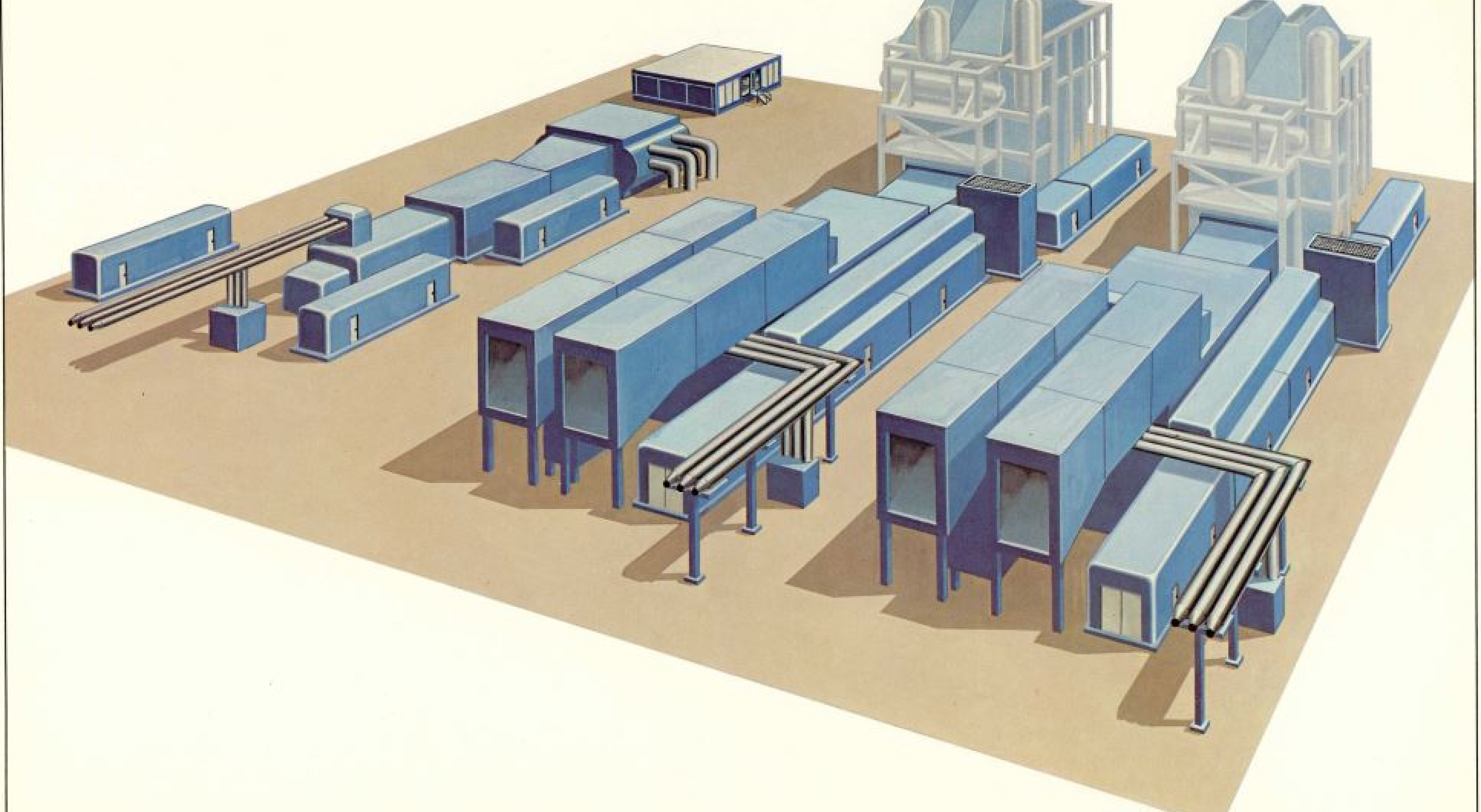
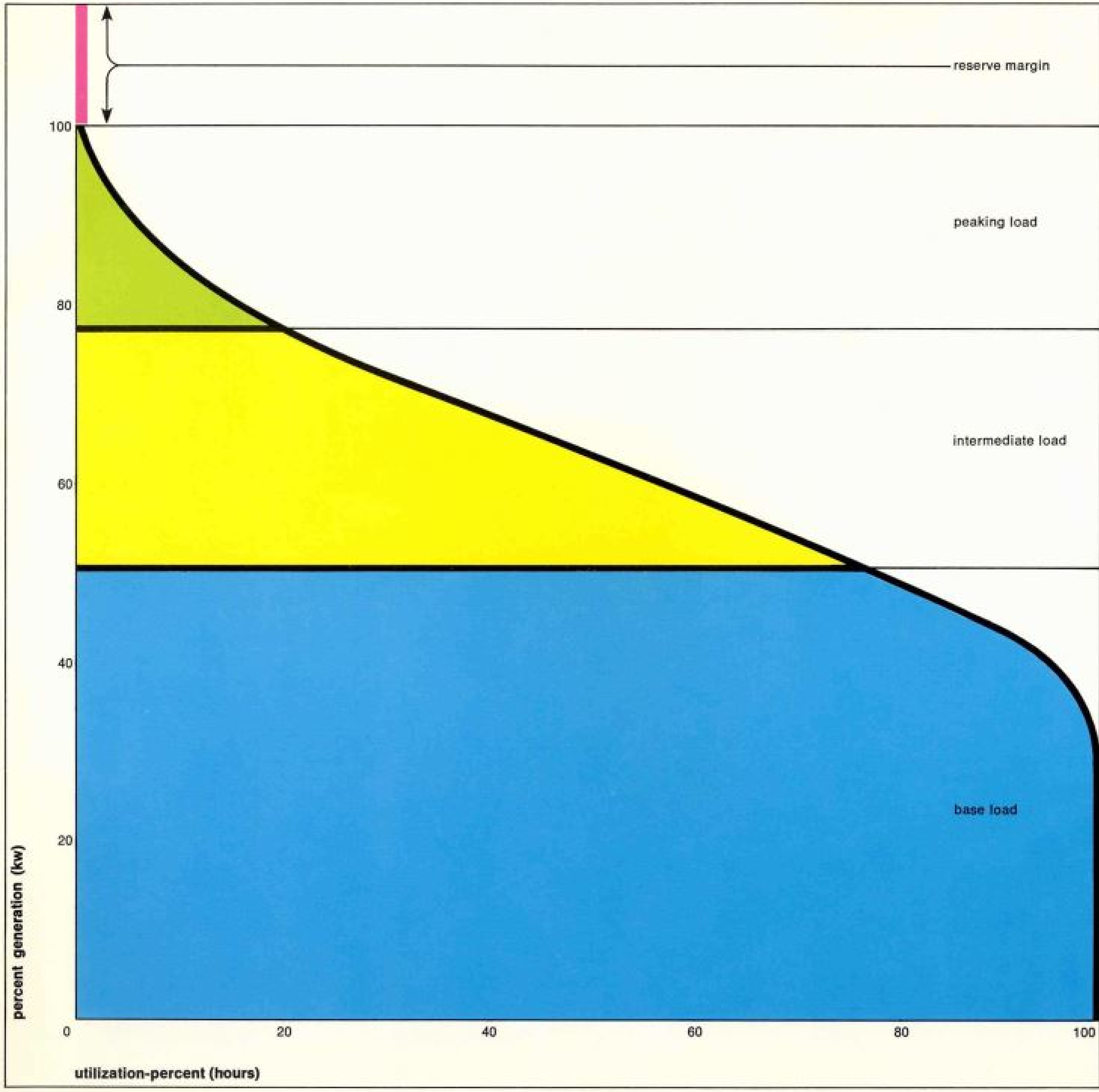
PACE

