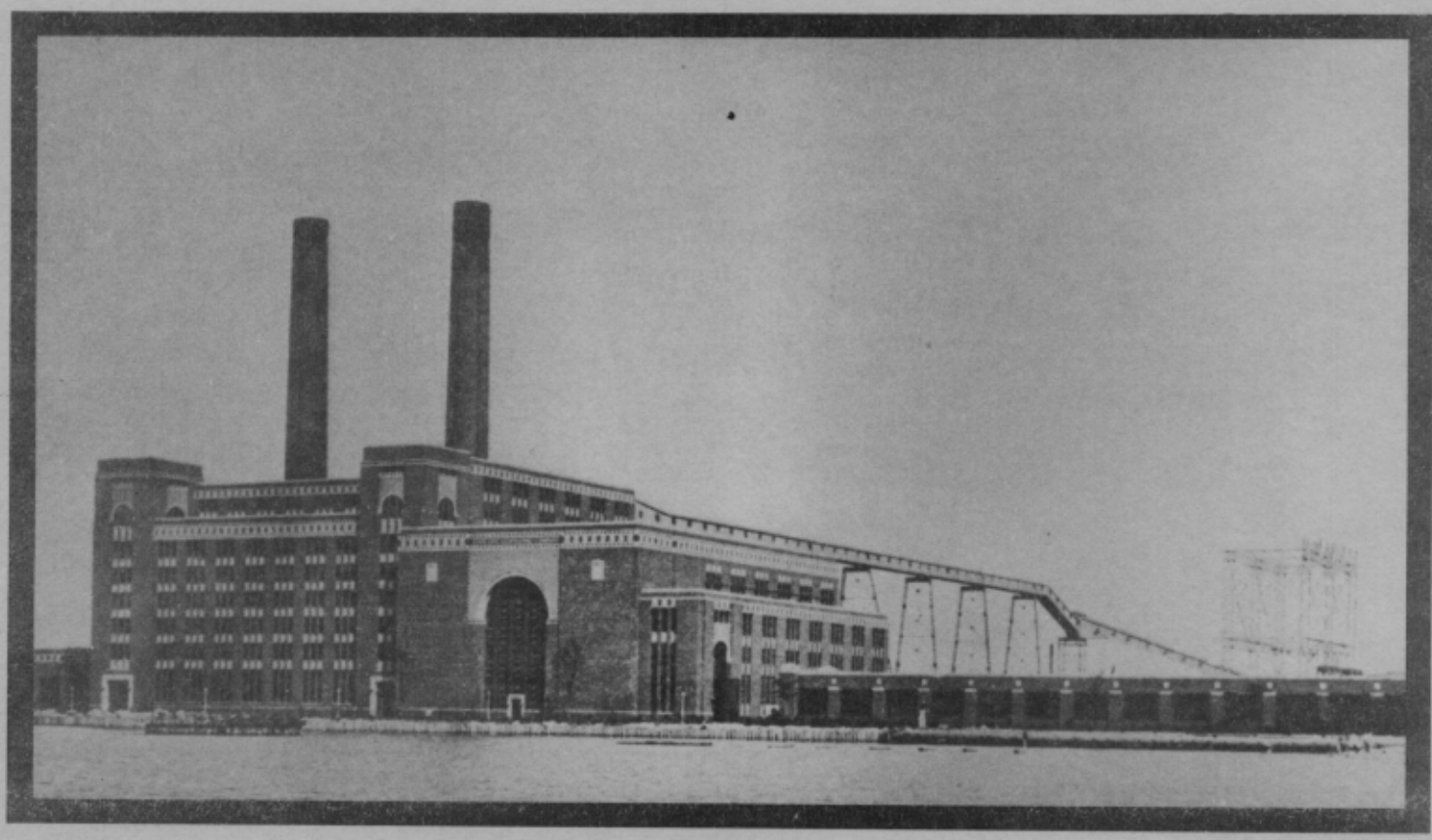
National Historic

Mechanical Engineering Landmark



STATE LINE GENERATING
UNIT NO. 1
1929

The American Society of Mechanical Engineers
Commonwealth Edison Company of Indiana, Inc.
April 19, 1977

FOREWARD

Taken from the 1929 State Line
Generating Unit Number One
Commemoration Booklet, October 1929

* * *

In Chicago and adjacent territory in northeastern Illinois and northwestern Indiana there is one of the great interconnected electric power systems of the world.

All of the electric generating stations in what is known as the Chicago Metropolitan District are interconnected in one system. They have a total capacity of 1,517,700 kilowatts or 2,034,450 horsepower. The various companies in this district serve nearly 1,300,000 customers.

In the midst of this great power system stands the new generating station of State Line Generating Company, operating a turbine unit of 208,000 kilowatts or 278,820 horsepower -- the largest generating unit ever built.

This station, which begins operation only fifty years after the invention of the incandescent electric lamp by Thomas A. Edison, is a dramatic example of the tremendous progress made by the electric light and power industry in half a century....

So continuous and so rapid has been this development that few stop to consider what electricity means in their everyday life. Yet it is interwoven into the very scheme of modern life, bringing comfort to the home, speeding transportation, aiding industry and relieving burdens and drudgery.

