ILLINOIS TECHNOGRAPH

MAY
1944

★

ABBOTT POWER PLANT

BACKWATER RESEARCH

HIGH SPEED PHOTOGRAPHY

NAMES IN THE NEWS

NORTH OF GREEN STREET

★

COVER
Abbott Power Plant

Established 1885 Member E.C.M.A.

20¢

Abbott . . .
Power Plant

By H. F. HRUBECKY
Instructor M. E.

The prime purpose of this article is to acquaint the reader with some of the major causes which incipiated the construction and subsequent development of the Abbott Power Plant as well as the thermodynamic and design features that it possesses. The exterior view of this plant is shown on the cover.

The "old power plant" (this being the name given to the plant preceding the present one located immediately adjacent to the Mechanical Engineering Laboratory) was originally placed into operation as a two-boiler unit in 1902-03 and a final addition was incorporated in 1925-26 and enlarged several times in accordance with expansion of the University. In its final stage it was a 150 lb. operating plant containing 8 longitudinal drum stoker-fired boilers, with one 1000KW and two 500KW non-condensing units, generating at 2300V distribution potential with the exhaust steam being fed to the heating system.

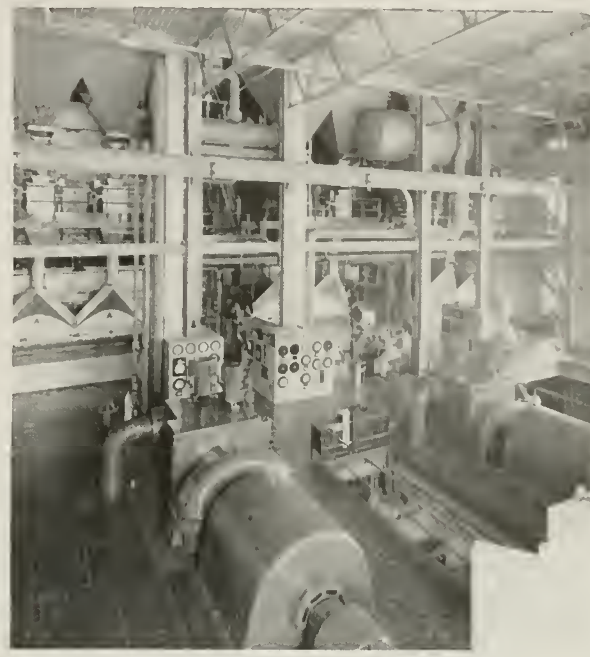
Electrical loads exceeding 2500KW had already taxed the then existing power supply to its utmost, the demand needs being in excess of the KW hours generated, consequently additional power had to be purchased from the Illinois-Iowa Power Company. The immediate question then confronting the University officials was whether to rebuild the existing plant or construct a new power plant taking cognizance of further campus expansion. The engineering issues kept in mind in arriving at the latter decision were the following:

A better standard of illumination was necessary for the existing buildings and also for the recently constructed buildings including the Illini Union, Gregory Hall, McKinley Hospital, Men's New Residence Halls, Geological Survey Laboratory, etc.

In addition, air-conditioning systems were planned for the Student Center and the new classroom building, as a consequence indications showed that the electrical requirements would reach a subsequent peak of 3400KW in the fiscal year 1940-41 far in excess of the available supply.

Finally, heating system requirements for the next ten-year period under standard design conditions of this locality indicated an increase to 200,000 pounds of steam per hour, an increase of over 50,000 pounds per hour for that period.

The abandonment of the alternate plan, that is, the rebuilding of the then existing plant, was due to the fact that it hindered any further expansion or improvement of the University's future projects. As an illustration, the former plant was located at the northeast extremity of the campus while all future projected growth was toward the south and west, disectionally opposite to the plants location which would have necessitated longer and additional steam mains. Nevertheless, space would have been available in the old boiler room by removal of six existing boilers lacking in heat recovery equipment and substituting therein the three 80,000 pound per hour steam generators required. Also by certain arrangement in the turbine room it would have been possible to install two 3000KW turbines. In that event thermodynamic, as well as mechanical alterations, would have to be made; steam pressure to 400 lbs. and temperature as high as possible to control exhaust conditions



