

- Efficient Power for a better Environment

# Guam Piti Power Station



Commissioned in 1999  
for the  
Independent Power Producer



by





# Guam Piti Power Station Project Background

In urgent need of electrical power, the Pacific island of Guam needed a fast and dependable route to additional generating capacity. In 1996, legislators approved Public Law 23-103, enacted to provide for emergency procurement of new power plant.

After fiercely competitive tendering, Guam Power Authority (GPA) awarded the contract for a new 87 MW diesel power plant. The plant would be the island's first Independent Power Producer (IPP) project, and in the autumn of 1996, GPA awarded the Energy Conversion Agreement (ECA) to Enron Development Piti LLC. Enron was made fully responsible for construction of the new plant and chose Mitsui Engineering & Shipbuilding Co. Ltd. (MES) with Burmeister & Wain Scandinavian Contractor (BWSC) as their Turnkey Contractor (EPC).

The new plant would replace ageing and retired generating plant and would support the growing power demand in Guam, caused primarily by increased tourism.

Two-stroke diesel engine technology was chosen because of its well-established record of high availability, reliability and long working life, together with low

specific fuel consumption. In addition to these benefits, two-stroke technology can also meet the stringent exhaust gas emission requirements of the United States Environmental Protection Agency (USEPA).

For this reason the plant is equipped with special features for primary NOx reduction, to bring NOx emissions below the USEPA maximum limit of 950 ppm.

## Project Execution

The project was completed in just 16 months from the issue of the Notice to Proceed (NTP), more than 1 month in advance of the contractual delivery date.

The site is located between an existing power plant and a high-voltage substation. Before starting construction of the new plant, a number of existing overhead lines, underground power cables and other utility systems crossing the site had to be located, isolated and re-routed.

Guam is located in a UBC4 seismic zone (heavy exposure with high magnitude) and is vulnerable to typhoons. Additionally, poor sub-soil conditions compounded the construction problems and special designs were produced for the plant. More than 800 piles had to be driven deep into the sub-soil before the concrete foundation works could proceed and construction could commence.

The relocation and piling works were included in the Turnkey contract and were within the 16-month project schedule.

The plant consists of 2x10 cylinder K90MC-S MAN B&W 900 mm bore diesel engines with full waste heat recovery. Waste heat recovered from cooling water is used for fuel oil heating and a 2.1 MW steam turbine generator is driven by waste heat in the exhaust gas, recovered through an exhaust gas boiler system.

Although Guam is a relatively small island community with approximately 160,000 inhabitants, construction at site - including civil engineering & building works as well as mechanical & electrical installation - has been carried out by Guam contractors. Only specialist assistance has been brought in from abroad.

During construction of the plant the super-typhoon "Paka" hit Guam with world-record windspeeds of up to 236 mph. Luckily, the plant was in the early stages of construction and only minor damage occurred. The project team quickly recovered the situation and achieved construction completion within the original project schedule.



Detail from  
K90MC-S  
diesel engine



Power Generation  
Control  
– Video Display  
Unit (VDU)



## Operation and Maintenance

Operation and Maintenance (O&M) of the power plant will be undertaken by Enron.

Enron recruited operation and maintenance staff well before completion of construction, so that they would be fully trained and working as a team at the time of taking over the plant. A number of specialized training sessions were provided by BWSC as part of the Turnkey contract. These sessions were a combination of 'class-room' and 'hands on' training, partly during construction of the new plant and partly at a similar plant already in operation in the Philippines.

Enron has also entered into a Technical Service Agreement with BWSC for the initial operating period of the plant. Two skilled service engineers are provided by BWSC and are permanently based in Guam to support the Enron O&M organization. A 'flying squad' is also available to assist with major overhauls. An initial comprehensive stock of spare parts has been provided under the Turnkey construction contract.

Further, for the mutual benefit of Enron and BWSC, a Warranty Engineer has been based in Guam for an initial period, to provide prompt support and action on any warranty related issues.