The Westinghouse Combined
Cycle Packaged Powerplant





PACE
meets the need for an intermediate-load powerplant

For many years, the primary emphasis in power generation has been to meet baseload and peakload demands. Steam turbines have been used as the main power source for baseload, and more recently, gas turbines for peakload.

But what about the important intermediate load between baseloads and peakloads? In the past, this intermediate area had been served by the less efficient steam turbines of a utility. However, today the heat-rate improvement of new baseload steam turbines has begun to slow down. Therefore, the older units of the system, now displaced to intermediate-load service, are not that much less efficient than the new steam turbine units.

In addition, the cyclic ability of these older plants is not suitable for the on/off duty required of intermediate generation equipment.

This important power generation area demands a unit that combines low capital cost, good cycling capability, and efficiency.

Westinghouse has developed PACE (Power At Combined Efficiencies) to meet these needs. It is a combined-cycle packaged powerplant designed specifically to meet intermediate power demands in the 2000- to 8000-hour-per-year service range.

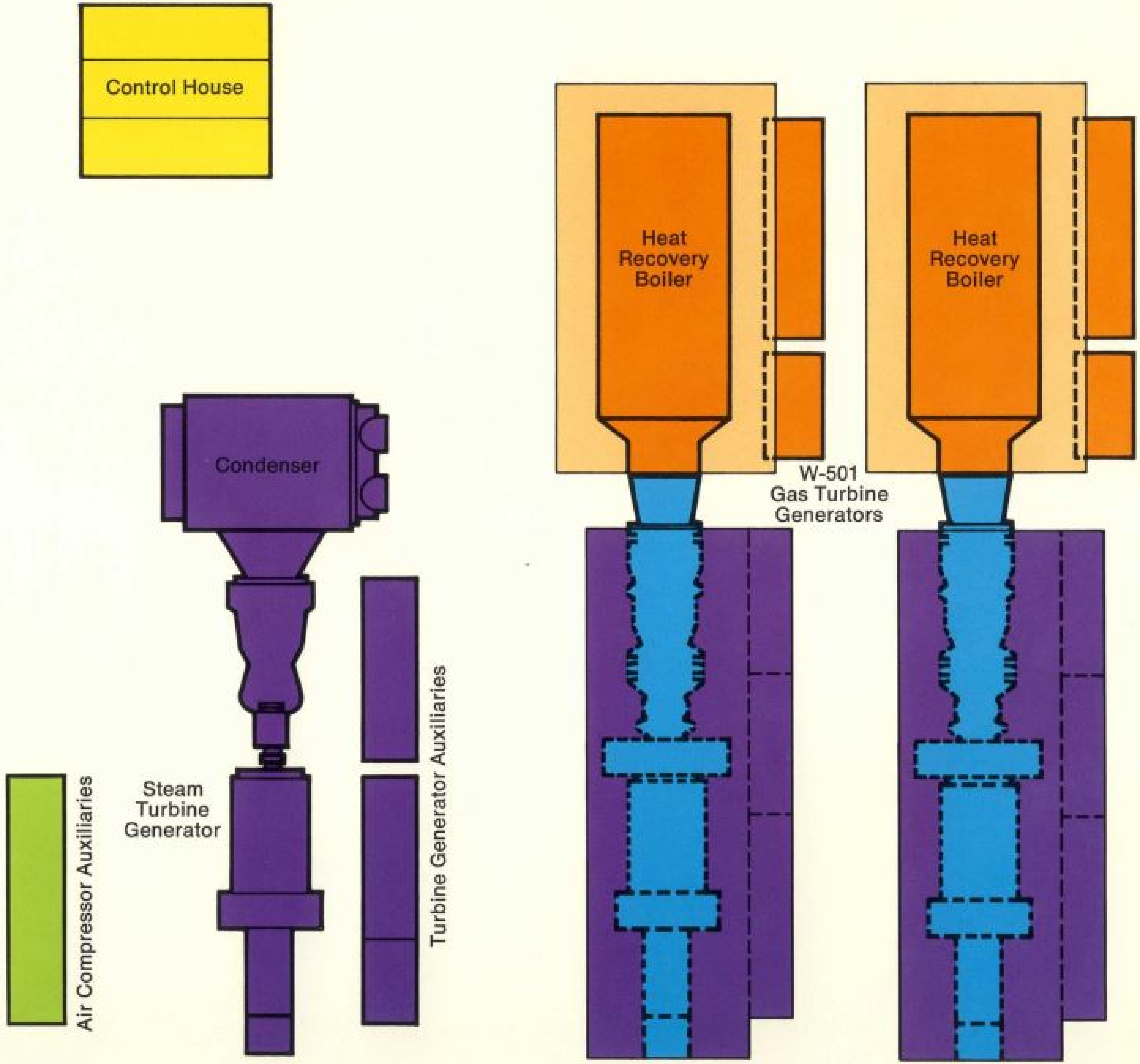
PACE
has two gas turbines, two heat-recovery boilers, one steam turbine—and Westinghouse know-how and experience