Interior View Abbott Power Plant

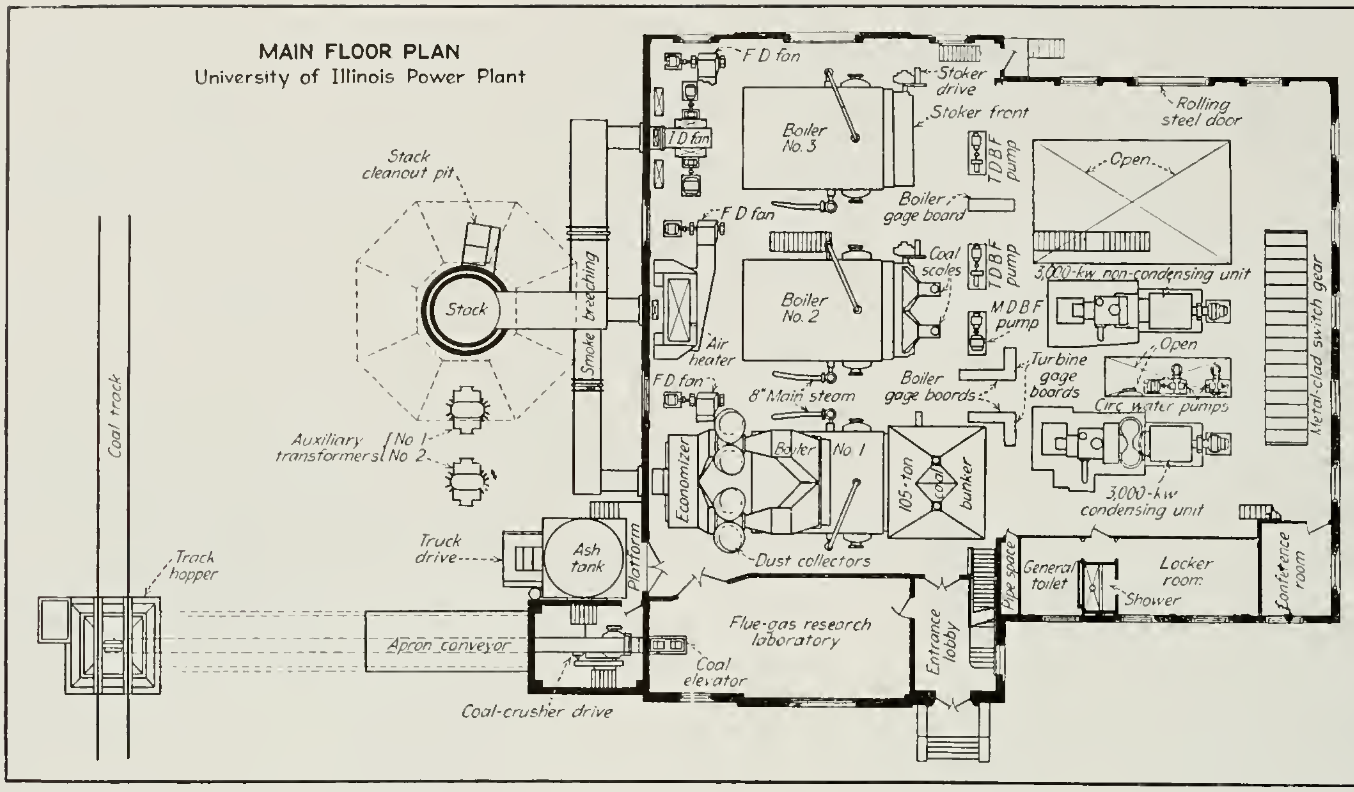
to a maximum of 400°F. In addition temperature and pressure reading equipment would be necessary to connect the new boilers and the generating equipment. Let alone mechanical difficulties, alterations in the structural steel supports, building walls, and floors would have to be made and all in progressive steps while the plant was in operation. Thus, are seen the overwhelming obstacles which confronted the adoption of this program.

Construction of the new plant began in January of 1940 and was totally completed in February of 1941. The plant was put into actual operation on September 23, 1940, and a short while later the contract with the I.I.P.C. was cancelled. The new plant operated in parallel with the former plant in the interval from September, 1940, to February, 1941. In direct contrast to previous practice, the U. of I. power plant began selling instead of buying power to the I.I.P.C., an amount reaching as high as 324,000KW hours in 1941-42.

For the year 1942-43 the plant generated a total of 12,911,800KW hours, as compared to 7,016,000KW hours for the final year (39-40) of operation of the former plant; for the same year period the U. of I. consumed 8,757,000-KW hours, thus necessitating the purchase of 1,741,000 additional KW hours.

