

- Generation for the new millennium

Pembroke Power Station Extension



Built in 2000
for
Bermuda Electric Light Company Limited



by



Burmeister & Wain Scandinavian Contractor A/S

Pembroke Power Station Extension

Project Background

In the spring of 1998, Bermuda Electric Light Company Limited (BELCO) invited tenders to extend their system with two large diesel generators. The new generators will cover a growing power demand and substitute old plant, scheduled to be retired at a later date.

After tendering, technical and commercial clarifications took place over a 2 month period, leading to final negotiations with BWSC for the power station extension with units E5 and E6. Following an intensive contract negotiation period, including technical development of the plant concept and lay-out, BELCO awarded the contract to BWSC in October 1998.

The turnkey contract for the East Power Station extension included a new 34.5 kV high-voltage switchgear building and a 65 m³/h HAGO (Heavy Atmospheric Gas Oil) fuel treatment plant. Reliable operation of the new generating plant is achieved using a state of the art computer

control system, supervising the whole plant. A comprehensive fire detection and fire fighting system ensures the protection of operation and maintenance staff, while also safeguarding machinery and equipment.

The selected MAN-B&W 14V48/60 diesel engines, belonging to the new generation of energy efficient four-stroke technology, achieve not only a significant reduction in running expenses, but also reduce the environmental impact because of their low consumption of fuel and lubricating oil.

BWSC is well known to BELCO as contractor for design, engineering, supply, construction, erection, and commissioning of diesel power plants. In 1984, BWSC was the main contractor of the first phase of the East Power Station and has since then completed several major improvement and upgrading projects to the BELCO generating plant.

Project Implementation

BWSC undertook implementation of the turnkey contract with MAN B&W, Germany, as nominated subcontractor for the generating sets.

In response to the contractual commitment for maximum utilization of Bermudian services, much of the civil work design and construction was subcontracted to local Bermudian consulting engineers and contractors.

Construction work was divided into four major subcontracts:

- Demolition of an old gas turbine building and preparatory earthworks for all the new construction works.
- New powerhouse building with mechanical annex, electrical annex, fuel treatment room, tank farm, and transformer areas.
- New switchgear building, cable installation, and HAGO fuel treatment building.
- New chimney, comprising slip formed concrete windshield and four flue gas pipes.

The site layout, chimney, and cable channels have already been prepared for the installation of two additional generators into the East Power Station Extension.

Mechanical and electrical erection was carried out by BWSC's supervisors assisted Bermudian subcontractors.

Safe and on-schedule pre-testing and starting up of the individual systems were achieved by BWSC test engineers, assisted by test engineers from all the major suppliers of machinery and equipment.

Engine Hall





Control Room

Operation and Maintenance

Operation and Maintenance (O&M) of the Pembroke East Power Station Extension will be undertaken by BELCO.

BELCO has its own operation and maintenance organization, and many of BELCO's staff of technicians and engineers have developed their skills during years of experience both at Phase One, the two-stroke 2 x 12.5 MW diesel power plant commissioned in 1984/1985, and at Phase Two, the four-stroke 2 x 10.2 MW diesel power plant commissioned in 1988/1989.

To ensure that BELCO's staff possess a thorough knowledge of this new generation of diesel power plant, a number of specialized training sessions were provided by BWSC as part of the Turnkey Contract. These sessions were a combination of classroom and hands-on training and were organized during installation and testing of the new diesel power plant.

Summary

Contract	
Type	Turnkey
Contract effective	October 1998
Handing over	April 2000

Technical Data

Diesel Engines

Make	MAN B&W
Type	2 x 14V48/60 4-Stroke
Output	2 x 14,900 kW
Speed	514 RPM

Alternators

Make	ALSTOM Electrical Machines Ltd.
Type	AK 275, brushless excitation
Rating	2 x 18,000 kVA
Voltage/frequency	13.8 kV / 60 Hz
Output at 100% load	2 x 14,400 kW at pf 0.8

Radiator Coolers

Make	LUWA
Type	Horizontal, induced draft
Cooling capacity	2 x 8,911 kW

Fuel Treatment

Make	ALFA-LAVAL
Type	FOPX 611
Capacity	2 x 9.75 m ³ /h at 180 cSt/50 °C
Capacity	3 x 14.5 m ³ /h MDO