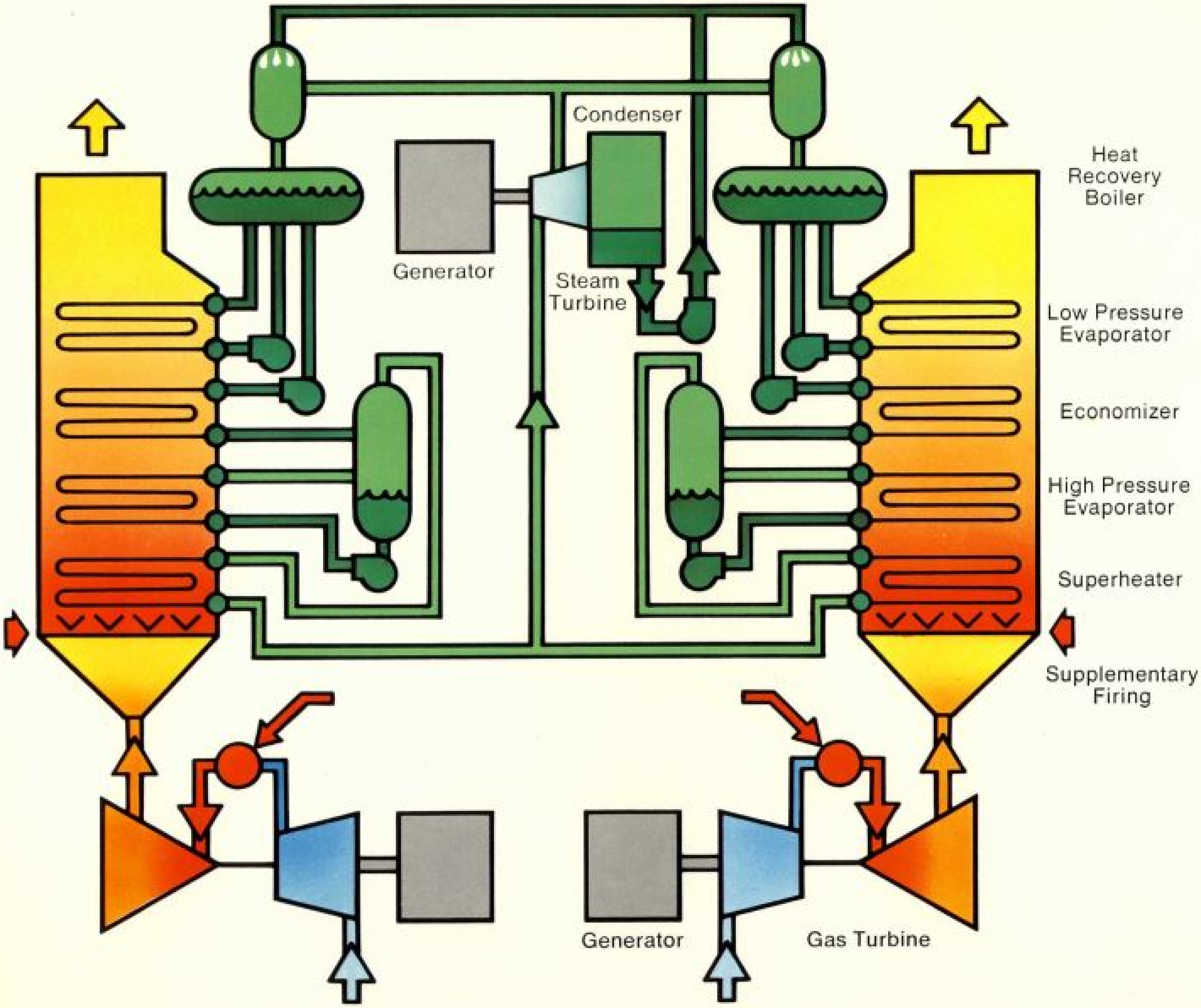
Combining gas turbines, heat-recovery equipment, and a steam turbine is not new. There are any number of ways to do it. But what is unique about the Westinghouse PACE plant is the application and combination of the equipment in the cycle. Only Westinghouse has joined these standard power-generating components to form the most efficient, economical, and reliable combined-cycle packaged powerplant for intermediate-load service.

