**Invitation For Multi-Step Bid**

**No. GPA-013-07**

# PERFORMANCE MANAGEMENT CONTRACT

# FOR THE

# GUAM POWER AUTHORITY
# CABRAS #1 AND #2 STEAM POWER PLANT

**Volume III**

**Plant Technical Description**

**FEBRUARY 2007**

# 1. Introduction

## 1.1. Purpose

The purpose of this Technical Review is to provide technical information about the Cabras Units 1 & 2 generating station to prospective proponents of the Performance Management Contract (PMC). This work is in conjunction with the Volume I Commercial Terms and Conditions, Volume II Technical and Functional Requirements, Volume IV Proposal Scoring Mechanism, Volume V Cabras 1 & 2 Plant Reports and Drawings and Volume VI Appendices documents. This document provides information on the plant's design, historical performance, operation, maintenance activities, future maintenance, capital requirements and condition assessment.

The technical assessment of the Cabras 1&2 Plant relies upon the input from experienced and knowledgeable plant, corporate and support personnel. The information contained in this Technical Review is the Guam Power Authority's best effort at organizing, documenting and describing in their best words the overall condition of the plant equipment. All efforts have been taken to represent the status of the plant as accurately as possible to the prospective proponents. However, although every effort has been taken to represent the plant's condition in a fair manner, not every item or actual condition of some equipment can be represented in this document.

## 1.2. Assumptions and Scope

The review of the description, history and condition of the station and its major equipment and systems was accomplished by performing physical inspections, reviewing documentation and conducting interviews with key plant and support personnel. The review included but was not limited to an assessment of the plant's design and layout, capacity, system redundancy and equipment operations and maintenance (O&M) history. . GPA's current PMC, TEMES, has contributed significantly to the development of this volume.

Historical performance indicators regarding capacity, reliability, availability and heat rate can be referenced in this section. Key station description, historical and condition assessment documents, drawings and procedures were reviewed to gain insight to the plant's overall condition.

The historical documentation of equipment and systems reviews was not intended to be all inclusive, but rather to provide a reasonable perspective of the operating and maintenance history of the plant. The technical review is intended to be a factual description of the facility and refrains from offering conjecture or opinion, except where clearly identified. It is assumed that prospective proponents of this PMC will conduct their own verifying due diligence effort.

## 1.3. Station Description

The Cabras generating station is wholly owned and operated by the Guam Power Authority. GPA completed construction and commissioned Cabras Unit 1 in 1975. Cabras Unit 2 is an identical unit of Cabras Unit 1. It was commissioned in 1976. Both units are rated at a 66,000 kW gross output capacity.

The plant's boilers are Babcock & Wilcox, natural circulation, radiant reheat, El Paso style. Each boiler is rated at 450,048 lbs/hour of steam at 1005 degree F, SH outlet pressure at 1850 psi and RH inlet 451 psi. The boilers primarily burn #6 low and high sulfur fuel oil and light off on #2 diesel.

The turbine generators are General Electric type TCDF, with reheat and dual flow, single low-pressure section. The turbine generator sets were manufactured in Lynn, Massachusetts and are serial numbers 197622 and 197623.

## 1.4. Conclusions

The plant was supplied with equipment from reputable manufactures located in the United States (boiler, turbine, and switchgear) and Asia(feedwater heaters, pumps and transformers). The vast major of the equipment is still serviceable by the respective OEM's and non-OEM vendors.

The station had a considerably had reduced the inventory of spare parts to $3.1 million in line with one of the goals of the PMC The Proponents will have to determine the degree to which all items in inventory will support the current mix of equipment. At present, these warehouse items are not tied to the current CMMS system.

Originally, the Cabras facility was designed and built to support the base load needs of the island. GPA has since added the new slow speed diesels, Cabras 3 & 4 as well as the MEC units 8 & 9. Therefore, the Cabras Steam units now have fallen from the top two positions to the fifth and sixth order in the economic dispatch order. This change in system profile means that the Cabras 1 & 2 units must now swing load on a daily basis to best fit the needs of the GPA system dispatch. This has created new challenges for the staff in order for the GPA system to optimize its fuel costs, driven by the cost of imported oil.

This new operating mode will be one of the challenges to the PMC. The PMC will be required to improve the operation and maintenance activities to allow the equipment to evolve toward an operation fully supportive of automatic generation control (AGC) mode.

Improvements in the operations and maintenance organizations serve to achieve the new operating model. Improvements in plant output flexibility serve to meet system dispatch requirements.

GPA has spent a considerable amount of money in recent years to improve the plant and maintain the quality of the boilers in conformance with the National Board Inspection Code (NBIC) requirements. The historical spending profile section of this review details these efforts.

Both units' boilers have undergone costly condition assessment of the furnace sections. A considerable amount of furnace wall tubing was replaced to improve the boilers reliability. Additionally both turbine generators were overhauled/inspected within the past two and one half years. Unit 2 was overhauled in 1999-2000 and Unit 1 in 2000-2001.

In 1999 and 2000 major non-destructive examination efforts were performed to ensure solid base line data was established. Additionally, thin tubes, which were targeted by the eddy current inspection process, were preventively removed from service to prevent near term failure. Both condensers were 100% tested and all low and high-pressure feedwater heaters were tested 100%. Engineering and Inspection (E&I) of Boca Raton, Florida performed both condenser along with feedwater heater inspections. Details of these test results are available for review by the prospective proponents.

The turbine generators have also undergone extensive repairs in the past six years. The following were highlights of the repairs:

<u>Cabras Unit 1</u>

- In 2006, generator collector ring & ground brushes inspected;
- Turbine explosion diaphragm replaced;
- Turbine low pressure (LP) hood inspected;

Cabras 1&2 maintenance crew performed repairs and inspections with technical representative provided by TEMES.

- In 2004, 21$^{st}$ stage (L-1) & 10$^{th}$ stage (IP-1) blades replacement;
- Seals rings completely replaced;
- Diaphragms repaired;

Diversified Energy Services (DES) performed the repairs, inspection, and rotor balancing. DES also performed the generator NDE inspection.

- In 2003, #3 bearing replaced;
- New stem installed in main stop valve ;
- New stem, disc and pin installed in the #1 control valve;

GPA Central Maintenance performed the repairs with technical representative provided by DES. DES performed the rotor balancing also.

- In 2000, 1st stage nozzle replaced;
- 10th stage (New Design upgrade) diaphragm replacement;
- LP to generator coupling was resurfaced;
- 7th stage blading machined to remove hardened material from rub;
- 10th and 11th stage bucket covers repaired;
- Reheat stop valve seat repaired;
- Main steam stop valve repaired (resurfaced);
- New LP hood water sprays installed;
- Many diaphragms were repaired;
- All new packing and seals were installed;

General Electric opened and closed the turbine and both Diversified Energy services, of Oahu Hawaii and General Electric completed repairs; however, a third party was contracted to correct the mechanical deficiencies by GE and DES.

Cabras Unit 2

- In 2006, governor control valve (#5) major repair;
- Turbine motorized drain valves repair;

GPA Central Maintenance performed the repairs with technical representative provided by TEMES.

- In 2005, L-1, L-2 and 10th stage buckets replacement;
- 11th sage bucket and diaphragm repairs;
- 10th stage diaphragm repair;
- Seal strip replacement;
- Main Stop, reheat stop, reheat intercept and control valves inspection;

TEMES performed the inspection, repairs and HP-IP and LP rotor balancing with technical representive provided by General Electric.

- In 2004, #3 bearing replacement;
- New main stop valve installed;

GPA Central Maintenance performed the repairs with technical representative provided by DES. DES performed the rotor balancing also.

- In 2000, new retaining rings by General Electric;
- New first stage nozzle;
- Main steam stop valve seat;
- Diaphragm repairs;
- New packing and seals;

Diversified Energy Services performed the inspection and repairs with technical representation provided by General Electric.

The most recent heat rate and performance testing values will be provided upon request.

The plant is fired on heavy oil, and lights of with #2 diesel. Both high and low sulfur oils are burned. The low sulfur oil has been used as high as two quarter of the year based on environmental conditions, which dictate the switching of fuels to mitigate environmental issues.

The plant also handles and burns processed oil from a local refinery, Pacific Environmental Resources Incorporated (PERI). The processed oil is collected from through out the island from oil change centers, consumers, maintenance organizations and service stations as well as the waste oil byproducts from the oil cleaning systems at Cabras 3 & 4 and MEC 8 & 9. The processed oil quality is tested and documented by local suppliers prior to delivery at the Cabras site. Currently, the Cabras 1 & 2 Steam Power Plant is the only plant on the island capable of burning this processed oil product.

Major design modifications and upgrades that have occurred in the past 10 years are:

- New air pre-heater rotor assemblies and baskets and seals, Unit 1 in 1990 and Unit 2 in 1996;
- Unit 1 generator was rewound in 1994;
- Unit 2 economizer in 1994;
- Main turbine condenser re-tubing with new tubes in 1994 for Unit 1 and 1996 for Unit 2;
- Boiler water wall tube replacement (U-2 1999 and U-1 2000);
- Units 1 & 2 steam drum replacement of new cyclone separators;
- New Unit 1 air pre-heater cold end baskets and seals in 2000;
- Unit 1, installation of new GE Mark V, digital turbine generator control system in 2000-2001;
- Unit1, economizer replacement in 2001;
- Number 6 oil handling equipment to facilitate automatic switching from high to low sulfur oil when the environmental conditions require the use of low sulfur fuel;
- Units 1 & 2 step-up transformer radiators and fins replacement;
- Waste oil facilities upgrades.

Major equipment repairs that have occurred on the past 5 years are:

- Unit 2, installation of new GE Mark V, digital turbine generator control system in 2002;
- Unit 2, economizer replacement in 2002;
- Unit 1 and 2, condenser lines replacement in 2003;
- Unit 1, make-up water line replacement in 2003;
- Unit 1, air-preheater cold end basket replacement in 2003;
- Unit 1, steam drum, hot & cold reheat and superheater safety valves repair in 2003;
- Unit 1, force draft fan inlet vane replacement in 2003;
- Unit 1, condenser retubing in 2003;
- Deaerator replacement (unit 1 2004 and unit 2 2005);
- Force draft fan rotors replacement (unit 1 2004 and unit 2 2005);
- Unit 1, 1A cooling water pump and service water pump replacement in 2004;
- Air pre-heater baskets, #1 hot end bearing, and seals replacement (unit 1 2004 and unit 2 2005);
- Unit 1, auxiliary transformer refurbishment in 2004;
- New plant service air compressor in 2004;
- New ERV safety valve installation (unit 1 2004 and unit 2 2005);
- Major steam pipe hangers repairs (unit 1 2004 and unit 2 2005);
- Sootblowers repairs (unit 1 2004 and unit 2 2005);
- Unit 2, reheater tube replacement in 2005;
- Unit 2, feedwater heater safety valve replacement in 2005;
- Unit 2, steam drum level gauge replacement in 2005;
- No. 5 high pressure feedwater heater re-tubed with stainless ones (unit 2 2005 and unit 1 2006);
- Circulating water and service water pumps replacement in 2004 (Unit 1) and in 2005 (Unit 2) ;
- Unit 2, start-up transformer replacement in 2005;
- Plant’s fuel oil piping replacement in 2006;
- Plant’s fuel oil daytank API inspection in 2006;
- Unit 1 and 2, attemperator system replacement in 2006;
- Unit 1, condenser retubing in 2006;
- Unit 1 and 2, service water system renovation in 2006;
- Unit 1 and 2, cooling water pump butterfly valves and power cable replacement in 2006;
- Unit 1 and 2, battery charger and uninterrupted power supply (UPS) replacement in 2006;
- Unit 1 and 2, boiler flue duct expansion joint replacement in 2006;
- Unit 1 and 2, air pre-heater assembly refurbishment in 2006;
- Unit 1, safety valve refurbishment in 2006;
- Unit 2, cooling water pump butterfly valves with actuator replacement in 2006;

- Unit 2, boiler feed pumps overhauled in 2006.

The plant was designed with its remote geographic location in mind. Sufficient redundancy in its major auxiliary and support systems to meet the operating requirements of the stations are indicated below in Table 1.

In conclusion, the Cabras generating station offers challenging opportunities in relation to the required operation and maintenance activities inherent in a non-interconnected, island electric generating environment. In general, the plant has a good mix of quality equipment and solid OEM relationships.

Table 1. Major Auxiliary and Support System Redundancy

| Equipment Description | # Of Normal Operating | # Of Spares |
|---|---|---|
| Boiler Feed Pumps | 1 | 1 |
| Ignition Oil Pumps | 1 | 1 |
| Service Air Compressors | 1 | 1 |
| Inst. Air Compressors | 2 | 2 |
| Condensate Pumps | 1 | 1 |
| Heater Drain Pump/Unit | 1 | 1 |
| EHC Pumps/Unit | 1 | 1 |
| A.C. Turbine Lube Oil Pumps/Unit | 1 | 1 |
| Service Water Pumps | 1 | 1 |
| Service Water Heat Exchangers | 1 | 1 |
| Fuel Oil Pumps | 1 | 1 |
| Circulating Water Pumps, 2 per Unit, each Rated at 60% Capacity | 2 | 0 |
| 500 kW Diesel Generator | 1 | 1 |
| 100 kW Diesel Generator | 1 | 1 |

## 2. Site Description And Characteristics

### 2.1. General Location

The Cabras Units 1 & 2 power plant is located on the island of Guam. Guam is the largest and southernmost island of the Marianas archipelago. The westernmost possession of the United States since 1898, the island is at 13.48° north latitude and 144.45° east longitude. Guam is approximately 1,500 nm southeast of Tokyo; 2,100 nm southeast of Hong Kong; 1,500 nm east of Manila; and 3,100 nm northwest of Sydney; 6,000 nautical miles (nm) west of San Francisco; 3,700 nm west-southwest of Honolulu.