The electric industry, only fifty years old this month (October 1929), stands today on the threshold of still greater expansion, facing greater duties, ready for greater accomplishment in its public service.

* * * *

The 1920's was a decade of rapid expansion with the American people, as always, looking for better, more efficient ways of doing things. The vestiges of a fast-paced decade required electricity...radios, washing machines, refrigerators, victrolas, clocks, toasters, etc. The requirements of industry became even greater as mass production became the byword. In an era of tremendous technological and economic growth the electric age finally arrived, full bloom.

Seeing the need for increased electrical capacity Commonwealth Edison officially announced in March of 1926 the plans for a million kilowatt station, to be known as "State Line." Given the state of our present day generating capacities such a development might seem insignificant in retrospect. An undertaking such as "State Line," however, has come to represent a definitive example of the foresight and ingenuity which provided a foundation upon which our present day innovations could be built.

"STATE LINE" TURBO-GENERATOR BEGINS SERVICE IN 1929, THEN THE WORLD'S LARGEST

State Line Station, so named because of its location at Hammond, Indiana, on the shore of Lake Michigan at the Illinois-Indiana border, was the largest projected addition to the power supply of the Metropolitan Chicago District in the 1920's. Preliminary construction on the plant began in 1925 and was entirely located on 90 acres of "man-made" land or fill. The consulting engineers on the plant were Sargent & Lundy, Inc., while the architect was Graham, Anderson, Probst & White. The first turbine generator unit, which was built by General Electric, had a capacity of 208,000 kilowatts. Between 1929 and 1954 the Unit I Turbine Generator was the largest electrical production unit in the world.

The Edison Round Table magazine of March 31, 1926 quoted then Commonwealth Edison President Samuel Insull as saying: "From the viewpoint of electric service, the State Line Station is only reasonable preparation for the future power needs of the Chicago-Illinois-Indiana industrial area and contiguous territory.

"The first unit of 200,000 kilowatt capacity will represent, when ready for service in 1929, only about 15 percent of the estimated combined maximum demand, at that time, of the companies which will take energy from it.

"Realization of future possibilities will be hastened by an adequate supply of power. Hence, we take some pardonable pride in believing that the State Line and similar enterprises contribute tangibly to community growth and prosperity."

CHARACTERISTICS OF UNIT NO. I

The Unit Number One turbo-generator group consisted of one high-pressure steam turbine and two low-pressure turbines. The high-pressure turbine operated at 650 pounds steam pressure and would exhaust through live steam reheaters into the two low-pressure turbines at 110 pounds pressure. Each of the three turbines was connected to an electric generator. At 85 percent power factor the generator on the high-pressure turbine had a rating of 76,000 kilowatts while those on the two low-pressure turbines were of 62,000 kilowatts each. Electrical energy was generated at 22,000 volts.

All the elements of the generating unit operated at 1,800 revolutions per minute, while each of the low-pressure turbines, in addition to the main generator, drove a 4,000 kilowatt direct-connected auxiliary generator. The high-pressure element was supplied with steam at a total temperature of 730 degrees F. Between the high-pressure and low-pressure elements exhaust steam, from the high-pressure turbine, was reheated from 400 degrees F. at 110 pounds absolute pressure to 500 degrees F. at 110 pounds absolute pressure, with live steam from the high-pressure heater, supplying the low-pressure turbines. There were five stages of feed-water heating, ranging from a maximum of 380 pounds to a minimum of 9.4 pounds absolute.

Each of the low-pressure turbines was double-flow, arranged so that each set of low-pressure wheels was served by two surface condensers, making four condensers for each low-pressure turbine of a total of eight condensers

for the unit. These condensers had a total of 176,000 square feet of cooling surface and were designed to condense 1,600,000 pounds of steam per hour when supplied with 380,000 gallons of circulating water per minute. The circulating water, provided by four vertical circulating pumps placed in the crib-house outside of the generating station, entered the condenser through the lower water box, flowed upward through the tubes and was discharged downward through the overflow pipes in the condenser shell.

Means were provided by which any one of the three turbo-generators comprising the group-unit might be taken out of service and the other two continued in operation. This met the objection, from an operating point of view, that it would be unwise to concentrate so great a capacity in one unit. Further, the object of this arrangement, rather, than, say, two sets, in the group unit, was to obtain flexibility which would permit greater efficiency at varying conditions of load. This improvement in efficiency, as the actual load fell off from the ideal point of steam-turbine efficiency, was due not altogether to the turbine design but also to improvements in feed-water cycle efficiency.

To obtain a better conception of the size of this unit, one needs only to realize that it furnished sufficient power to light three and one-half million standard 60-watt lamps used in home lighting. This number of lamps spaced 50 feet apart would girdle the globe with enough left over to reach from New York to San Francisco. This amount of electrical energy was sufficient to light more than 100,000 average homes with all the lights in each house burning simultaneously.

Steam was supplied by six boiler units with steel drums 52 inches in diameter built for 800 pounds working pressure and operating at 650 pounds. This was the first time such high steam pressure had been used in electric generating stations in the Chicago District. Each boiler unit, operating with superheater, economizers, air heaters and water walls, had a guaranteed output of 450,000 pounds of steam per hour.