The plant itself is located strategically with respect to the future expansion area as well as with the source of fuel, located on a siding connected with the Illinois Central Railroad System with coal storage facilities immediately adjacent to the plant. Steam service to the University buildings is effected by means of an 8′3″ high by 7′6″ wide concrete steam distribution tunnel, a photo of which is shown in an accompanying figure, containing two 12″ exhaust steam lines, one 8″ high pressure main for makeup and utility service, one 6″ high pressure main for 150 to 25 lb. process steam, two 4″ return mains and one 2½″ compressed air line.

Temperatures in the tunnel attain values of 90-100°F., (thus affording an excellent substitute recluse for annual Florida enthusiasts). A maximum steam pressure of 70 lbs. is expected at 200,000 lbs. per hour flow. The high temperatures result in an expansion of 110″ in the 4,000′ run, the effects of this expansion being modified by double off-set expansion loops at approximately 270′ centers. No expansion



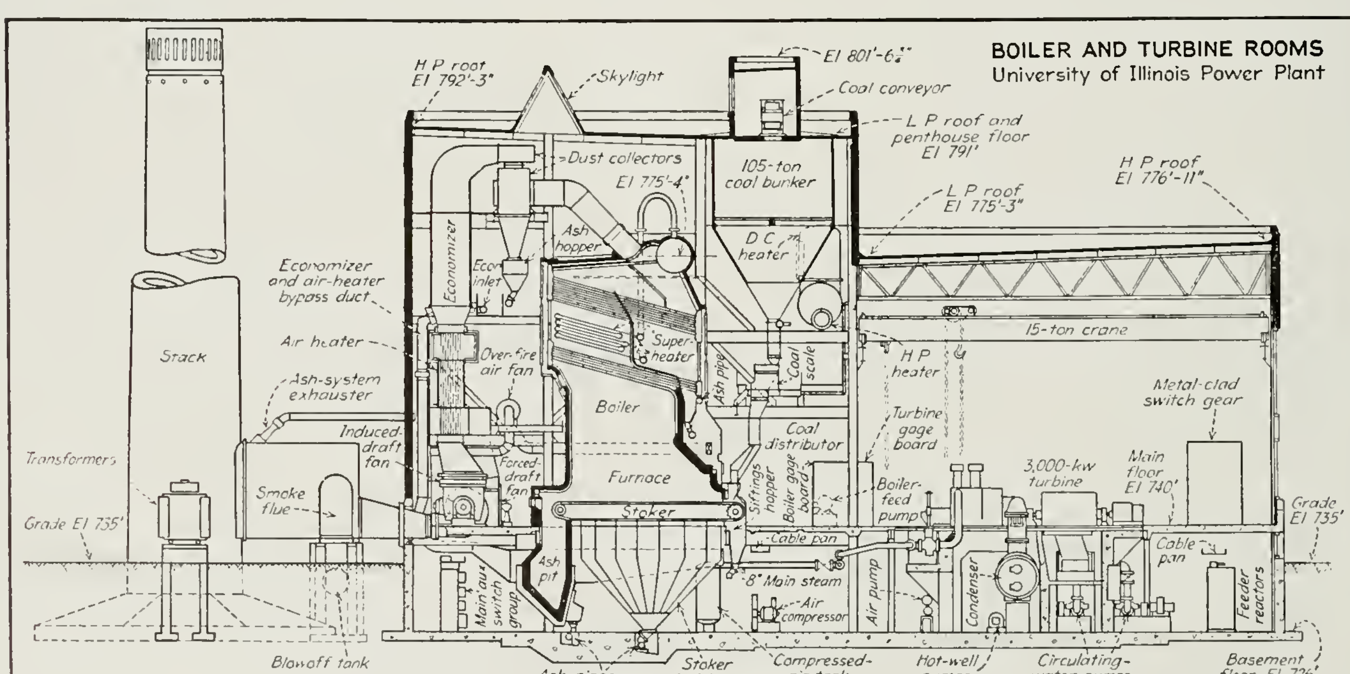
MAIN FLOOR PLAN
University of Illinois Power Plant

loops are used at the corners, the pipes being allowed to slide on flat plate supports. Provision is made for removal of drainage and storm water at the expansion loop vault while electrical power is distributed by cables run in a tile conduit about six feet from the pipe tunnel, with man holes at suitable distances.