Here's how the PACE plant works

The gas turbines in the PACE cycle have two functions. They produce power in the form of electrical energy and supply preheated combustion air to the waste-heat boilers mounted in the exhaust system. Each of the two gas turbines draws in ambient air. In each unit the air is compressed to approximately 12 atmospheres, fired in the combustion section, and expanded through the turbine element to drive the generator. The exhaust gas energy is then supplemented with additional fuel before entering the boilers.

The next stage in the PACE cycle starts at the two heat-recovery boilers. These boilers are specifically designed to use large volumes of gases and to incorporate extended-fin-tube construction. The condensate leaving the condenser is pumped to the feedwater-heater deaerating system which consists of a low-pressure drum. Steam extracted from the steam turbine and heat extracted from the gas-turbine exhaust by the extended-fin-tube surfaces provide the heat for the low-pressure drum. These two sources heat the feedwater to 250 F before entering the high-pressure economizer. Then the heat extracted from the gases in the economizer raises the feedwater to 5 F below saturation temperature in the evaporative section. Extracted heat from the gas-turbine exhaust is used again by





the evaporative and superheater sections to generate steam. This steam is piped to a steam header which supplies the steam for the steam turbine.

The steam turbine completes the cycle by supplying steam to heat feedwater through extraction and, most important, produces electrical power from its own generator.

Here's what the PACE 320 plant has to offer

The Westinghouse combined-cycle powerplant develops over 300 MW of efficient capacity at a heat rate of less than 8300 Btu/kWh.

Design simplicity is carried out in all major components and their interactions in the PACE plant to maximize reliability. A single component failure can't shut the plant down. Simplified design, coupled with coordinated single-source responsibility, decreases installation cost below that of a central station steamplant, and, in addition, the design decreases installation time.

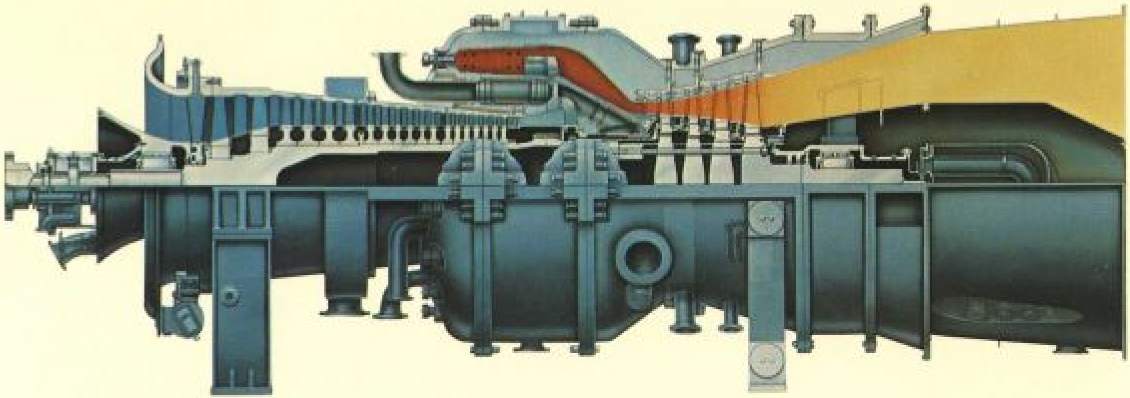
And the PACE plant greatly reduces both thermal and exhaust pollution. Gas-turbine power is 60 percent of the plant's output and requires no condenser; thus the total plant pounds of water per kW is reduced to a minimum. Advances in gas-turbine combustion technology have also reduced exhaust pollutants.

