A HISTORY OF THE COLLEGE OF ENGINEERING OF THE UNIVERSITY OF ILLINOIS 1868-1945

Part II

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CHAPTER XX

MISCELLANEOUS UTILITIES OF ENGINEERING INTEREST DEVOTED TO UNIVERSITY SERVICE

A. UNIVERSITY HEATING, LIGHTING, AND POWER PLANTS

General. The University has always maintained its own heating, lighting, and power facilities,–for the most part in a central plant located within the campus area. Brief descriptions of these plants follow in the next few pages.

University Hall Central Heating, Lighting, and Power Plant.– The first central heating plant on the campus was constructed in the fall of 1881, in a one-story building that stood directly back of University Hall. It is described in the 1882 Report of the University of Illinois[1] as follows:

"The Boiler House is 34 x 80– and 14 feet in height of wall. Its north end forms the south side of the quadrangle of the main building. Its floor is depressed four feet below the surface, and is covered with concrete. The first six feet of its walls are rough rubble laid in cement; the remainder of its walls is of old brick surfaced with new. The roof is of matched flooring covered with metallic shingles. The interior is divided by a partition. The north end contains two boilers, which furnish steam for the main building through a six-inch pipe. The capacity of the two boilers is 75 horsepower each. Space remains for a third boiler, when it shall be removed from the Chemical Building. The room also contains a small high-pressure boiler, and the steam- pump, heater, etc. The south end has an estimated capacity of receiving 250 tons of coal.

"The boiler flues are taken about 60 feet under ground to the chimney, which is placed south of the east wing of the main building, and as near as the foundation would permit. The foundation is twelve feet square, and is ten feet below the surface of the ground. With the first ten feet of the chimney above ground the foundation is of rough stone masonry laid in cement. The remainder of the chimney is of brick, and is circular above the octagonal stone base. The work has been excellently done. The scaffolding was placed inside the chimney and when removed the interior surface was smoothly plastered with lime and salt. The draft proves to be all that could be desired. The season was so far advanced before the work was done that it was not thought best to attempt the removal of the boiler from the Chemical Building, which is therefore deferred to the future.

"One of the boilers in the new house is new, taking the place of a condemed boiler from the basement of the main building. Thus far one of the boilers supplies abundant steam, and it is hoped that the second boiler in reserve will give us such power of warming the building in extreme cold weather as has never before been enjoyed[2].

"The area of the quadrangle has been neatly graded, and such walks and approach have been made about the boiler house as are required for delivery of coal and other purposes."

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1. Page 208
2. In addition to the boilers in this central plant, three others all of 40 horsepower horizontal tubular type, were installed in the old Mechanical Building and Drill Hall on the north campus,– one in 1890 to heat that building and provide power for the shops, one in 1892 to heat the Armory, and one in 1895 to heat Machinery Hall (Now Machine Tool Laboratory).

Most of the brick used in the construction of the building and chimney were salvaged from the old Dormitory on the north campus when it was razed during the previous summer.

The heating capacity was gradually expanded as changes were made and new buildings were erected. A new 110-horsepower Sterling boiler was added in the fall of 1892 to heat the old Chemistry Building (Harker Hall) and the first unit of the Natural History Building, and two new 220-horsepower Babcock and Wilcox boilers were put in in the fall of 1894 to heat Engineering Hall.

The building was taken down about 1902-03,-several years after the constructic of the Boneyard plant,-and the chimney was removed in 1910. The chimney was badly cracked and was considered dangerous. Besides, it no longer served any useful purpose.

The electric-light plant was set up in the quarters occupied by the Department of Physics and Electrical Engineering, which was located on the ground floor of the east wing of University Hall. For a short time, the plant was powered by a 10-horsepower Atkinson-cycle gas engine procured in the summer of 1891, but because of difficulties in operation, a 60-horsepower "Ideal" steam engine manufactured by Ide and Son of Springfield was installed early in 1892. The boiler which supplied the steam for the Ide engine was a 60-horsepower water-tube Sterling type[1] and was set at the same time as the steam engine in the old boiler-room in the east wing of that same building.

The electrical equipment driven from a jackshaft, consisted of the Weston 5-light arc lighting generator obtained in 1886, a Thomson-Houston 300-light alternating-current generator, and a Thomson-Houston 35-light direct-current generator, both installed in 1891. Shortly after 1891 several other dynamos[2] were added to the facilities of the Department of Physics and Electrical Engineering although it is not clear how many of them, if any, were used for central-lighting purposes.

