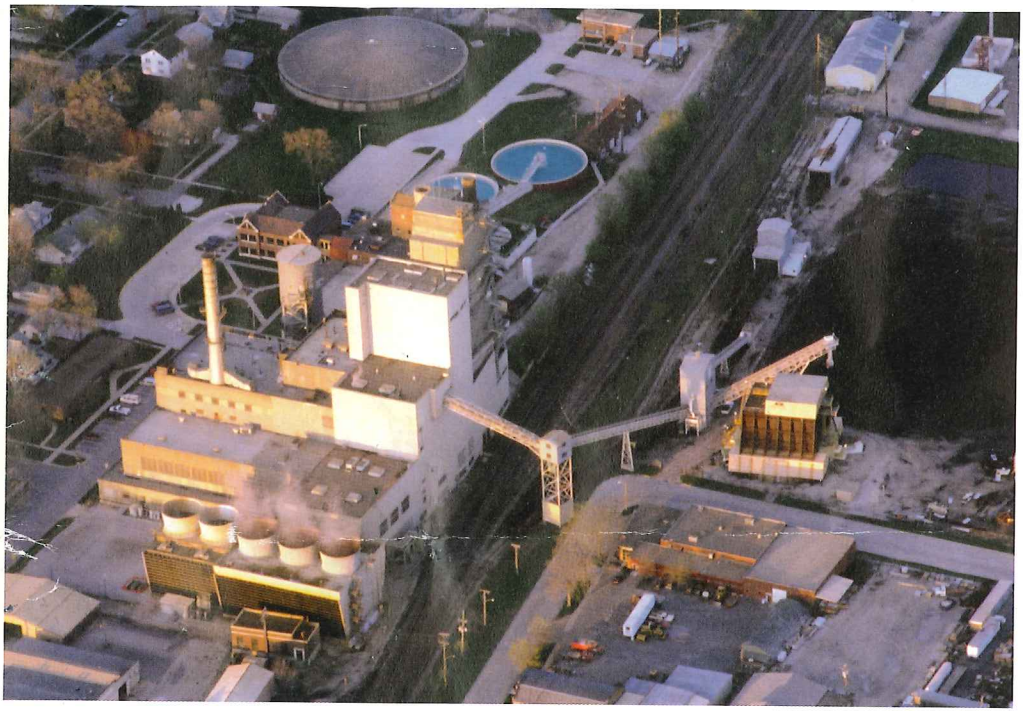
Power Plant



The City of Ames
Electric Services
Ames, Iowa

CITY OF AMES IOWA

Highlights from the Ames Municipal Power Plant's History

In 1896 the citizens of Ames voted 298 to 40 in favor of constructing a municipal power plant. That plant was constructed for $17,000 on a 50 x 184 foot lot where Unit #8 now stands. That first plant produced 150 kilowatts for lighting between 5:00 a.m. and midnight.

In 1901 there were 175 consumers on the system, including Iowa State College. By 1904 there were 350 consumers on the system. From 1945 through 1975 the city's electrical consumption doubled every 10 years and likewise did the Power Plant's capacity.

