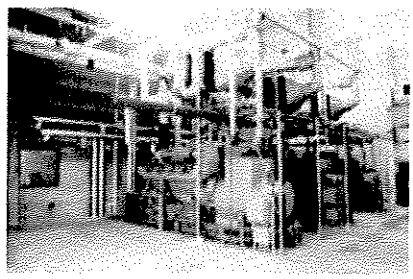
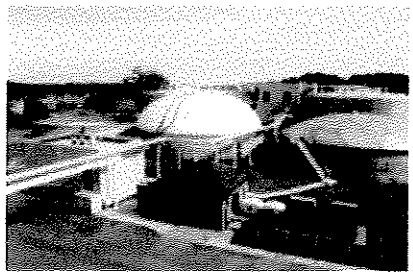
a.

Ballard Engineering Case Studies

Rock River Water Reclamation District Rockford, Illinois
(Industrial)

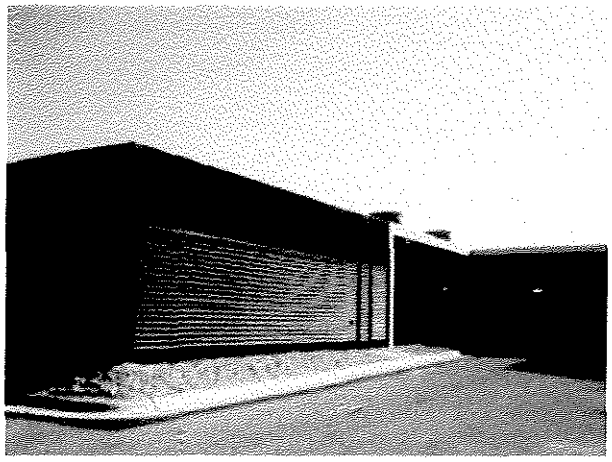
Ballard Engineering with the Rock River Water Reclamation District designed and built a dual fuel ~~2,475~~ 3000+ KW Natural Gas / Digester Gas powered Combined Heat and Power facility. The system provides maximum flexibility to the facility by its capacity to operate the entire facility independent of the utility automatically if necessary, provide all process heating requirements thru heat recovery from water jacket and exhaust, and switch fuels on the fly based on digester gas availability. Typical operation is one of the three engines operating 24 / 7 on digester fuel, with the remaining two engines operating 9 am to 6 pm Monday thru Friday.



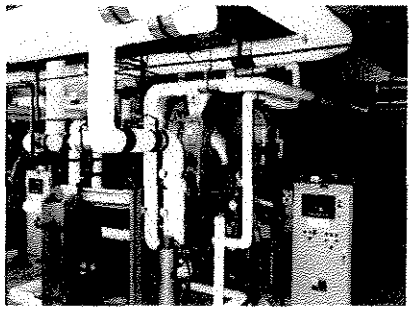


Ballard Engineering Case Studies

Beloit Memorial Hospital, Beloit, Wisconsin
(Healthcare)



Ballard Engineering installed a 3,000KW distributed power/cogeneration system at Beloit Memorial Hospital in Beloit, Wisconsin. The system provides maximum flexibility to both the hospital and local utility company in regards to electricity, heating, air conditioning, and hot water usage.



Additional Material

- **Beloit Memorial Hospital Cover Sheet (http://www.ballardcos.com/userfiles/Beloit cover sheet.pdf)**
- **Beloit Memorial Hospital Brochure (http://www.ballardcos.com/userfiles/file/BMH_Brochure.pdf)**
- **Beloit Memorial Hospital Article in *"Distributed Power"* (http://www.ballardcos.com/userfiles/file/BMH_Article.pdf)**
- **Beloit Memorial Hospital Flyer *"Midwest CHP Application Center"* (http://www.ballardcos.com/userfiles/file/BMH_Flyer.pdf)**

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Beloit Memorial Hospital

Ballard Engineering recently completed the design and construction of a 3,000 KW distributed power/cogeneration system at Beloit Memorial Hospital in Beloit, WI. The system provides maximum flexibility to both the hospital and local utility company (Alliant Energy) in regards to electricity, heating, air conditioning, and hot water usage.

