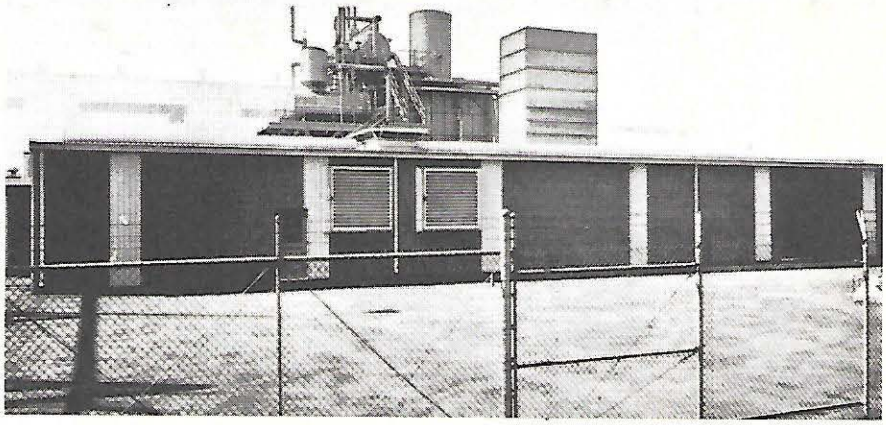


Energy-plant enclosure, 117 by 18 ft, is constructed of insulating panels with enamel finish. Enclosure design permits 4-hr access for major turbine overhauls

Electric utility supplies on-site power

Utility's gas-turbine energy plant on property of paper company provides both thermal and electrical power for newsprint process

By G E Baker
Westinghouse Electric Corp

This story begins in September, 1965, when Garden State Paper Co decided to build a multimillion dollar plant at Pomona, Cal. for producing newsprint from scrap newspaper, using a patented de-inking process. The special process required a balance of energy estimated to be 9000 kW of electrical power and 92,000 lb/hr of dry, saturated steam at 75 psig.

These energy needs led to early consideration of a concept, long advocated by Westinghouse Electric Corp, known as the "electric utility energy center." In this concept, a partnership is arranged between an electric utility and an industrial firm, with the utility installing a gas-turbine energy plant on the firm's property. The utility retains ownership, maintains and operates the plant, and supplies both electrical and thermal energy for the industrial process. Electrical backup is provided from the connected system of the utility.

Both utility and user benefit

Under this arrangement, benefits accrue to both the user and the utility, as follows:

UTILITY BENEFITS

- High utilization of energy developed by the gas turbine.
- High plant efficiency resulting from dual-energy utilization.
- Absorption of excess electrical energy into connected system at attractive rates.
- Black-plant startup capability for any nearby steam plants.

USER BENEFITS

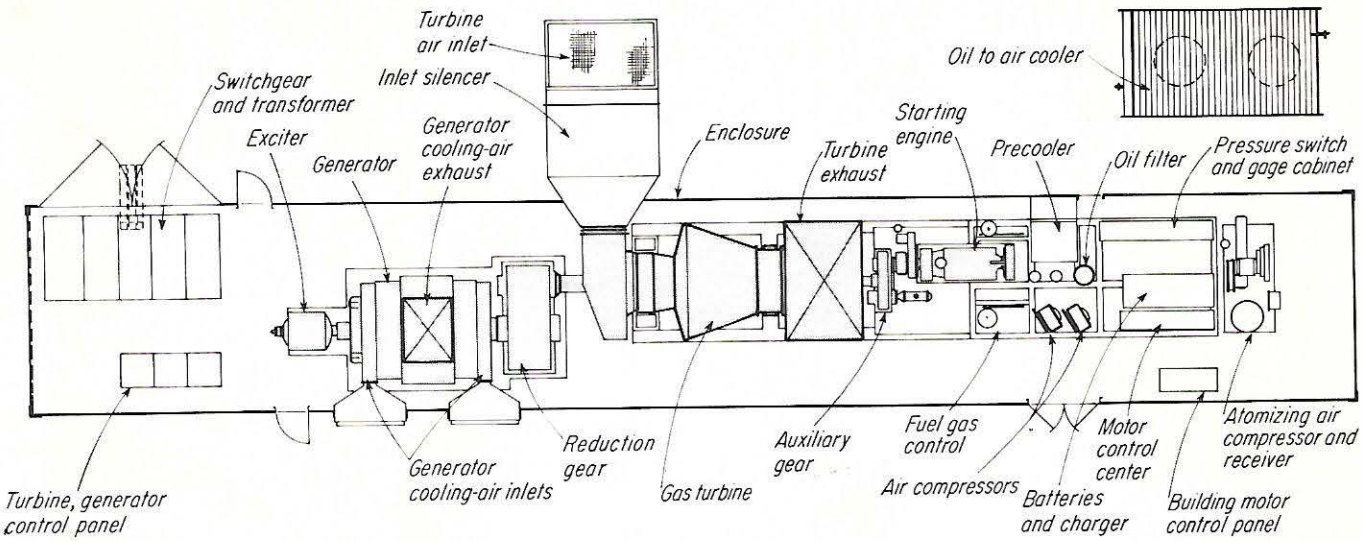
- Reliable power source resulting from interties with the utility's standard distribution system.
- Reliable steam source because waste-heat boiler has burners and forced-draft fan. Equipment is capable of furnishing enough gas-side energy for required steam output.
- Improved reliability since experienced personnel provided by utility operate and maintain the plant.