1. This boiler was also used to supplement the 110 horsepower Sterling in heating the Chemistry and Natural History buildings after 1892.
2. These are listed under Physics in Chapter XV. Previous to 1891, the University buildings had been lighted by gas.

The Boneyard Central Heating, Lighting, and Power Plant.- The second central heatin lighting, and power plant was constructed in 1897-1898. The following discussion of the purposes of the new plant is summarized from an article provided by Professor L. P. Breckenridge in The Technograph.[1]

The rapid growth and development of the University of Illinois rendered it imperative that increased facilities should be installed for the proper heating of the buildings already erected on the campus. The completion of the Library during the summer of 1897 added 3,000 square feet of hot-blast radiation to the system. Largely on account of insufficient chimney draft, the boiler capacity of the old plant was not adequate to handle any increase in radiation. All of the water of condensation from Engineering Hall was being discharged into the Boneyard. The operation of two plants, one for the north and one for the south end of the campus, was not economical and smoke was always a nuisance, whether the wind was north or south. On account of the poor chimney draft, it had been necessary to burn lump coal costing the University from $1.75 to $2.25 a ton. The coal consumption for the years 1895-96 and 1896-97 had been about 3,500 tons.

In the design of the new plant, it was the aim of the writer to accomplish the following results:

1. To concentrate at the lowest point on the campus, all of the heating boile

2. To provide increased draft, so that the cheaper grades of coal might be used for fuel.

3. To prevent smoke.

4. To provide a system of tunnels large enough to carry the heating mains, water mains, gas mains, compressed-air mains, vacuum mains, as well as for electric light and power purposes.

5. To concentrate all engines near the boiler house so that all exhaust steam might be used for heating purposes.

6. To provide 1,000 incandescent lights for the buildings and 20 arc-lights for the campus.

7. To provide electric current for running motors for power purposes at any point on the campus.

1. Vol. 12, 1897-98, pages 79-85

8. To arrange this entire plant so that, as far as possible, it might be available for educational purposes.

The new plant was located in the 55-by 120-foot brick building [1] that now stands directly north of the Boneyard and the University Fire Station. A complete description of the building and the stack was presented in The Technograph, from which the following extracts were taken[2].

The walls of the long sides were twenty-six feet high. The west wall was covered on the inside by coal bins and coal-handling machinery, and the east wall had outside along its entire length a smoke funnel five feet wide and twelve feet high. This connected with the chimney at the middle of the wall and with the various boilers which occupied that side of the building. The boiler house was lighted by clerestory windows on both sides. Seven light steel trusses of special design supported the roof. To the south extended a pump, tool, and stock room 25 by 50 feet. This portion of the building crossed the Boneyard and provided an entrance to a system of tunnels which connected the various buildings. The boiler house and stack were constructed of common red brick, laid in red mortar.

The brick stack, which had an inside diameter of 6 feet and a height of 150 feet, stood on the east side of the building about midway between the two ends of the structure. It rested on a solid foundation of Portland cement concrete 6 feet thick which decreased in six steps from 24 feet and 8 inches square at the base to 18 feet square at the top. The stack had a separate core extending to a height of 90 feet, the lower 40 feet being 12 inches thick, the next 30 feet, 8 inches thick, and the last 20 feet, 4 inches thick. It was entirely free from the chimney wall and was never nearer to it than two inches.

The stack proper rested on a base 34 feet high. The shaft itself was circular and consisted of a 24-inch wall to a height of 54 feet, where it was reduced to a 20-inch wall to a height of 76 feet, then to an 16-inch wall to a

1. Building designed by Professors C.D. McLane and S.J. Temple. This site was chosen by Professor Breckenridge because it was the lowest point on the campus.

