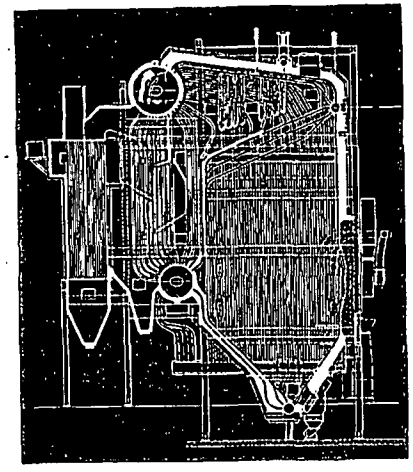
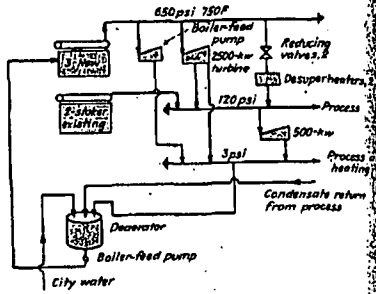


LATEST ADDED STEAMING CAPACITY for buildings and growing load is a 50,000-lb-per-hr pulverized-coal-fired boiler



FLEXIBLE SUPPLY for steam to both plant process and power generation employs reducing valve and desuperheating station

NORTON CO

Large Worcester, Mass. manufacturing concern expands its power plant to keep ahead of growing process and power needs

PLANT EXPANSION, including new buildings and a greater demand for electric energy and process steam, made the recent addition to the C Street power house, of the Norton Co, Worcester, Mass., an important element in meeting and planning for future growth.

By 1939, considerable progress had been made in preparing for expected load growth as far as it could be determined by conditions at that time. Two 50,000-lb-per-hr pulverized-coal-fired high-pressure steam generators, designed for 690-psi drum pressure and 650-psi turbine throttle pressure, were ready to come on the line, replacing two of four older low-pressure (125-psi) stoker-fired units. The remaining two low-pressure units served as standby in summer, but were on the line all the time through the winter. Steam for locomotives used on the plant grounds came *off the high-pressure units.* These locomotives use steam at 440 psi. Despite this enlargement of steam-generating facilities, plant growth since 1939 has made additional steam- and electric-generating capacity a necessity.

New Equipment. Latest addition is a 50,000-lb-per-hr pulverized-coal-fired unit operating in parallel with the still fairly new 1939 units.

The additional steam generator is designed for 690-psi drum pressure and 650 throttle. The unit has a furnace volume of 3700 cu ft, a total heating surface of 15,070 sq ft, a heat release of 18,800 Btu per cu ft and a tubular air heater of 5900 cu ft. The entire setting is steelclad. The two older 1939 pulverized-coal boilers are equipped with economizers but this most recent unit is not. The three steam generators (one new, two older) all supply 650-psi 750-F steam to a main header for distribution within the power plant itself.

Off this header, see flow diagram above, comes a 60,000-lb-per-hr 3600-rpm turbine-driven boiler-feed pump, a 2500-kw extraction turbine and two pressure-reducing valves, 650-120 psi. Ideal heat balance would call for full use of extraction turbines and boiler-feed pump. But in industrial steam plants heavy demands for process and power rarely occur together. Because this is so, the pressure-reducing stations had to be included. They give to the station a flexibility that permits supplying full plant process needs no matter how electric-power demand varies.

Below the 650-psi level and receiving steam from three sources is a 120-psi steam header. These three sources are: (1) two existing stoker-fired boilers, (2) 120-psi bleed point from the 2500-kw turbine-generator (3) output from the two 3-in. steam-pressure-reducing valves and desuperheater stations.

From this 120-psi header comes all plant process steam as well as steam for a 500-kw 3600-rpm station-service turbine-generator.

Below this pressure level runs a 3-psi steam main. It receives the exhaust of the high-pressure turbine-driven boiler feed pump, the exhaust of the 2500-kw main turbine-generator, and also the exhaust from the 500-kw station-service turbine-generator. Steam at this pressure level goes to some limited process points and to raise the temperature of the 120,000 lb-per-hr deaerator, but the majority enters the heating system.

Condensate Return. Although plant buildings spread out over a considerable area and about 20% of the steam used in process becomes contaminated, close to 80% of condensate is returned. Makeup, roughly about 20%, consists of city water admitted at the deaerator level to meet water needs.

Four boiler-feed pumps—two 120,000-lb-per-hr, 3600 rpm motor-driven, and two 60,000-lb-per-hr, 3600 rpm, one motor and one turbine-driven—are hooked up to pull water from the deaerator and introduce it to the boiler against boiler pressure. A differential pump control regulates pump output in conjunction with the boiler water-level control.

Carryover Control. Generating steam at the 690-psi pressure level and operating with a 20% city-water makeup makes a good water-treatment system a necessity. The problems of silica and carryover are particularly important. A successful system for control of these factors comes from a series of daily checks for various chemical concentrations in the boiler water followed up by an over-all supervision and advice by an outside water consultant. A specified amount of various chemicals as determined by these checks is added.

Control of carryover also receives help from the design of the boiler circulating system. The steam-water mix coming from the steaming tubes enters the steam-release drum above the water level. Releasing all generated steam in the open drum space of the main boiler drum above the water level prevents geysering and turbulence of the water body in the drum. Such a method, the designer feels, effects rapid separation of steam from water. Also, the separation is free and without disturbance.

Fan Loading. Before the 1939 plant change, a single stack employing only *natural draft proved ample for operation* of the underfeed stoker-fired boilers. When the 1939 plant expansion went into effect a single stack design was followed for handling all flue gas from the pulverized-coal and stoker-fired boilers. But it was necessary to add a separate induced-draft fan to serve the stoker units in addition to the fans called for in the design of the then new pulverized-coal-fired boilers. A mechanical dust collector was also placed in the flue-gas circuit, which added further to fan loading.