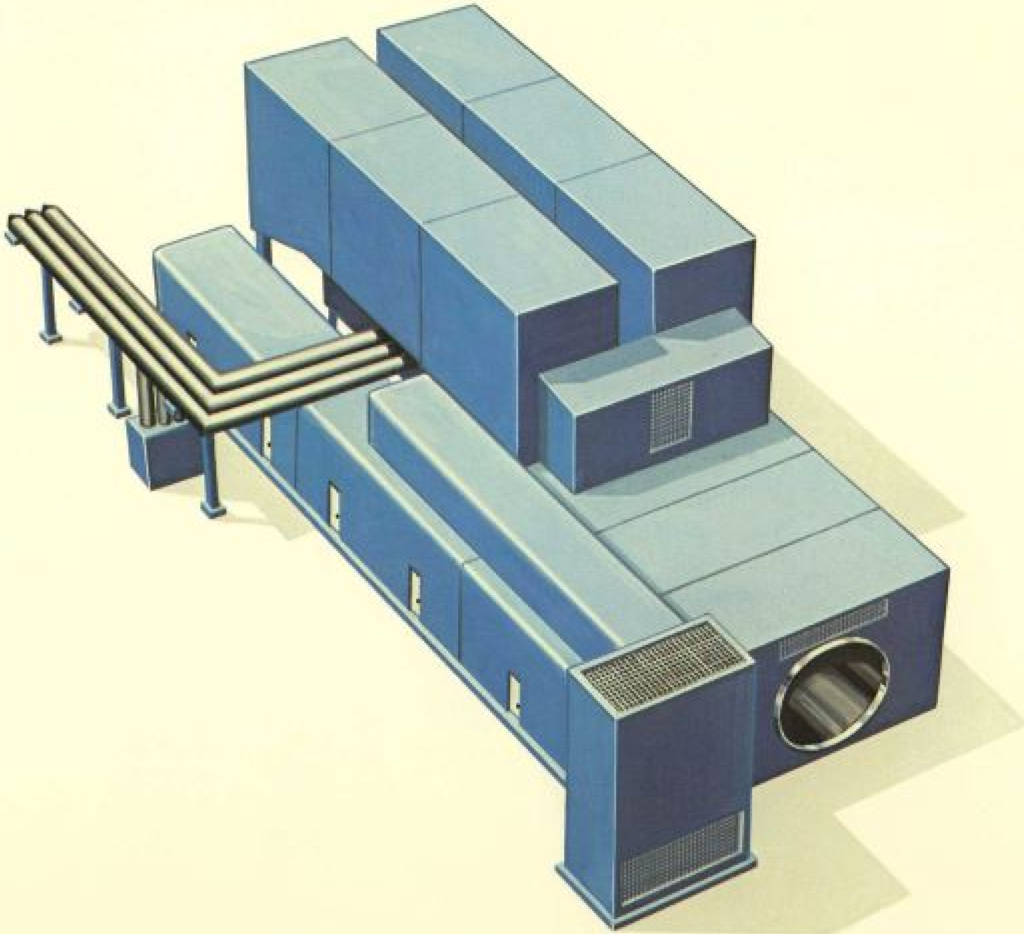
The PACE 320 plant requires about 1.7 acres of ground space—an overall plot size of 243 feet by 282 feet. Start-up from a "normal standby" condition to full load takes about one hour, and 30 minutes to reach 60 percent load.

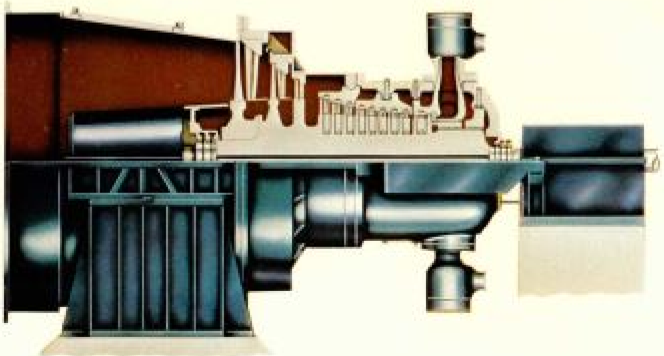
Two gas turbines

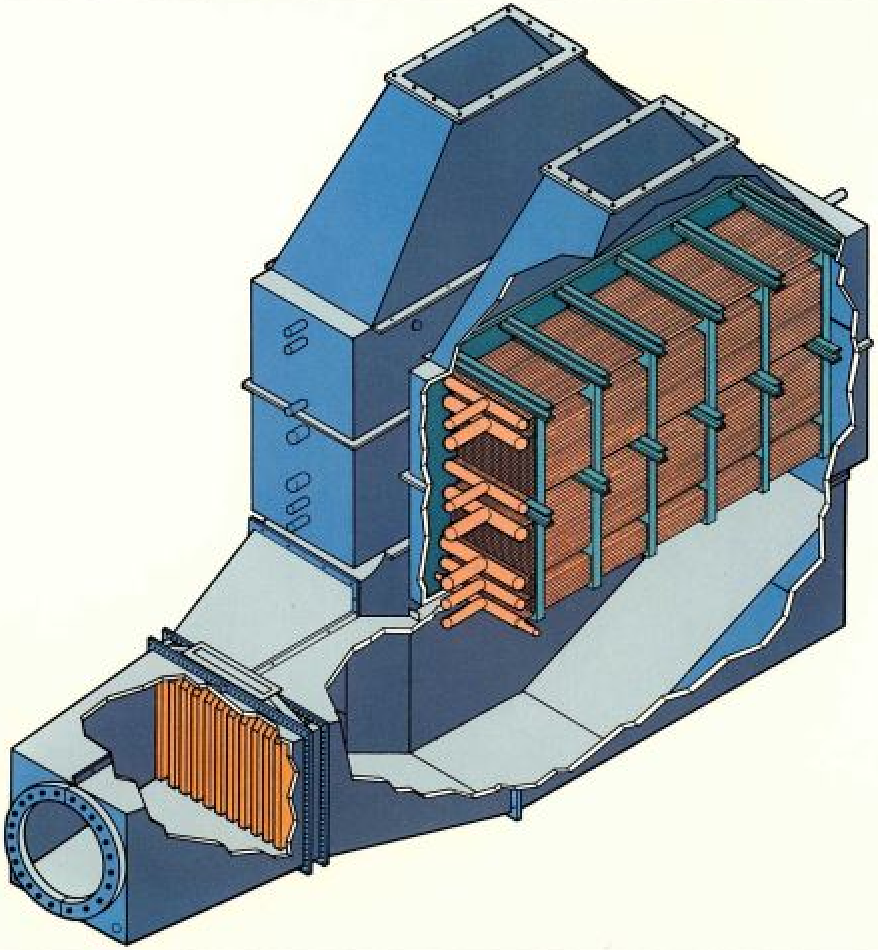
The Westinghouse PACE 320 combined-cycle packaged powerplant uses two gas turbines. Each one is a complete heavy-duty packaged power-generating plant operating at 3600 rpm with a heat-recovery boiler to utilize the exhaust gases as preheated combustion air.