A highly interesting and ingenious phase of the plant is its coal handling system. Manufactured by the Jeffrey Mfg. Co., it is designed to handle 75 tons per hour. The coal is fed from side or bottom dump cars into a 12'x14' track hopper. At this point a reciprocating feeder supplies an apron conveyor, where, if necessary, the coal may be crushed and then sent by means of a bucket elevator and two longitudinal scraper conveyors to overhead double-hopper, Gunite lined rectangular coal bins, each having a capacity of 150 tons. Ash and dust are collected and removed from the ash pit stoker wind boxes, sifting and dust collectors, hoppers and the stack base by means of an ash handling system with a capacity of 15 tons per hour through an 8" ash conveyor pipe with a steam consumption of 2700 lbs. per hour.

For the year 1942-43 the plant consumed 38,000 tons of coal with a corresponding boiler efficiency of 80 per cent, as compared to consumption of 43,000 tons for the year 1928-29 and a resultant boiler efficiency of 63 per cent. Thus can be seen the overall increase in efficiency of the power plant due to the modernized combustion system.

When consideration is given to the total heat, allocation,

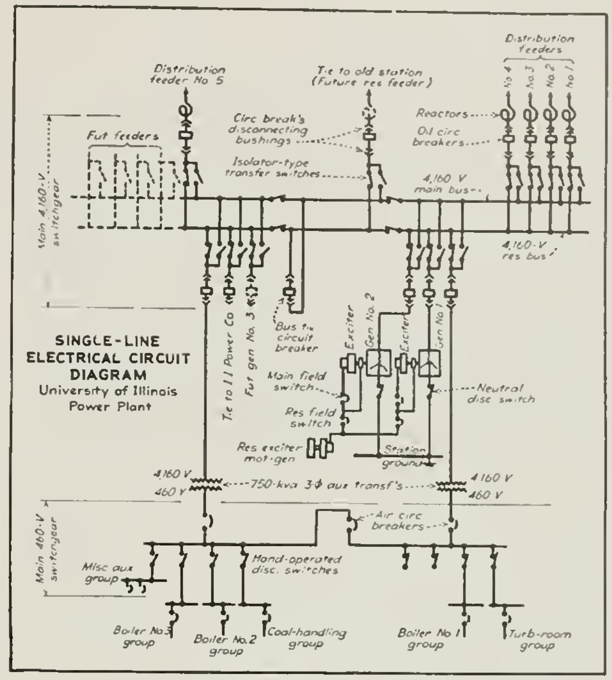


BOILER AND TURBINE ROOMS
University of Illinois Power Plant

it is seen that the steam charged to power is nominal (13 per cent of the total). Correspondingly it follows that the main emphasis is placed on the heating system (87 per cent of the total); the obvious advantage being the centralized source of heat, resulting in prodigious saving from the economic point of view, when one considers the expense involved in sustaining individual heating plants for University buildings. At present the plant utilizes two 3000KW General Electric turbines to supply power. Each operate at 3600RPM, throttle conditions of 300 pounds, 625 degrees, and the same current characteristics (.8 Power Factor, 4160 2400 volt, 3 phase, 60 cycle). However, one is an automatic extraction condensing turbine while the other is a non-condensing, chosen in a manner to provide flexibility in operation. The condensing unit supplies heating steam through a grid valve at extraction pressures ranging from 10-70 lb. gauge with exhaust to a 2500 sq. ft. two-pass Allis-Chalmers surface condenser having 780-7/8″, 18 BWG, 14′ long copper tubes with a capacity of 30,000 lbs. of steam per hour; cooling water being provided at a rate of 4500 gallons per minute at 90°F. In the summer months the above will operate condensing with two-point extraction for feed water heating while the back pressure unit exhausts to the heating system at pressures up to 70 lbs. and has one uncontrolled extraction point for feed water heating (note Flow Diagram). Since no cooling water facilities are available in the plant itself a forced draft, wood filled, cooling tower with a capacity of 4708GPM, when operating with a 100°F. inlet water, 90°F. outlet water, and 78°F. wet bulb air temperature, is used.