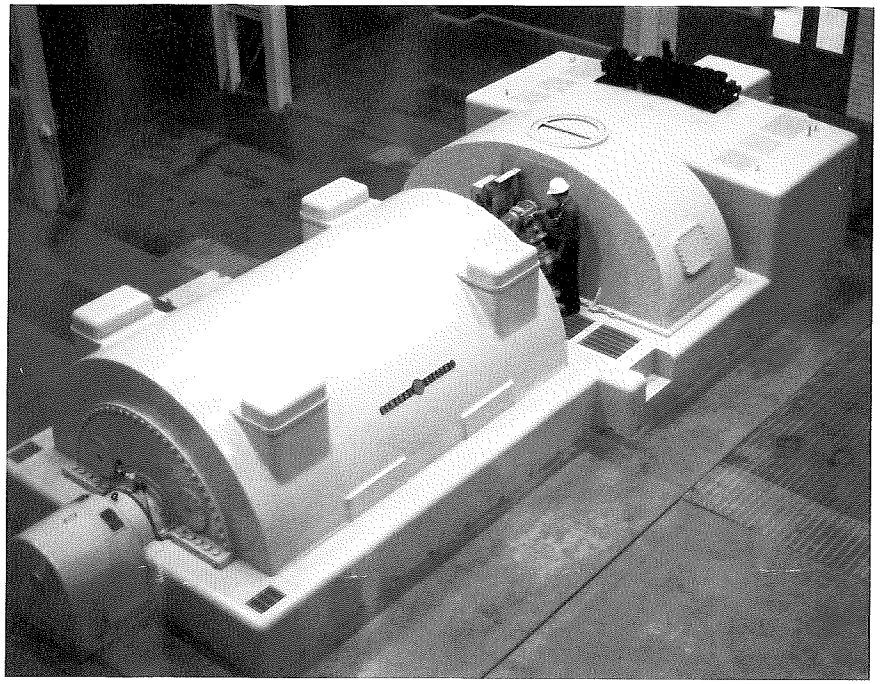
In 1949 construction was started on the north end of the existing Power Plant. Unit #5 (7,500 KW) was completed in 1951 for a plant cost of $2.4 million. Unit #6 (12,650 KW) was completed in 1958 for $2 million. Both Units #5 and #6 were retired during 1986. In 1967 Unit #7 (33,000 KW) was completed for $7.5 million. In 1972 the 20,000 KW gas turbine generating unit was completed for a cost of $2 million. This unit is located just off Dayton Avenue (1 1/4 miles east of the Power Plant).

Late in 1975 the Resource Recovery Plant was completed and the Electric Utility began burning Refuse Derived Fuel as a supplemental fuel.

Mid year in 1978 the construction of Unit #8 (65,000 KW) began. In November of 1980, as part of the Unit #8 addition, the hospital service steam line between the Power Plant and Mary Greeley Medical Center was placed in operation. Unit #8 became operational in May 1982 at a cost of $46.7 million.

In 1957 a 40 MW, 69 KV interconnection with Iowa Power and Light Company, currently Mid-American Energy Co., was built between Ames and Des Moines. In 1989 an 80 MW, 69 KV interconnection with Iowa Electric Light and Power, currently Alliant Energy Utilities, was built between Ames and Boone.