Two Westinghouse W-501 gas turbines are used to provide the optimum amount of exhaust gases for the cycle. The W-501 is the largest single-shaft packaged gas turbine in the world. For the PACE plant this gas turbine package is a minor modification of the popular ECONO-PAC unit recognized throughout the industry.









One steam turbine

The Westinghouse 28.5-inch last-row-blade steam turbine was designed specifically for the PACE plant to maximize the power production of the steamplant, permit prepackaging, and still be as economical as possible.

The steam conditions for the steam-turbine inlet are 1210 psig/950 F. A limit of 950 F avoids the use of more costly materials for the steam turbine. The pressure level of 1210 psig avoids mechanical design problems, excessive water treatment, and limits steam-turbine back-end moisture.

Two heat-recovery boilers

The link between the two gas turbines and the steam turbine is the two heat-recovery boilers.

Each boiler consists of five components. A burner element adds supplemental heat to the gas-turbine exhaust gases. The superheater and the high-pressure evaporator provide superheated steam for the steam turbine. And an economizer and low-pressure evaporator heat the feedwater for the steam system.

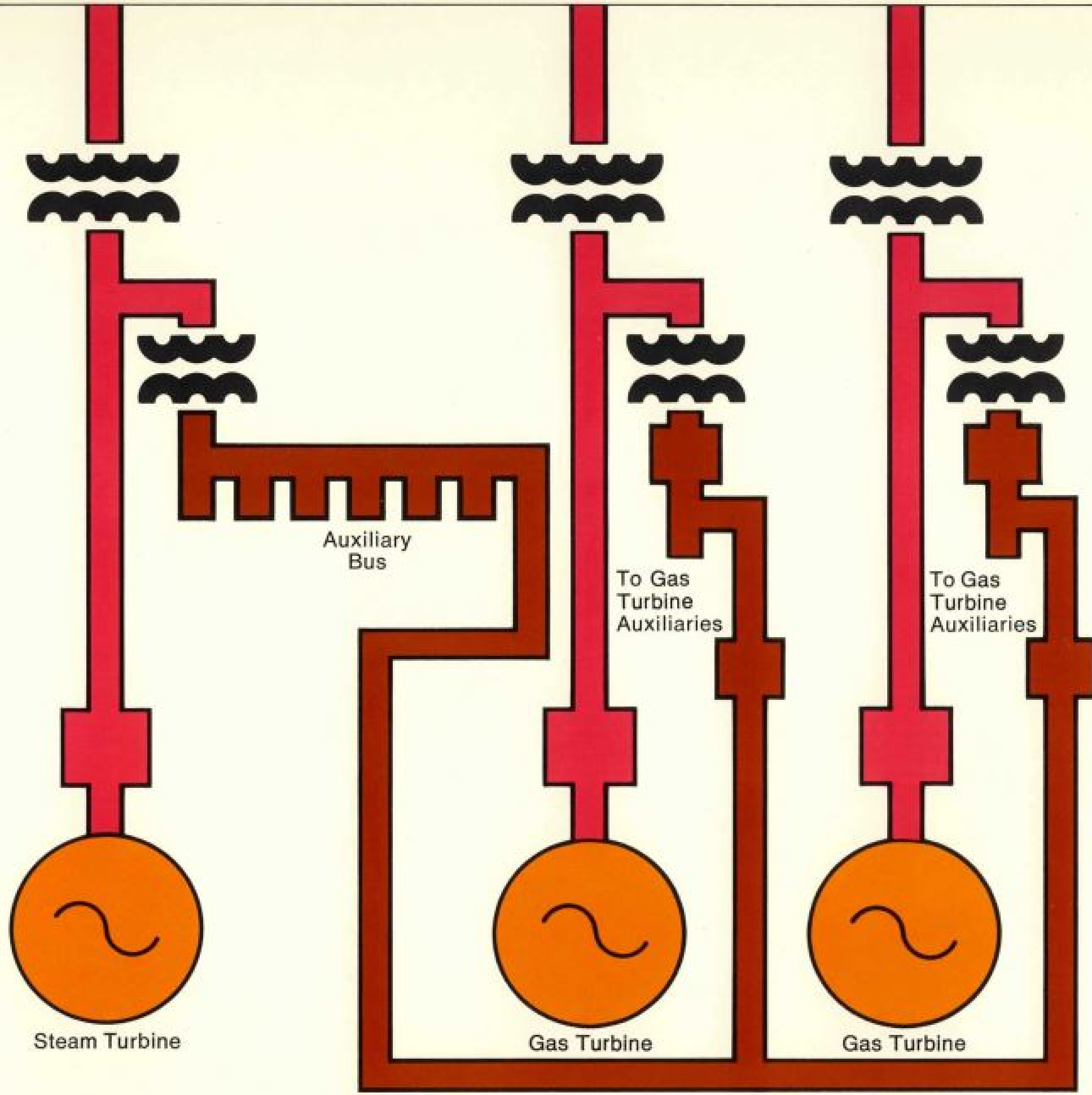
The boilers take the exhaust heat from the gas turbines and, with the additional heat from their burner elements, produce the steam required for the steam turbine.

