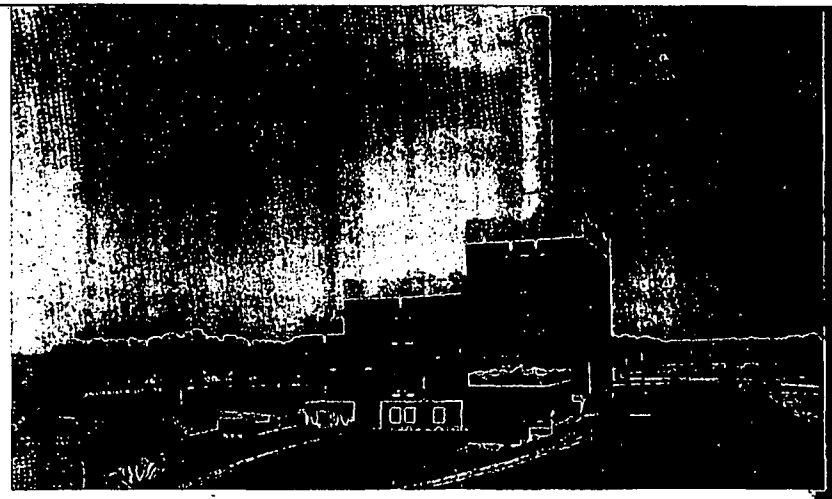


1 Arthur S Huey Generating Station, Oklahoma Gas and Electric Co, has two turbines with total capability of 56,000 kw, but boilers limit output to 51,000 kw. New gas turbine will work in conjunction with the existing station heat balance

3500-Kw Gas Turbine Raises Station Capability By 6000-Kw

First commercial power producing gas turbine in U. S. A. will operate with existing steam plant. New capacity is obtained at lowest cost and improves overall heat rate

By J W BLAKE, *Oklahoma Gas and Electric Co.*
and R W TUMY, *General Electric Co.*

▶ WHAT IS ALMOST CERTAIN to be the first gas turbine producing power commercially on a U. S. utility system has been purchased by Oklahoma Gas and Electric Co from General Electric Co (POWER, May 1948, p 94). A 3500-kw simple-cycle unit, it will be installed at OG&E's Arthur S Huey Generating Station near Oklahoma City, initial work probably starting about Jan 1, 1949. An abundance of low-cost high-Btu natural gas and favorable conditions for working the gas turbine into the existing plant heat balance make the installation attractive, extensive studies show.

Station History. Byllesby Engineering and Management Corp (now Pioneer Service and Engineering Co) designed the original installation at Huey Station. Operation started in 1930 with No. 1 unit, a 30,000-kw Allis-Chalmers steam turbine, supplied by three 150,000-lb-per-hr Springfield boilers. One of the three boilers was intended as a spare. Operating conditions were 400 psig, 750 F, 2 in. Hg abs backpressure. Gas-burning equipment with fuel-oil standby was installed and building and draft provisions made for future installation of coal-burning equipment. Subsequent operation showed that boiler output could be raised to 200,000 to 220,000 lb per hr with gas fuel but with proportionate drop in efficiency, increased maintenance because of internal circulation difficulties and shorter life of superheater tubes.

At the beginning of World War II it became apparent that additional system generating capacity was mandatory with a minimum expenditure of critical material and manpower. With WPB approval it was decided to add No. 2 unit, a 20,000-kw (25,000-kw capability) General Electric turbine-generator, to take advantage of the proven reserve boiler capacity. Present station capability now is only 51,000 kw, limited by maximum heat input to boilers, although the turbine units have a combined capability of 56,000 kw.

The Post-War Demand. The unprecedented and unexpected increase in power demand since World War II concentrated attention on, and study of, all possible sources of potential supply which could be obtained economically and quickly. Huey Station was immediately attractive because of its extra turbine capability. First consideration was a fourth boiler, but the high unit cost, two-year delivery or longer and gain of only 5000 kw made it not too attractive for the current situation, though it was definitely indicated for some future time.

