NOTRE DAME UTILITIES DEPARTMENT

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The University of Notre Dame Power Plant Growing with the Campus for Over a Century

The origin of Notre Dame utilities dates back to the late 1800s. At that time, a steam plant, located adjacent to the Main Building, served the small campus. Near the turn of the 19th century, a new steam plant was built on what is now the site of the University Health Center. The plant's current site was first occupied in 1932. Over the last 78 years, there have been significant expansions to the current site (see Location and Facilities).

Steam for heating was the original product of Notre Dame utilities. Prior to the 1950s, the demand for electricity was small and not worth the effort to produce. In the early 1950s, however, as the campus grew, the generation of electricity became a legitimate issue. Historically, Notre Dame was the first university in the United States to generate electricity. In 1881, a less-than-10KW generator supplied electricity to eight lights in the Main Building.

Steam Plant circa 1890

Power Plant circa 1931

As the demand for electricity grew, it became apparent that cogenerating electricity was the logical next step in Notre Dame's overall utility system. The cogeneration of electricity as a byproduct of steam-heating the campus has turned out to be a very cost-effective and environmentally friendly process for the University. The University used cogeneration to provide all of its own electricity from 1953 until 1970. Then, as electrical demand outpaced the demand for steam, additional electricity was purchased from the local utility provider to supplement internal cogeneration.

With the construction of the Hesburgh Library in 1962, the decision was made to centrally produce chilled water to cool campus buildings. Originally, chilled water was produced directly by steam-driven turbines.

In 1984, as chilled water demand increased, the cogeneration process was implemented to provide electricity as a byproduct of the production of chilled water.

While the demands for steam, electricity, and chilled water have increased steadily over time, the relative growth for these three commodities has shifted, with demands for cooling and electricity outpacing that of steam (on a per-square-foot basis). This shift is a result of the improved design of building envelopes, as well as the growing use of electrical equipment inside buildings and increased reliance on cooling for personal comfort.

Power Plant circa 1957

Location and Facilities

Since 1932, the utility complex has remained on the same site, immediately east of St. Joseph Lake. There have been eight additions to the original plant:

1952	Electrical Generation (Generators 1, 2, 3, and 4)
1962	Chiller Addition (Chillers 1 and 2)
1966	Boiler Addition (Boiler 4, Generator 6, and Chiller 3)
1973	Boiler Addition (Boiler 5)
1984	Chiller Addition (Chillers 4 and 5)
1999	Generator Addition (Generator 7)
2007	Boiler Addition (Boiler 6)
2008	Air Quality Control Systems Additions

In 1999, for the purposes of expansion, the Utilities Department took over the former Ave Maria Press building immediately to the north of the power plant. This facility currently houses chillers 6 and 7, as well as departmental offices.

In addition to the facilities above, the Utilities Department manages an electrical substation (for purchased power). Built in 1995, it is north of the plant and adjacent to a 138KV transmission line owned and operated by American Electric Power (AEP). Adjacent to the substation is a diesel generator facility (2007) that provides emergency power, peak shaving, and interruptible power services.

Power Plant

University Substation

Boiler No. 6

Energy and Environmental Stewardship

Good stewardship entails producing and consuming energy as efficiently as possible so as to minimize the impact both economically and environmentally.

Operating responsibly and in compliance with state and federal regulations in order to protect the air we breathe and the water we drink is vital to ourselves and future generations. Emissions from the University of Notre Dame power plant are regulated by the Indiana Department of Environmental Management and the United States Environmental Protection Agency.

AIR – New air-pollution control equipment was installed on all coal-fired boilers in 2008 to reduce constituent emissions. This equipment, along with the purchase of lower-sulfur coals, allows for operation below all current emissions regulations. Low-NOX burners have also been installed on all natural gas/fuel oil-fired boilers in recent years. Continuous monitoring equipment is used to verify and report compliance with required state and federal regulations.

WATER – The University also operates and monitors (in conjunction with the Department of Risk Management and Safety) the campus drinking water system to ensure safe, potable water. The University has a Wellhead Protection Plan approved by the Indiana Department of Environmental Management.

STORM WATER – The University functions as a municipally separated storm and sanitary system operator, thus managing erosion controls and illicit discharges to protect the campus lakes and waters of the state.

ENERGY – Efforts to increase energy production efficiency and reduce energy consumption through the use of technology and education are hallmarks of the University utility operations. Efforts to reduce the University's overall impact on our environment are paramount. The Utilities Department, working in concert with the Office of Sustainability, is actively involved in "demand-side" energy conservation measures throughout campus. For more information, visit green.nd.edu.