While the furnaces were relatively large in comparison with boilers and economizers, the total amount of building space occupied by the boiler units amounted to only 985 cubic feet per 1,000 pounds of steam capacity. The reserve boiler capacity of the station was such that the plant could be operated with five of the six boiler units, and in an emergency it was believed that four of the six would serve.

The then modern feed-water cycle for large steam turbine units called for large air heaters. Air going through the furnace was pre-heated and forced draft was used. Dust and soot eliminators were installed on all boilers.

More than two tons of pulverized coal could be consumed each minute for steam generation when the station was at full operating capacity.

The two smokestacks were constructed of steel and stood 250 feet high above the powdered fuel burners with a diameter of 18 feet at the top and 22 feet 6 inches at the bottom. The stacks were concrete-lined, the lining having been applied by means of a cement gun.

CONTROL OF POWER

The control of the power generating equipment and power delivery to customer companies was centered in an operating room located on the same floor as the turbo-generators and separated from them by glass partitions through which the operator could view the machines. A complete system of automatic telephones, signals and loud speakers kept the operator fully informed with regard to the satisfactory operation of the equipment throughout the plant.

The placing of a generator in service or the sending out of power was accomplished merely by pulling a small control switch. When the switch was operated, a small lamp on the switchboard indicated whether power connection had been made. To guard as far as possible against serious mistakes, the entire switching was interlocked through a system of relays which prevented the improper closing of power circuits.

Adequate transformer capacity was provided by eighteen transformers. Their total capacity was 360,000 kilowatts or nearly twice the generating capacity of Unit Number One. This capacity was necessary to insure flexibility since the power requirements of the different purchasing companies varied considerably from time to time. These variations, of course, were dependent upon the load required by the purchasing companies in the various zones in which they operated.

To guarantee, to the greatest extent possible, against the shutdown of any feeder, spare transformers were provided. Defective transformers could therefore be replaced quickly.

FORESEEING THE FUTURE

The site upon which the State Line Station now stands was acquired by a number of individuals who organized the State Line Land Company which was incorporated by the state of Indiana in 1921.

Among the favorable factors of this particular site were: its accessibility to the main lines of several railroads, which could guarantee a source of fuel from land transportation; the availability of water facilities for the transportation of coal in the event of railroad tie-ups; the unlimited supply of water which is necessary for plant operation; and the proximity to the city of Chicago, the center of the load requirements. Also, at this time it was located in the growing industrial district between Chicago's South Side and Gary, Indiana.

In 1928 the State Line Land Company sold its interest in the real estate and the improvements made upon it to the State Line Generating Company.

CONCLUSION

From 1929 to 1954 the "State Line" turbine-generator was the largest unit of its kind in the world. Its 208,000kw rating was 30% above the next largest unit at that time. In December of 1953 the Ohio Power Company's Muskingham #1 unit surpassed the "champ" with a rating of 213,000kw. In an industry which had doubled its output at less than ten year intervals a 25 year reign represented a substantial engineering feat.

In 1929 the average kw capacity for a generating unit was 15,000-30,000kw. The establishment of the "State Line's" 208,000kw interconnected system evidenced a startling engineering breakthrough which set a precedent for future developments.

Today's largest coal burning generating unit is the Georgia Power Company's Bowen system, with a capacity of 3,498,600kw. A comparative juxtaposition of State Line and the Bowen Unit makes obvious the advances which have taken place since 1954, a 23 year period. This fact makes the "champ's" unparalleled record even more remarkable.

According to Commonwealth Edison at least one of the three shafts was in service from initial service through February 5, 1977. In addition the turbine-generator is still in use today. For example, in 1974 it had 7,015 service hours. The State Line Unit #1 has, therefore, not only established for itself a place in our technological history, but still remains an integral component of present day energy service systems.

REFERENCES

1. The Edison Round Table, Commonwealth Edison Company, March 31, 1926, "Announce Plans for Million Kilowatt Station," p. 2.

2. The Edison Round Table, Commonwealth Edison Company, October 31, 1929, "Two New Units at State Line," p. 4.

3. The Edison Round Table, Commonwealth Edison Company, January 31, 1930, "Order Two New Units for State Line Plant," p. 1.

4. The Edison Round Table, Commonwealth Edison Company, November 2, 1936, "Plan to Complete Unit No. 2 at State Line," p. 1.

5. The Edison Round Table, Commonwealth Edison Company, August 31, 1938, "Development of Chicago District Generating Corporation Reviewed," p. 5.

6. The State Liner, State Line Generating Station, July 1939, Vol. 8, No. 7, Tenth Anniversary Issue.

7. The State Liner, State Line Generating Station, April 1954.

8. "Still the Champ," News Release, William Bromage, Director, Publicity, Commonwealth Edison, April 7, 1954.