The Steam Turbine and Electric Generator

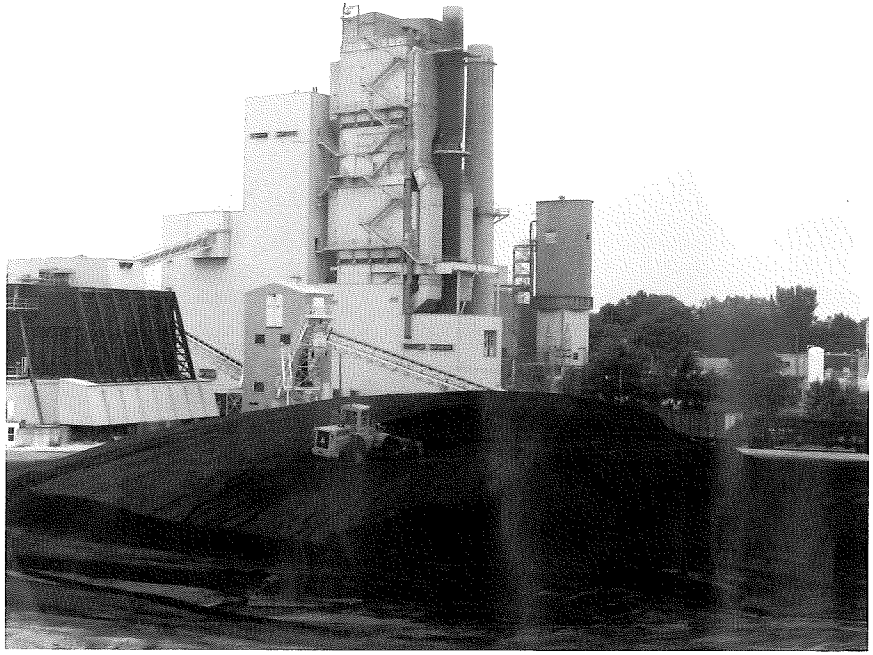


General Electric 65,000 KW Generator & Steam Turbine

The Power Plant's steam turbines and electrical generators are manufactured by General Electric. At rated capacity, Unit #8's turbine receives 620,000 lbs / hr of steam at 950°F and 1,250 psi pressure from the boiler. When steam leaves the turbine, it has a temperature of about 100°F and is at 2.5" Hg Absolute vacuum. The vacuum is created by the condenser. As the steam flows through the turbine, it gives up its energy to 17 sets of precision machined turbine (fan) blades, which spin the turbine shaft and the generator's rotor. Electrical current flows through the conductors that are wrapped around the rotor and creates a spinning magnetic field inside the generator. This spinning field induces a voltage in the generator's stationary windings (stator), which forces the power carrying current out of the generator to the power transformer for distribution to the customer.

Power and Boiler Fuels

Coal is the primary fuel for both steam generating units at the Power Plant. Low sulfur coal delivered by rail and truck may be stockpiled in the coal yard or conveyed directly to the coal bunkers. Each unit is capable of burning Refuse Derived Fuel (RDF) as a supplemental fuel. Unit #8 is built to burn RDF with coal. When generating 65,000 kilowatts, Unit #8 consumes about 45 tons of coal per hour. The coal when injected into the front of this boiler is finer than face powder and burns in suspension like a liquid fuel.

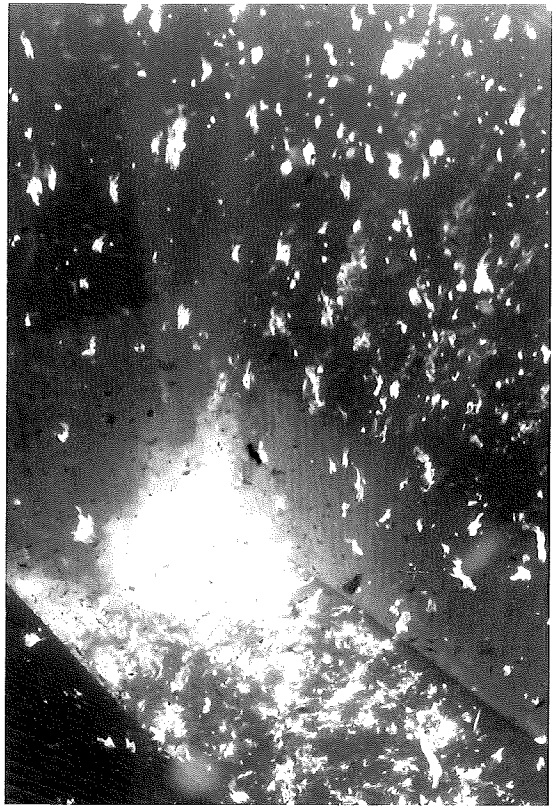


RDF Bin

Dozer on Stockpile
COAL YARD

Coal Cars

Power and Resource Recovery



Burning RDF in Boiler #8

Refuse Derived Fuel

Refuse Derived Fuel (RDF) is primarily composed of the shredded combustible part of municipal solid waste (refuse). Most of the metal and dense material in the refuse is separated from the light combustibles at the Resource Recovery Plant, which is located just south of the Power Plant's coal yard. RDF is a supplemental boiler fuel which may provide up to 20% of either unit's fuel requirement. Most of the RDF blown into the boiler is burned on the dump grate at the bottom of the boiler. RDF provides about 10% of the annual fuel requirement for the Power Plant.