After due consideration of the concept (see pages 46 and 47), Garden State entered into an agreement with Southern California Edison Co (SCE) which called for installation of a Westinghouse gas turbine.

The energy plant that evolved from this agreement (photo, above) occupies a ¾-acre portion of Garden State's 12-acre site at Pomona, at an elevation of 780 ft above sea level. The total system was designed, purchased and coordinated by SCE, which also supplied construction and startup supervision.

Gas-turbine size was determined by the amount of exhaust energy needed to produce design quantities of process steam. The turbine selected is described in box, next page. In furnishing this unit, Westinghouse assumed responsibility for all engineering, field supervision, labor and material for complete installation of the turbine on SCE's foundation.

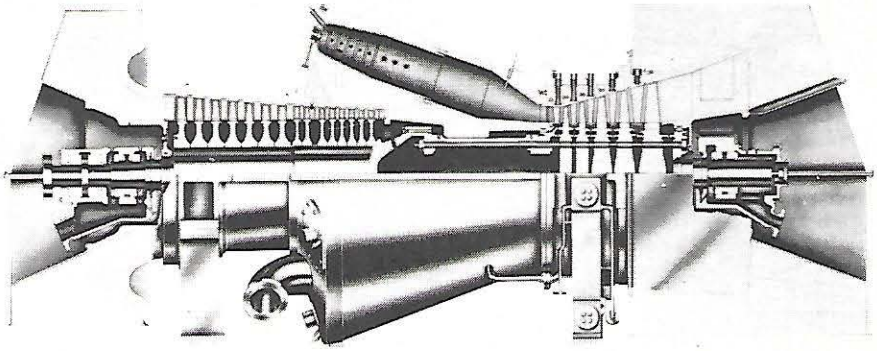
The gas-turbine plant generally may



Major plant components embrace electricals, generator, gas turbine and auxiliaries. Radiator lube-oil cooler and air-cooled generator allow plant to operate without water. Control panel is located in adjoining central control house

Turbine is dual-energy source

Westinghouse W-191 gas turbine is a simple cycle, single shaft, two bearing design with 15-stage, axial-flow compressor and five-stage reaction-type turbine. The unit's base-load site rating is 14,260 kW on an 80 F ambient temperature day, when burning natural gas. Maximum low-ambient capability is 19,500 kW.



be characterized as a pre-engineered, standardized package that requires no water and is suitable for unattended, automatic operation. The plant is equipped to burn either natural gas or distillate oil. Major components in the package incorporate factory prepiping, wiring and testing to facilitate field installation.

Energy plant components

Plant components can be studied in sections: auxiliaries, turbine, generator and electricals (arranged from right to left in upper drawing). The auxiliaries portion provides the support functions for the turbine, including a pressure switch and gage cabinet, motor control center, lube oil filter, air compressors and two fuel-control systems.

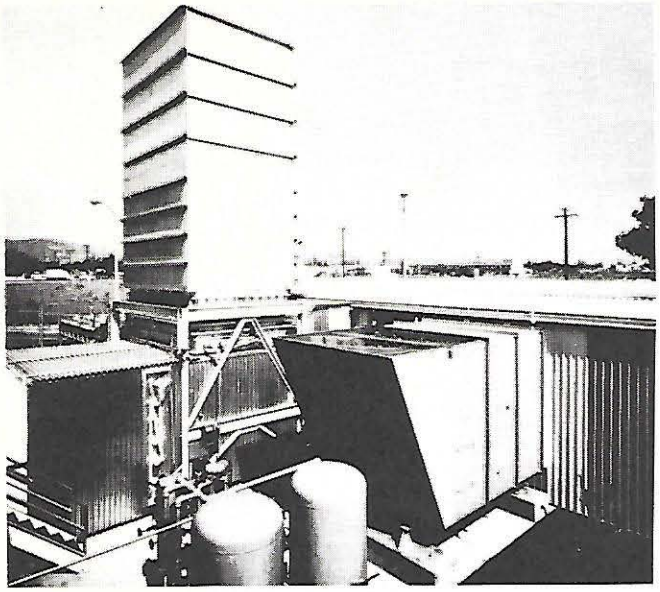
The atomizing air skid is a self-contained packaged unit which supplies air for fuel oil atomization and for sweeping of the fuel oil nozzle passageways when operating on natural gas. The building motor control center controls such systems as heating, lighting and ventilation.