The scope of the work revolved around ten major features:

1) Remove and replace old emergency generators.
2) Provide approximately 1,500 KW power for the entire hospital.
3) Export approximately 1,500 KW power to the local utility company.
4) Provide heat to drive a 400-ton absorption chiller or the facility's existing heating loop.
5) Provide heat for domestic hot water usage.
6) Make it possible for the system to operate on natural gas or diesel gas in the event of an emergency.
7) Provide instantaneous power in the event of a utility failure.
8) Provide the utility company with an "on-call" system to reduce utility load or grid short falls.
9) Maintain the entire cogeneration system at 69.8% efficiency.
10) Remove and replace older 12KV cables which were located internally to the hospital.

In order to provide all these services to the customer, it was determined that seven (7) major components would need to be put in place. First, a 3,250 sq. ft. two level sub-grade matching style building addition to the north end of the existing hospital would have to be constructed to house the engine room and the control room. Two (2) Fairbanks Morse dual fuel 900 RPM 1,500 KW engine generator sets were purchased along with (2) 3,000 AMP 480V and a 6,000 AMP 480V automatic breakers. A 12KV automatic main service breaker was utilized for connection to the local utility. A 400-ton Carrier absorption chiller was also used. Plate and frame heat exchangers and finned tube type heat recovery units captured heat for domestic hot water, heating and steam. Two (2) outdoor excess heat rejection radiators (1 Jacket Water and 1 Aux Water) were installed and located in an enclosed 1,600 sq. ft. courtyard directly west of the new building addition. Finally, a networked graphic system was installed which routed all the major equipment's readings to a central computer terminal located in the control room for monitoring and record keeping.

See attached article that was published in DISTRIBUTED POWER magazine (November/ December 2000 issue) which is a supplement to DIESEL & GAS TURBINE WORLDWIDE.

MIDWEST CHP APPLICATION CENTER

DESIGNED AND BUILT BY Ballard

CHP Application

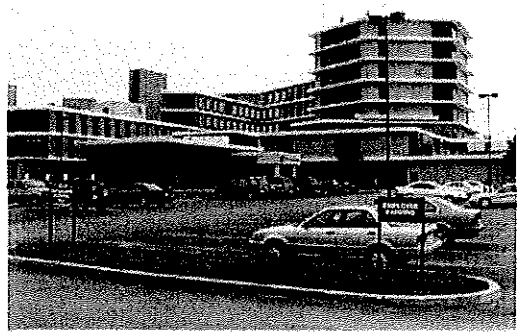
Beloit Memorial Hospital 3.0 MW CHP Application

Fact Sheet

In the late 1990's, Beloit Memorial Hospital of Beloit, Wisconsin, was faced with the need to upgrade its electrical distribution system and to address other energy capacity issues that developed over the years since opening in 1970, Instead of simply upgrading and/or replacing the existing equipment, Beloit Memorial Hospital (BMH) decided to install a Combined Heat and Power (CHP) Plant, which also helped reduce annual energy costs. The 3.0 megawatt CHP plant provides maximum flexibility to both the hospital and the local electric and gas utility company, in regards to electricity, heating, air conditioning, and hot water usage.

QUICK FACTS

Annual Savings:	$223,000
Equipment Cost:	$1.2 Million
Simple Payback:	5.4 Years
Generation Capacity:	3.0 Megawatts
Operation Since:	June 1, 2000
Campus Size:	340,000 sq ft
	187 Beds



ID	Task Name	Duration
1	Engineering & Design Phase	60 days
2	Equip. Selection & Procurement	80 days
3	Building Construction	40 days
4	Installation of BCHP Equipment	90 days
5	Start-Up, Troubleshooting & Testing	64 days
6	Commercial Operation	0 days

Design and installation schedule completed in 12 months.

REASONS FOR CHP
"UPGRADE ENERGY DISTRIBUTION" & "FUTURE DEREGULATION"

In general, hospitals are excellent candidates for CHP applications because they usually operate 24 hours/day, year-round, creating fairly consistent electric and thermal loads plus high thermal loads. Beloit Memorial Hospital proved a viable candidate for CHP and replaced its existing emergency generators and heating and cooling equipment with the CHP plant. The system now serves both 1) day-to-day CHP operation and 2) emergency power. Alliant (local utility) financed part of project with a low interest rate.