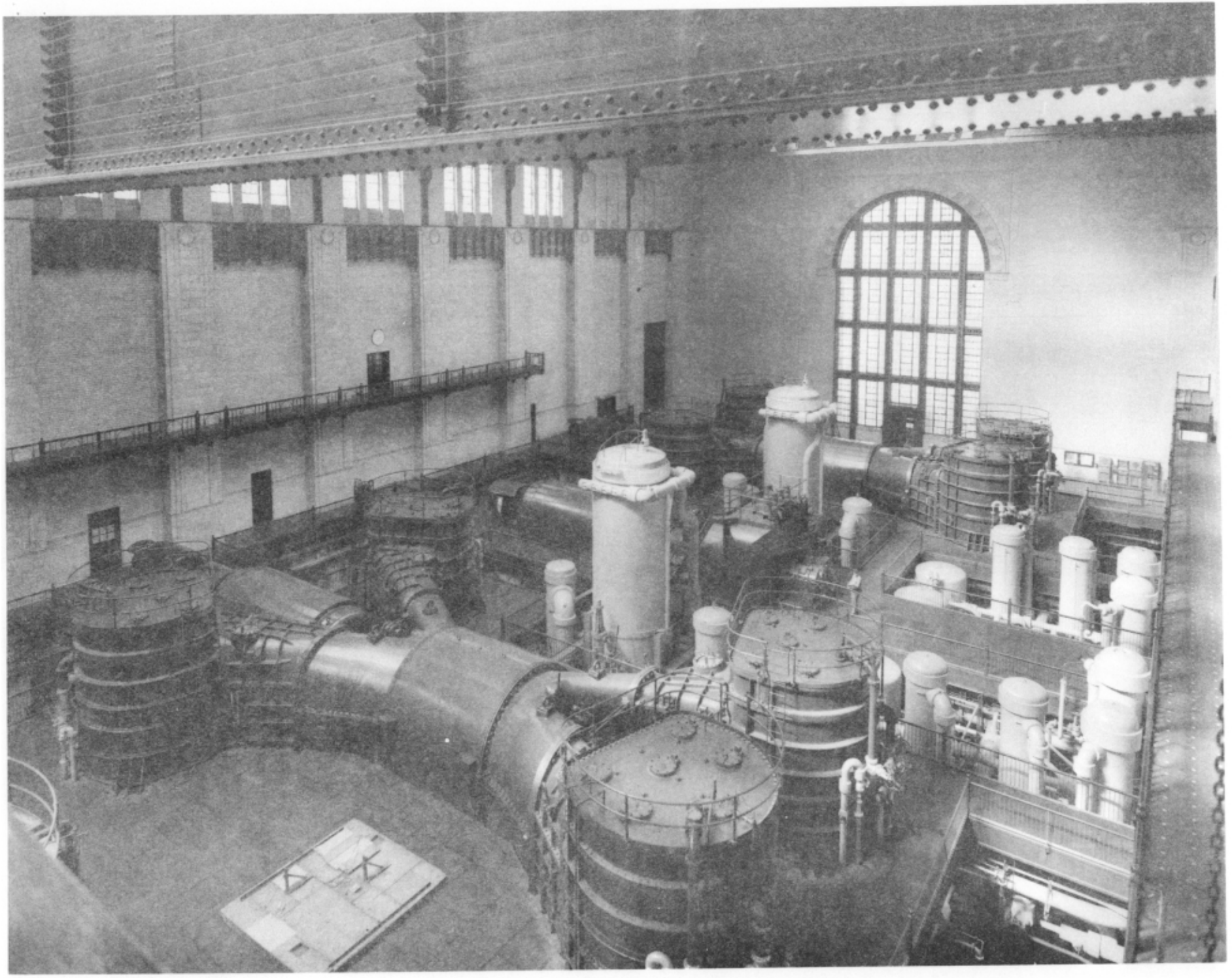
National Historic Mechanical Engineering Landmark Program

In September 1971 the ASME Council reactivated the Society's History and Heritage program with the formation of a National History and Heritage Committee. The overall objective of the Committee is to promote a general awareness of our technological heritage among both engineers and the general public. A charge given the Committee is to gather data on all works and artifacts with a mechanical engineering connection which are historically significant to the profession. An ambitious goal, and one achieved largely through the volunteer efforts of the Technical Divisions, Section History and Heritage Committees and interested ASME members.