The island is composed of both volcanic material and limestone base seabed material from coral deposits.

Guam's climate is tropical marine; generally warm and humid, moderated by northeast trade winds. Guam's temperature ranges between 73 and 90 degrees Fahrenheit (23 and 32 degrees Celsius). It has a mean annual temperature of 81 degrees (27 degrees C). May and June are the hottest months of the year. However, there is little seasonal temperature variation.

The coolest and least humid months, December through February, are marked by prevailing westerly trade winds. The average humidity varies from an early morning high of 86% to an afternoon low of 72%. The high moisture content of the atmosphere during the rainy season, combined with the warm temperatures, contributes to the rapid deterioration of manufactured materials through rust, rot and mildew.

The average yearly rainfall ranges between 90 and 110 inches (229 and 279 cm). There are two seasons, the dry and the rainy. The dry season (fanumnangan) lasts from December through June. The rainy season (fanuchanan) prevails within the remaining months. Guam's subterranean water lens supplies fresh water far in excess of the island's present needs.

### 2.2. Site Location and Description

The Cabras generating station is located on the west central side of the island of Guam in Piti, Guam on a landfill over what was Cabras Lagoon and Cabras Island. The plant is accessible from highway 1 and is located on the main road to and from the island's only commercial shipping seaport. The units' basement level is located approximately 6 feet above the mean sea level of the Pacific Ocean.

The remainder of the Cabras site has the Units 3 & 4 and their associated common structures such as oil storage tanks. Oil storage tanks for Cabras 1 & 2, Central Maintenance facilities, Generation Engineering support, Central planning support, Waste Oil processing facility, Central Laboratory Building, Units 1 – 4 Switchyards, Central Parts Inventory and System Dispatch Center are also located on the same property.

### 2.3. Transmission Line Interface

The power plant is interconnected to the GPA transmission network via four 115kV transmission lines:

- Cabras-Agana 115 kV Line #1;
- Cabras-Agana 115 kV Line #2;
- Cabras-Piti 115 kV Line;
- Cabras T-300 115/34.5 kV Interchange Transformer

The vast majority of the power produced on the island is at the Cabras-Piti Complex. Out of a total installed gross capacity of 555.4 MW, 340 MW is sited at the Cabras-Piti Complex. Other peaking combustion turbines and black start diesels are strategically located through out the island and interconnected via various high voltage transmission lines.

Each of the plants' units is protected by an existing generator unit-tripping scheme. This scheme will trip each unit as required to prevent instability of the system as well as overload conditions.

### 2.4. Community

The island has a population of approximately 156,000 people excluding tourists. Tourism, the number one business of Guam, adds approximately 15,000 at any time to the island's total at any given time.

The United Stated military has a presence on the island. The Andersen Air Force base is located at the island north end. The US Navy has a small operation only two miles from the Cabras site.

The US Navy recently turned over the operation of the shipyard to a private contractor. The private contractor has a multi-year contract to operate the shipyard, primarily in support of the Navy ship repair. This facility has tremendous maintenance equipment and capabilities as would be expected of a remote ship repair facility. This facility if utilized properly could be a strategic asset to the PMC contractor in that, maintenance alliances and services may be developed to support various aspects of the facilities maintenance needs.

The station personnel are government employees. The employees earn vacation based on time worked and seniority.

Employees are encouraged to support various community activities such as government-sponsored programs, parades and events such as the recent South Pacific Games held on Guam in 1999.

A variety of local vendors supply important services to the site as follows:

- Rental Equipment;
- Electrical and Mechanical Parts;
- Various Tools and Consumable Materials;
- Janitorial Services;
- Welding and Machining Supplies;
- Hardware Supplies;
- Construction Equipment;
- The Former US Navy Shipyard Maintenance Facilities with Tremendous Machining and Repair Capacity.

Employees are active with the following community affairs: Liberation Day (GPA sponsored float in parade), Labor Day Government of Guam Picnic, Military Reserves, GPA Public Power Week and associated island wide clean-up activities, GPA sponsors Fitness & Wellness program where an employee can use three hours of the normal base 40 hours each week to exercise and receive normal pay.

### 2.5. Site Map

Site maps will be provided upon request.

### 2.6. Site infrastructure

#### 2.6.1. Utilities

The station's utilities include potable water, electric power, communications and sewage discharge lines.

##### 2.6.1.1. Domestic Water

Domestic potable water is provided to the plant by the US Navy reservoir located near by. This source of water is used for the demineralizer water treatment facility and all other potable needs. The same water supply charges the fire hydrants on the plant property and no plant booster pumps are required. Domestic potable water is also used in areas of the plant where the closed cooling water system cannot meet the flow requirements.

##### 2.6.1.2 Station Electrical

The auxiliary power system for the Cabras 1 & 2 plant consists of the following equipment:

- Two 13.2 kV/115 kV step-up main transformers (East and West);
- Two 4160 V auxiliary transformers;
- One 34.5 kV start-up transformer;
- Three 480 V power center transformers.

Table 2 contains a description of the aforementioned transformers.

Two 13.2 kV/115 kV step-up transformers, one for each unit, serve to export power out of the Cabras 1&2 power plant.

Part of each Cabras steam power generator's electrical power production at 13.8 kV is diverted to the each unit's auxiliary transformers to provide station power to the plant. The auxiliary transformer is connected to the generator before the main transformer. At the auxiliary transformer, the voltage is stepped-down to 4160 V. This energizes the 4160 common, 4160 Unit 1 or 2 MC, and the power center transformers.

Each unit's potential transformer energizes the plant's instrumentation such as the var, watt, and watt-hour meters. These potential Transformers are located in the basement area and step down the 13.8 kV voltage to 120 V.

As an alternate source for emergency power, the station start-up transformer is tapped off the 34.5 kV line leading from the 115-kV/34.5 kV power interchange transformer to the Piti 34.5 kV substation. The start-up transformer provides an alternate black start capability via the 34.5 kV transmission system down to 4.160 kV.

### 2.6.1.3. Station Lighting

Station Lighting consists of all interior lighting and outside lighting 180 degrees on the left side of the Cabras 1 & 2 plant. The main panel breaker for most of all the lights is located on the operating floor, next to the stairway in front of the control room area. This is a newly installed breaker panel replacing and relocating the original plant panel.

From the main and the individual breakers, the circuits branch out to various smaller breaker panels scattered throughout the plant.

Table 2. Cabras 1 & 2 Plant Transformers

| Name | Location | Quantity | Input Source | Input Voltage | Output Voltage | Equipment | Historical Maintenance Record |
|---|---|---|---|---|---|---|---|
| 54 Main Transformer | Outside Building Perimeter | One transformer per unit | Generator | 13.8 kV | Stepped up to 115 kV | Provides power to IWPS on 115 kV East and West Buses | Maintenance performed by T&D substation. |
| 56 Auxiliary Transformer | Outside Building Perimeter | One transformer per unit | Generator | 13.8 kV | Stepped down to 4160 V | Provides Station Power to plant and to Power Center Transformer | Maintenance performed by T&D substation. |
| 55 Power Interchange Transfer | Cabras Switch Yard | | 115 kV Buses | 115 kV | Stepped Down to 34.5 kV | Goes to Piti Power plant | Maintenance performed by T&D substation. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 57 Start up Transformer | Outside Building perimeter | One transformer | Piti substation | 34.5 kV | Stepped down to 4160 V | Alternate power source for start up. Common bus 1&2 tie in for station power | Maintenance performed by T&D substation. |
| 58 Potential Transformer for Generator | Basement Area (Below generator) | One per unit | Generator | 13.8 kV | Stepped down to 120 V | Generator controls: Wattmeter, Variance, and Watt-hour meter. | |
| 69 Power Center Transfer | Operation Floor | Three (Cabras unit #1, #2, and Common) | Auxiliary Transforme r | 4160 V | Stepped down to 480/277 V | 480 Power Centers | Performed Cleaning of internals in 1997 and 1998 |

#### 2.6.1.4. Emergency Generators

Cabras 1 & 2 presently have two emergency generators located in the plant’s basement area.

One generator is the 500 kW generator installed in 1997. The 500 kW generator is connected to the 480 V common 3-phase panels providing plant lighting and power to various plant equipment.

The second generator is a 100 kW generator.

#### 2.6.1.5. DC Batteries

Cabras 1 & 2 DC Battery systems consist of two 60 cells battery banks, one per unit, located on the mezzanine floor. One set was replaced in 2007 The second set was taken from the Power System Control Center (PSCC or Dispatch), and is approximately 11 years old from the time it was taken.

The DC batteries provide 125 VDC (100 Amps) power via the 125 VDC distribution bus panel located on the mezzanine floor.

The batteries are re-charged by a GUTAR battery charger located next to the 125 VDC distribution bus panels.

Replacement of the second set of batteries is still pending.

#### 2.6.1.6. Communications System

The plant is equipped with both telephones and a plant Gia-Tronics paging system. Currently the paging system required extensive maintenance or replacement in the near future.

## 2.7. Incident Mitigation Capabilities

The plant has a series of Standard Operating Procedures (SOP) which are employed GPA wide. The following SOP's pertain to these issues:

- SP-049 Tropical Cyclone Emergency System Restoration (ESR);
- SP-050 Oil Spill Containment, Clean-up and Reporting;
- SP-057 Supplements I through VII to the Hazard Communication Program;
- SP-063 Hazard Communication Program;
- SP-067 Employees Hazard Reporting;
- SP-088 Emergency Condition (Support Services Section).

## 2.8. Fire Hazard Mitigation

### 2.8.1. Station Fire Protection System Descriptions

The fire alarm and protection system has been upgraded at the plant.

#### 2.8.1.1. Fire Pumps

The newly upgraded system includes an electric driven "Jockey pump" to maintain system pressure to the plant header system. In the event that the system pressure drops, indicating high demand such as in fighting a fire, the diesel driven main pump will automatically start-up providing the required capacity and pressure to the new header system.

#### 2.8.1.2. Back Up Fire Water System

The plant will have four major six-inch diameter headers installed. Two headers will run vertically in each unit to a series of hose stations. The fire fighting system is manually controlled and operated. Multiple pull stations will be installed tied to the alarm system. The new system employs an automatic deluge or sprinkler system for fuel oil pumps located in the basement.

#### 2.8.1.3. Hydrants and Piping

The Cabras facility is equipped with a variety of permanently installed fire hydrants. Most fire hydrants are located around the perimeter of the facility by the access roads. The fire hydrants are tied to the Guam Water Authority water lines and are always under pressure through their system series of towers and storage tanks.

#### 2.8.1.4. Automatic Sprinkler Systems

No automatic sprinkler systems are employed at the Cabras 1 & 2 plant. Fire protection is available from the hose reels and hydrants located outside of the power block.

#### 2.8.1.5. Locally Mounted Fire Extinguishers

Fire extinguishers are located in the battery room, relay room and in various locations through out the plant.

#### 2.8.1.6. Spray Nozzles

Spray nozzles and hose reels are located throughout the plant. No automatic fire sprinklers or sprinkler heads are part of the facility.

### 2.9. Security Operations

The GPA safety department protects the plant and other locations are responsible for:

- Station access and control (Provided through a local security company);
- Emergency incident and alarm response;
- Incident investigation;

The GPA transportation and plant are responsible for station vehicle and locker control.

### 2.10. Support Structures and Facilities

This section provides a description of the following support facilities:

- Central Maintenance;
- Peripheral facilities;
- Power System Control Center;
- Fuel Management Facility;
- Cabras 3 & 4 Slow Speed Diesel Plant;
- Warehouse operations;
- Generation Administration, Engineering and support offices; and,
- Parts inventory storage.

Approximately 22 personnel are assigned to the Central maintenance group, two are assigned to the fuel management and approximately 12 are assigned to the Central dispatch center.

One person is assigned to the warehouse operation, two assigned to the waste oil facility and 35 are assigned to the Cabras 3 & 4 facility. At any given time contract and support personnel can be located on site in support of unit overhauls, construction, upgrade or maintenance related projects.

#### 2.10.1. Intake and Discharge Channels

GPA constructed the approximately 30 feet wide and 10 feet deep intake channel.

The intake inlet runs from the west side of the Cabras Island, under the port and plant access road to the inlet of the traveling screens. Dredging was last performed in 2003. Plan to continue this work in 2008. This activity will continue to be the responsibility of the GPA in that Cabras 3 & 4 requires inlet water to support their operation.

### 2.11. Emission Monitoring and Reporting

#### 2.11.1. Continuous Emission Monitoring System (CEMS)

Presently, Cabras 1 & 2 monitor opacity. The plant uses an opacity monitor manufactured by Photomation (model: DSM-1PB). The company Photomation is defunct, but a company called Optomonitor, Inc still supports the product line.

In anticipation of the U.S. Environmental Protection Agency's Title V regulations, sampling of the flue gases produced by the generating units will have to be taken to support proposed boiler efficiency changes.

#### 2.11.2. Water Discharge Monitoring and Reporting

Guam Power Authority is mandated to comply with the Clean Water Act (33 U.S.C. 1251 et seq., the "Act"). This requires GPA to apply for environmental permits for water discharge from the Cabras 1 – 4 power plants into the Piti Channel, Apra Harbor. This involves considerable work with effluent limitations, monitoring requirements, other general conditions and conditions under EPA Region IX Standard Federal National Pollutant Discharge Elimination System (NPDES) Permit Conditions. GPA presently holds permit number GU0020001. This permit became effective on January 30, 2001 and expires January 30, 2006. GPA has submitted in March 2006 for renewal but we are still waiting for USEPA approval

Effluent limitations are applied to cooling water and storm water discharge. GPA Cabras 1 & 2 lab personnel conduct monthly monitoring and sampling for flow, temperature at receiving water and influent/effluent areas, fluoride and pH. A third party contractor provides sample testing.