FUTURE DEREGULATION

BMH managed to reduce the impact of higher energy costs and susceptibility to power quality issues, especially those which could occur when deregulation becomes a reality.

ADDITIONAL ELECTRCITY

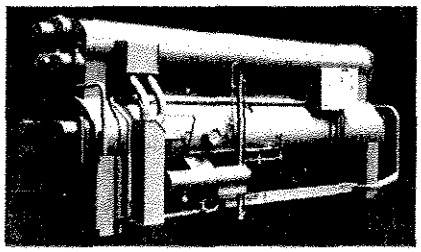
Generated electricity not needed by the hospital (up to 1.5 megawatts) is sold to the local utility. This proves beneficial to the local utility during high peak demand periods and/or when generating capacity is reduced due to equipment problems and/or maintenance.

CHP SYSTEM EQUIPMENT

- 2 Fairbanks Morse dual fuel 900 RPM, 1,500 kW engine generator sets
- One 6000 AMP tiebreaker and two 3000 AMP, 480V auto generator breakers
- One 12 kV auto main service breaker
- One 434-RT Carrier single stage hot water absorption chiller
- 7.66 MBtu/hr shell and tube heat exchanger (backup for recovered heat)
- 6.733 MBtu/hr Sondex plate and frame heat exchanger
- 6.149 MBtu/hr Sondex domestic hot water heat exchanger
- 2 Cain 2.389 MBtu/hr generator set finned tube heat recovery units
- 2 outdoor excess heat rejection radiators

CHP OPERATION

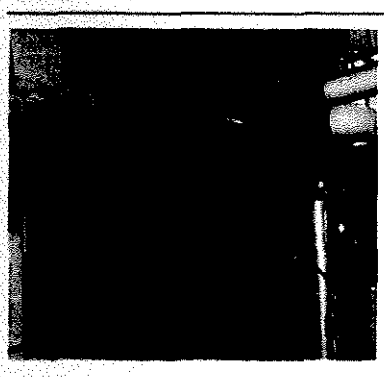
The CHP plant normally operates from approximately 8:00AM to 10:00PM Monday through Friday, 52 weeks per year. The system supplies all domestic hot water during on-peak hours and the engines always start-up on diesel, switching over to natural gas when load reaches 50%.



SCOPE OF CHP PROJECT

Ballard Engineering completed the design and construction of the 3.0 MW CHP Plant revolving around these 10 major features:

1. Remove and replace old emergency generators
2. Provide 1.5 MW power to hospital
3. Export 1.5 MW power to local utility
4. Provide heat to drive 400-ton absorption chiller or facility's heating loop
5. Provide heat for domestic hot water
6. Enable system to operate via natural gas or diesel gas in event of emergency
7. Provide instantaneous power in the event of a utility failure
8. Provide the utility company with an "on-call" system to reduce utility load or grid short falls
9. Maintain entire CHP system at 69.8% efficiency
10. Remove/replace older 12 kV cables



ADDITIONAL FACTS

- The total project cost of upgrading and replacing the existing electrical distribution equipment and installing the CHP equipment was $3 million
- Breakeven point before natural gas price was too high-priced was $9.64/MMBtu
- Heat recovery savings were 1.0¢ -1.5¢/kWhr
- Fairbanks Morse engines met 10 second start-up time requirements for emergency power generation approved by the Wisconsin's Department of Health and Family Services

CHP plant reduces impact of higher energy costs and power quality issues towards future deregulation