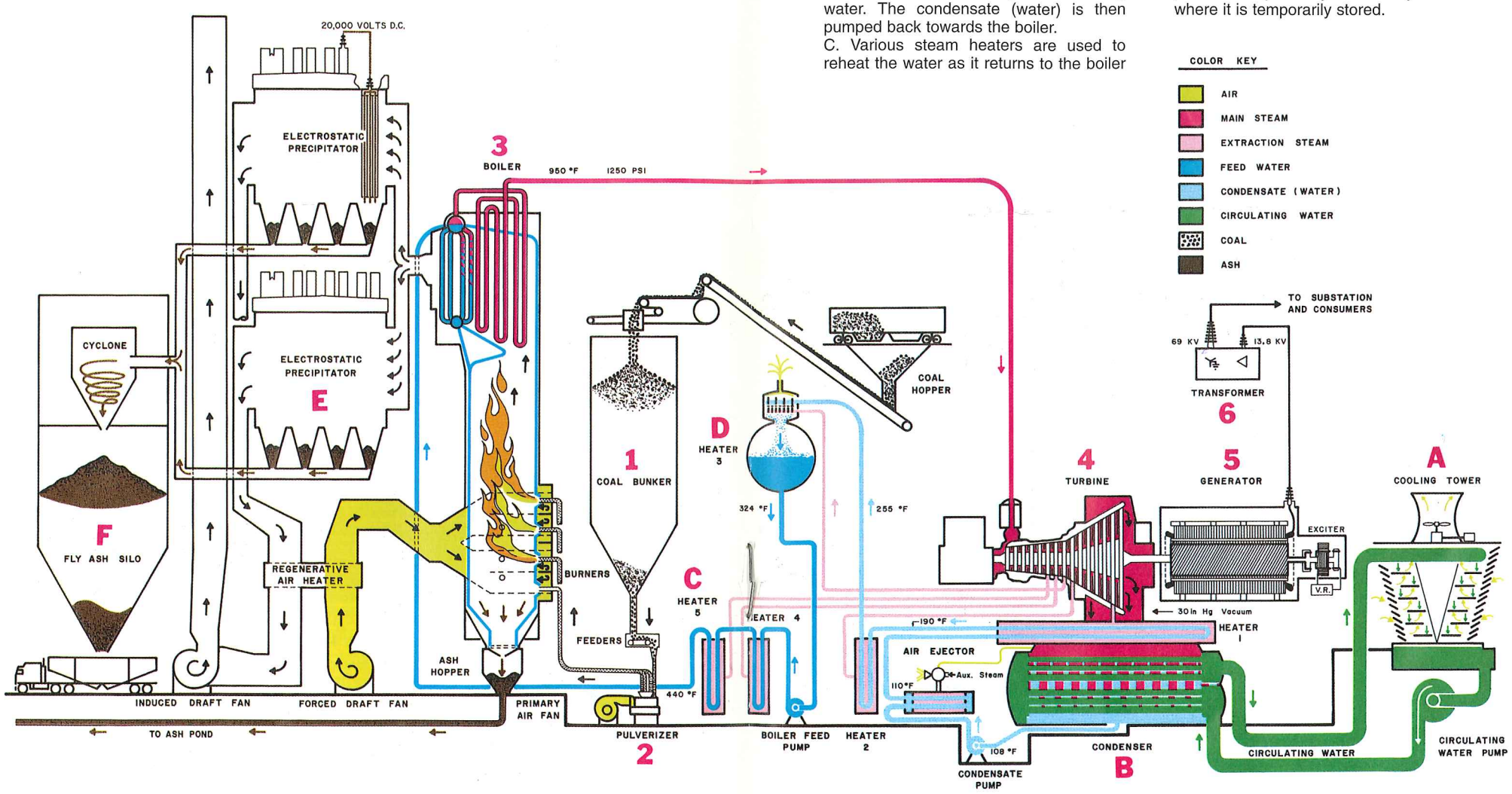
The Basic Operation of Unit #8

ENERGY FLOW AND TRANSFORMATIONS

1. Coal is delivered to the Power Plant by rail and truck. Belt conveyors transfer the coal to the coal bunkers within the plant.
2. The coal flows by gravity from the bunkers into the pulverizers which grind the coal into a dust that is finer than face powder. The primary air fan blows this dust into the boiler where it mixes with air and burns in suspension like a liquid fuel.
3. The boiler consists of many steel tubes filled with water. The heat of combustion boils the water, and steam is collected in the steam drum at the top of the boiler. The steam is further heated in the superheater before it is piped to the turbine. Unit #8 burns RDF as a supplemental fuel. Bottom ash is collected in the ash hopper at the bottom of the boiler and is flushed to the ash pond.
4. The turbine consists primarily of blades attached to a shaft. Steam flows against the blades causing the shaft to turn at 3600 RPM.
5. The generator and turbine are connected by a shaft. The rotating energy of the turbine is transformed into electrical energy by the generator.