Bleed-Steam Power. Supplying external heat for raising feedwater temperature thereby releasing bleed steam for power and increasing station capability was studied. Four means, original with OG&E, were investigated:

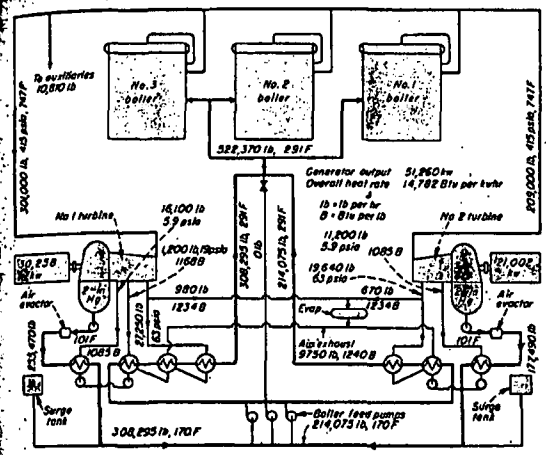
(1) Using steam from existing 165 psi boilers in an older nearby station. This steam would be used in the closed heaters so no mixing of boiler water from the two plants would occur.

(2) Similar to (1) except portable gas-fired oil-field boilers would be installed adjacent to the station, using the same boiler-water system.

(3) Installation of a gas-fired feedwater heater, similar to those used for waste-heat recovery on diesel engines.

(4) Installation of a simple-cycle gas turbine, operating on natural gas, and equipped with an exhaust-gas-recovery heat exchanger.

The first three methods would gain up to full capability, or 5000 kw additional from the steam turbines. However, this would be done at an increase in station heat rate. The fourth method, using a simple-cycle low-efficiency gas-turbine unit with heat exchanger, would produce a combined station capability increase in excess of 6000 kw, and if fully expanded by adding two more gas-turbine units would raise station capability a total of 15,500 kw. The additional capability is produced at a heat rate lower than the present base station heat rate.



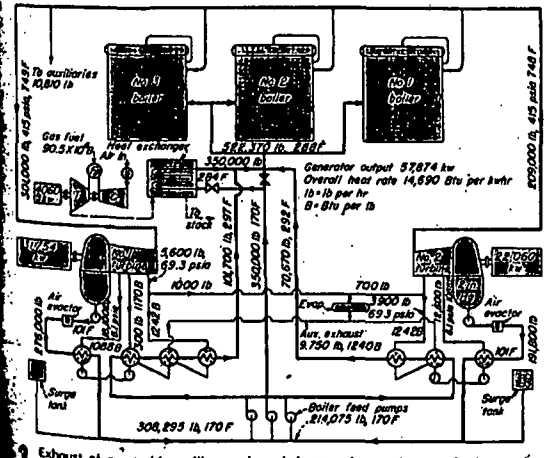
2 Present heat balance of Huey Station includes three boilers and two turbines with regenerative feed heating. All boilers may feed either of the turbines

Heat Balance. The station, located on a lake, has its circulating water cooled by natural evaporation and recirculation, augmented in summer months by a 13,600-gpm induced-draft cooling tower. Annual average back-pressure equals 2 in. Hg abs with outside temperature of 70 F. Fig. 2 shows present station heat balance before adding to gas turbine.

In investigating gas-turbine use it was necessary to be sure the unit would function as required during the peak season. For the OG&E Co the peak demand comes in the hot summer months. A gas turbine is least attractive with high ambient temperatures since the compressor is a volumetric device and delivered air weight varies inversely with the inlet temperature. The installation proved justified for air temperatures which prevail during the summer. A precooler will be installed at the compressor inlet, which will drop the inlet temperature about 25 F below ambient during the hottest weather.

More Kilowatts. Makeup for the lake, supplied, in part, by deep wells at 65 F, will do the precooling. Originally this water was put into the lake via generator air coolers and oil coolers on the steam units. The quantity of water available will allow passing it through the gas-turbine precooler without impairing effectiveness of its original use. Fig. 4 shows estimated effect on gas-turbine capability of the precooler with high ambient temperatures. Actual ambients in this area reach values shown in Fig. 5. Also shown is the inlet-air temperature for the compressor.

Gas-turbine exhaust temperature has been limited to a maximum of 780 F by the manufacturer. This will be the limiting factor in loading the unit except at low ambients when generator rating will be the limit. The high exhaust-gas



3 Exhaust of gas turbine will pass through heat exchanger heating feedwater that has bypassed the turbine closed heaters. This raises steam-turbine kw output