Dual fuel Fairbanks Morse engines meet DHFS emergency power and CHP requirements

$223,000 Annual Energy Savings

For further information contact

Energy Resources Center
851 S. Morgan Street
Chicago, IL 60607-7054

Phone: (312) 413-5448
Fax: (312) 996-5620

www.**CHPCenterMW**.org

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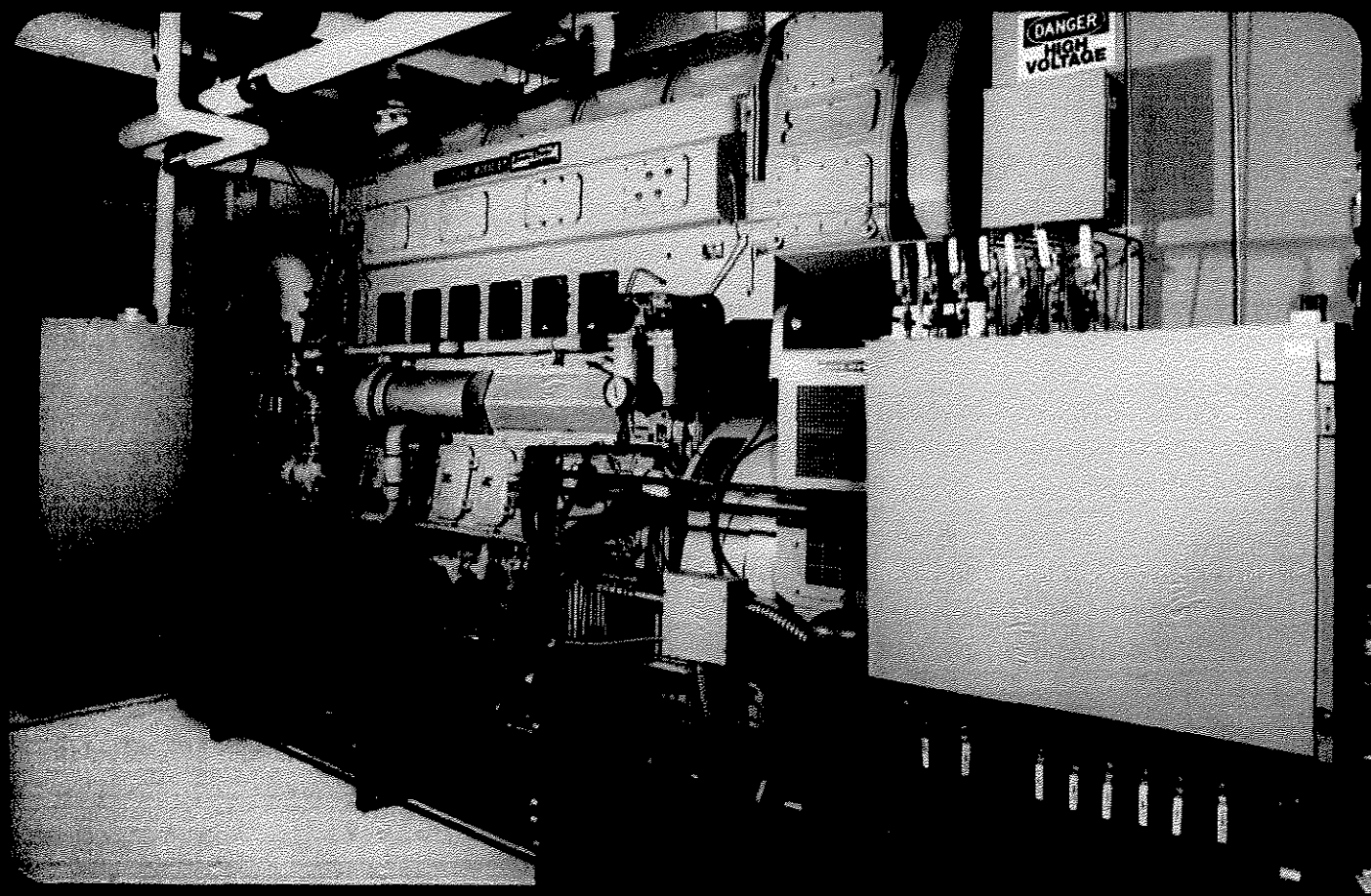
DISTRIBUTED POWER

November/December 2000



Microturbine Interconnection

Cogeneration Projects

Power in the Amazon

New Gas Gen-Sets

A Supplement To:

DIESEL &

HOSPITAL COGENERATES FOR SAVINGS, RELIABILITY

Fairbanks Morse engines help facility meet peaking and emergency power needs

by Mark McNeely

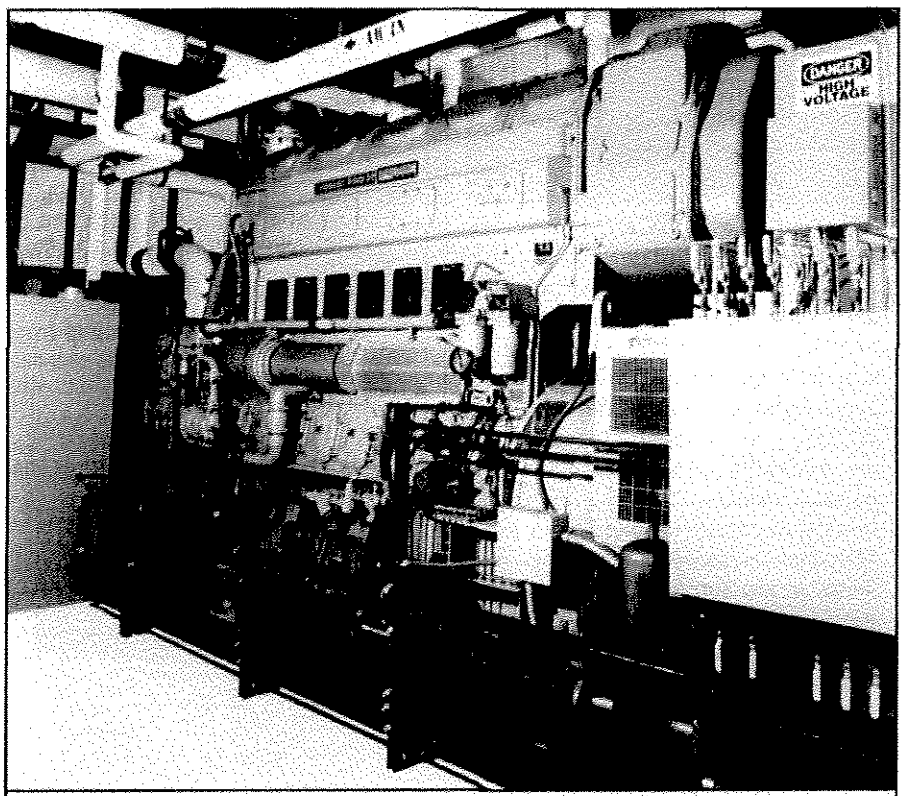
As each of the 50 individual states in the United States marches down its own path to electricity deregulation, more and more private and public institutions are making decisions to ensure their future supply of energy. Various facilities, given their load profiles and energy requirements, lend themselves ideally to the energy efficient use of cogeneration. Whether it is steam or hot water produced as a byproduct, cogeneration plants offer the ability to maximize the given fuel's energy content.

Faced with the need to upgrade its electrical distribution system and address other energy capacity issues, Beloit Memorial Hospital in Beloit, Wisconsin, U.S.A., chose two Fairbanks Morse-powered generator sets as it planned its peak shaving and emergency power improvements. The power plant began operation in June 2000.

"We needed to modernize our electrical distribution system anyway and that was the first issue," explained Philip Larson, director of engineering for the hospital. "Plus I needed additional capacity to meet the hospital's air conditioning requirements."

The hospital's 3000 kW cogeneration plant is based on two Enviro-Design generator sets from Fairbanks Morse Engine Division, also based in Beloit. Two six-cylinder model 38TDD8-1/8 Turbo-Blower opposed piston dual-fuel engines produce 2100 hp (1566 kW) at 900 rpm to drive 480 V Baylor generators each with outputs of 1510 kWe.

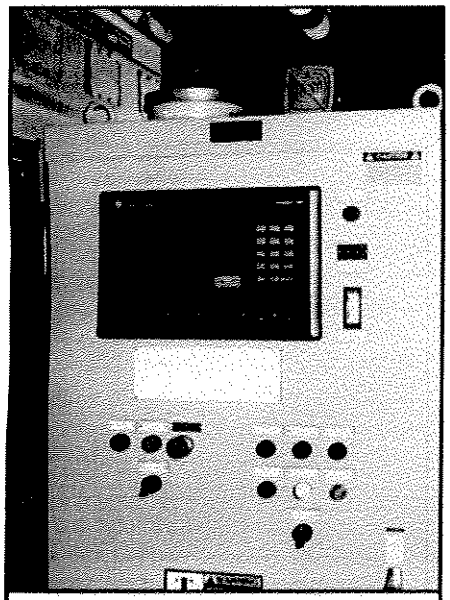
"The Fairbanks Morse engines act as both peaking and emergency power sources for the hospital," said Larson. "Also, we are able to sell electricity, roughly 1000 kW, back to the local utility as well as to help in production of the air conditioning for the facility in the summer and hot water heat for the buildings in the winter. We make our own 434 tons of air conditioning through 250° hot water via a Carrier absorption chiller.