2. The Technograph, Vol. 12, 1897-98, by S.J. Temple, Assistant Professor of Architecture, Pages 44-46.

height of 98 feet. A 12-inch wall then extended to a height of 123 feet where the ortamental top began. The cap was 27 feet high and consisted of an 8-inch wall strengthened by 2-inch rods every 8 inches. The stack was laid in cement mortar above 76 feet, and all the joints on the outside were raked out and pointed up after completed. There was an iron ladder running from bottom to top on the inside and a cast-iron cap protected the upper course from disintegration.[1]

The general contractors for both building and stack were M. Yeager & Son of Danville, Illinois. The iron and steel work was furnished by the La Fayette Bridge and Iron Company of La Fayette, Indiana. The contract price for the building was $37,935, which could be divided approximately as follows: Chimney $4,000; boiler house, $9,500; laboratory building $24,435. The building cost a trifle over 7 cents a cubic feet, and the boiler house a trifle under 4 cents a square foot.

During December,[2] 1897, one new 250-horsepower National Water Tube boiler was set in this new power house. This boiler was equipped with a Murphy smokeless furnace and automatic stoker. The boiler was fired up on December 28 and Steam was turned into the heating system from it on January 3, 1898. A Berryman closed feed-water heater was set so that the exhaust steam from the engine might be turned through it or around it as desired.

The two 220-horsepower Babcock and Wilcox boilers, formerly used in the old University Hall Central Plant were set in May, 1898, and were equipped with Roney mechanical stokers. the 110-horsepower horizontal tubular boiler[3], moved from University Hall itself, was set with a Brightman stoker. The coal and ashes were

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1. The stack was taken down in about 1921 or 1922, and the brick was used as back up brick in the construction of the first unit of what was then called the North Garage, now a part of the Nuclear Radiations Laboratory.

2. The mechanical and Electrical Engineering Laboratory and the boiler house were to be finished by December 1, 1897, according to the contract. The boiler house was finished on schedule, but the laboratory part required an additional ninety-seven days.

3. Removed during 1905.

handled by machinery, -the coal-storage capacity being about 600 tons, and the coal consumption in 1897-98 being about 3,500 tons.

Some of the smaller details of the boiler-house equipment consisted of a No. 6 Schaeffer & Budenberg exhaust steam injector, a Locke damper regulator, Davis'back pressure valves, 8-inch Lyman exhaust head, Worthington 2-inch hot-water meter, Crosby recording pressure gages, feed pumps with automatic control from return tanks, oil filters, and Austin separators.[1]

A short time later, there was added one 150-horsepower Babcock & Wilcox special boiler carrying a 275-pound steam pressure, equipped with a hand-feed furnace and one 150-horsepower standard Babcock & Wilcox boiler supplied with a Babcock and Wilcox chain-grate stoker, making the total rated horsepower about 1,100. Two 200-horsepower Sterling boilers equipped with chain grates and automatic stokers were installed during 1905. Still other boilers were added until in 1907, the boiler capacity had been increased to about 1,800 or 2,000 horsepower

For a time, coal was hauled to the plant in wagons, but in 1906, the Illinois Traction System put in a spur from its tracks to the north. This line was removed in 1919 at the time of the construction of the third unit of the Mathews Avenue Power Plant.

The engine and generating equipment provided for the power plant was installed in the West end of the east wing of the Mechanical and Electrical Engineering Laboratory in the early part of 1898. It consisted of one 60[2]horsepower "Ideal" single-cylinder, high-speed engine; one 50-horsepower Westinghouse "Junior" engine; and one 100-horsepower Ideal tandem-compound engine. These engines, supplied with

1. Descriptions taken largely from an article "The Central Heating, Lighting, and Power Plant", by L. P. Breckenridge in the Technograph, 1897-98, pages 79-85.

2. Listed in same descriptions as 50 horsepower. It was originally installed on the ground floor of University Hall in 1892 as a part of the Department of Physics Power Plant.

high-pressure steam through an independent main from the boiler house, were used mainly to drive the electric generators described in the following paragraph.

The electrical equipment operated by the above steam power, was provided to furnish current for the incandescent lamps in the buildings, for the arc lamps on the campus, and for the motors which ran the machine shop, the dynamo and other laboratories, and the ventilating fans in the several buildings. The generating equipment included one Westinghouse 45-kilowatt, 440-volt, 2-phase, 60-cycle, alternator, belted; one Westinghouse 75-kilowatt, 440-volt, 2-phase, 60-cycle, alternator, belted; one 30-kilowatt, 500-volt direct-current generator; and one 25-kilowatt, Wood arc light generator that supplied current for the 25 arc lamps on the grounds and in Military Hall. The plant was provided with a transformer to reduce the pressure from 440 volts to 110 volts for the incandescent lamps. In the latter part of 1902, there was added a 120-kilowatt, 440-volt, 2-phase, 60-cycle Westinghouse generator with revolving fields, directly connected to a Westinghouse compound steam engine of 200 horsepower, and the 45-kilowatt machine was returned to the manufacturer.