Step-up Transformers

Make	BRUSH Transformers Ltd.
Type	ONAN, double wound core
Ratio	34.5 kV and 23 kV / 13.8 kV
Rated power	2 x 18 MVA

Substation

Make	ALSTOM T&D Distribution Switchgear Ltd.
Type	2 x 10 HMXD switchboard panels
Rating	36 kV - 2000 Amp; 31.5 kA at 3 sec

Power Building

Height	14.6 meters
Length	28.0 meters
Width	20.5 meters
Overhead cranes	1 x 30 tons, 1x5 tons
Concrete stack	1 x 60 m (with four flue gas pipes)

Project Challenges

Vibration Control

From previous experience both BELCO and BWSC were aware that the site was very sensitive with regard to the radiation of vibrations to neighbouring residential areas. To ensure that the completed power plant would not be a nuisance to its neighbours, the vibration design requirements were defined as low as 50-260 m μ (1 m μ = 1 milli-micron or 1/1,000,000 mm) measured at the generator foundation baseplate.

To meet these very strict requirements, advanced design modeling was applied and a confirmation study carried out, employing a Finite Element Model of the entire gen-set, including base plate and a portion of the surrounding subsoil, consisting of 61,597 elements. An advanced foundation design was developed utilizing air spring supports to isolate the generator assembly from the foundation baseplate and its surroundings. The diesel engine and generator are mounted on a common concrete foundation block supported by air

spring dampers on a wide foundation baseplate carrying both E5 and E6 generator units.

Noise

As the power station is situated close to residential areas, effective noise control is an important environmental issue. The general sound pressure level requirements were defined at the boundary to residential areas as 50 dB(A) / 70 dB(C), and at the boundary to the industrial areas as 65 dB(A) / 75 dB(C). In addition, the noise limit at one particular location was defined as 60 dB(A) / 70 dB(C).

The guaranteed C-weighted sound pressure levels imposed extraordinary demands on the design of the exhaust gas silencers for low frequency noise. A 1/4 Lambda resonator was installed in order to meet the required attenuation in the exhaust gas system.

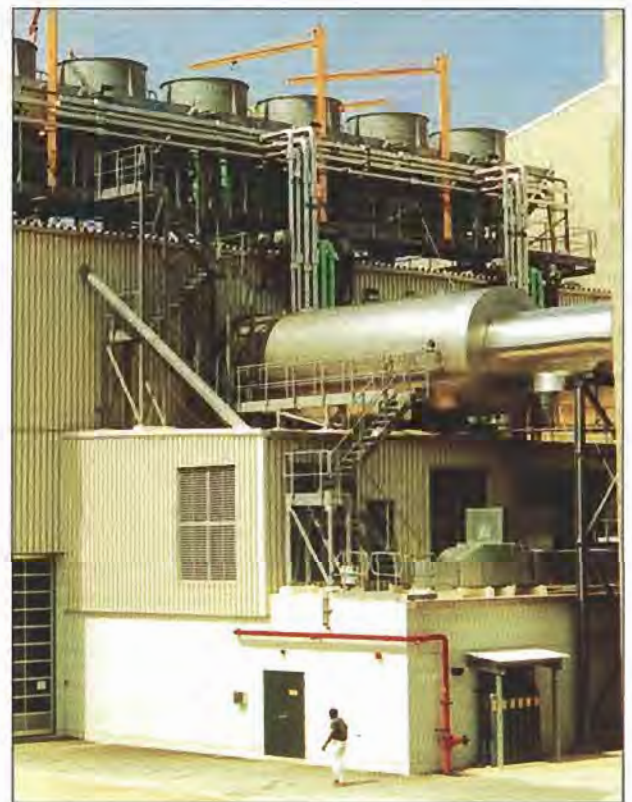
Confined Site Lay-out

With the limited area available within the present BELCO site and the requirement to reserve space for future extensions, it was decided to employ an untraditional lay-out solution with radiator coolers placed on the power station building roof. This feature has also eliminated the risk of hot air recirculation experienced previously on other BELCO units with radiator coolers placed normally on the ground.

Radiator coolers and exhaust silencer E6



Air spring vibration dampers



ScanGrafik AS - 19873 - 6/2000



Burmeister & Wain Scandinavian Contractor A/S

Gydevang 35, P.O. Box 235, DK-3450 Allerød, Denmark

Phone: +45 48 14 00 22, Fax: +45 48 14 01 50, e-mail: sales@bwsc.dk, homepage: www.bwsc.dk