The current limits subject to USEPA approval for cooling water discharge required the temperature change of the received water, to not exceed 1.0 degree C. on a daily and average monthly basis. Fluoride must not exceed 1,350 kg/day or 1.5 mg/l per day. The pH of the effluent shall not be less than 7.0 standard units or greater than 9.0 standard units and shall be within 0.5 standard units of natural conditions at al time. Other than pH, which is monitored weekly, all other characteristics must be monitored on a monthly basis, sampled by the plant and taken to a contracted testing company.

Storm water discharge is monitored and sampled for flow, suspended solids, oil and grease, fluoride and pH by GPA Cabras 1 & 2 plant personnel. Like cooling water discharge, samples for storm water are also tested by a contracted testing company, presently Raytheon. Limitations include suspended solids not to exceed 50 mg/l per day; oil and grease shall not exceed 20 mg/l per day and 15 mg/l on an average monthly basis. The pH levels shall have the same limits as the cooling water discharge. GPA is also required to continue the Water Quality Monitoring Plan for thermal discharge, which was a previous requirement to the additional discharge due to the operation of Cabras 3 & 4.

Other general conditions ensure other pollutants are not released through the plant discharge. These conditions restrict discharge from being unaesthetic, detrimental to or adversely affect aquatic life, and /or toxic or harmful to humans, animals, plants or aquatic life. As well, there is no allowance for discharge of polychlorinated biphenyl compounds or chlorine.
Under the permit conditions GPA must also monitor low-volume waste, monthly for oil and grease, conduct quarterly toxic testing of organisms exposed to the effluent and develop and implement storm water "Best Management Practices" (BMP), plan. The permit does include guidelines for testing, required BMP's, non-compliance reporting procedures, as well as remediation requirements.

Toxicity sampling and analysis is contracted to Environmental Monitors, located in Maina, Guam. All sampling and testing contracts are handled by the Cabras power plant. All monitoring, sampling and testing reports from the Cabras 1 & 2 planning and Regulatory Section, for the submittal of the monthly and quarterly compliance reports both EPA and Guam EPA.

## 3. Process & Equipment Description

Initial operation of the Cabras generating station unit 1 & 2 began in 1975. Each unit is rated at 66 MW net. The plant is situated on a small track of land on the islands west central side. The following is a description of the plant's major equipment, systems, the major historical events and the overall condition assessment of the equipment.

### 3.1. Boiler and Related Systems

Description of equipment and system: The Babcock & Wilcox, (B&W) boilers are natural circulation, radiant style, pressurized, oil fired, and indoor units. The design pressure is 2,225 psig (nominal) at both the economizer and furnace. The superheater design outlet pressure is 1,850 psig. The reheater outlet pressure is 424 psig. The economizer inlet design temperature is 454 degree F.

The superheater design steam flow is 450,048 lbs/hour. The reheater has a design steam flow of 376,013 lbs/hour. The air preheater design outlet temperature is 334 degree F.

This section and subsections describe specific major equipment for the Cabras Unit 1 & 2 Steam Power Plant. The last boiler condition assessment studies for both units were completed in 2003 (unit 1) and 2004 (unit 2). B&W performed the assessment for unit 1 and Taiwan Power Company for unit 2.

### 3.1.1. Steam Generator Arrangement

Description of equipment and system: Table 3 provides a summary of the heating surface in square feet, of the major boiler components.

Table 3. Major Boiler Component Heating Surface Area

| **Boiler Component** | **Heating Surface Area (square feet)** |
|---|---|
| | |
| Boiler | 5,995 |
| Furnace | 4,262 |
| Saturated Superheater | 260 |
| Primary Superheater | 16,300 |
| Secondary Superheater | 2,864 |
| Reheat Superheater | 6,265 |
| Economizer | 10,105 |

### 3.1.2. Fluid flow Path Description

***Description of equipment and system***: Preheated feedwater from the low and high-pressure feedwater heaters enters the boilers economizer section under pressure from the boiler feed pump. The feedwater from the economizer outlet enters the lower portion of the steam drum, below the water line. The pumping action that produces this flow is created in natural circulation boilers by the force of gravity acting on fluids of different densities. The downcomers contain a saturated or sub cooled water while the generating or riser tubes contain a lighter steam and water mixture. The mixture leaving the riser normally contains 5% to 20% steam by weight, depending on the pressure and load on the boiler.

Feedwater entering the steam drum mixes with the existing saturated water and flows down through the downcomers located outside the hot gas passes or, in some cases, in the coldest gas pass. Water from the downcomers is distributed to the generating tubes via lower headers and the drum. Heat applied by radiation and convection to the generating tubes causes boiling of the fluid in the tubes. Circulation will increase with heat input until the pumping pressure equals frictional and other losses.

The primary purpose of the furnace is to provide a gas-tight enclosure for the complete combustion of fuel. Since complete combustion is essential for efficient, smoke free, operation, the furnace and the fuel burning equipment must provide the three basic conditions for complete combustion:

- Temperature to support combustion;
- Turbulence to bring air into contact with unburned fuel;
- Time in the high temperature and turbulent zone for combustion to be complete.

These key variables are reviewed to remind the potential proponents of the importance of the boilers proper operation while burning both normal #6 fuel oil as well as the waste oil streams that are required of these units.

Completing the boiler water cycle is the steam drum where the steam-water mixture is separated by internal baffling and cyclone separators. This separated saturate steam is then processed to the primary superheater, then the secondary superheater prior to being processed to the turbine.

***History***: Unit 1 boiler suffered from a major explosion in 1990. Repairs were made in phases – phase 1 was immediate repairs to allow it to return to service and phase 2 was long term integrity repairs which were undertaken 3 years later. Both boilers have been the reason for the plants' high equivalent forced outage rate (EFOR). Both have suffered repeatedly from arch and furnace tube failures due to heavy internal deposits that resulted in overheat and often caused hydrogen damage. The root cause of this problem was condenser leakage allowing salt water into the boiler during operation.

***Condition Assessment***: Both boilers have undergone several inspections within the past 7 years. Cabras Unit 1 inspected in 2000 and 2003 by Babcock & Wilcox, in 2001 by Edison O&M, in 2004 by USSI, and in 2006 by Smithbridge. Unit 2 in 2001 by Babcock & Wilcox, in 2002 by Edison O&M, in 2004 by Taiwan Power Company, in 2006 by Smithbridge. Because of these inspections, major furnace and arch way tubings were replaced or repaired by GPA Central Maintenance section. Proposed proponents of the Cabras facility should review the B&W repair reports dated May 2000 (Unit 1), and June 1999 (Unit 2) to fully understand the as found and newly repaired condition of these boilers.

### 3.1.3. Boiler General Arrangement and Major Components

#### 3.1.3.1. Economizer

***Description of equipment and system***: The single counterflow economizers are 71 elements wide. The total surface area is 10,105 square feet.

***History***: The unit 1 boiler economizer suffered chronic tube failures that were rectified by plugging off each affected tube at the inlet and outlet headers. The section was replaced in 1995 and the headers tube stubs were repaired in 2003. It was similarly replaced on unit 2 for the same reasons in 2001. The headers and more sections were replaced in 2002.

***Condition Assessment***: Both units' economizers are relatively new and should have many years of acceptable performance available.

#### 3.1.3.2. Furnace Walls

***Description of equipment and system***: The furnace wall tubes is generally where fuel combustion and cooling for the combustion products take place and also provides much of the steam generating surface in the boiler.

***History***: Both units have suffered repeatedly from furnace and arch way tube failures due to overheating and hydrogen damage. In order to improve the reliability of both boilers, GPA had extensive repairs performed after every inspection of the furnace and arch way tube. Babcock & Wilcox, of Barberton, Ohio, repaired unit 2 in 1999 – 2000 and Unit 1 in 2000 – 2001. The determination of repair requirements first used the nondestructive examination techniques referred to as FST-GAGE and FHyNES. Both inspection techniques scanned 12,800 linear feet of water wall tubes on both units. To ensure complete coverage of the tubes, a triple scan (left-to-right) was performed on each tube resulting in approximately 38,400 linear feet of scanning. All of the welds and bends in the inspection area were inspected using the FHyNES test technique and T&R transducers.

Unit 1 was inspected from May 8 through May 14, 2000. Unit 2 was inspected from June 17 through 24, 1999. Each boiler had several hundred feet of tubing replaced. The Babcock & Wilcox reports of June 1999 and May of 2000 contain complete details of these repairs.

***Condition Assessment***: The Babcock & Wilcox reports provide considerable detail of every tube as tested. These reports form the basis of an excellent base line for future comparative analysis. The information can further provide condition assessment input to the suspected proponent of this facility. Both boilers underwent complete chemical cleanings shortly after the major repairs and with good water chemistry control, should be good for several years of reliable service once other boiler components are repaired or replaced.

#### 3.1.3.3. Roof Tubes

***Description of equipment and system & History***: The roof tubes and penthouse sections of both boilers are all original. The refractory seals in the penthouse were replaced in recent years. B&W employees during the 1999 and 2000 inspection and repair activities inspected these components for each boiler. GPA Central Maintenance section performed refractory repairs on unit 1 in 2003 and on unit 2 in 2004.

***Condition Assessment***: No NDE testing or tube samples have been performed on this section of the boilers.

#### 3.1.3.4. Superheater

***Description of equipment and system***: The boiler superheater section has two major components: the secondary and primary superheater. These sections of the boiler are horizontal in nature and designed to be self-draining. The superheater is the highest heat transfer component of the boiler.

***History***: The Unit 1 secondary superheater was replaced by B&W in 1987 to further increased the main steam temperature. All other secondary and primary superheaters are original.

***Condition Assessment***: NDE inspection was performed by B&W on unit 1 in 2003 and unit 2 in 2004 by Taiwan Power Company. The secondary and primary are still in good conditions.

#### 3.1.3.5. Reheater

***Description of equipment and system***: The reheater section of each boiler returns the steam temperature back to the designed 1,000 degree Fahrenheit. This helps to match the steam temperature of the main steam as both enter the high-pressure steam chest of the turbine.

***History***: Both units' reheaters suffered from plugged tubes due failures within the banks.

***Condition Assessment***: Eight of the bad tube bundles were replaced by Central Maintenance Section in 2005 on unit 2. The reheater tubes for unit 1 still required repairs.

### 3.1.4. Boiler Casing and Flue Gas Ducts

***Description of equipment and system & History***: In general the boiler flues and ducts are in serviceable condition. The two expansion joints in the flue area are packed with fly ash requiring basic repairs.

***Condition Assessment***: No major components are in need of major repair. The expansion joints were replaced in 2006 for both units.

### 3.1.5. Burners

***Description of equipment and system***: The boiler is equipped with the original B&W, Racer 10Y-41-53-4-80 burners. The burners are equipped to be both steam and air atomization. Each burner has a capacity of 9,610 lbs/hour.

***History***: There are four burners per boiler. The burners were originally located in the lowest two rows, that being the "A" and "B" elevations below the NOx ports. However, due to low steam temperatures, the NOx ports were converted into burners by relocating original lower burners into the ports in approximately 1970. The boiler is started-up on the "B" row of burners. The boiler is initially ignited with #2 diesel oil. The Forney burner controls are currently in use with the boiler. The original windbox dampers before the burners were removed at B&W's recommendation many years ago.

***Condition Assessment***: General inspections of the burners are conducted in conjunction with the B&W boiler inspections. Heavy wear on the burner tips is being experienced due to the processing of waste oil in the boiler and improper fuel temperature treatment.

### 3.1.6. Steam Drum and Internal Components

***Description of equipment and system***: The steam drum separates saturated steam from the boiler water, such that it may be processed to the boilers primary and secondary superheater. This steam quality is important to the safe and reliable operation of the turbine.

***History***: The operation of the boiler with poor water chemistry has impacted the steam drum like that of the furnace wall tubes.

***Condition Assessment***: The steam drum internal moisture separators, cyclones and moisture separators were replaced on unit 2 in the early 1990's. The steam drum internal components for Cabras Unit 1 were also replaced in 2000. Internal and external surface cracked detection was conducted by B&W on unit 1 in 2003. The B&W reports document this issue.

### 3.1.7. Boiler and Major Valves

#### 3.1.7.1. Boiler Control and Stop Valves

***Description of equipment and system***: The boiler is not equipped with a main steam outlet stop valve. The turbine main stop valve serves this requirement in conjunction to protecting the turbine. The boiler's SH & RH single spray water attemperator valves help to trim the steam temperatures to the turbine from the boiler.

***History***: Both turbine main stop valves were disassembled, inspected and repaired in conjunction with the two most recent turbine inspections. Both valves are in serviceable condition.

Both SH and RH spray water attemperator valves were replaced for both units in 2006.

New boilers feed pump minimum flow recirculation valves were installed on Unit 1 in 2000.

***Condition Assessment***: Both main steam stop valves are in working order.

#### 3.1.7.2. Boiler Safety Valves

***Description of equipment and system***: Each boiler steam drum is equipped with a pair of safety valves. These valves are critical to reliable and safe operation of the boilers.

***History***: In 1998 Arakaki Mechanical of Hawaii replaced the steam drum safety valves for Unit 2 with new valves. In 2000, Babcock and Wilcox of Barberton, Ohio replaced the steam drum safety valves for Unit 1 with new valves. Additionally the superheater outlet safety valve was replaced on Unit 1 in 2000. Recently, the valves were dissembled, inspected, and repaired by Basin Valve Company in 2003 (unit 1) and in 2006 (unit 2).

***Condition Assessment***: All safety relief valves are in good condition. Originally, both boilers were equipped with Electromatic relief valves. These valves were high maintenance and were blanked off and not available for service but new valves were installed in 2004 (unit 1) and in 2005 (unit 2) and placed back in service.