The electric plant was discontinued in 1911-12, after the Mathews Avenue plant had been placed in service.

<u>The Mathews Avenue Heating, Lighting, and Power Plant.-</u> The first unit of the Mathews Avenue Heating, Lighting, and Power Plant, a four-story brick structure, was completed about June 1, 1910, at a cost of $75,000, and the equipment was installed shortly thereafter. Two Babcock and Wilcox longitudinal-drum boilers, each of 500 horsepower, operating under natural-draft conditions at 150 pounds steam-pressure, were provided with cast-iron headers and with Green Engineering Company's chain grates. The Chimney, erected by the Alphons Custodis Chimney Construction Company of Chicago, was 10 feet in diameter at the top and was 175 feet in height above the boiler-room floor, which gave it a rating of about 3,500 horsepower. The plant began full-load operation on December 22, 1910. It was largely for heating purposes, for the lighting and power loads made comparatively small demands.

Some of the engine and generating equipment including the 120-kilowatt Westinghouse plant mentioned in the preceding section, was transferred from the old power plant to the new one. In addition, a Ball non-releasing Corliss engine, directly connected to an Allis Chalmers Company 250-kilowatt, 440-volt, 2-phase, 60-cycle, generator, and a 125-kilowatt, 2,300-volt, Curtis turbo-generator set were installed. The Ball engine and the turbine could carry the full electric load required of the plant. A simple engine was chosen because the exhaust steam was used for heating, and the engine, therefore, served only as a reducing pressure valve for the heating system. As previously stated, however, the electrical equipment of the Boneyard plant was kept running until the beginning of the school year 1911-12.

The new mechanical equipment was decided upon by W.L. Abbott, president of the Board of Trustees, and Dean Goss of the College of Engineering. Plans for the building were prepared by W. C. Zimmerman, the State Architect, Details of piping, wiring, etc., together with the selection of pumps, feed-water heaters, and so on, were entrusted to W. H. Zimmerman, '96, Consulting Engineer, of Chicago. The general contract was awarded to E.C. English, '02.

During 1914, an addition was made to the new power plant. The spur to the Boneyard plant was moved slightly and the new building was extended to the west of the original structure along the railway tracks. Two more Babcock & Wilcox boilers duplicating the first set of slightly over 1,000 horsepower, were installed in 1915-16, thereby doubling the boiler capacity of this plant, making about 2,200 in all. At that time, the link-belt coal-and ash- handling system was installed. The coal was unloaded from cars on the Illinois Traction siding to a hopper beneath the track, from which it was carried by a pan conveyor to a crusher and then to a bucket conveyor. This conveyor elevated the coal to the hopper-bottom, cylindrical steel bunkers, which had been provided because there was so much danger from spontaneous combustion with the low grade of fuel used, that it was felt necessary to have the bunkers so constructed that the coal would be continuously moving. The coal was fed directly from the bunkers to the automatic stokers through individual electrically-operated scales provided to measure the coal consumption. A 200,000-pound Buffalo platform scale was installed in the unloading track immediately in advance of the unloading hopper.

In 1920, another extension was made to the power-plant building and two more Babcock & Wilcox boilers of the same capacity as those previously installed, were added. In 1925, another two of similar make and capacity were put in, making eight altogether in service totalling about 4,400 horsepower. All of these boilers were equipped with natural draft operating equipment; but when it became necessary in 1935 to repair the two original boilers, they were remodelled to operate with forced draft.

In 1920, the original 125-kilowatt Curtis turbo-generator was retired[1] to make room for a 500-kilowatt, 2,300-volt, 3-phase generator driven by a horizontal Curtis steam turbine. In 1925, another 500-kilo-watt generating unit duplicating the 1920-model, was installed. A 1,000-kva generator having a direct-connected exciter and being driven by a single-stage General Electric non-condensing steam turbine, was added in 1929,-being placed into operation on September 16 of that year. The turbine was designed for 140 pounds steam pressure and 15 pounds back pressure. The operation was non-condensing because of the need for exhaust steam in the heating system. The turbine ran at 3,600 r.p.m., and was directly connected to the 2,300-volt, 3-phase, 60-cycle, alternating-current generator.[2]

During this period from 1921 to 1929, the stand-by connection with the local power company was increased from 250-kilowatt to 750-kilowatt capacity, then to 1,000 and finally to 1,500, making a total electrical capacity of 3,500 kilowatts.