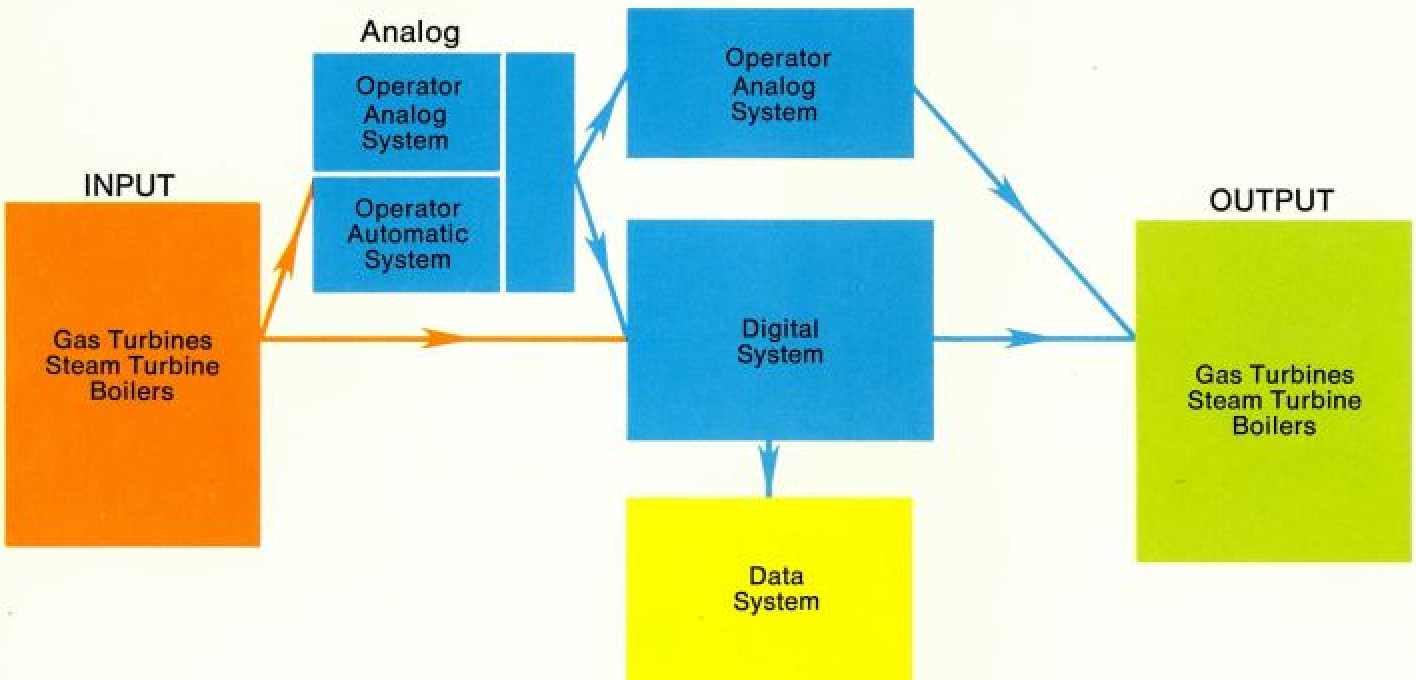
Electrical system

The electrical system of the PACE plant consists of pre-engineered, packaged, modular equipment matched to specific areas of control. Equipment is of a design that allows flexibility in adapting to most customer systems.

During normal standby and startup, the PACE plant requires external auxiliary power from the utility system. At load, the plant supplies its own auxiliary power needs.

A typical arrangement involves the three generators producing power at 13,800 volts which is passed through isolated phase bus to the oil circuit breakers and on to the main power transformers through open bus. Power for the steam and gas turbine auxiliaries is taken from the open bus, stepped down to 4,160 volts and fed to the various auxiliaries through the 5-kV switchgear.





Control system

The control system of the PACE plant is centralized and automatic. Factory wired, it gives high-speed operation and fast system response.

The control system permits full control of the entire plant by only two operators. Combined digital and analog control, and logic and relay sequencing provide for either automatic or manual operation with bumpless transfer from one control operating level to another. And it provides a range of operating modes from fully automatic plant control to manual control.

The fully automated mode provides the highest level of automation ever achieved in a powerplant. It assures optimum plant performance in the selected operating configuration. On this operating level, the digital system can sequence all three generating units from hot standby to full power in approximately one hour. After synchronization, the digital system operates the plant to achieve optimum heat rate and to produce the highest possible number of megawatts of power from a given amount of fuel.

Each PACE control system is factory tested against a plant simulator. This permits dynamic and static testing of all control and information functions.

PACE keeps pace with your power-generating needs

The Westinghouse PACE combined-cycle packaged powerplant will meet your intermediate-load needs generating 300 MW of power in approximately one hour from a standby position. At an estimated cost of about $15 an hour to maintain this standby position, a PACE plant can keep pace with your power needs with only an hour's notice.