### 3.1.8. Boiler Controls and Instrumentation

***Description of equipment and system***: The original boiler control system is currently in service. The Bailey control company provided this original system. The series of equipment is the Mini-line unit, which is responsible for the air system steam temperature, feedwater control and the Forney burner controls. In addition to the Bailey Mini-line boiler control system, Cabras utilizes a flame detector cooling air blower, by the Buffalo Forge Company. The type 3 RE L-1008 blower has a capacity of 250 CPM and an outlet pressure of 31.8 inches. A 5 HP, 460-volt motor powers this blower. This blower turns at 3600 RPM.

***History & Condition Assessment***: The Mini-line system has been a good performer over the years, however replacement parts are becoming difficult to obtain since the manufacture no longer supports this vintage system. With this in mind, GPA is investigating the possibility of replacing the current control system with a new digital control system

### 3.1.9. Air Preheaters

***Description of equipment and system***: The air preheaters along with the unit’s steam inlet coils help to preheat the boiler air to precombustions levels. This equipment plays an important aspect on the units’ heat rate and levels of performance.

***History***: Each boiler was originally equipped with two Ljungstrom, regenerative type 17 HS X 44 air preheaters. These air preheaters were replaced in their entirety in 1990 on unit one and 1996 on unit 2, with type 17HSX series equipment. Each air heater has a total heating surface area of 30,800 sq. ft.

Each boiler also has a pair of ASNF copper fined steam preheaters manufactured by Aerofin Company.

***Condition Assessment***: Like new cold end baskets were removed from a unit at the nearby Piti power plant, modified and installed in unit one in 2000 during the major boiler and turbine overhaul. After inspecting of the air preheaters in the 2003 unit 1 major boiler and turbine overhaul the baskets were found to be significantly deteriorated and were replaced with ones from Piti again, but these baskets were not the right ones so it was recommended by B&W to replace these baskets with the proper new ones. These baskets and seals were replaced in 2004 with the proper ones. Unit 2 baskets were badly corroded and also seals were leaking. These were replaced in 2005

### 3.1.10. Sootblowers

***Description of equipment and system & History***: The sootblowers keep the internal heat exchange surface areas of the boiler clean. This greatly facilitates the efficient exchange of heat from the fuel to steam. There are seven sootblowers for each boiler and two for the air preheaters. The boiler utilizes five type IK-525 and two IK-525-EL sootblowers. The sootblowers use steam from the boilers drum at a maximum of 600 psig for the boiler and 200 psig for the air preheaters. Diamond Power/B&W manufactured the sootblowers. Each boiler is equipped with a thermo probe, which is used only during start-up and is located at the secondary superheater inlet.

The sootblowers have undergone repairs and replacements in 2004 (unit 1) and in 2005 (unit 2)

***Condition Assessment***: All sootblowers are included in the routine preventive maintenance (PM) program.

### 3.1.11. Forced Draft Fans and Drives

***Description of equipment and system***: Each boiler is equipped with a pair of Westinghouse supplied forced draft fans. The units are positive pressure and are not equipped with induced draft fans. The fans are type #4054C-D Airfoil with a capacity of 299 x 1000 lbs/hour. The fan outlet pressure is designed at 34 inches of water at 105 degree Fahrenheit, at a speed of 1780 RPM. Westinghouse, frame # 5808S type LAC motors drive the fans. Each motor is rated at 600 HP, 4,000 volts, 60 HZ and 1,800 RPM.

***History***: These are the original forced draft fans. The plant has a pair of spare rotating elements complete with shaft and fan rotor located in the spare parts warehouse.

***Condition Assessment***: The rotors on unit 1 were corroded significantly and were replaced with the spare rotors in 2004. The rotors were similarly replaced on Unit 2 for the same reasons in 2005.

### 3.1.12. Feedwater Heaters and Deaerator

***Description of equipment and system***: Each unit is equipped with two low pressure, two high-pressure feedwater heaters (FWH) and one Deaerating (DA) heater and storage tank. Both low and high pressure FWH's were manufactured by Toshiba. All heaters are horizontal, U-tube type heaters. The surface area in square feet of each heater is as follows: 1-1,345, 2-1,290, 4-1,830 and 5-2,480.

The deaerating heater and storage tank has a maximum capacity of 502,767 lbs/hour. The storage tank is rated at 9,570 gallons. The outlet temperature of the feedwater is designed at 296.6 degree F.

***History***: All heaters are original equipment. Many of the heaters have only a few tubes with plugs in them to prevent leaks.

***Condition Assessment***: In 1998, 1999 and 2000 extensive NDE inspections were performed. Engineering and Inspection of Boca Raton, Florida and Oahu, Hawaii inspected all tubes excluding the U-bent areas. Compete detailed inspection reports were created. Several tubes were identified and preventatively plugged to minimize the possibility of leaks. The Engineering and Inspection, Inc. reports along with the Information 2 ENERGY, Inc., of Stuart, Florida reports should be reviewed for details.

In 2003 B&W performed NDE inspection on the deaerator and storage tank on Unit 1. Both of this equipment were in unacceptable condition and should not be operated in their present conditions. They recommended to replace the deaerator and storage tanks and as well as the associated safety valve and supports. A year later the DA and storage tank and associated equipment were replaced. They were similarly replaced on Unit 2 for the same reasons in 2005.

### 3.1.13. Miscellaneous Equipment

#### 3.1.13.1. Stacks

The smoke stacks were visually inspected by Sealand Construction Company in 2003 (unit 1) and in 2004 (unit 2). The insulating lining has badly deteriorated and it is planned to be replaced in phases starting this year for unit 1. The insulating lining is in better condition for unit 2 but it is also planned to be replaced in phases starting this year.

### 3.1.13.2. Building, General

The turbine room roof was replaced after typhoon PAKA in 1997 and 1998. Work was completed to repair exposed reinforcement bars, concrete and repaint the outer walls of the building's structure, both inside and out. The stairs located by the #2 main transformer and maintenance shop was also replaced or repaired. Lastly, miscellaneous drain downspouts are scheduled for replacement in conjunction with the above items.

### 3.1.13.3. Circulating Water Vacuum Pumps

Each unit was originally equipped with water box vacuum pumps. These pumps pulled a vacuum on the water boxes to ensure the removal of air. By removing the entrapped air in the water boxes good performance was ensured by having all tubes properly exposed to circulating water. All the vacuum pumps have failed and were not replaced. Instead water powered air pumps were installed to vent the air from the water boxes as best possible. (dec 2005 – new air priming system for water box

### 3.1.13.4. Hydrogen Manifold

The common hydrogen manifold and several of the pipings were repaired in 2004.

### 3.1.13.5. Turbine Lubricating Oil Tank Berm

Both units' lubricating oil tanks are not protected with a containment berm. In the event of an oil leak, the oil would end up in the floor drain system. Plant personnel would have to remedy this situation.

### 3.1.13.6. Acid Tank

The acid storage tank is in poor condition. Should this tank continue to be used, replacement should be considered. With the advent of the newly proposed reverse osmosis water treatment system, reliance on this tank could be greatly reduced.

### 3.1.13.7. CO & Opacity Monitors

New CO monitors were installed in 2006. The opacity monitors are original equipment but inoperable.

### 3.1.13.8. Plant Paging System

The existing plant paging system requires repairs and possible upgrading. This system is a Gia-Tronics system commonly used at power plants.

#### 3.1.13.9. Asbestos Insulation Removal

The plant has asbestos insulation, requiring monitoring and removal as required. The plant has made a significant stride in removing the asbestos in the plant within the past 5 years. They have removed considerable amount of asbestos insulation from inside the plant during the overhauls. In 2006 they remove almost in its entirety the asbestos insulation covering the fuel oil piping outside the plant.

#### 3.1.13.10. Condensate Storage Tanks

Both condensate storage tanks are corroded and require wall thickness testing.

#### 3.1.13.11. Battery Chargers

Both battery chargers were replaced in 2006.

#### 3.1.13.12. Waste Oil and By-products

Currently GPA has accumulated approximately 155+ drums of waste oil, waste absorbent, oily rags used in operation and maintenance and protective suits used in support of maintenance. GPA is committed to removing these waste streams prior to the PMC beginning operation.

#### 3.1.13.13. Elevator

The Otis elevator was last certified in 2003, but requires annual recertification. Currently it is not certified due to electrical, mechanical and communication issues. Quarterly preventive maintenance is performed by Island Elevators a licensed local contractor.

#### 3.1.13.14. Air Compressors

No. 1 Service Air Compressor was replaced with a new Ingersoll Rand Rotary Screw type unit in September 2004. The new unit included the following: IR Model H 150W Rotary Screw Air Compressor; IR Model TS 1000 Air Dryer; 1 Micron Prefilter; 0.01 Micron discharge filter. It is equipped with an air dryer it can also be used to augment dry instrument air if required.

No. 2 Service Air Compressor high pressure end cylinder and piston was replaced by Cabras maintenance personnel in September 2003. A new intercooler has been purchased and received and is awaiting No. 1 SAC return to service for installation.

***Condition Assessment*:** Unit 1 is currently awaiting warranty repairs. New air end package scheduled for arrival at the end of April 2007. Scheduled to be completed and return to service end of May 2007.

## 3.2. Main Turbines/Generators

The turbine is a General Electric, 22 stages, reheat machine, operating at 1,800 psig. The operating temperatures are 1,000 degree Fahrenheit for both the main steam and reheat. The turbines were manufactured in Lynn, Massachusetts and are serial numbers 197622 and 197623.

The generator is a three-phase, synchronous, hydrogen cooled, direct coupled to the turbine unit rated at 77,647 KVA. The power factor is rated at 0.85 lagging while the frequency is 60 Hz, at 3,600 rpm. Rated terminal voltage is 13,800, and the rated current is 3,249 Amperes with a Wye connection. Hydrogen pressure is designed for 30 pounds and the excitation has a maximum rating of 192 kW. The total temperatures of the stator coils are 91-degree C, collector 125 degrees C, and the field coil 125-degrees C, by resistance. Required cooling water is 600-gpm and a maximum temperature of 95 degree F. The original exciter is a static unit with a rated capacity of 200 kW, 800 amperes. The static exciters have been upgraded from the original units.

### 3.2.1. Main Turbine Auxiliary Equipment

***Description of equipment and system***:

Additional turbine support equipment is as follows:

Main Steam Jet Air Ejectors – Type twin element two- stage steam, with a rated capacity of 10 scfm. The single ejector per unit has a suction pressure of 1.0 inches of Hg absolute. The required working steam pressure is 200 psig and can consume 600 lb. while cooling 120 gallons per minute.

Starting Ejector – Each unit is equipped with a single stage steam jet type ejector with a rated capacity of 642 SCFM and working suction pressure of 17 inches Hg absolute. The working steam pressure is rated at 200 psig and has a steam consumption of 3,200 pounds. The manufacturer of both ejectors is Toshiba.

Condenser – The condenser is a single shell, double flow of steam with divided water box type surface condenser. The condenser has 53,800 sq. feet of surface area, and is designed to condense 316,888 # of water per hour. The design heat load is $3.147 \times 10^{8}$ BTU, with seawater at 85 degrees F. The tubes are 1.0-inch outer diameter. The circulating water quantity is rated at 57,220 GPM. The manufacture is Toshiba.

***History and Condition Assessment***: The condensers had suffered from chronic tube failures due to old tubes, ammonia attack, and over rolled tubes from previous replacement work. In 1998, 1999 and 2000 extensive NDE inspections were performed. Engineering and Inspection of Boca Raton, Florida and Oahu, Hawaii inspected all tubes. Complete detailed inspection reports were created. Several tubes were identified and preventatively plugged to minimize the possibility of leaks. The Engineering and Inspection, Inc. reports along with the Information 2 ENERGY, Inc., of Stuart, Florida reports should be reviewed for details. Edison O&M performed NDE inspection and replaced several tubes on unit 2 in 2002. Similar work was performed by E&I on the condenser on unit 1 in 2003. TEMES replaced majority of tubes on unit 1 with stainless tubes in 2005 to improve the performance and minimize downtime.

Condenser Vacuum Pumps – Each unit is equipped with Ebara, water ring type vacuum pumps (model 50-NV6M). There is an installed spare pump to service both units. Each pump has a design capacity of 24.7 scfm and a negative pressure of 15 inches of Hg. The Ebara liquid ring vacuum pumps rotate at 1,750 rpm, and are drive by a five horsepower motor rated at 460 volts. The make-up water requirements are 3.96 GPM per pump. Toshiba (Ebara) manufactured all these pumps.

Make-up Water Pump – The horizontal volute turbine pumps are rated at 250 gpm with a total head of 130 feet. The pumps rotate at 3,500 rpm and are driven by a 15 HP, 460-volt motor. Each unit’s pump was manufactured by Toshiba pump (Yoshikura).

Turbine Lube Oil Transfer Pump – These pumps are horizontal gear type pumps rated at 43.3 gpm, at 132 feet of head. The pumps rotate at 1,150 rpm and are driven by a 3 HP, 460-volt motor.

Turbine Lube Oil Storage Tank – Each unit is equipped with a 3,200-gallon storage tank manufactured by Jashiba.

Dirty Oil Storage Tank – Each unit is equipped with a 3,200-gallon storage tank manufactured by Jashiba.

Turbine Main Oil Tank - Each unit is equipped with a 2,233-gallon storage tank (including 485 gallons of flow back) manufactured by General Electric.

Turbine Oil Cooler – Each unit is equipped with a pair of turbine oil coolers, which use 315 gpm of cooling water at a maximum design temperature of 95 degrees F. The manufacture is General Electric.

Bearing & Seal Oil Pump – Each unit is equipped with a pair of vertical bearing & seal oil pumps. One pump is a spare unit, which is driven by a 20 HP, 460-volt, 3600-rpm motor. General Electric manufactured the pumps.