Steam Distribution Tunnel

A pressure- and temperature-reducing station is used to provide makeup steam when the turbine exhaust is inadequate. All campus condensate returns are collected in a deaerating heater floating on the heating supply line, and their temperature is further raised to 300°F. in a high-pressure heater previous to entering the economizer. The plan view of the plant shows that steam generation is provided by three Springfield cross drum, straight tube boilers, each having a heating surface of 6600 sq. ft. and a continuous capacity of 80,000 lb. per hr. when burning central or eastern Illinois screenings of 10,000 BTU as fired heating value, the firing being done by three Babcock-Wilcox chain grate stokers. The use of stoker fired fuel in lieu of pulverized fuel is appropriate because of the proximity of the campus, the prevailing winds of this locality, range of load, lower maintenance, and usability of stoker cinders for road grading.

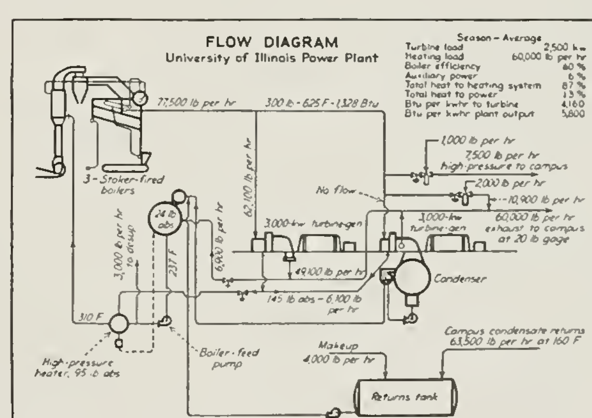


SINGLE-LINE ELECTRICAL CIRCUIT DIAGRAM
University of Illinois Power Plant

The boilers have a maximum steam working pressure of 375 lbs. per sq. in., a total temperature of 700°F., and an efficiency of 84 per cent, at a flow rate of 60,000 lbs. per hr. An important operating advantage of the new plant has been its high boiler efficiency, ranging in the neighborhood of 80 per cent as compared to the "old plant" which operated with an average boiler efficiency of about 65 per cent. In addition, the boiler furnaces are completely water cooled with a heat release of 30,000 BTU per cu. ft. per hr. at rated capacity. Buell type centrifugal collectors, located between the boiler and economizer, remove practically all the residue while the heat recovery equipment—consisting of economizers (each 2180 sq. ft.) and tubular air heaters (each 4600 sq. ft.)—are employed to reduce the final exit gas temperature to 375°F. at rated capacity.

An accompanying illustration presents electrical circuit system now in use—a 4160 volt, 3 phase, wye connected 4 wire system. The campus is divided into a number of

(Continued on Page 24)



FLOW DIAGRAM
University of Illinois Power Plant

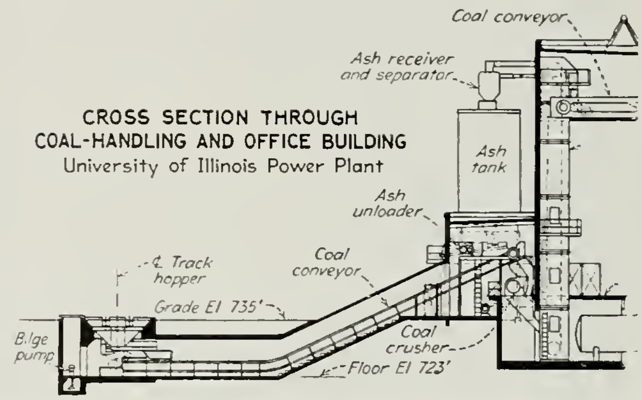
ABBOTT POWER PLANT . . .

(Continued from Page 9)

load areas, each being fed by a circuit from the power station (4-conductor, No. 00 underground cables) with emergency reserve feeders running through the several areas. Station auxiliaries operate at 440 volts and are supplied by two 750KVA transformers from the main lines, one transformer being a spare. Auxiliaries are fed from groups of air circuit breakers, being either manually or electrically operated, as conditions would require.

The author wishes to acknowledge thanks to Mr. Charles E. Markland, Supervising Engineer, Physical Plant Department, and to Mr. John Doak, Superintendent of Buildings and Grounds, for their most helpful suggestions and criticism.

Bibliography: Reasons Behind the University of Illinois Plant, by G. A. Gaffert and F. V. Smith of Sargent and Lundy, *Power* magazine, May, 1941.



CROSS SECTION THROUGH COAL-HANDLING AND OFFICE BUILDING
University of Illinois Power Plant