Beloit Memorial Hospital uses two Fairbanks Morse Enviro-Design generator sets to power the hospital's 3000 kW cogeneration plant. The two six-cylinder model 38TDD8-1/8 opposed piston dual-fuel engines produce 2100 hp (1566 kW) at 900 rpm to drive 480 V Baylor generators each with an output of 1510 kWe.

"There were other issues why we did this. Retail competition is certainly on our horizon and when we deregulate my feeling is the quality of power will decrease and the cost will increase. California, this summer, would be a good example of that. There has not been enough electricity during peak demand times," Larson noted.

"The market for these types of installations is increasing due to commercial electricity customers looking for a lower cost energy supply," said Jay Burnette, director



A view of the engine room generator set controls, which feature Allen Bradley PLCs.

of marketing for Fairbanks Morse. "This particular application operates approximately 3500 to 4000 hours per year as a peaking facility, which seems to be the growth market. For our sized reciprocating engines, it is the hospitals, universities and medium-sized industrial companies that appear to be the best fit."

Burnette continued, "In this particular case, the hospital was proactive in recognizing that having their own power producing facility would provide options as electricity competition comes closer to reality. Using their engine generators, in conjunction with supplementing their hot water production, will put them in a tremendous negotiating position with the many potential power suppliers in an 'open access' marketplace."

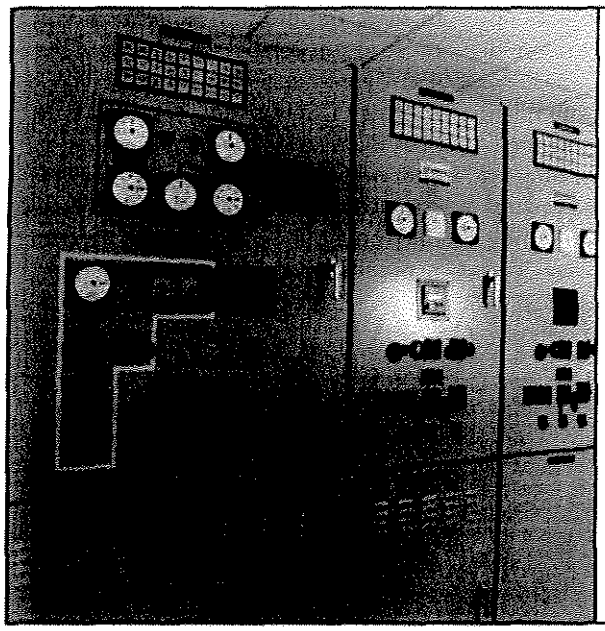
The hospital's electrical distribution system consists of three electrical buses. There is a normal bus, an emergency power bus and the life safety bus. The buses are all supplied from the cogeneration plant, with 100% in back up capacity for the hospital's total needs.

GE-Zenith Controls supplied the paralleling switchgear for the installation. The switchgear is designed to parallel with the utility for peak shaving capability to allow the hospital to take advantage of the utility's curtailment rate. Additionally, the system is designed for automatic standby capability if the utility should fail. In the standby mode, the system automatically operates in two scenarios — it picks up the code-required emergency loads and then adds the entire facility.

The switchgear is supplied with Allen Bradley SLC 504 programmable logic controllers (PLCs) that interface directly between the system control, the generator control and the SCADA monitoring system on the A/B Data Highway. The 480 V system also features a custom utility metering cubicle designed specifically to meet the utilities requirements in order to run parallel with the grid. The 480 V power is stepped up to 12.4 kV.

"There is redundancy," said Larson. "The PLCs are in the engine controllers and switchgear cabinets. Fairbanks is connected to their equipment via a dedicated phone line and modem so they can make any necessary software changes, and as well the GE-Zenith gear is con-

continued on page 18



The power plant's paralleling switchgear was supplied by GE-Zenith Controls. The switchgear is designed to parallel with the utility for peak shaving capability, as well as automatic standby capability if the utility should fail.

nected by phone modem directly to Ballard Engineering so they too can make adjustments."

Other major components in the cogeneration plant include seven ITT Standard plate frame heat exchangers, two Universal silencers, engine intercoolers from Young Touchstone and two UTRI series exhaust heat recovery units from Cain Industries.