Emergency Bearing & Seal Oil Pumps – Each unit is equipped with one vertical pump, which is driven by a 20 HP, 125-volt, 3500-rpm motor. General Electric manufactured the pumps.

Turbine Oil Tank Vapor Extractor – each turbine oil tank is equipped with one vapor extractor driven by a ¾ HP, 460-volt motor. General Electric manufactured the vapor extractors.

Gland Steam Condenser – Each unit is equipped with one General Electric gland steam condenser, each rated at 220 square feet. The design condensate minimum and maximum flow ratings are 300 gal/min and 686 gal/min, respectively. The maximum steam flow is rated at 1,130 lbs/hr. and the air is rated at 655 lbs/hour. General Electric manufactured this equipment.

Gland Steam Exhauster – Each unit is equipped with one Lamson model 3066-0-AD gland steam exhauster with a maximum capacity of 700 lbs/hour. The exhausters are powered by five HP, 460 volt, 3,600-rpm motors and were manufactured by General Electric.

***History***: Both turbine generators were overhauled recently. Diversified Mechanical, of Oahu, Hawaii, overhauled Unit 1 in 2004. Unit 2 was overhauled by Taiwan Power Company, of Taiwan in 2005. One of the generators was shipped from Guam in 1996 for major rewinding. Both units' generator retaining rings have been upgraded.

***Condition Assessment***: Both generators are in good/serviceable condition. The vendor reports should be reviewed by prospective PMC for further details or clarification.

### 3.2.2. Turbine Controls and Instrumentation (Mark V)

***Description of equipment and system & History***: Both units are fitted with a new General Electric Mark V, digital turbine control system. The system was installed on Unit 1 in 2000 and Unit 2 in 2002.

As part of the Mark V, the system incorporated a new excitation system referred to as the EX2000. Additionally a new vibration monitoring system from Bently Nevada was installed on both units.

***Condition Assessment***: With the newly installed Mark V system, many years of reliable service should be obtained.

## 3.3. Fuel Supply

### 3.3.1. Heavy Oil Storage and Transfer System

***Description of equipment and system***: Both Cabras 1 & 2 are operated using light oil (diesel) and heavy fuel oil (#6 – Bunker C). The light oil is used during start-up only.

The diesel oil is delivered by tankers operated by either Shell or Mobil oil companies and is loaded in the 50,000-gallon ignition storage tank approximately two to three times annually.

From these large tanks, the oil is then transferred to the plant and is metered using the Varec level gauge. In the plant, the oil is filtered before the pumps and burners.

The high sulfur heavy fuel oil is transferred from the 430,000-barrel tank (#1902) at the Shell yards to the 250,000 – barrel storage tank (#1935) once a month and the low sulfur heavy fuel oil is pumped directly from the ship (F1 dock) to the 250,000-barrel storage tank (#1934) about every two months. These two storage tanks are located at the GPA tank farm, approximately one mile east of the plant, and are maintained and operated by a contractor (Peterra Corp.). From there, the fuel oil is pumped to the two (2) 10,000-barrel Cabras 1 and 2 day tanks on a daily basis. This is where the oil is metered locally using the Brooks BiRotor meter and by the Varec level gauges.

The #6 oil is circulated and mixed with approximately 5,000 gallons of waste oil daily in the high sulfur tank but not in the low sulfur tank. Steam-supplied heaters located in the suction of the storage tanks heat the oil. In the plant, fuel oil is filtered through duplex strainers, reheated again by steam driven heaters and filtered again thru duplex strainers before it goes to the four (4) burners.

The actual fuel oil consumption of the burners is measured or metered by the existing Bailey meter and newly installed Micro Motion meter located before the burners. Both the flow rate and totalizer (only Bailey) readings from these meters are monitored in the control room. GPA intends to phase out the Bailey meter.

During start-up, operating the heavy fuel oil is circulated, thus by passing the burners for about 15 minutes. A new Micro Motion meter on the return line meters this. The recirculation stops when one burner is in operation. The fuel oil flow is regulated to the burners. To protect the pumps the rest of the fuel oil is returned to the day tanks through the return line.

### 3.3.2. Oil Storage and Transfer Equipment Description

***Description of equipment***:

Fuel Oil Storage Tank – The plant has 2 outdoor C.R.T. type, 10,000-BBL tanks. The tanks are approximately 43 feet in diameter and 40 feet high. Kovo Iron, of Japan, provided the tanks.

Ignition Oil Tank - The plant has two outdoor C.R.T. type, 50,000-gallon tanks. The tanks are approximately 25 feet in diameter and 23 feet high. Sharpareille Steel Fabricators, provided the tanks.

Fuel Oil Pumps – Two DeLaval model A3DH-275 pumps are on each unit. The pumps have a capacity of 37,000 lbs/hr. (500SSU at 120 degree F). 30 HP, 460 volt, 1,200-rpm motors, drives the pumps. Diamond Power provided the fuel oil pumps.

Replace pumps with new ones on both units in 2005 major overhaul.

Ignition Oil Pumps – Each unit is equipped with two ignitions oil pumps, type 1 ½” GRH, manufactured by Diamond Power. The capacity and pressure is 25 GPM and 250 psig, while 10 HP, 460 volt, 1,800-rpm motors, drive the pumps.

Fuel Oil Heaters – Each unit is equipped with two horizontal OBD-28156 #6 oil in-shell tube heaters. The heaters are powered by steam at 37,000 lbs/hr and have an oil output temperature of 260 degree F. Diamond Power provided the fuel oil heaters.

#### 3.3.3. Oil Transfer System and Pumps Condition

***Condition Assessment***: In 2006, the high (Tank #1) and low (Tank #2) sulfur tanks were cleaned and painted. Repairs included replacement of fuel lines. All equipment is in good working order.

#### 3.3.4. Oil Quality Sampling and Testing

Description of equipment and system: Oil quality is sampled, tested and reported back to GPA by SGS Guam, Inc. of Redwood Petroleum and Petrochemical Services. Sample report headings include the product type, source, type of sample, and date. Results of the sample are summarized and include the oils API Gravity @ 60 degree f., Viscosity @ 100 degree F, Flash Point, Fire point, Water, Sediment, sulfur, ash content, carbon residue, metals such as Vanadium and aluminum + silicon, and lastly the gross heating value.

### 3.4. Steam System

#### 3.4.1. Main & Hot/Cold Reheat Steam

***Description of equipment and system***: All lines of this type contain some asbestos insulation. Prior to insulation being removed, it is tested and if found to contain asbestos, is handled in accordance with specific asbestos approved handling procedures. Non-asbestos insulation replaces the old asbestos insulation and is clearly marked and labeled as “asbestos free”.

***History***: The Unit 1 hot reheat and main steam lines were inspected for degradation and potential damage. The lines were tested for seams and unit one has been confirmed to be seamless pipe. Engineering & Inspection, Inc. of Boca Raton, Florida performed the inspections and provided detailed inspection reports. Currently there are no plans to inspect the cold reheat line. They were further inspected and confirmed by B&W in 2003. The Unit 2 main steam and hot and cold reheat lines were inspected similarly in 2004. Several pipe hangers were repaired and adjusted during the 2004 and 2005 overhauled.

***Condition Assessment***: Currently there is excessive movement of the Unit 1 main steam line, while hangers and supports require adjustment or repair. The main steam line has been impacting with solid structures and the insulation is destroyed.

## 3.5. Station Water Systems

### 3.5.1. Circulating Water

#### 3.5.1.1. Inlet Canal

***Description of equipment and system***: The inlet canal begins at the oceans edge away from the plant property. The canal is approximately 30 feet wide and less than 10 feet deep.

***Condition Assessment***: The canal requires cleaning and divers are utilized annually to clear debris from in front of the traveling screens. Should dredging be required of the intake structure, GPA will maintain this area since Cabras 3 & 4 is also dependent on this system.

#### 3.5.1.2. Traveling Screens

***Description of equipment and system***: The plant is equipped with two traveling screens per unit. The screens are an inclined type bar screen and are equipped with front spray type traveling screens. Each screen has a screen wash pump for cleaning the screens. The screen openings are 3/8” of 304 SS wire. UBE Industries were the original manufactures of the traveling screen.

***History***: Two of the four screens underwent major renovation in 1996. The cathodic protection system was reinstalled about seven years ago, to help protect the equipment for excessive damage from the seawater and electrolysis.

***Condition Assessment***: Currently two of the traveling screens require repairs and possible upgrading.

#### 3.5.1.3. Circulating Water Pumps

***Description of equipment and system***: Each unit is equipped with two 60% capacity circulating water pumps. The pumps are vertical, open type impeller mixed flow pumps. Each pump is capable of 30,000 USGPM at a total head of 28 feet. The 340 HP, 505RPM motors drive the pumps. Ebara is the manufactures of the pumps.

***History***: The #1, circulating water pump for Unit 1 underwent repairs by the Navy shipyard approximately 4 to 5 years ago. It was replaced in 2004. The #2, circulating water pump was similarly replaced in 2005.

***Condition Assessment***: All of the four circulating water pumps except one should be inspected in the near future. In years past, the motors were routinely cleaned but this has not been performed for at least five years now and is overdue. Motors undergo annual oil changes as part of the CMMS program.

#### 3.5.1.4. Circulating Water Pipes

***Description of equipment and system***: The 42" diameter circulating water pipes are original equipment. Each circulating water pump discharge enters into its own CWP pipe and travels under ground to each half of the main condenser. The pipe is fabricated from carbon steel and processes salty seawater.

***History***: The circulating water pipes have very thin walls where they turn and enter the building. This condition has resulted in several outages to weld patches on the lines. Recently the cathodic protection system was returned to service and upgraded.

***Condition Assessment***: The circulating water pipes are currently in the capital improvement program slated for replacement. Replacement of these pipes is scheduled for fiscal year 2002 for Unit 2 and shortly thereafter for Unit 1.

### 3.5.2. Closed Cooling Water System

#### 3.5.2.1. Closed Cooling Water (CCW) Heat Exchangers and Pumps

***Description of equipment and system***: Each unit is equipped with Closed Cooling Water (CCW) systems, also referred to locally as the service water system. Each units system consists of 2 100% pumps and 2 100% heat exchangers. Each cooler or heat exchanger can process 1,500 gpm of clean equipment cooling water at an inlet of 110-degree F. and outlet of 95-degree F. The seawater volume is 3,000 gpm and designed to have a seawater inlet temperature of 90-degree F., and outlet of 97.7-degree F. The total surface area of each cooler is 3,929 sq. ft. Toshiba manufactured the coolers.

Each unit's CCW system has a pair of 100% circulating pumps. The pumps are horizontal volute turbine type, with a capacity of 1,500 gpm at a 120-foot head. The pumps rotate at 1,800 rpm and are driven by 67 HP, 460 V motors. Toshiba manufactured the pumps.

***History***: The CCW heat exchangers are routinely opened and cleaned using a "pick and clean" method. The tube inner diameters are not cleaned often but appear to still perform well. Both pump and heat exchangers are original equipment.

***Condition Assessment***: The heat exchangers have little to no tubes plugged and appear to have considerable life remaining.

#### 3.5.2.2. Chemical Feed System

***Description of equipment and system***: Injecting chemicals into the closed cooling water system protects the CCW system. Currently a Nalco 8328, sodium nitrate (rust inhibitor) is used. This chemical is delivered in 55-gallon drums approximately two times each week. One drum is used each month.

***History***: Multiple leaks have occurred in this system and currently several air compressors are not tied to the CCW system. City water is used to cool the compressors.

***Condition Assessment***: Many feet of small diameter pipe requires replacement to the air compressors to restore this system to its original design. Several of the larger diameter pipes require close inspection to ensure adequate flow.

### 3.5.3. Condensate Production/Demineralizer

#### 3.5.3.1. Existing System

***Description of equipment and system***: The existing system consists of the following equipment:

Raw Water Tank – The two units share one raw water tank. The tank holds 50,000 gallons and is 22' wide by 18' high. Koyo Iron manufactured the tank. PM in 2005

Condensate Storage Tank – The plant has two condensate storage tanks each with a capacity of 50,000 gallons. The tanks are 22' in diameter and 20' high. Like that of the raw water Koyo Iron Works manufactured the condensate storage tanks. PM in 2005

Water Treatment – The units share the output from a dual train water production facility. Each train has one cation, one anion and one mixed bed polishers. Each train is rated at a maximum of 75 gpm. Water quality was originally specified to be less than 1MV/CM at 77 degree F. The manufacturer was the Japan Organo Co. Ltd.

***History***: The water production facility has under gone major repairs in recent years and more repairs are needed. It has been determined that replacement of the system is more cost effective than further repair. SCE Services of Los Angeles, California performed a study, which will help direct the GPA personnel in replacing the system. Currently the system is scheduled for replacement in fiscal year 2002.

Currently the plant boilers are using coordinated phosphate such as: tri-sodium phosphate, Di-sodium phosphate and for emergency use only, caustic. The sampling system is in poor condition due to the service water lines being possibly plugged. The new sampling system is on order but the actual delivery date is uncertain at the time of this review. Additionally the neutralizing sump system does not have chemicals available and the plant personnel are diluting with plain water. The water from this system is then pumped to the ponding basin, which is located behind Units 3 & 4 near the outfall.

***Condition Assessment***: The water production system is in poor condition and requires replacement. The PMC will have to operate the units until the existing system is replaced.