The 50,000-lb-per-hr boiler addition uses the already existing steel stack. This stack, together with induced- and forced-draft fans, is set up just outside the power plant building. The fans have a special outdoor housing for protection against the weather.

As in the older units, a mechanical dust collector has been connected into the new boiler exit flue-gas path. This unit consists of a series of 6-in.-dia tubular cyclone dust collectors. These individual tubular collectors have a single inlet, comparatively narrow, with inlet height approximately ten times width of opening. Tube inlet and diameter are proportioned so as not to effect any change in gas velocity. Such a velocity change between tube entrance and the precipitating portion of the tube could quite readily set up an erosive action.

The particular tube in service at this plant has a lower capacity than the *standard design but a higher degree of* collection. The tubes operate on a flat collection efficiency curve with almost 100% collection of dust particles larger than 20 microns (approximately 675 mesh). Draft loss ranges between ⅛ in. and 4 in. wg.

Coal System. The new boiler fires in pulverized form a bituminous coal, ranging from 13,600 to 13,900 Btu per lb and having an ash-fusion temperature of 2750-2950 F. Combustion control operates from a compressed-air actuated system that regulates the coal to air ratio and rate of fuel feed for various steam loads.

Freight cars haul the coal in and it is unloaded to a plant coal-storage pile. From storage it is admitted to the coal-handling system for delivery to unit pulverizers for grinding.

Incoming coal to the pulverizer moves on a belt over a magnetic drum where all tramp metal is separated. From here coal falls to the pulverizer where it undergoes a combined impact and attrition form of pulverization.

A pulverizer fan mounts on the pulverizer shaft and from the fan chamber blows the coal and air mixture through pipes directly to the burners where it enters the furnace.

PRINCIPAL EQUIPMENT OF C STREET POWER PLANT

Norton Company, Worcester, Mass.

STEAM GENERATORS AND AUXILIARIES:

Boilers, two, 50,000 lb per hr, 720 psi, 750 F	Riley Stoker Corp
Boiler, one, 50,000 lb per hr, 720 psi, 750 F	
Burners, six, 2 per unit, pulverized coal	
Preheaters, 2, tubular, 3850 sq ft	
Preheater, 1, tubular, 50,000-lb unit	
Economizers, two, 30,000-lb units, 1080 sq ft	
Pulverizers, three, 1 per unit	
Superheaters, two, 12 tubes, 50,000-lb units	
Superheater, 1, suspended type	
Soot blowers, rotary and retractable	Diamond Power Spec Corp
Water columns	Reliance Gauge Column Co
Safety valves	Manning, Maxwell & Moore
Blowdown system, continuous	Hagan Corp
Blowoff valves	Yarnall-Waring Co
Traps, inverted bucket	Strong, Carlisle & Hammond Co
Dust collectors, 2, mechanical	Prat-Daniel Corp
Forced-draft fans, three, 1 per unit	B F Sturtevant Co
F-d-fan motors, two, 25 hp, 2-speed	Westinghouse Elec Corp
F-d-fan motors, one, 20 hp, 2-speed	Westinghouse Elec Corp
Induced-draft fans, 4	B F Sturtevant Co
1 per unit plus 1 added to old stoker units	
I-d-fan motors, two, 100 hp, 2-speed	Allis-Chalmers Mfg Co
I-d-fan motors, two, 75 hp, 2-speed	Allis-Chalmers Mfg Co
Ash-removal system	United Conveyor Corp
Combustion-control system	Hagan Corp

ELECTRIC GENERATORS AND AUXILIARIES:

Turbine-generator, one, 3125 kva, 3600 rpm	General Electric Co
85 psi, bleed at 120 psi, exhaust at 3 psi	
Turbine-generator, one, 500 kw, 3600 rpm	Allis-Chalmers Mfg Co
Electric switchboard	General Electric Co

WATER-TREATMENT SYSTEM AND AUXILIARIES:

Deaerator, one, 120,000 lb per hr	Worthington Pump & Machy Corp
Chemical pump, 1, automatic flush valve,	Worthington Pump & Machy Corp
Condensate return pumps, 4	Ingersoll-Rand Co
125 gpm, 3460 rpm, 80.8-ft head	

PRESSURE REDUCERS, CONTROLS, INSTRUMENTS:

Pressure reducers, 2, 3-in. valves	Mason-Neilan Regulator Co
Desuperheating stations, 2	Elliott Co
Desuperheater control	Mason-Neilan Regulator Co

PUMPS AND COMPRESSORS:

Boiler feed, two, 1000-psi outlet	Ingersoll-Rand Co
3600 rpm, 120,000 lb per hr, motor driven	
Boiler feed, two, 1000-psi outlet	Ingersoll-Rand Co
3600 rpm, 60,000 lb per hr, 1 motor- and 1 turbine-driven	
Boiler-feed motors, two, 200 hp, 3600 rpm	Westinghouse Elec Corp
Boiler-feed motor, one, 125 hp, 3600 rpm	Westinghouse Elec Corp
Boiler-feed turbine, one, 125 hp	Terry Steam Turbine Co
Pressure regulators, 2	Northern Equipment Co
Differential pressure pump control	
Compressors, 2	Westinghouse Elec Corp
100 psi, standby for combination controls	
Combustion controls, water and steam flow	Bailey Meter Co
Recorders, boiler temp, steam and water	Bailey Meter Co. Hoyes Corp Co
Gages, draft	Ashcroft
Gages, pressure	Manning, Maxwell & Moore, Inc

CONSULTING ENGINEER—Sill & Warrington