6. The power transformer increases the generated voltage from 13,800 volts to 69,000 volts. From the power transformer the electrical energy goes to a substation for distribution to the consumer.

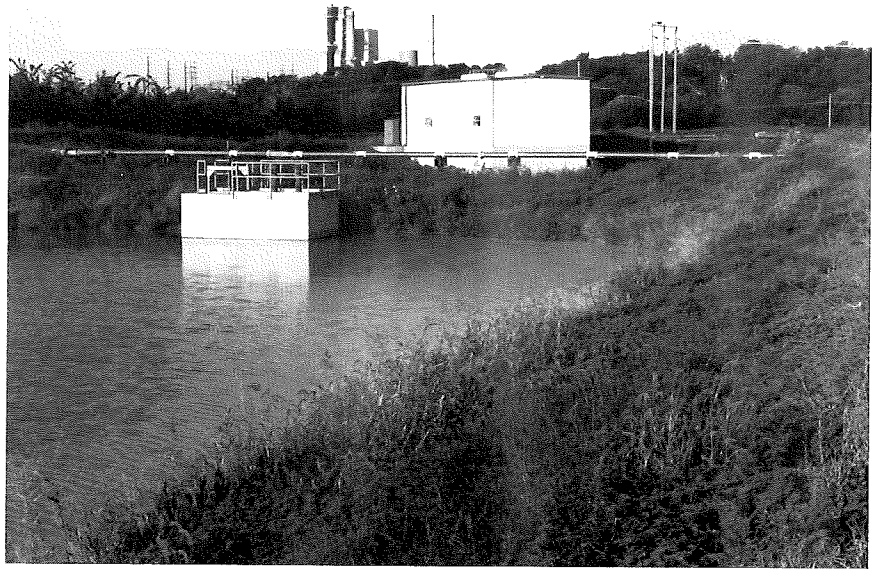
MAJOR ASSOCIATED EQUIPMENT

A. The cooling tower is used to provide a source of cool circulating water. This is done by moving air across the water that is falling through the cooling tower.
B. The exhaust steam from the turbine is admitted into the condenser where it is cooled and condensed by the circulating water. The condensate (water) is then pumped back towards the boiler.
C. Various steam heaters are used to reheat the water as it returns to the boiler from the condenser. The small amount of steam required by the heaters is obtained from different points in the turbine.
D. One of the heaters is called the "deaerator" because in addition to heating the water it removes air and other dissolved gases.
E. The hotside electrostatic precipitator eliminates 99.7% of the fly ash from the boiler flue gases by means of a 20,000 Volts DC electric field so that ash will not be emitted from the chimney.
F. The fly ash that is collected in the electrostatic precipitator hoppers is pneumatically conveyed to the fly ash silo where it is temporarily stored.