A second radial-brick chimney 15 feet inside diameter at the base and 13 feet at the top, was erected for the power plant in the summer of 1930. The walls

1. At that time the generating equipment consisted of the Allis-Chalmers 250-kilowatt machine driven by the Ball engine, the Westinghouse 120-kilowatt generator driven by a Westinghouse vertical single-acting engine, and the 500-kilowatt generator.

2. The Technograph, November, 1929, Page 23.

were 24 inches thick at the bottom and 8½ inches at the top, and were laid with firebrick for a height of 50 feet above the breech.

Since the boilers in the plant were no longer used after the new Abbott Power Plant, described in the next section, was completed in 1940, they were removed, the two chimneys were taken down a short time later, and the boiler-room portion of the building came to be used by the Physical Plant Department for service, storage, and other purposes. The 500-kilowatt generators were removed, also, but the 1,000-kilowatt generator and the steam turbine were left in place, although they were not used in 1945. There was also left there the 100-kilowatt motor-generator set installed in 1924 for supplying direct current for general campus use. In 1941, the Ball engine was transferred to the brake-shoe laboratory, as previously mentioned.

William Lamont Abbott Power Plant.[1] - Because the facilities of the Mathews Avenue Power Plant would not be able to meet the demands that would be imposed in serving the needs of several new major buildings to be located on the middle and south campus, it was decided to erect an entirely new power, heating, and lighting plant along lines of more modern power-plant construction. The site chosen was one on the southwest campus in a section adjacent to the right-of-way of the Illinois Central Railroad Company, where track and coal-storage facilities could be conveniently provided.

This plant, designed by Sargent and Lundy, Inc., was constructed between January, 1940, and February, 1941, at a cost of $1,685,934,- the plant having been placed in operation on September 23,1940, and having been operated in parallel with the Mathews Avenue Plant until February, 1941. The three steam generating units each having a continuous capacity of 80,000 pounds of steam per hour when burning central or eastern Illinois screenings of 10,000 B.t.u., were procured from the Springfield Boiler Company. They were equipped with three Babcock-Wilcox forced-draft chain grate stokers. The coal-handling system designed to move 75 tons of fuel per hour, was constructed by the Jeffrey

1. Some of the material in this section was taken from The Technograph, May, 1944, pages 7-9.

Manufacturing Company. The United Conveyor Corporation furnished the ash-and dust-handling system, and the Richardson Scale Company supplied the six automatic scales for weighing the coal. The concrete chimney was constructed by The Heine Chimney and Construction Company. The two 3,000-kilowatt turbo-generator units, operating at 3,600 r.p.m.,- one an automatic-extraction condensing turbine and the other a non-condensing turbine,- were manufactured and installed by the General Electric Company, a Whiting 15-ton travelling crane having been provided to handle and service them.

The construction of this plant made it possible to expand the building program to cover the present requirements for instructional and experimental purposes and to provide for additional capacity for future growth in the building and campus plan. This assemblage of structure and equipment was very appropriately named the William Lamont Abbott Power Plant in honor of one of the University's most distinguished alumni engineers and who was for many years a member of the Board of Trustees of this institution.

B. WATER SUPPLY STATIONS

University Water-Works Plant.[1]- With the growth of the University and the construction of many new buildings, there came a largely-increased consumption of water, and this fact and the desire to serve facilities for experimental work led to the construction in 1901-02 of the first unit of the University waterworks. The plant consisted of wells, storage tanks, pressure tanks, pumps, distribution mains, and a reservoir. Extensions were made to old mains and the connections to the city mains were closed by gate valves.

The water-works building was located at the south end of the Boneyard boiler house and pump-room addition. The building, 38 by 73 feet, constructed of pressed-brick, contained pumps and tanks, and also the hose carts and other fire-protecting apparatus. In 1936, this building was remodeled somewhat and

1. "University Water Works," by A. N. Talbot, in The Technograph, Vol. 16, 1901-02, page 87-88. Professor Talbot designed and supervised this first installation.