### 3.5.3.2. New RO Water System

***Description of equipment and system***: On October of 1999, Southern California Edison delivered the final document of a study, where they were commissioned to review the water quality needs of the Cabras 1 & 2 generating station. Within the body of the report were a series of recommendations. The following items are highlights of the summary:

- Modification of some of the laboratory techniques and methods;
- Equipment of the laboratory with more sensitive instruments and necessary supplies including:
- Sample cooling system replacement and upgrade – cooling racks;
- Flowing samples and continuous and indication core instruments – two (2) water chemistry, analyzer panel and a computer workshop.
- Comprehensive theoretical and practical laboratory training.
- Installation of new cycle chemical feed systems including the following:
- New amine, oxygen scavenger, and phosphate feed pumps;
- Associated chemical solution tanks, local control panel, and required piping, valves and fittings.
- Replace the Cabras 1 & 2 demineralizers with a reverse osmosis electrodeionization (RO-EDI) system. Current plans call for a long-term lease of the RO-EDI system including full maintenance support from the vendor rather than an out-right purchase.

The RO-EDI System is planned to consist of the following:

- Two 50% activated carbon/multimedia filters (capable of flowing 100% when the second unit is in backwash mode);
- Two 100% sodium zeolite softeners;
- Two 50% 5µm cartridges filters;
- One ultraviolet sterilizer;
- Two booster pumps;
- One ultraviolet sterilizer;
- Two booster pumps;
- Two 50% reverse osmosis trains;
- Piping to and from a membrane degasifier and to and from two electrodemineralizer modules each with a recycle pump;
- Connections and piping to and into GPA's demineralized water storage tanks;
- Two pumps for backwashing softeners and filters using recovery water tank;
- Ion exchange materials;
- Regeneration equipment for softeners;
- Local and CRT based controls and instrumentation as required for the automatic

and/or manual operation of water system
- One control panel with a CRT screen with all associated controls and instruments mounted, tubes, piped, wired and tested
- Brine saturator tank and brine pumps
- Fiberglass recovery water tank for reclaiming RO reject and rinse water

The SEC document is available for review to those prospective proponents. Currently the new RO system is not bid out, however GPA clearly realizes the importance of this equipment and will make all reasonable efforts to move forward with this project.

### 3.6. Waste Fuel Oil Handling System

#### 3.6.1. Waste Generation Sources

***Description of system and history***: Generating plants, local garages and commercial operations generate large volumes of waste oil and their by-products throughout the island. Currently the island does not have any good method to dispose of this waste oil other than shipping it off-island and having it either processed or burned.

In order to resolve this situation, GPA and the government devised a plan to have Cabras 1 & 2 burn this oil as fuel in the boilers. Various sources of this oil are from the following:

- Commercial deliveries from service stations, oil change locations and recycling centers;
- Enron 8 & 9, waste oil from engine fuel oil separators;
- Cabras 3 & 4, waste oil from engine fuel oil separators;
- TEMES, combustion turbine, lube oils;
- Tanguisson 1 & 2, lube oils;
- The GPA combustion turbines and diesel generating units;
- Waste oil from the shipping, trucks and airline.

It is estimated that Cabras 1 & 2 is requested to process and burn up to 5,000 gallons of this waste oil and byproducts daily.

#### 3.6.2. Waste Handling Process

***Description of equipment and system***: The Guam Power Authority has developed several procedures for the receiving, storing, handling and disposal of waste oil and waste oil by-products at the Cabras 1 & 2 plant. The first procedure, is titled, “Waste oil Storage Tank (55,000 gals- Capacity and Main Oil/Water Separator”). Within this very short document, the basic process is identified and the valve operation sequence required for handling the waste oil is identified.

The second procedure is titled, "Appendix H, Oil/Water separator Procedures". This short document also highlights key assumptions of this process. In addition to this Appendix H, there is an Appendix D, which is an inspection record for oil removal from Secondary Containments. This Appendix D document is a blank page to help capture hand-written notations for oil deliveries at the plant.

The last of the waste oil handling procedures is titled, "Waste Oil Transfer System." This procedure is four pages in length and covers more of the actual details the waste oil-handling operators must perform on a daily basis.

***Condition Assessment***: Many portions of the waste oil handling process are manually operated.

### 3.6.3. Waste Oil Handling Manpower

***Description of Manpower Requirements***: Currently operation of the waste oil storage and handling system uses two full time personnel. This operation is restricted to day light hours and is running seven days per week. Opportunities exist to upgrade the equipment and possibly restrict deliveries of oil to the normal work week (Monday – Friday) and gain efficiencies. GPA will continue to provide the required labor to support this important operation.

### 3.6.4. Waste Oil Burning

***Description of equipment and system***: Currently only Cabras 1 & 2 is capable of processing, handling, storing and burning the waste oil of the other generating units and commercial operations on the island. The waste oil is mixed with good high sulfur oil and pumped through the existing plant equipment such as heaters and booster pumps. The oil is then processed through the existing burners and into the boiler.

## 3.7. Electrical System

### 3.7.1. Main Transformers

***Description of equipment and system***: Each unit has a main transformer manufactured by Toshiba. The transformers are outdoor, three-phase, core type, two winding, mineral oil immersed, forced oil and forced cooled. Each transformer has a rated capacity of 80 KVA. The low voltage side is 13.2 kV and the high side provides 115 kV (+5, +2.5, +0%). The connections on the low side are Delta while the high side is Wye (neutral). Insulation levels are BIL, and the low voltage is rated at 110 kV with the high side rated at 550 kV. The insulation of the low side bushings is 150 kV and the high side is 750 kV. The frequency of the transformer is 60 cycles while the impedance is 10% (at 80 MVA base). The ambient temperature is designed at 40 degrees C. The oil temperature rise is 55 degrees C, (by thermometer) and the winding temperature rise is 55 degrees C, (max 65 degrees C) measured by resistance.

***History***: The GPA Transmission and Distribution (T&D) division maintains transformers. Currently it is proposed, that the PMC will support all transformers with maintenance services and trouble shooting activities through the life of the PMC contract.

***Condition Assessment***: It is believed that the main transformer for unit 1 will operate above the desired temperature at full load. This fact will need to be confirmed when the unit returns to service from its extended turbine outage in early 2001. The main transformer for unit 2 appears to operate within designed limits at full load but confirmation will come soon after the installation of a new boiler economizer.

### 3.7.2. Power Interchange Transformer

***Description of equipment and system***: The power interchange transformer is located in the Cabras switchyard, and is maintained by the T&D section of GPA. The transformer receives 115 kV, island power and steps it down to 34.5 kV. This power is then feed to the old Piti plant and substation area.

The power interchange transformer is an outdoor design, three phase, core type, with three windings that are mineral oil immersed, forced oil and forced air cooled. The rated capacity is 50 KVA, and the low voltage is 34.5 kV with a high voltage side rated at 115 kV (+5, +2.5, +0%; 251 amps). The transformer has buried connections and a Wye neutral high and low voltage, delta design. The insulation level is 550 kV on the high side and 200 kV on the low side. The bushing insulation level was designed at 750 kV and 350 kV for the high and low respectively. The frequency is 60 cycles and the impedance is 10% at an 80 MVA base. The design ambient air temperatures are 40 degrees C, while the oil temperature and winding temperature rise is 55 degrees C. Toshiba manufactured this transformer.

***History & Condition Assessment***: Currently there are no known problems with this transformer and it is operating within all design limits.

### 3.7.3. Unit Auxiliary Transformer

***Description of equipment and system***: There are two unit auxiliary transformers, one per unit. These transformers are located on the backside of the Cabras 1 & 2 plant. The auxiliary transformers are connected to the generator before the main transformers. These transformers step down the generator voltage from 13.8 kV to 4,160 Volts. At the 4,160volt switchgear panels located on the main turbine operating floor, the power to the plant is provided at 480 volts.

The unit auxiliary transformers are three-phase, core type two windings, cooling with mineral oil and both air and forced cooled. The capacity is 5,000 KVA and the high voltage is rated at 13.8 kV (with +5, +2.5, and 0%). The low voltage is 4.16 kV. The high voltage winding is a

Delta and the low voltage winding is a Wye (neutral). The high voltage insulation is designed at 110 kV while the low is rated at 75 kV, as well as the neutral. The bushing insulation for the high side is 150 kV and the low is 90 kV. The design ambient air temperatures are 40 degrees C, while the oil temperature and winding temperature rise is 55 degree C. Toshiba manufactured these transformers.

***History & Condition Assessment***: Currently there are no known problems with this transformer and it is operating within all design limits.

### 3.7.4. Start-up Transformer

***Description of equipment and system***: The Cabras plant has one start-up transformer serving both units. The start-up transformer steps the voltage form 34.5 kV to 4,160 volts. The Cabras 1 & 2, via the 4,160-volt common, feeding the 4,160-volt Unit 1 & 2 motor control center (MCC). The start-up transformer also serves as an emergency means of station power for the Cabras plant.

The start-up transformer is three phase, core type, two windings, cooling with mineral oil and both air and forced cooled. The capacity is 5 kVA and the high voltage is rated at 34.5 kV (with +5, +2.5, and 0%). The low voltage is 4.16 kV. The high and low voltage windings are Wye (neutral). The high voltage insulation is designed at 200 kV while the low is rated at 75 kV, as well as the neutral. The bushing insulation for the high side is 350 kV and the low is 150 kV. The design ambient air temperatures are 40 degrees C, while the oil temperature and winding temperature rise is 55 degree C. Toshiba manufactured this transformer. History & Condition Assessment: Currently there are no known problems with this transformer and it is operating within all design limits.

### 3.7.5. High Voltage Switchgear (4,160V)

***Description of equipment and system***: There are three 4160 volt switchgear panels: 1) The 4160 common, 2) 4160 volt unit one motor control center, 3) 4160 volt unit two motor control center. These switchgears feed the major motors such as the forced draft fans, boiler feed pump motors, and the 480-volt power centers. These switchgears are located on the third operating floor near the turbine generators. The individual switchgears are tied together via the 4,160 V common. This allows one unit to support the both units' power requirement for various plant equipment.

The Table 4 highlights specific equipment tied to these components.

Table 4. 4160-Volt Switchgear Power Distribution Schedule

| Switchgear Panel Identification | Power Distribution Schedule |
|---|---|

| | |
|---|---|
| 4,160 V Common<br><br>Location: Operating Floor Input Source: Auxiliary Transformer | Bus PT<br>Incoming and PT PC TR<br>Feeder Bus Tie #1 |
| 4,160 V Unit 1 MC<br><br>Location: Operating Floor<br>Input Source: Auxiliary Transformer | Bus Tie & Bus P.T.<br>CWP 1B<br>CWP 1A<br>Incoming PT<br>BFP-1B<br>BFP-1A<br>FDF-1B<br>FDF-1A<br>PC TR Feeder |
| 4,160 V Unit 2 MC<br><br>Location: Operating Floor<br>Input Source: Auxiliary Transformer | Bus Tie & Bus P.T.<br>CWP 2B<br>CWP 2A<br>Incoming PT<br>BFP-2B<br>BFP-2A<br>FDF-2B<br>FDF-2A<br>PC TR Feeder |

***History & Condition Assessment***: Much of this equipment's maintenance needs are covered by the computerized maintenance management system (CMMS). All of the above listed components are in good working order and available for service.

### 3.7.6. 480 Volt Switchgear

Description of equipment and system: The 480 Volt Switchgear Panels are known as the 480 V Power Centers. The Power Centers are located on the Operating floor areas. There are three 480 V Power Centers that receive a 4,160 V signal from the 4,160 V Switchgears, also on the Operating Floor, and step down the voltage to 480 V. The 480 V Power Centers feed the various 480 V Motor Control Centers located throughout the Cabras 1 & 2 plant. Table 5 summarizes this information.

Table 5. 480-Volt Power Center Distribution Schedule

| **Power Center Identification** | **Power Distribution Schedule** |
|---|---|

| | |
|---|---|
| 480 V 1&2 Common Power Center<br>Location: Operating Floor<br>Input: 4160 V Common | PT<br>Incoming (52 PC 1C)<br>480 Bus Tie No. 1 Power Center (52 BT, 480V)<br>480 Bus Tie No. 2 Power Center (52 BT, 480V)<br>480 V No 1.2 Common – 1 Control Center<br>480 V No 1.2 Common – 2 Control Center<br>480 V No 1.2 Common – 3 Control Center<br>480 V Screen Control Center |
| 480 V No 1 Power Center<br>Location: Operating Floor<br>Input: 4160 V Unit 1 MC | PT<br>Incoming (52 PC 1)<br>480 V No 1-1 Control Center<br>480 V No 1-2 Control Center<br>480 V No 1-3 Control Center |
| 480 V No 2 Power Center<br>Location: Operating Floor<br>Input: 4160 V Unit 1 MC | PT<br>Incoming (52 PC 2)<br>480 V No 2-1 Control Center<br>480 V No 2-2 Control Center<br>480 V No 2-3 Control Center |

***History & Condition Assessment***: Much of this equipment's maintenance needs are covered by the computerized maintenance management system (CMMS). All of the above listed components are in good working order and available for service.

### 3.7.7. 480 Volt Motor Control Centers

***Description of equipment and system*****:** There are approximately ten, 480 V Motor Control Centers (MCC) located throughout the plant, mainly on the mezzanine and basement areas. These centers house the various field breakers for various plant equipments for Cabras 1 & 2. Tables 6 through 8 summarize the information for 480 V Motor Control Centers.

