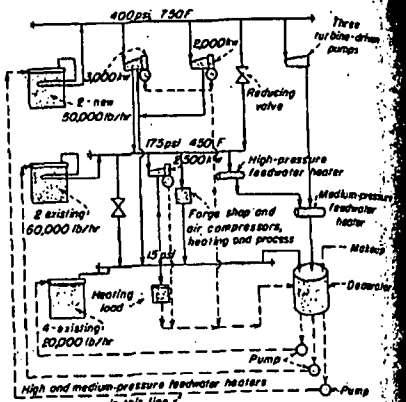


TWO NEW STEAM GENERATORS of 50,000-lb-per-hr capacity add the needed steam at a pressure level that permits economies



LOAD CHANGES resulting from seasonal variations are fitted into this steamflow pattern by proper adjustment of the flow

PULLMAN STANDARD CAR

Better operating economy plus additional steaming capacity results from a combined power expansion and modernization program carried out at this manufacturer's Chicago plant

▶ THE 110TH STREET, Chicago plant of the Pullman Standard Car Manufacturing Co had in 1945 the following major equipment in its power house:

(1) two 175-psig 450-F 60,000-lb-per-hr steam generators

(2) four 15-psig saturated 20,000-lb-per-hr steam generators

(3) one 2000-kw turbine-generator operating with throttle conditions of 175 psi, 450 F; 5-psi extraction or induction; 27 in. vacuum

(4) one mixed-pressure turbine-generator of 2500-kw capacity with throttle conditions of 175 psi, 450 F; 2.5-psi induction; exhausting to 27-in. vacuum

(5) two 1500-kw turbine-generators operating with throttle conditions of 175-psi 450-F exhausting to 27-in.

Modernization. This lineup of equipment could no longer meet growing plant needs. Additional steaming capacity and also additional electric-generating capacity became highly important. To provide this needed additional capacity and at the same time give a better over-all operating economy a plan for modernizing and expanding power was put under way.

Major steps in this modernization program involved:

(1) installing two new 50,000-lb-per-hr steam generators to deliver steam at 425 psi and 750 F.

(2) removing one of the 1500-kw turbine-generators and installing in its place a 3000-kw turbine designed to take steam at 400 psi and 750 F with provision for extraction at 175 and 5 psig

(3) making certain necessary alterations in the 2000-kw turbine for operation with 400-psi 750-F steam

(4) installing a new 300,000-lb-per-hr deaerating heater, new boiler-feed pumps and other auxiliary equipment

(5) setting up the required switchgear and electric substations

(6) fitting all old and new equipment into a well-engineered and completely integrated plant so expected operating economies could be realized.

Boiler Units. The two new steam generators, rated at 50,000 lb per hr, have a heat release of 22,000 Btu per cu ft per hr, a total heating surface of 1870 sq ft and a furnace volume of 3000 cu ft. There is no economizer but a 4050-sq-ft tubular air heater has been supplied.

Circulating system of these boilers includes a radiant waterwall section in the furnace and a cross-baffled convection section, built around two main drums. Upper or steam-release drum has a 54-in. inside diameter and the lower or mud drum has 42-in. inside diameter. A pendant superheater of 3500 sq ft raises steam temperature.

Steam Distribution. Steam from the two new boilers enters a header at 400 psig and 750 F. The quantity of steam they deliver varies with the season. For summer conditions steam load at this level averages about 98,200 lb per hr and for winter with the plant heating load added, 120,000 lb per hr.

Coming off this 400-psi header, shown in flow diagram above, are (1) two condensing-turbine-generators (2) boiler feed pumps (3) a pressure-reducing station. The 3000-kw machine carries base load. Its summer throttle flow is 94,150 lb per hr, and of this, 74,290 lb per hr are bled off at 175 psig. Remaining 19,860 lb per hr return to the deaerating heater from the condenser. In winter, as in summer, both the 3000- and 2000-kw machines carry load. The 3000-kw unit takes 53,500 lb per hr. It delivers 51,000 lb to the 15-psi bleed point and 2500 to the deaerator as condensate. The 2000-kw unit receives 31,500 lb per hr at the throttle; delivers 20,000 lb through the 15-psi bleed point, returns 11,500 lb to deaerator as condensate.

The boiler-feed pumps operating from the 400-psi level use 4050 lb per hr in summer and 4610 lb per hr in winter. In both cases all steam exhausts to the medium-pressure closed feedwater heater in the feed line to the new boilers.

Last major element off the 400-psi header, the pressure-reducing station, handles no steam under summer operating conditions, but 30,390 lb per hr during the winter.

Intermediate Pressure. Next pressure level, the 175-psig 450-F header, has connections for steam from (1) two 60,000-lb-per-hr existing steam generators (2) the pressure-reducing station from 400-psi header (3) bleed from the 3000-kw turbine-generator.

Summer and winter steam distribution differs. Summer load is such that no steam enters the 175-psi header from the 60,000-lb older boilers nor from the main pressure-reducing station between the 400- and 175-psi levels. All steam comes from the 175-psi bleed point of the 3000-kw unit. Winter loading brings about a different balance. The 3000-kw high-pressure turbine supplies no steam to this header at all. The older boiler units deliver rated capacity, 120,000 lb per hr, and add to the 30,390 lb coming through the pressure-reducing station.