Adjacent to the power generation facility, in an outside fenced area, are situated two Amercool horizontal radiator units for the residual engine jacket water and intercooler cooling requirements.

Larson noted, "We recover energy on these engines a little differently because we recover the lube oil, intercooler, jacket water and exhaust gas heat. We try to take all the generated heat in the engine and use that heat for a purpose. That's really what helps improve the payback.

"We added the absorption chiller as part of this project because the hospital was actually several hundred tons short of capacity," Larson continued. "We also make all of our domestic hot water for the building, five days a week, 52 weeks a year from the time we start, around 7:30 in the morning, until we shut down typically about 10:15 at night. That encompasses about 95% of the hot water usage of the buildings during those hours."

The hospital also has three boilers for additional hot water production for the building — two are 22,000 lb/hr (10,000 kg/hr) and one is 6000 lb/hr (2720 kg/hr).

While the dual-fuel Fairbanks Morse engines run primarily on natural gas, diesel fuel is also available as a backup. The boilers are also dual-fuel units typically running on natural gas. The facility has 20,000 gal. (75,700 L) of on-site diesel fuel storage.

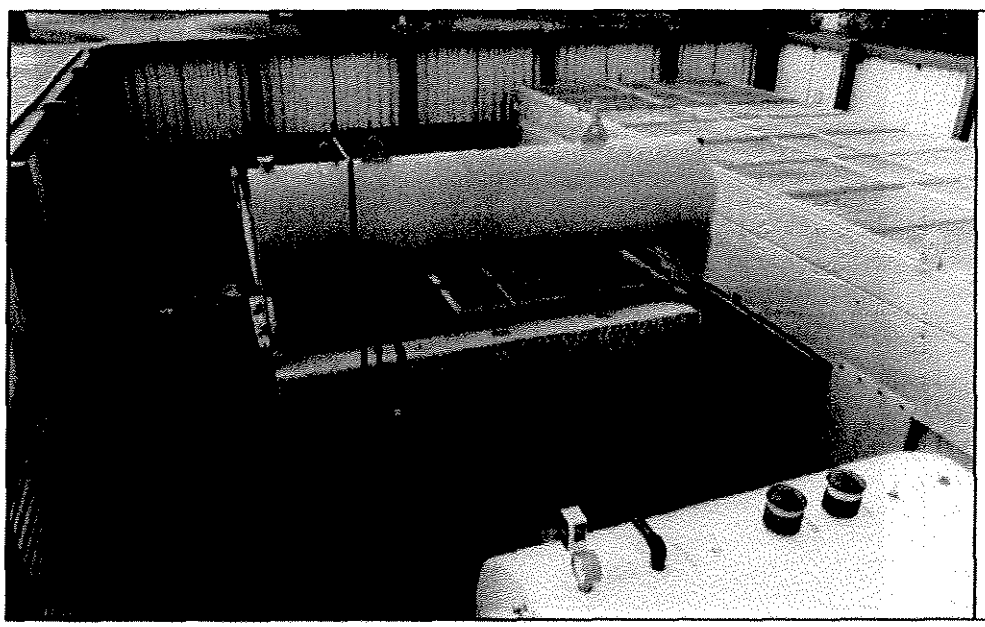
"One of things we liked about the Fairbanks Morse engines was the ease of switching in the dual-fuel mode. Transferring over to natural gas is a matter of turning a switch and we're on natural gas. Since we are an interruptible natural gas customer, the engine's capability to automatically switch over to diesel-fueled operation upon loss of gas supply is one of the large advantages," Larson commented.

Quarterly maintenance on the engines is provided through a service contract by Fairbanks Morse. Maintenance on the switchgear is through Ballard Engineering.

Burnette said, "We would project that these particular engines would operate between 35,000 and 40,000 hours before any major maintenance activities are required."

"We shut down and removed two old 440 kW engines that were part of our original standby power system. One of those was actually a Fairbanks Morse engine that dates some 32 or 33 years," Larson noted. A third engine was also recently taken out of service. ☆

CIRCLE 73 ON READER SERVICE CARD



Adjacent to the cogeneration facility is a fenced area containing horizontal cooling units from Amercool that provide cooling for engine jacket water and intercoolers.