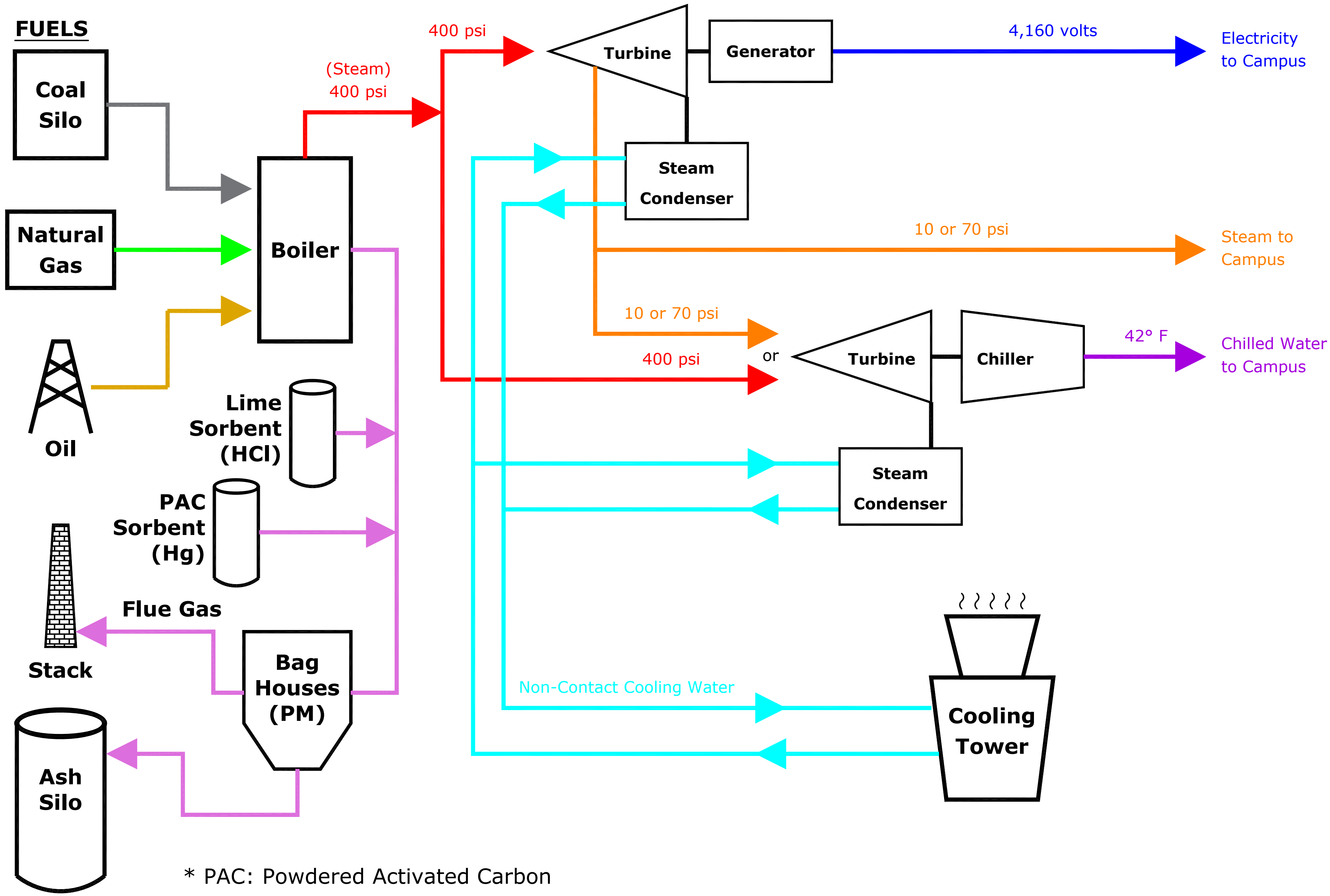
RECYCLE/REUSE/REDUCE – The Utilities Department plays an important role in the University's overall commitment to these initiatives. Over 5,000 tons of ash is produced annually from coal combustion. In lieu of adding this material to local landfills, the University diverts nearly 60 percent of this post-industrial waste for reuse as sandblasting material. The balance of ash is then recycled and used as infill and cover material at a local landfill in lieu of the traditional use of topsoil.

Systems and Equipment

The utility complex has grown to include a large number of major pieces of equipment; currently there are six boilers, seven chillers and ten generators. The diversity of equipment and the overall capacity allow for the efficient operation of each unit.