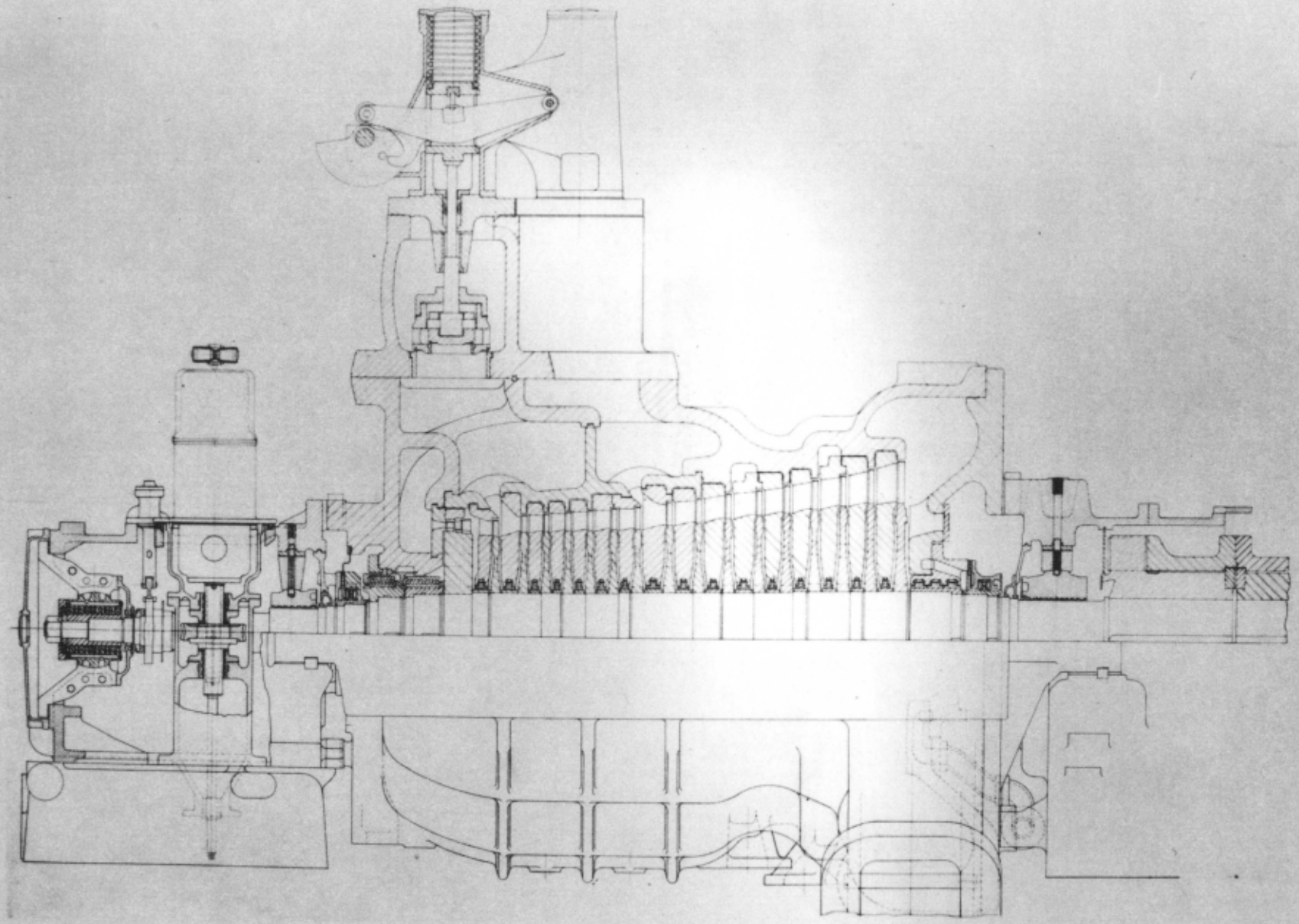
Accordingly, several programs are carried out under the direction of the National Committee. The National Landmarks program is a demarcation of local sites which are of national significance, honoring people or events which have contributed to the general development of mankind. A complete description of activities appears in MS-72, the H&H Manual. A copy is available from the ASME Public Relations Department.

The State Line Generating Unit #1 is the twenty-second landmark to be designated since the program began in 1973. The others are:

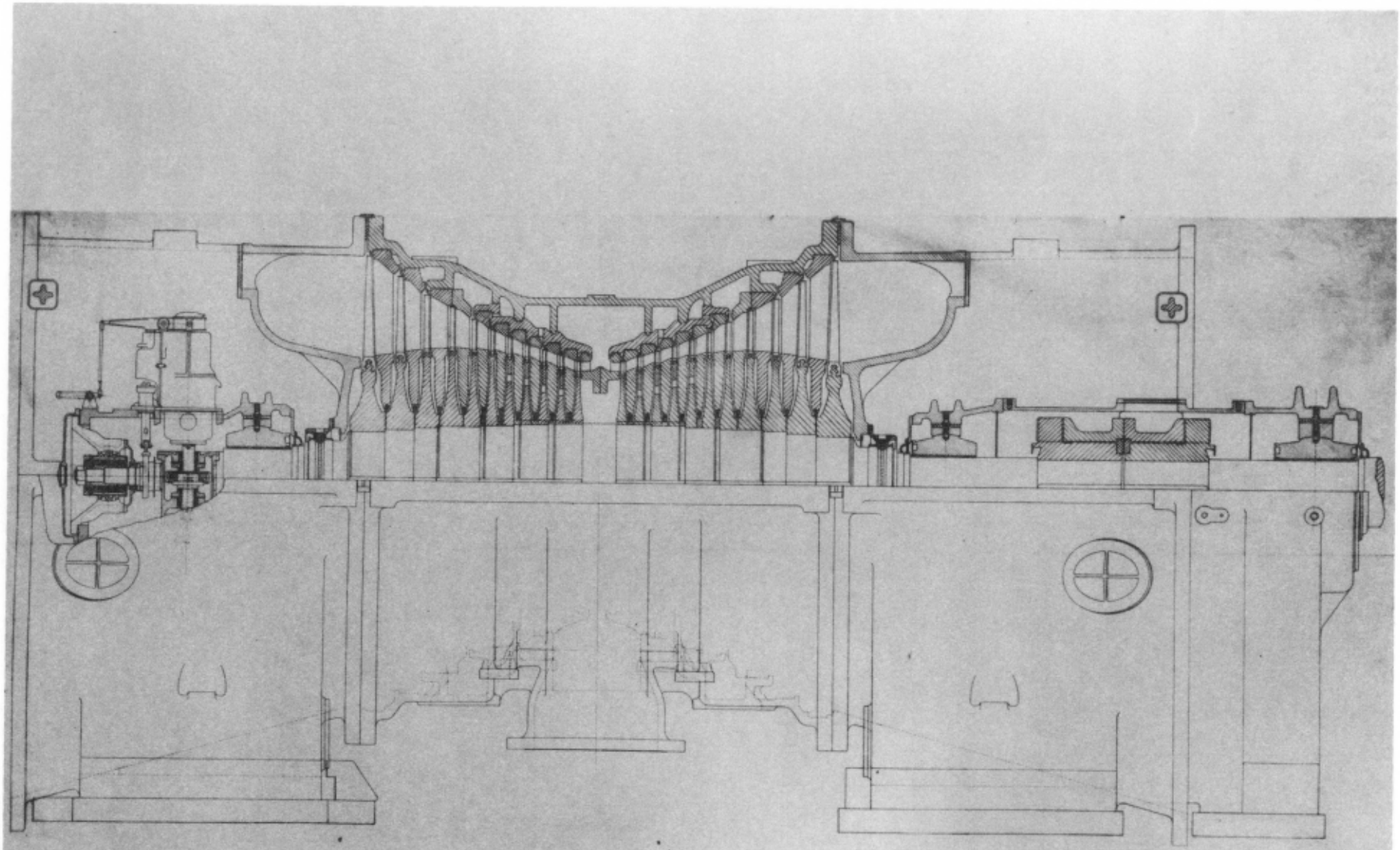
Ferries and Cliff House Cable Railway Power House, San Francisco, CA - 1973
Leavitt Pumping Engine, Chestnut Hill Pumping Station, Brookline, MA - 1973
A. B. Wood Low-head High-Volume Screw Pump, New Orleans, LA - 1974
Portsmouth-Kittery Naval Shipbuilding Activity, Portsmouth, NH - 1975
102-inch Boyden Hydraulic Turbines, Cohoes, NY - 1975
5000 KW Vertical Curtis Steam Turbine-Generator, Schenectady, NY - 1975
Saugus Iron Works, Saugus, MA - 1975
Pioneer Oil Refinery, Newhall, CA - 1975
Chesapeake & Delaware Canal; Scoop Wheel and Engines, Chesapeake City, MD - 1975
U.S.S. Texas, Reciprocating Steam Engines, Houston, TX - 1975
Childs-Irving Hydro Plant, Irving, AZ - 1976
Hanford B-Nuclear Reactor, Hanford, WA - 1976
First Air Conditioning, Magma Copper Mine, Superior, AZ - 1976
Manitou and Pike's Peak Cog Railway, Colorado Springs, CO - 1976
Edgar Steam-Electric Station, Weymouth, MA - 1976
Mt. Washington Cog Railway, Mt. Washington, NH - 1976
Folsom Power House #1, Folsom, CA - 1976
Crawler Transporters of Launch Complex 39, J.F.K. Space Center, FL - 1977
Fairmount Water Works, Philadelphia, PA - 1977
U.S.S. Olympia, Philadelphia, PA 1977
5 Ton "Pit-Cast" Jib Crane, Birmingham, AL - 1977