## SUMMARY

### Contract

#### Particulars

Type	Turnkey (EPC)
Contract NTP	30 September 1997
Hand-over	31 January 1999

### Technical Data

#### Net Plant Output

Guaranteed	87,200 kW
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#### Diesel Engines

Make	Mitsui/MAN B&W, Japan
Type	2 x 10K90MC-S, two-stroke
Speed	102,9 rpm
Rating (flywheel)	2 x 45,200 kW

#### Alternators

Make	Meidensha, Japan
Type	TEWAC Slipring Alternator
Inertia	16,000 tm <sup>2</sup>
Voltage/frequency	13.8 kV/60 Hz
Rating	2 x 51,953 kVA
Output at 100% load	2 x 44,160 kW

#### Fuel/Water Emulsifying Plant

Make	Reson A/S, Denmark
Type	Ultrasonic
Capacity (F / W)	2 x 11 / 5 m <sup>3</sup> /h

#### Exhaust Gas Boilers

Make	Aalborg Industries A/S, Denmark
Type	Water tube with super heater section
Steam pressure	6 bar(a)
Capacity	2 x 10,000 kg/h

#### Steam Turbine Generator

Make Turbine	Kühnle, Kopp & Kausch AG, Germany
Make Generator	Leroy Somer
Capacity	2,100 kW

#### Power House

Height	25.7 m
Length	51.2 m
Width	47.2 m
Overhead cranes	2 x 80/10 tons
Steel stack	1 x 62 m (with two flue gas pipes)



# Environmental Protection

Guam is subject to United States governance, and follows guidelines and regulations laid down by the United States Environmental Protection Agency (USEPA).

USEPA established for the plant a maximum allowable NOx concentration in the exhaust gas of 950 ppm (at 15% O<sub>2</sub>). To achieve this in a diesel engine installation, primary NOx reduction using a combustible emulsion of water and heavy fuel oil was considered the best and most efficient available technology. Emulsion fuel significantly reduces maximum combustion temperatures in the engine, resulting in much lower NOx emissions.

Using emulsion technology, water is mixed with the fuel oil as it enters the diesel engine. In order to achieve a homogeneous emulsion, water and fuel oil is fed into a

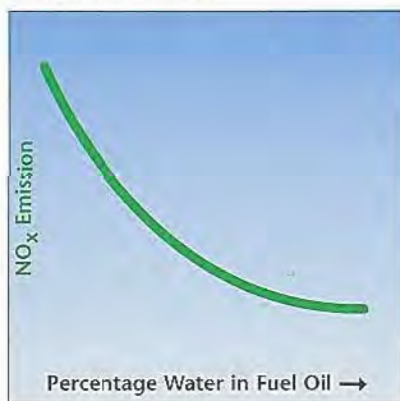
homogenizer equipped with mixing chambers and ultrasonic sound generators. Ultrasonic sound breaks down the molecular bonds in the fluids and allows controlled quantities of water and fuel oil to mix intimately. The homogenizer is adjustable to achieve a water to fuel oil mixture of between 20 and 45%. The water consumption at full load and 950 ppm NOx is approximately 2 x 3.2 m<sup>3</sup>/h.

Emulsion fuel, increases by less than 3.0% the heavy fuel oil consumption of the diesel engines and, based on the verified site test results, achieves a NOx emission level less than 950 ppm. It also ensures that two-stroke diesel engine technology provides a very attractive and competitive solution for power plants operating under strict environmental controls.

*The boiler area*



*NOx/Water relation*



**Mitsui Engineering & Shipbuilding Co., Ltd.**

6-4, Tsukiji 5-Chome, Chou-Ku,  
Tokyo 104, Japan  
Tel.: +81 3 3544 3475  
Fax: +81 3 3544 3063



**Burmeister & Wain  
Scandinavian Contractor A/S**

P.O. Box 235 · DK-3450 Allerød · Denmark  
Tel.: +45 48 14 00 22 · Fax: +45 48 14 01 50  
e-mail: sales@bwsc.dk  
homepage: www.bwsc.dk