The various elements depending upon the 175-psi header for steam, see flow diagram above, are: (1) a 2500-kw turbine-generator (2) a high-pressure closed feedwater heater (3) a pressure-reducing valve connecting to the 15-psi system (4) air compressors in the plant, shop special heating and process, forge-shop uses.

In summer, 9230 lb per hr of the 74,290 lb coming off the bleed point of the high-pressure 3000-kw turbine go to the closed high-pressure feedwater heater with exhaust passing on to the medium-pressure feedwater heater. The 2500-kw turbine-generator takes 17,170 lb per hr of this supply to generate 2000 kw. Together with 15-psi steam entering at a later stage the 2500-kw unit passes all steam through a condenser and back to the deaerator. All the rest of the 175-psi steam, 55,000 lb per hr, goes to the forge shop and air compressors.

Winter load produces the following rearrangement of steam flow at the 175-psi level. The 120,000 lb per hr developed by the older boilers supplying this header and the 30,390 lb from the reducing valve divide up this way: The high-pressure closed feedwater heater takes 12,410 lb per hr; 55,000 goes to the forge shop and air compressors and the remainder passes through the reducing valve to meet the heating load.

Low-Pressure System. The only remaining operating steam system is a 15-psi one. It has four 20,000-lb-per-hr boilers built to generate steam at this pressure. In addition, it connects with (1) the 175-psi steam through a pressure-reducing valve (2) three turbines, the 3000, 2500 and 2000-kw units (3) extraction, forge shop uses and air compressors.

Operating economy dictates the following balance. For summer, all steam entering the 15-psi system comes from the exhaust of air compressors and forge-shop uses. This steam goes (1) to meet the process heating load, 11,000 lb per hr, (2) to enter at the later stages (27,530 lb per hr) of the 2500-kw turbine-generator, and (3) to raise the temperature in the deaerator, 10,970 lb per hr.

Winter loading produces this distribution. The 15-psi boilers develop 76,710 lb per hr of steam. To this is added 82,980 lb per hr from the pressure-reducing valve operating off the 175-psi header and a total of 71,000 lb per hr from the 3000-kw and 2000-kw turbine-generators. Exhaust system from compressors and forge shop supply another 55,000 lb per hr.

The various users of steam from the 15-psi system handle available steam in this proportion: 32,930 lb per hr go to the deaerator to raise its temperature; the plant heating load for winter needs amounts to 252,700 lb per hr.

Condensate from this heating load joins with the 14,000 lb per hr coming from the condensers of the 3000-kw and 2000-kw turbine-generators when carrying full load. The 2500-kw 175-psi turbine-generator under normal winter operation carries no load.

Water Cycle. All condensate returns, plus the exhaust from the medium-pressure closed feedwater heater, meet with the makeup at a 300,000-lb-per-hr deaerator. Some steam from the 15-psi system goes to raise the deaerator temperature. A series of two different-size and pressure pumps deliver water from the deaerator to (1) the new 50,000-lb-per-hr high-pressure boilers (2) the two existing boilers supplying steam at 175 psi, and (3) the four boilers delivering 15-psi steam.

PRINCIPAL NEW EQUIPMENT OF POWER PLANT

Pullman Standard Car Manufacturing Co, Chicago, Ill.

STEAM GENERATORS AND AUXILIARIES:

Boilers, two, 425 psi, 750 F, 2-drum, bent-tube, waterwalls, 50,000 lb per hr; superheaters, 2, one per unit; Air heaters, 2, one per unit — Wm Bros Boiler & Mfg Co
Soot blowers, air puff — Diamond Power Specialty Co
Coal handling — W A Melchlor
Ash handling — United Conveyor Corp
Spreader stokers, 2 — Detroit Stoker Co
Chain-grate, 18 ft 1½ in. wide x 11 ft 8 in., 3 feeders
Combustion control — Leeds & Northrup Co
Induced-draft fans — Clarage Fan Co
Forced-draft fans — Clarage Fan Co
Flowmeters — Republic Flow Meters Co

WATER-TREATMENT SYSTEM AND AUXILIARIES:

Deaerator, 1 — Worthington Pump and Machy Corp
300,000 lb per hr, 9 ft 6 in. dia x 13 ft 3 in. plus storage section, 9 ft x 13 ft 8 in.
Feedwater regulators — Northern Equipment Co
Feedwater heaters, 2 — Alberger Heater Co
512 sq ft, 123,000 lb per hr, each from 220 to 370 F; steam pressures 40 and 175 psi, respectively
Boiler feed pumps, 3 — Ingersoll-Rand Co
Turbine-driven, 6-stage centrifugal pumps, 125 gpm, 1032-ft total head

ELECTRIC GENERATORS AND AUXILIARIES:

Turbine-generator, one, 3000 kw — General Electric Co
6.8 psi, extraction at 175- and 5-psig, throttle conditions; 400 psi, 750 F
Condenser, 2-pass — Allis-Chalmers Mfg Co
3250 sq ft effective cooling surface
Switchgear, low voltage — Allis-Chalmers Mfg Co
Per six-750-kva indoor substations
Unit substations, 6 — Allis-Chalmers Mfg Co
Includes main 1200-amp, 30,000-amp interrupting capacity air circuit breakers, one per station; 400-amp, 25,000-amp interrupting-capacity feeder breakers, 5 per station

CONSULTING ENGINEERS — Laramore & Douglass, Inc