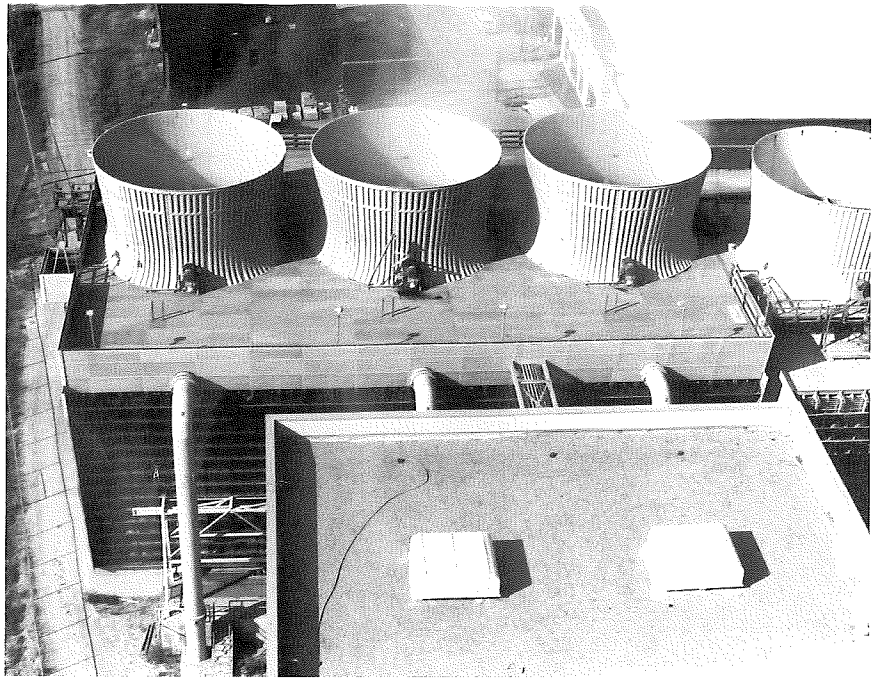
The Ash Pond

Water used at the Power Plant is recycled to the fullest extent. Water is used to sluice (flush) bottom ash from the ash hoppers, that are under Boilers #7 and #8, to the ash pond. The ash pond, which is divided into three sections, has an impermeable clay liner to prevent leakage. The ash settles in the first section of the ash pond. Clarified water is pumped from the third section of the ash pond as required for sluicing bottom ash.



Ash Pond and Pump House

The Cooling Towers

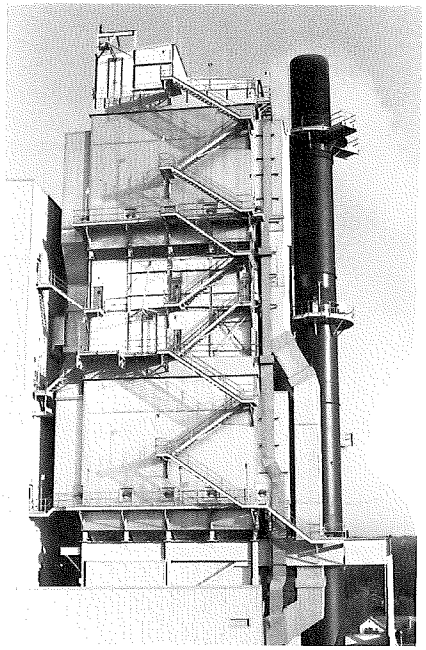


Unit #8's Cooling Tower

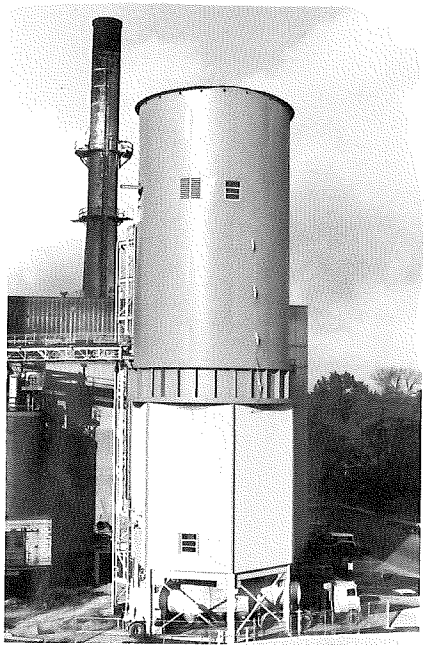
The 57,000 gpm cooling system for Unit #8 is equipped with cooling towers. The warm circulating water from the condenser is cooled in the towers as it splashes down the wooden latticework, thus dispersing its heat to the atmosphere through evaporation. Water no longer of high enough quality to be used in the cooling system is discharged to the ash pond, where it is used to sluice bottom ash from the boiler's ash hoppers.