The gas turbine itself is bedplate-mounted, with the oil reservoir an integral part of the bedplate construction. Mounted over the reservoir are the auxiliary gear, turning gear assembly and starting diesel engine, which has its own set of batteries for independent starting. The main lube-oil pump is driven off the auxiliary gear and is backed up with a full-capacity, reservoir-mounted, ac primary pump; in the event of ac outage, a dc reservoir-mounted secondary pump is started automatically. The turbine drives from the cold end into a double-helical, single-reduction-type gear which reduces turbine speed down to the rated 900 rpm of the generator.

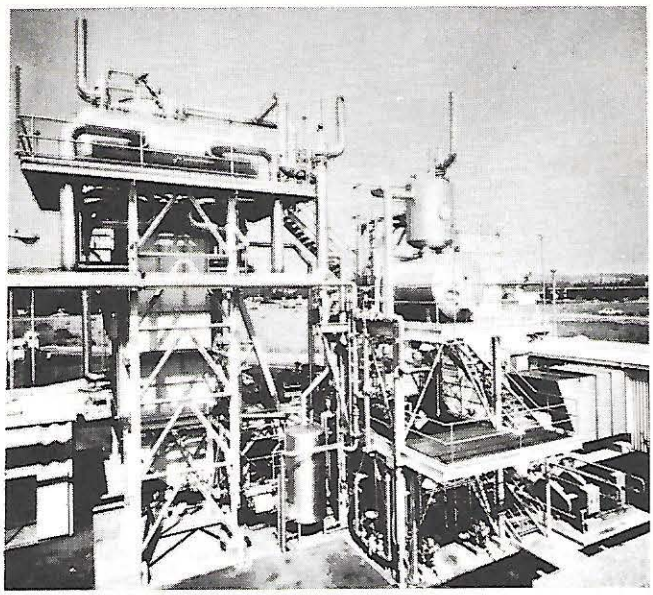
The inlet-air system to the turbine is side oriented and contains an inlet scoop and parallel baffle-type silencer. Exhaust system includes dampers and bypass stack (with silencer) to enable exhaust gases to be diverted to atmosphere. This sytem, in conjunction with the forced-draft fan at the boiler inlet, allows for independent operation of the boiler or gas turbine.

The generator is an open, air-cooled, salient-pole type rated at 19,-200 kVA on an 80 F ambient day. The large cooling-air passages allow a generous amount of ambient air to pass through the internals of the machine. Consequently, generator output will vary with ambient temperature at a rate compatible with turbine output, which is also a function of ambient temperature.

The 15-kV switchgear at the elec-



Inlet, exhaust systems for gas turbine. Silencer on air inlet provides attenuation to NEMA level "e" at 200-ft distance



Process steam from waste-heat boiler is delivered to paper plant at flow rate of 92,000 lb/hr and at 75 psig pressure

trical end of the enclosure includes the station auxiliary power transformer, main breaker, excitation switchgear and surge protection. Supply of 480-V power for auxiliary loads is obtained from the bus with a feed through the 150-kVA dry-type transformer to the motor control center.

Gas turbine operation

Startup of the gas turbine is accomplished by a single operator at the turbine control board, which consists of a generator panel, dual turbine panels and a boiler control panel. With all station services established and exhaust vented through the bypass, depressing the start button on the panel initiates automatic sequencing of the turbine up through synchronization to the system. The operator then loads the unit through switch action in increments of 20% of full load/min.

Normal shutdown is accomplished by unloading the turbine below 1 MW, at which time the stop button may be depressed. This action triggers the automatic shutdown sequence including energizing of the turning-gear motor. When the exhaust temperature cools to 150 F, or after 48 hr have elapsed, the unit is brought to complete rest. Restarting is permissible any time after 20% of rated speed is reached.

Emergency shutdown, which may be made manually at three locations within the enclosure, will immediately open the generator breaker, close the fuel valve and bypass the normal cool-down time in the sequence. The turbine is self-protecting during all phases of operation so that any "fault" will lead to protective action through control relays and annunciator points.

By means of the fuel selector switch, the operator may change from primary gas fuel to secondary oil fuel while the turbine is under load. Transfer is completed in a matter of seconds, although decay of fuel gas pressure below a preset minimum will cause the unit to go into alarm and shut down if action is not taken.

Steam generating system

In normal operation, the gas turbine exhaust flow is fed to a supplemental-fired, waste-heat boiler rated at 120,000 lb/hr, generating dry and saturated steam at 100 psig. The boiler is sized to provide process steam plus that required for feedwater heating and steam atomization of oil.