STEAM GENERATION is based on a 400-psig operating pressure system. Each of the six boilers is connected to a common looped header to supply steam throughout the power plant. The units range in size from 70,000 pounds per hour (Kpph) to 180 Kpph. The production of steam can be derived from a variety of fuel sources. Coal, #2 fuel oil, #6 fuel oil, and natural gas are all available fuel sources. Having fuel source selectivity allows the operation to remain flexible and very cost-effective. The 400-psig steam is used to operate chillers and generators. The byproduct of these operations is lower-pressure steam (70 and 10 psig) that is distributed to campus for heating and other process loads (such as the laundry and dining halls).

Power Plant Process



* PAC: Powdered Activated Carbon

(   ) : Constituent Control

ELECTRICITY is produced from ten generators. Five of these units are steam-driven turbine generators and five are diesel engine-driven generators. The units range in size from 1.0 megawatt (MW) to 9.4 MW. All of the steam turbine-driven generators are supplied with 400-psig steam, but there are a variety of pressure outputs (70 and 10 psig) as well as generator types (extraction and back pressure).

Three of the steam turbine generators are equipped with full condensers and extraction capabilities. This means that they can operate as electrical generators without the need of a host for the steam output, or if an opportunity exists, the steam can be extracted for heating, process, or chilled-water production. The other two steam turbine generators are "back pressure" units that rely solely on the need for steam elsewhere in order to produce electricity. Having a secondary use for the resulting steam from our steam turbine generators greatly increases the efficiency of the cycle. This is what is meant by "cogeneration," which makes the overall system very cost- and environmentally effective.

The diesel generators provide a source of power for peak shaving and emergency situations. Two of the units (diesel generators 3 and 4), which are located in the power plant, are powered by WWII surplus submarine engines (*USS Haddock*). In late 2007, three diesel generators were installed adjacent to the substation to allow the University to become an interruptible power customer of AEP.

Peak shaving and the ability to self-produce electricity for interruptible and emergency situations provide increased reliability and cost effectiveness.

CHILLED WATER PRODUCTION is derived from seven steam-driven centrifugal chillers. The units range in size from 1,500 tons to 4,000 tons. There are a variety of chiller steam pressure inputs (400, 70, and 10 psig) with the low- and medium-pressure chillers capable of operating in a cogeneration scheme with the steam turbine generators.

Turbine Generator No. 7

Diesel Generator No. 4

Chiller No. 7

COOLING TOWERS – The Utilities Department operates a total of seven counterflow cooling towers. The towers reject heat to the atmosphere from the condenser water that is used to cool various power plant equipment. The warmed condenser water is pumped to the cooling towers where it trickles down through the tower fill in a filming action. Large fans pull cool, dry air up from below in a direction counter to the water flow. The air picks up both heat and moisture and disperses it into the atmosphere.

Cooling Towers No. 1 – No. 5

Five of the cooling towers operate on a once-through, non-contact condenser water system that utilizes St. Joseph Lake as a source of water. Typically, the towers return water to the lake that is cooler than the temperature of the water taken from it. Eight large pumps with ratings from 6,000 to 9,700 gallons per minute (gpm) are used to pump water from the lake, through the plant, and into the towers. In total, these cooling towers have a rated flow capacity of 52,000 gpm.

The other two cooling towers operate on a closed loop and are dedicated to serve either of two 4,000-ton chillers. Each tower has a dedicated pump capable of delivering 9,700 gpm of condenser water.

Distribution Systems

The various distribution systems and their approximate lengths that exist throughout campus include:

Tunnel System *	7.3 miles
Ricwel System **	1.5 miles
Chilled Water	12.1 miles
Electrical System	30.6 miles
Domestic Cold Water	25.4 miles
Domestic Hot Water	8.8 miles
Sanitary Sewers	17.6 miles
Storm Sewers	24.4 miles

* *Tunnel System includes steam, condensate, compressed air, domestic hot water, fire alarm, telecom, and IT systems.*

** *Ricwel System is a direct-buried steam and condensate piping system.*

DISTRIBUTION SYSTEMS

STEAM – Low- (10psig) and medium- (70psig) pressure steam is distributed for heating and process uses. The steam is distributed to the campus buildings through tunnels and ricwels supplying radiators, air-handling units, and heat exchangers to provide the heating needs. Over 87 percent of the heating need of campus is served by this distribution system.

CHILLED WATER – Chilled water nominally at 42°F is supplied from the power plant chillers to over 63 percent of the campus. Once utilized, the chilled water at nominally 55°F, is returned to the power plant for reuse. The chilled-water lines are direct-buried cast iron or steel pipes ranging in size up to 36″ in diameter. The chilled water flows through air-handling units and fan coil-units to meet the cooling needs for the buildings.