Table 6. 480 V Motor Control Center Summary (Operating Floor)

| **Motor Control Center Identification** | **Summary Information** |
|---|---|

| | |
|---|---|
| 480 V 1&2 Common Power Center<br>Location: Operating Floor<br>Input: 4,160 V Common | PT<br>Incoming (52 PC 1C)<br>480 Bus Tie No. 1 Power Center (52 BT, 480V)<br>480 Bus Tie No. 2 Power Center (52 BT, 480V)<br>480 V No 1.2 Common – 1 Control Center<br>480 V No 1.2 Common – 2 Control Center<br>480 V No 1.2 Common – 3 Control Center<br>480 V Screen Control Center |
| 480 V No 1 Power Center<br>Location: Operating Floor<br>Input: 4,160 V Unit 1 MC | PT<br>Incoming (52 PC 1)<br>480 V No 1-1 Control Center<br>480 V No 1-2 Control Center<br>480 V No 1-3 Control Center |
| 480 V No 2 Power Center<br>Location: Operating Floor<br>Input: 4,160 V Unit 1 MC | PT<br>Incoming (52 PC 2)<br>480 V No 2-1 Control Center<br>480 V No 2-2 Control Center<br>480 V No 2-3 Control Center |

Table 7. 480 V Motor Control Center Summary (Mezzanine)

| **Motor Control Center Identification** | **Summary Information** | |
|---|---|---|
| 480 V No 1-3 Control Center | Gland Exhaust Blower<br>Heater Drain Pump 1B<br>CWP Lube Water Pump 1B | EHC Pump 1B Condenser Inlet Valve 1B (V7-002B) |
| Location: Mezzanine Floor | Condenser Outlet Valve 1B (V7-003B) Condenser Inlet Valve 1B (V7-02B) CWP Discharge Valve 1B (V7-01B) | Instrument Air Dryer Fuel Oil Pump 1B Service Water Pump 1B |
| Input: 480 V No 1 Power Center | Instrument Air Compressor 1B Condensate Pump 1B | Test Power Source Main TR Unit Cooler |

Table 8. 480 Motor Control Center Summary (Basement)

| **Motor Control Center Identification** | **Summary Information** |
|---|---|

| | | |
|---|---|---|
| 480 V No 1-1 Control Center<br><br>Location: Basement Floor<br><br>Input: 480 V No 1 Power Center | Condenser Sump Pump 1A Condenser Sump Pump 1B Turbine Sump Pump Unit 1 Condensate Pump 1A CWP Lube Water Pump 1A Heater Drain Pump 1A Condenser Outlet Valve 1A (V7-003A) Condenser Inlet Valve 1A (V7-002A) Make Up Water Pump Turbine Oil Transfer Pump Turbine Oil Pump | Condenser Backwash V-7009 BRG Seal Oil Pump 1A BRG DRN ENL Blower Vapor Extractor EHC Pump motor 1A COND Backwash V7008 Condenser Backwash Valve V7-007 Test Power Source COND Return V5-18 CWP Discharge Valve 1A V701A Service Water Pump 1A |
| 480 V No 1-2 Control Center<br><br>Location: Basement Floor<br><br>Input: 480 V No 1 Power Center | BFD Auxiliary Oil Pump 1A BFD Auxiliary Oil Pump 1B Flame Detector Seal Air Blower Seal Air Booster Blower Thermo Probe Fuel Oil Pump 1A Chemical Feed Soot Blower Boiler Oil Sump Pump Steam Seal System Drain Valve (V4-85) Instrument Air Compressor 1A Air Preheater 1A BFP Discharge Valve 1A (V2-03A) | BFP Discharge Valve 1B (V2-03B) MSV Before Seat Drain Valve (V01-2) MSV After Seat Drain Valve (V01-4) Air Preheater 1B CRV Before Seat Drain Valve (V01-6) CRV After Seat Drain Valve (V01-8) Third Stage Shell Drain Valve (V01-10) Reheat Bowl Drain Valve (V01-16) Test Power Source Cold Reheat Drain Valve (V01-12) Hot Reheat Drain Valve (V01-14) Steam Seal Regulator Bypass Valve (V4-83) Steam Seal Regulator Shut Off Valve (V4-82) |

***History & Condition Assessment***: Much of this equipment's maintenance needs are covered by the computerized maintenance management system (CMMS). All of the above listed components are in good working order and available for service.

### 3.8. Emergency Power

***Description of equipment and system***: Emergency Power is providing from the Startup Transformer or the 500 kW generator. Power from the Startup transformer would feed through the 4,160 V Switchgear panels.

The 500 kW generator however, feeds the 480 V Common-3 panel.

***History & Condition Assessment***: Much of this equipment's maintenance needs are covered by the computerized maintenance management system (CMMS). All of the above listed components are in good working order and available for service.

## 3.9. Station Lighting System

(NOTE: See 2.5.1.3 Station Lighting also for further details)

### 3.9.1. Battery Room, Batteries, Chargers

***Description of equipment and system***: The Battery room is located on the mezzanine floor adjacent to the Relay room. The battery room houses two-battery racks, and each rack holds 80 cells (batteries).

The Chargers are located just outside the battery room on the mezzanine floor. One charger is a Yuasa Charger, which is an original charger, and an Exide charger, which is just as old. Table 9 summarizes the specifications for the chargers.

Table 9. Battery Charger Specification Summary

| **Yuasa Charger – Unit #1** | **Exide Charger – Unit #2** |
|---|---|
| MFG No. 733278 | Model: SCR 130-3-100 |
| AC input: 480 Volts, 28.5 Amps | AC Input: 480 Volts, 27.8 Amps |
| DC output: 144 Volts, 100 Amps | DC Output: 130 Volts 100 Amps |

For information on the DC batteries please see 2.5.1.5 DC Batteries

***History & Condition Assessment***: The plant battery room caught fire in 2000. The root cause of the fire was a failure of a battery due to low water levels. These maintenance items were included in the PM program, however not all of the batteries were included for checking; only a randomly selected set was tested. This issue of random PM inspections has been changed to include all batteries. Batteries from the system dispatch were brought over to replace damaged batteries and the system is now working as designed. The batteries and chargers require replacement.

### 3.9.2. Low Volt System (125 & 208 Volt)

Description of equipment and system: The 125 Volt DC system consists of three panels located on the mezzanine floor near the battery room. The DC systems supply energy to various DC equipment located throughout the Cabras 1 & 2 plant. Tables 10 and 11 summarize the information for these Low Voltage Distribution System Panels.

Table 10. 125 VDC Power Distribution Panel

| **125 VDC Power Distribution Panel Identification** | **Summary Information** |
|---|---|
| 125 VDC Common Distribution Panel<br><br>Location: Mezzanine Floor<br>Input: | Paging System<br>No 1.2 Start-up TR.<br>Emergency Lighting (Tamundong Office)<br>SER Recorder<br>No 1.2. Common MC Elevating (MTR. Control)<br>P1 TR. Cooler Cub.<br>No 1.2. Common MC Control (Closing)<br>No 1.2. Common PC Control (Opening)<br>Line Control PNL<br>No.1 Unit (modified: 10/15/99)<br>No.2 Unit (modified: 10/15/99) |
| 125 VDC Cabras #1 Distribution Panel<br><br>Location: Mezzanine Floor | Burner Control Panel<br>EHC<br>Turbine Trip and Reset<br>Hydrogen Control<br>Non return valve<br>Condenser Backwash Valve<br>No 1 Unit MC Elevating<br>Main TR. Control<br>No. 1 Unit Auxiliary TR.<br>Excitation Control Circuit (EX2000)<br>MC Breaker Test Source<br>No 1 Unit MC Control<br>No 1 Unit PC Control<br>No 1 BTG Board<br>Emergency Bearing and Seal Oil Pump |

| | |
|---|---|
| 125 VDC Cabras #2<br>Distribution Panel<br><br>Location: Mezzanine Floor | Burner Control Panel<br>EHC<br>Turbine Trip and Reset<br>Hydrogen Control<br>Non return valve<br>Condenser Backwash Valve<br>No 2 Unit MC Elevating<br>Main TR.Control<br>No. 2 Unit Auxiliary TR.<br>Excitation Control Circuit (EX2000)<br>MC Breaker Test Source<br>No 2 Unit MC Control<br>No 2 Unit PC Control<br>No 2 BTG Board<br>Emergency Bearing and Seal Oil Pump<br>Fire<br>Instrument Shop<br>Control Room DC-2 |

Table 11. 208 Volt Power Distribution Panel

| **208 V Power Distribution Panel** | **Summary Information** | |
|---|---|---|
| 208 V Common<br>Distribution Panel<br><br>Location:<br>Mezzanine Floor | Sampling Rack<br>Analyzer Rack<br>Fire System Panel<br>Chemical Feed System<br>Smoke Detector<br>Space Heater<br>No. ½ Com. CC<br>Office Pwr Supply<br>New Elev, Rm. Panel<br>SER Recorder<br>75 A Outlet Breaker (modified 7/10/93 w/ trip button)<br>No 1.2. Common PC<br>Ventilation Fan | Plant Plugs<br>No 1.2. Start-up TR.<br>No 1 BTG Board Instrument Testing Source<br>Power Receptacle (SW & Trans Yard)<br>Power Receptacle (indoor Yard)/Pwr Supply for Elec. Shop<br>Power Receptacle (Tank Yard)<br>Line Control Panel<br>Aux. Control Panel<br>No 1.2. Common MC<br>Paging System (APH Temp 1&2/FO Controllutron 1&2/ACV ACA Recorder 1&2/Smoke Detectors 1&2) |

| | | |
|---|---|---|
| 208 V Cabras #1 Distribution Panel<br><br>Location: Mezzanine Floor | Burner Control Panel<br>Drum Level Lighting<br>Auto Burner Control<br>Device Relay Rack<br>Transmission FDF Dumper Control<br>Air Heater<br>Aux Air Motor<br>Air Heater Inside Lighting<br>Flue Gas O2 Analyzer<br>Blow Down Tank Level<br>EHC<br>Turning Gear Control<br>Hydrogen Control<br>SCT Enclosure Fan | Excitation Control Circuit<br>No. 1 MC<br>Generator Collector Lighting<br>Space Heater No 1-1 CC<br>Space Heater No 1-2 CC<br>Space Heater No 1-3 CC<br>No 1 Main TR<br>No 1 BTG Board<br>Cathodic Protection<br>No 1 Unit Aux TR.<br>No 1 PC TR. Ventilation Fan<br>Roll up door |
| 208 V Cabras #2 Distribution Panel<br><br>Location: Mezzanine Floor | Burner Control Panel<br>Drum Level Lighting Auto<br>Burner Control Device<br>Relay Rack Transmission<br>FDF Dumper Control<br>Air Heater Aux Air Motor<br>Air Heater Inside Lighting<br>Flue Gas O2 Analyzer<br>Blow Down Tank Level<br>EHC<br>Turning Gear Control<br>Hydrogen Control<br>SCT Enclosure Fan | Excitation Control Circuit<br>No. 2 MC<br>Generator Collector Lighting<br>Space Heater No 2-1 CC<br>Space Heater No 2-2 CC<br>Space Heater No 2-3 CC<br>No 2 Main TR<br>No 2 BTG Board<br>Obstruction Light<br>No 2 Unit Aux TR.<br>No 2 PC TR. Ventilation Fan<br>Waste Oil Pump |

***History & Condition Assessment***: Much of this equipment's maintenance needs are covered by the computerized maintenance management system (CMMS). All of the above listed components are in good working order and available for service.

### 3.10. Boiler Feed Pumps and Drives

***Description of equipment and system***: Each unit is equipped with two, 100% capacity, motor driven boiler feed pumps. The pumps are a horizontal barrel type design with an extraction structure at the middle stage. The pumps are four stages and have a capacity of 1,140 gpm. The designed suction pressure is 60 psig and the discharge pressure is 2,470 psig. The suction water temperature is 300 degree F. The pumps operate at 3,580 rpm and are driven by a 1,640 kW, 4,000-volt, 2,200 horsepower motor. Toshiba Ebara manufactured the pumps.

***History***: All four of the boilers feed pump drive motors are original. There is a spare rotating assembly in the warehouse in addition to the installed spare on each unit.

***Condition Assessment***: Several PM tasks are assigned to these pumps. The Central Maintenance personnel perform pinch tests on the pump bearings to monitor the clearances. These type activities are performed during annual overhauls. Vibration readings are obtained by the electrical group and documented.

The Unit 1 “A” motor windings were re-dipped in 1998 after typhoon PAKA. Motor megger readings are performed as part of the PM tasks. Historically, the motors have been pulled for preventive maintenance approximately every five years. Since the last motor that was pulled is the Unit 1 “A” in 1998, all three other motors are now due for major maintenance inspections.

Pump Performance is conducted by comparing the mass flow from each pump and the pressure at full load. This method is used to monitor the degradation of the pump.

Spare Parts: The boiler feed pumps have 137 individual items in the warehouse. These include items such as a complete rotating assemble, impellers, couplings, bearings, seals, motor rotor assemblies, check valves, gaskets, etc.

Currently, GPA stocks $329,156.80 of spare parts for the pumps (including a spare motor rotor valued at $78,000), and an additional total of $34,209.87 in motor related items.

### 3.11. Condensate Pumps and Drives

***Description of equipment and system***: Each unit is equipped with two, 100% condensate pumps. The pumps are of a vertical turbine design and rated at 750 gpm. The total head of each pump is 420 feet at 1,800 rpm. The 120 HP, 460-volt motors, drive the pumps. Kosyo Toshiba manufactured the motors. Yoshikura manufactured and the pumps.
History: The pump motors historically have been pulled for maintenance every five years. Since 1998 only one motor has been pulled for maintenance, thus three of the four motors are now due for maintenance.

***Condition Assessment***: The Electrical Maintenance Department collects readings and performs vibration analysis. All pumps and motors are currently in serviceable condition, but require inspection as aforementioned.

Pump Performance is conducted by comparing the mass flow from each pump and the pressure at full load. This method is used to monitor the degradation of the pump.

***Spare Parts***: The condensate pumps have 7 individual items in the warehouse. These include a complete spare pump valued at $65,000. The total value of pump and motor related parts is $72,312.33.

## 3.12. Air Systems

### 3.12.1. Service Air

***Description of equipment and system***: The plant has two, 100% capacity service air compressors. The compressors are type 7BDCCB-2, and have a capacity of 650 scfm at 100-psig discharge pressure. The compressors are driven by 125kW, 460 V, 600-rpm motors. The compressors were manufactured by Niigata Worthington.