When the gas turbine is at rated load, exhaust heat to the boiler will supply about three-fourths of the energy required. The rest is supplied by supplementary fuel burners capable of burning either natural gas or distillate oil. When the gas turbine is not operating, the total heat to the boiler can be supplied by the burners alone.

An important feature of the steam generating system is its ability to handle extreme load changes which occur when paper breaks on the machines. When this happens, the steam demand will change from full-load rate to quarter-load rate in about 20 sec and return to full load when paper flow is re-established.

At rated load, exhaust-flow temperature is approximately 780 F; the supplemental burners increase this to 1000 F. When the forced-draft fan is utilized, the flow temperature can be raised to 1300 F. Feedwater is supplied at a temperature of 212 F.

Electrical service

The plant's electrical output at 12 kV is fed to the 12-kV operating bus of SCE's substation. Alternately, this bus can be fed from SCE's system through a 20-MVA, 66,000/12,000-V transformer equipped with high- and low-side breakers. Boiler auxiliaries are serviced from three 12,000/480-V transformers. Turbine auxiliaries are serviced from a 12,000/480-V transformer within the 15-kV switchgear cubicle in the turbine enclosure. This substation arrangement allows the excess capacity of the turbine to be absorbed by SCE's system, at the same time offering ample power to the plant should the turbine be down.

Since the energy plant was placed in operation early in 1967, it has fully lived up to expectations; both user and supplier have found their partnership to be mutually beneficial. Moreover, gas-turbine performance is continually improving, which means that the potential for energy centers like the one at Pomona will be even greater in years to come. ●

Men who saw bright future for on-site energy plant

The preceding pages feature a gas-turbine energy plant on the property of a paper mill. The plant is unusual because it is owned and operated by an electric utility and supplies both thermal and electrical energy to the mill. Process steam comes from a supplemental-fired boiler, with thermal energy supplied by turbine exhaust and burners; electrical backup is provided from utility's connected system. This flexible arrangement is described in detail in the story.

But what about the men who saw a bright future for on-site power at the paper plant? Our story is not complete without them, so here they are—key men who gave shape to an idea and made it work. Representing the utility, William C Drewry (left) and Jack B Moore (lower right), both vice presidents of Southern California Edison Co. Representing the paper mill, John H Rich (below), president of Garden State Paper Co and Eric Smith (right), president of Alvin H Johnson Co, consultant to Garden State.

Our aim is to tailor service to customer needs—Wm C Drewry

"The new paper plant at Pomona offered Southern California Edison Co an ideal opportunity to install its first on-site, "dual-purpose" generating facility. Edison's decision was based on the plant's excellent balance in requirements for electricity and process steam. Our aim is to tailor the service to customer needs. In this case, an energy plant on the site appeared to offer optimum benefits to both utility and customer."

Professionals can do best job at lowest cost—John H Rich

"We are in the paper manufacturing business and not the utility business. The professionals in any field can do the best job at the lowest cost. When the idea of on-site power was presented to us, it had immediate appeal. Here was a chance to reduce capital costs, avoid utility involvement and obtain reliable energy. The concept has given us all that we were after and has led to the lowest possible cost to the company for steam and power."

It's a reliable plant; that's as important as cost—Eric Smith

"While the cost of steam and power service is important in any paper mill, reliability of these services is of equal importance. As compared to industry in general, a paper mill requires a very high investment of dollars in terms of output and therefore must operate 24 hr a day every day to be economical. Obviously, an energy source must be reliable to provide an almost constant source of energy of this nature, where even a voltage 'flicker' in the power source can cause the loss of production for an hour or more. The Pomona installation, by permitting the use of electric power either from the gas-turbine-driven generators on the site or from the power lines of Southern California Edison, with steam generation by waste heat, natural gas or fuel oil, in my opinion provides the utmost in reliability. And costs are quite attractive. Although the power rate is about the same as the utility's standard rate, the cost of steam is nominal—much less than the cost with a conventional plant."

Fortunate to have reliable on-site power—Jack B Moore

"An electric utility is in a uniquely favorable position to operate a dual-energy source on a customer's property. There is no waste of electrical power: energy not required for customer use can be absorbed in the utility's distribution system. Nor is emergency backup power required, since the full resources of the system are available to the customer. It also allows the utility to draw upon the on-site plant for power in times of emergency. We were fortunate in obtaining a reliable energy source for on-site generation at the Pomona paper plant. The Westinghouse gas-turbine energy plant has fully lived up to our expectations, enabling us to offer attractive rates because our operation and maintenance costs are reasonable. Moreover, since the energy plant was packaged to accommodate our needs, we were relieved of designing and installing a plant from basic components. With this arrangement, our mutual responsibilities were clear-cut, which simplified our planning."

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