ELECTRICITY – Electricity is supplied from a combination of the power plant generators and an interconnection with the AEP electrical system. The University substation transforms the AEP 138,000 volt transmission line voltage to 4,160 volts for distribution to campus buildings. To use this power, more than 200 transformers reduce the voltage to 480Y/277, 208/120, or 240/120 volts. The electrical distribution system is a three-phase underground network consisting of concrete-encased duct banks, electric manholes, and high-voltage switches providing both high reliability and minimal impact on the aesthetics of campus.

DOMESTIC COLD WATER – The University owns and operates its own domestic water system. This system consists of six wells, a 500,000 gallon elevated tank, and miles of direct-buried piping that provides the drinking water and fire protection needs of the University.

DOMESTIC HOT WATER – Using centrally produced soft water, the power plant produces and distributes hot water to most facilities served by the tunnel/ricwel systems.

SANITARY SEWERS – The University owns and operates a sanitary sewer collection system. A new sanitary sewer interceptor completed in 2007 conveys the sewage directly to the City of South Bend's Wastewater Treatment Plant, thus avoiding any combined sewer overflows.

STORM SEWERS – The University owns and operates a separated storm sewer collection system that collects storm water runoff, which is generally discharged into St. Joseph's and St. Mary's lakes.

SITE LIGHTING – All campus exterior lighting is installed and maintained by the Utilities Department.

COMPRESSED AIR – Compressed air is distributed from the power plant at 70 psig to campus buildings using the steam tunnel system. The air is used for pneumatic temperature controls.

Departmental Services

ENGINEERING AND TECHNICAL SERVICES – Mechanical, electrical, and environmental engineering support, as well as project management services, are provided to many departments on campus, including the Office of the University Architect.

BUILDING CONTROLS – Repair and maintenance services are provided to nearly all on-campus HVAC control system components, and most major pieces of equipment on campus are monitored and scheduled through a state-of-the-art central building automation system.

BUILDING SYSTEMS – Repair and maintenance services are provided to campus facility electrical and mechanical systems.

UTILITY LOCATES – Because of the extensive network of underground utilities, the Utilities Department coordinates a service to locate utilities prior to any excavation on campus and maintains maps of all underground utilities to minimize disruptions to utility services and to assist with campus planning.

More Utilities Department information, including forms, permits, outages, and contacts are available at our website at **utilities.nd.edu/**.

STEAM GENERATING UNITS (All units operate at 400 psig and 725 °F)

Boiler No.	Year Installed	Mfr.	Type	Fuels	Max. PPH
1	1961	Erie City	Keystone	Natural Gas, #6 Fuel Oil	100,000
2	1952	Union City Iron Works	Traveling Grate Stoker	Coal, Natural Gas	70,000
3	1952	Union City Iron Works	Traveling Grate Stoker	Coal, Natural Gas	70,000
4	1967	Babcock & Wilcox	Cyclone	Coal, #2 Fuel Oil, Natural Gas	170,000
5	1973	Combustion Engineering	Packaged Type "A"	Natural Gas, #2 Fuel Oil	180,000
6	2007	English Boiler & Tube	Packaged Type "S"	Natural Gas, #2 Fuel Oil	177,000
				Total:	**767,000**

ELECTRIC GENERATING UNITS (All generators rated 4, 160V)

Generator No.	Year Installed	Mfgr.	Type	Extraction/ Exhaust (psig)	Max kW
1	1961	Elliott	Auto Extraction Full Condensing	10	3,000
2	1952 (G) 1981 (T)	Elliott	Back Pressure	70	1,600
3	1952	Fairbanks-Morse	Diesel	N/A	1,000
4	1952	Fairbanks-Morse	Diesel	N/A	1,000
5	1955	Elliott	Back Pressure	10	2,000
6	1968	Elliott	Auto Extraction Full Condensing	10	5,000
7	1999	Tuthill	Auto Extraction Full Condensing	70	9,400
8	2007	Caterpillar	Diesel	N/A	1,880
9	2007	Caterpillar	Diesel	N/A	1,880
10	2007	Caterpillar	Diesel	N/A	1,880
				Total:	**28,640**

CHILLED WATER UNITS

Boiler No.	Year Installed	Mfgr.	Refrigerant Type	Turbine Inlet Pressure	Max. Tons
1	1962	Carrier	R-12	400	1,500
2	1962	Carrier	R-12	400	1,500
3	1967	Carrier	R-134A	400	3,000
4	1983	Carrier	R-134A	70	3,300
5	1990	York	R-22	400/10	4,000
6	1999	York	R-134A	70	4,000
7	2000	York	R-134A	70	4,000
				Total:	**21,300**

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