An interior view of State Line Generating Unit #1

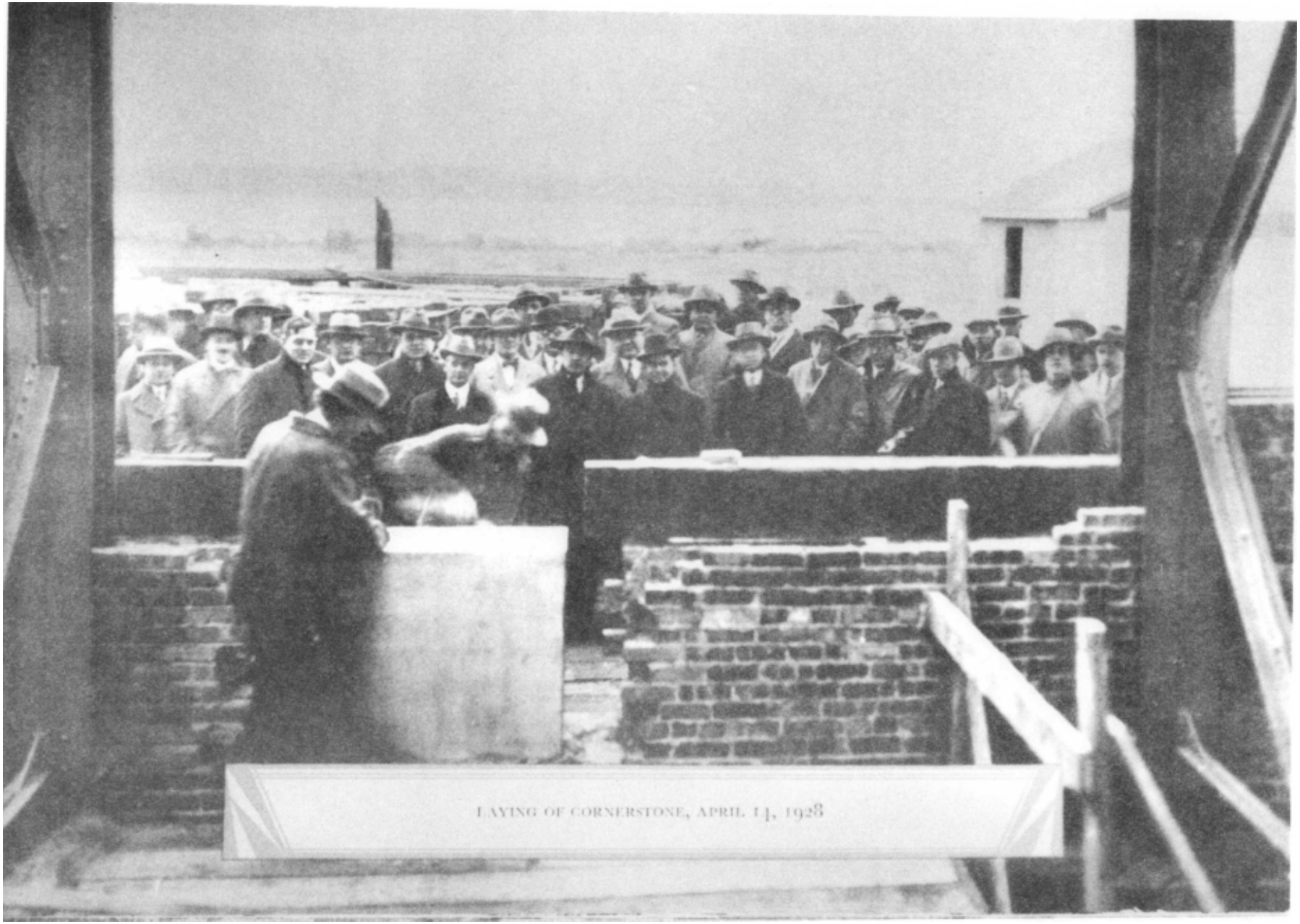


449579 SECTIONAL DRAWING OF 76000 KW-1800 RPM-17 STAGE TURBINE HIGH PRESSURE ELEMENT OF STATE LINE 208,000 KW TURBINE.

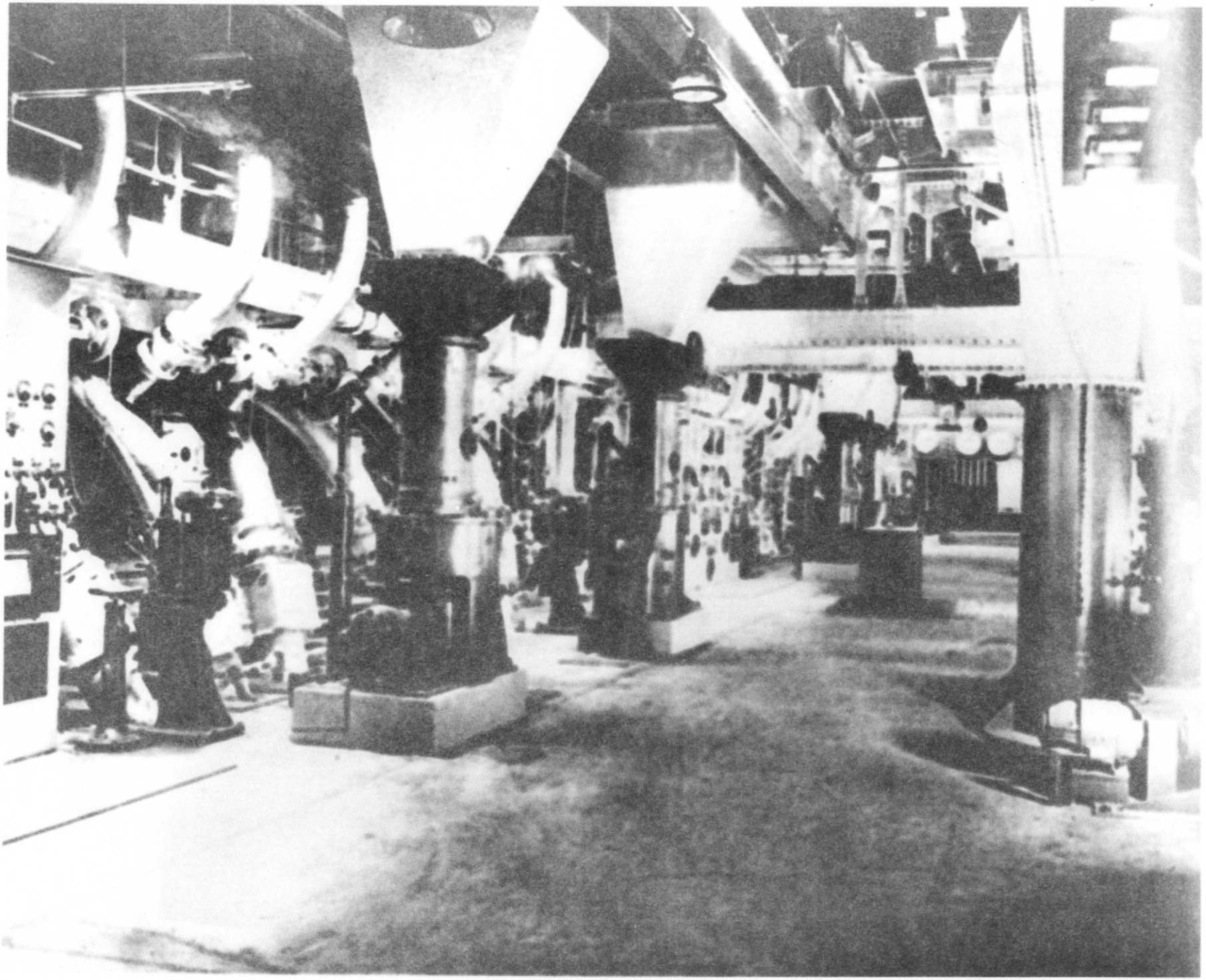


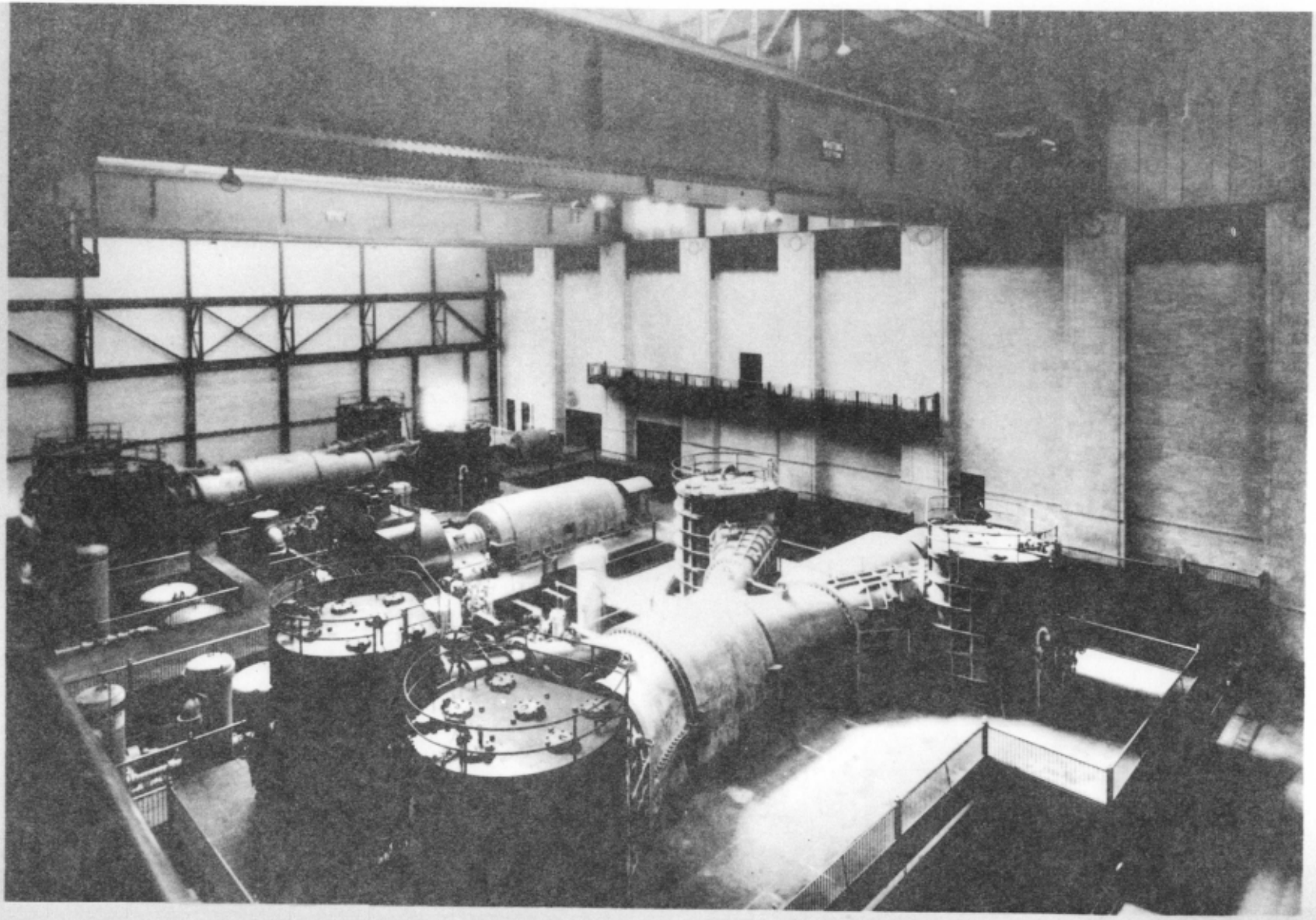
449789 SECTIONAL DRAWING OF 66000 KW-1800 RPM-11 STAGE DOUBLE FLOW TURBINE. ONE SECTION, LOW PRESSURE ELEMENT OF STATE LINE. 208,000 KW TURBINE.

10-11-87



LAYING OF CORNERSTONE, APRIL 14, 1928





465932 G-E 208,000-KW., 3-UNIT TURBINE-GENERATOR SET. 76,000-KW. HIGH-PRESSURE UNIT, TWO 62,000-KW. LOW-PRESSURE UNITS EACH WITH 4000-KW. HOUSE GENERATOR. AIR COOLERS USED WITH ALL EXCEPT HOUSE GENERATORS. STATE LINE STATION, CHICAGO DISTRICT GENERATING CO. HAMMOND, IND.

E318.152 11-7-29