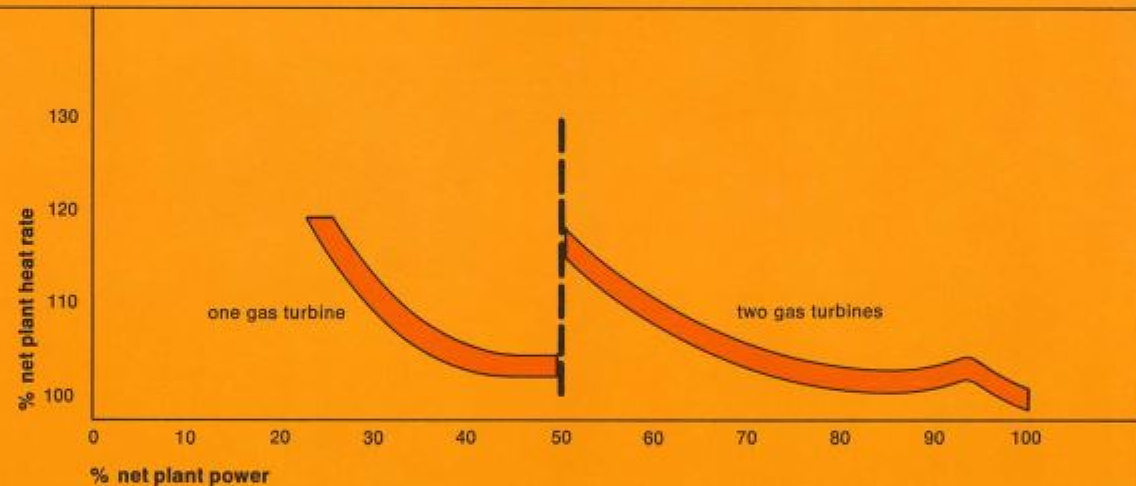
The gas turbines are brought to full load in about 15 minutes after synchronization and provide 60 percent total plant load 30 minutes after start-up. The steam turbine requires an additional 30 minutes to reach full-load capacity for a total of 60 minutes from standby to full power output.

Here are some more facts and figures on PACE's outstanding performance capabilities:

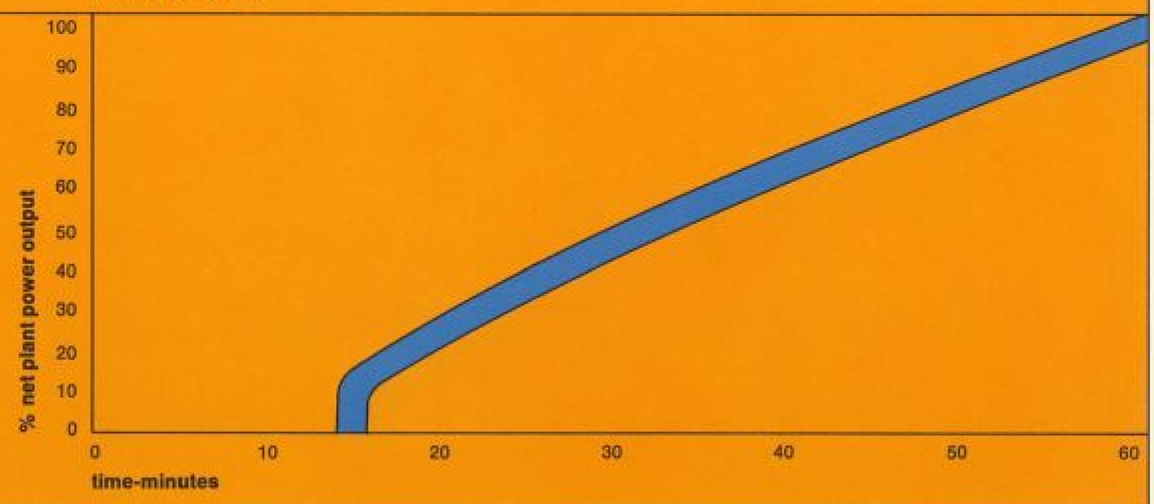
Combined cycle performance @ ISO conditions

	Natural Gas Fuel		Fuel Oil	
	Continuous duty	Intermittent duty	Continuous duty	Intermittent duty
Guaranteed capacity				
Net plant output (kw)	292,200	308,100	287,500	303,000
Net plant heat rate (Btu/kwhr-HHV)	8,360	8,130	8,030	7,800

Combined cycle part load performance



Combined cycle loading rate



Ten reasons why you should pick PACE

1. High power density
About 300 MW on 1.75 acres of space

2. Low heat rate
About 8000 Btu/ kWh at baseload—better than many steam powerplants, better than all gas turbine powerplants

3. Fast startup
From hot standby to full load in about one hour

4. Low installed cost
Pre-engineered packaged concept reduces cost below central station steamplant

5. Less installation time
Pre-engineered packaged concept reduces number of parts to be handled

6. Coordinated single-source responsibility
Precise component relationship, with coordinated shipment and installation

7. Simplicity of design
All major components and their interrelationships are simplified for maximum reliability—loss of a single component cannot disable the entire plant

8. Optimized design
Optimum combination of central station and peaking plant design philosophies

9. Minimum thermal pollution
60 percent of plant's output is from gas turbines which require no condenser.

10. Exhaust emission control
Westinghouse gas turbine combustion technology has reduced exhaust pollutants through a continuing research and development program

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Power at combined efficiencies

Westinghouse
helps make it happen

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