Power and Environment

Air Quality and Resource Recovery



Electrostatic Precipitator



Fly Ash Silo
loading a truck with fly ash

Stack emissions are improved in several ways. The boilers burn low sulfur coal to reduce sulfur dioxide emissions, and Boiler #8 has special burners to reduce NOx (Nitrogen Oxide) emissions. Electrostatic Precipitators (ESP) remove fly ash (particulate) from the flue gas. Unit 8's ESP removes 99.7% of the particulate from its flue gas.

Fly ash is collected in hoppers at the bottom of the ESP and pneumatically conveyed to the Fly Ash Silo, where it is stored until loaded into a buyer's truck.

The Control Room

The Control Room, which is located in the middle of the operating level of the Power Plant, is the nerve center for the entire plant. Here numerous gauges, recorders, meters, and other devices provide a means by which the plant operators can monitor and control the boilers, turbines, generators, and other associated equipment. From the Control Room the operators also monitor and control: 1) transformer loading, 2) energy and power flow through tie lines to other electrical systems, and 3) distribution circuits.

AMES MUNICIPAL POWER PLANT: EQUIPMENT STATISTICS

PLANT GENERATING CAPACITY (NET): 122,000 kilowatts

UNIT	#8	#7	Gas Turbine
CAPACITY (OPERATIONAL NET)	70,000 kilowatts	33,000 kilowatts	19,000 kilowatts
COST	$46.7 million (1982)	$7.5 million (1967)	$2.0 million (1972)
TURBINE/ ELECTRIC GENERATOR			
MANUFACTURER	General Electric Company	General Electric Company	Worthington Corporation
CAPACITY (NAME PLATE)	65,000 kilowatts	33,000 kilowatts	19,365 kilowatts
LINE VOLTAGE	13,800 volts	13,800 volts	13,800 volts
STEAM GENERATOR			
MANUFACTURER	Babcock & Wilcox Company	Combustion Engineering, Inc.	
STEAM FLOW (FULL POWER)	620,000 pounds per hour	320,000 pounds per hour	
STEAM PRESSURE	1250 psi	850 psi	
STEAM TEMPERATURE	950° F	900° F	
FUELS	Pulverized Coal (Primary) Refuse Derived Fuel (Supplemental - 20% by BTU) Oil (Light off to 10%)	Pulverized Coal (Primary) Refuse Derived Fuel (Supplemental - 20% by BTU) Natural Gas (Alternate) Oil (Ignitors and Warm Up)	Diesel Fuel
ELECTROSTATIC PRECIPITATOR			
MANUFACTURER	Air Correction Division, UOP, Inc.	American Standard Industrial Div.	
EFFICIENCY	99.7%	98.0%	
COOLING TOWER			
MANUFACTURER	Marley Cooling Tower Company	Marley Cooling Tower Company	
CAPACITY	57,000 gallons per minute	27,000 gallons per minute	

FLY ASH SILO	
MANUFACTURER	Hydro-Ash, Incorporated
CAPACITY	40,000 cubic feet (1,800 tons)

FUEL STATISTICS	COAL	REFUSE DERIVED FUEL (RDF)
TYPE	Sub-bituminus C	Air Classified Shredded Municipal Solid Waste
NOMINAL HEAT VALUE	8,800 BTU / lb (by weight, as received)	6,200 BTU / lb (by weight, as received)
NOMINAL MOISTURE CONTENT	27% (by weight, as received)	22% (by weight, as received)
NOMINAL ASH CONTENT	4.5% (by weight, as received)	12% (by weight, as received)
MAXIMUM SULFUR CONTENT	0.26% (by weight, as received)	0.29% (by weight, as received)
ANNUAL CONSUMPTION	210,000 tons	30,000 tons