***History***: Current problems are associated with required repairs to the unloader discharge valves. Currently city drinking water is connected to the cooling chambers of all six-air compressors.

***Condition Assessment***: The electrical maintenance employees perform vibration readings on this equipment. Motor filter changes and inspections, lubrication changes (PM's) are now due. All air compressors are in need of new cylinders.

### 3.12.2 Instrument Air

***Description of equipment and system***: The plant is equipped with four 50% instrument air compressors. The type is 11 X 7ESV-NL and has a rated capacity of 250 scfm at 100 lbs discharge pressure. The compressors operate at 514 rpm and are belt driven by 60HP, 460V, 1,800-rpm motors. Ingersoll-Rand manufactured the compressors.

The instrument air system is equipped with instrument air dryers, model 9-1661A. These dryers have a capacity of 250scfm. The inlet air design temperature is 95 degrees F, with a dew point at outlet of –12 degree F. Ingersoll-Rand manufactured the instrument air dryers.

***History***: The air compressors require replacement of the cylinders. There is one spare motor for these compressors available for use.

***Condition Assessment***: The electrical maintenance employees perform vibration readings on this equipment. Motor filter changes and inspections, lubrication changes (PM's) are now due.

## 3.13. Balance of Plant Systems

### 3.13.1. Station Hoist and Cranes

***Description of equipment and system***: The plant is equipped with a turbine room crane, rated at 35 tons. The crane was originally tested to 96,450 lbs. The crane is equipped with an auxiliary hoist rated at 10 tons and was originally load tested to 27,560 lbs. The crane spans 51 feet and has a lift capacity of 52 feet. Eitac Machinery Inc manufactured the crane.

***History***: This piece of critical equipment is not operated many hours each year.

***Condition Assessment***: The crane undergoes annual re-certification, which was last performed in October 2005. Island Certs re-certified the crane last.

## 4. Station Performance

### 4.1. Heat Rate

***Description of equipment heat rate results***: The GPA operates on an October to September financial reporting year. Since this is the financial reporting standard, the GPA chose to structure the plant budgets and performance reporting along this same time frame. The following history is a monthly/annual summary of each unit's performance:

GHR – Gross Heat Rate (BTU/KWH)
NHR – Net Heat Rate (BTU/KWH)
CF – Capacity Factor (%)
***(for each unit)***

***History***:

Table 12. Fiscal Year 2006 Cabras Unit 1&2 Heat Rate Performance

| MO./YR | #1 GHR | #1 NHR | #1 CF | #2 GHR | #2 NHR | #2 CF |
|---|---|---|---|---|---|---|
| Oct./2005 | 10,774 | 11,577 | 62.32% | 11,114 | 11,966 | 44.43% |
| Nov./2005 | 10,659 | 11,423 | 60.62% | 10,984 | 11,800 | 59.93% |
| Dec./2005 | 10,880 | 11,680 | 60.75% | 11,108 | 11,967 | 57.25% |
| Jan./2006 | 10,809 | 11,631 | 59.26% | 11,094 | 11,976 | 54.58% |
| Feb./2006 | 10,986 | 11,862 | 58.45% | 11,354 | 12,268 | 51.22% |
| Mar./2006 | 11,092 | 12,001 | 33.08% | 11,298 | 12,236 | 55.70% |
| Apr./2006 | 0 | 0 | 0.00% | 11,321 | 12,176 | 65.45% |
| May./2006 | 10,607 | 11,329 | 62.43% | 11,650 | 12,663 | 23.84% |
| Jun./2006 | 10,403 | 11,089 | 67.81% | 10,705 | 11,439 | 66.50% |
| Jul./2006 | 10,870 | 11,714 | 55.45% | 11,082 | 11,935 | 56.74% |
| Aug./2006 | 10,782 | 11,577 | 59.04% | 11,186 | 12,019 | 59.74% |
| Sep./2006 | 11,090 | 12,026 | 40.85% | 11,331 | 12,305 | 47.42% |
| **Average or Equivalent** | **8,087** | **8,674** | **52.28%** | **11,053** | **13,599** | **52.96%** |

Table 13. Fiscal Year 2005 Cabras Unit 1&2 Heat Rate Performance

| MO./YR | #1 GHR | #1 NHR | #1 CF | #2 GHR | #2 NHR | #2 CF |
|---|---|---|---|---|---|---|
| Oct./2004 | 0 | 0 | 0.00% | 10,894 | 13,207 | 36.07% |
| Nov./2004 | 0 | 0 | 0.00% | 11,372 | 12,404 | 52.12% |
| Dec./2004 | 11,029 | 11,878 | 39.12% | 11,428 | 12,368 | 63.04% |
| Jan./2005 | 10,901 | 11,747 | 62.27% | 11,794 | 12,716 | 2.03% |
| Feb./2005 | 10,713 | 11,465 | 0.00% | 0 | 0 | 0.00% |
| Mar./2005 | 10,147 | 10,892 | 68.58% | 10,149 | 10,861 | 39.39% |
| Apr./2005 | 12,949 | 15,009 | 12.29% | 13,160 | 14387 | 31.50% |
| May./2005 | 10,454 | 11,159 | 65.75% | 10,697 | 11,422 | 66.33% |
| Jun./2005 | 10,403 | 11,089 | 67.81% | 10,705 | 11,439 | 66.33% |
| Jul./2005 | 10,870 | 11,089 | 55.45% | 11,082 | 11,935 | 56.74% |
| Aug./2005 | 10,782 | 11,577 | 59.04% | 11,186 | 12,019 | 59.74% |
| Sep./2005 | 11,001 | 11,929 | 40.85% | 11,240 | 12,207 | 47.42% |
| **Average or Equivalent** | **9,876** | **10,596** | **48.53%** | **10,081** | **10,875** | **45.34%** |

Table 14. Fiscal Year 2004 Cabras Unit 1&2 Heat Rate Performance

| MO./YR | #1 GHR | #1 NHR | #1 CF | #2 GHR | #2 NHR | #2 CF |
|---|---|---|---|---|---|---|
| Oct./2003 | 10,755 | 11,590 | 18.07% | 10,909 | 11,693 | 56.06% |
| Nov./2003 | 0 | 0 | 0.00% | 11,042 | 11,845 | 67.17% |
| Dec./2003 | 12,140 | 13,145 | 18.17% | 10,861 | 11,728 | 68.38% |
| Jan./2004 | 10,772 | 11,517 | 56.73% | 11,014 | 11,867 | 60.31% |
| Feb./2004 | 10,516 | 11,195 | 54.26% | 10,867 | 11,647 | 66.61% |
| Mar./2004 | 10,530 | 11,270 | 57.92% | 11,037 | 11,842 | 56.44% |
| Apr./2004 | 10,650 | 11,391 | 59.85% | 10,912 | 11,714 | 60.60% |
| May./2004 | 10,728 | 11,472 | 51.44% | 11,075 | 11,921 | 61.12% |
| Jun./2004 | 10,561 | 11,350 | 54.11% | 11,084 | 11,945 | 58.26% |
| Jul./2004 | 10,623 | 11,361 | 58.49% | 11,183 | 11,935 | 57.81% |
| Aug./2004 | 10,111 | 10,835 | 47.85% | 10,175 | 12,069 | 59.28% |
| Sep./2004 | 0 | 0 | 0.00% | 11,548 | 10,973 | 61.00% |
| **Average or Equivalent** | **10,638** | **11,390** | **39.81%** | **10,975** | **11,813** | **60.97%** |

Table 15. Fiscal Year 2003 Cabras Unit 1&2 Heat Rate Performance

| MO./YR | #1 GHR | #1 NHR | #1 CF | #2 GHR | #2 NHR | #2 CF |
|---|---|---|---|---|---|---|
| Oct./2002 | 10,354 | 11,154 | 62.24% | 0 | 0 | 0.00% |
| Nov./2002 | 10,497 | 11,559 | 52.81% | 11,243 | 12,298 | 7.21% |
| Dec./2002 | 10,640 | 11,604 | 13.04% | 10,689 | 11,393 | 13.28% |
| Jan./2003 | 9,429 | 10,159 | 41.22% | 0 | 0 | 0.00% |
| Feb./2003 | 10,527 | 11,263 | 65.99% | 10,977 | 11,818 | 63.16% |
| Mar./2003 | 10,496 | 11,261 | 69.29% | 10,711 | 11,470 | 54.85% |
| Apr./2003 | 10,723 | 11,468 | 68.01% | 10,680 | 11,398 | 71.07% |
| May./2003 | 10,614 | 11,356 | 69.79% | 10,752 | 11,498 | 68.44% |
| Jun./2003 | 10,625 | 11,360 | 64.77% | 10,824 | 11,633 | 65.57% |
| Jul./2003 | 10,626 | 11,329 | 68.67% | 10,884 | 11,715 | 65.35% |
| Aug./2003 | 10,805 | 11,574 | 62.81% | 10,949 | 11,711 | 62.32% |
| Sep./2003 | 10,868 | 11,657 | 65.08% | 10,779 | 11,533 | 47.61% |
| **Average or Equivalent** | **10,556** | **12,520** | **50.16%** | **14,623** | **17,976** | **34.94%** |

***Expectations Assessment***: Heat Rate (Performance) improvement targets will be established in the Performance Incentive Scoring Mechanism document. The GPA is looking for improvements in plant heat rate well above the aforementioned items. For specific details as to the new desired performance, levels please refer to the Incentive mechanism-scoring document.

**4.1.1. Historical Operational Performance**

***Description of Reliability Reporting System***: The GPA operates on an October to September financial reporting year. Since this is the financial reporting standard, the GPA chose to structure the plant budgets and performance reporting along this same time frame. The following history is a monthly/annual summary of each units performance:

FOH – Forced Outage Hours
EFOR – Equivalent Forced Outage Rate
EAF – Equivalent Availability Factor
***(for each unit)***

***History***:

Table 16. Fiscal Year 2006 Cabras Unit 1&2 Operational Performance

| MO./YR | #1 FOH | #1 EFOR | #1 EAF | #2 FOH | #2 EFOR | #2 EAF |
|---|---|---|---|---|---|---|
| Oct./2005 | 0 | 0.00% | 100.00% | 192.18 | 25.83% | 74.17% |
| Nov./2005 | 14.13 | 1.96% | 98.04% | 0 | 0.00% | 100.00% |
| Dec./2005 | 0 | 0.00% | 100.00% | 0 | 0.00% | 100.00% |
| Jan./2006 | 0 | 0.00% | 100.00% | 0 | 0.00% | 100.00% |
| Feb./2006 | 0 | 5.59% | 94.41% | 37.8 | 6.81% | 93.19% |
| Mar./2006 | 0 | 10.22% | 51.08% | 0 | 0.39% | 99.61% |
| Apr./2006 | 0 | 0.00% | 0.00% | 0 | 0.00% | 100.00% |
| May./2006 | 4.43 | 3.46% | 89.31% | 0 | 0.00% | 45.16% |
| Jun./2006 | 47.08 | 6.12% | 84.37% | 0 | 2.47% | 75.68% |
| Jul./2006 | 0 | 0.00% | 100.00% | 2.67 | 0.36% | 99.64% |
| Aug./2006 | 0 | 0.00% | 100.00% | 0 | 0.95% | 99.05% |
| Sep./2006 | 0 | 0.00% | 100.00% | 0 | 6.44% | 93.56% |
| **Total or Equivalent** | **65.64 Hours** | **2.28%** | **84.77%** | **232.65 Hours** | **3.60%** | **90.01%** |

Table 17. Fiscal Year 2005 Cabras Unit 1&2 Operational Performance

| MO./YR | #1 FOH | #1 EFOR | #1 EAF | #2 FOH | #2 EFOR | #2 EAF |
|---|---|---|---|---|---|---|
| Oct./2004 | 0 | 0.00% | 98.18% | 180.25 | 57.29% | 42.34% |
| Nov./2004 | 0 | 36.67% | 62.18% | 139.68 | 41.38% | 58.62% |
| Dec./2004 | 94.7 | 12.73% | 53.37% | 0 | 0.00% | 75.76% |
| Jan./2005 | 87.13 | 9.05% | 85.56% | 0 | 0.00% | 2.58% |
| Feb./2005 | 0 | 0.48% | 99.52% | 0 | 0.00% | 0.00% |
| Mar./2005 | 1.98 | 0.00% | 99.73% | 0 | 9.10% | 52.77% |
| Apr./2005 | 104.8 | 0.08% | 85.37% | 100.85 | 14.98% | 79.55% |
| May./2005 | 0 | 1.44% | 98.56% | 0 | 0.00% | 100.00% |
| Jun./2005 | 0 | 0.00% | 100.00% | 0 | 0.00% | 100.00% |
| Jul./2005 | 4.48 | 4.47% | 95.53% | 0 | 2.03% | 97.97% |
| Aug./2005 | 0 | 0.00% | 100.00% | 0 | 0.93% | 99.07% |
| Sep./2005 | 191.88 | 27.25% | 72.75% | 54.47 | 21.98% | 78.02% |
| **Total or Equivalent** | **484.97 Hours** | **7.68%** | **87.56%** | **475.25 Hours** | **12.31%** | **65.56%** |

Table 18. Fiscal Year 2004 Cabras Unit 1&2 Operational Performance

| MO./YR | #1 FOH | #1 EFOR | #1 EAF | #2 FOH | #2 EFOR | #2 EAF |
|---|---|---|---|---|---|---|
| Oct./2003 | 0 | 3.18% | 22.41% | 6.22 | 0.44% | 77.37% |
| Nov./2003 | 0 | 0.00% | 0.00% | 19.07 | 4.65% | 95.35% |
| Dec./2003 | 227.75 | 38.86% | 20.17% | 2.48 | 7.84% | 92.16% |
| Jan./2004 | 88.03 | 23.70% | 76.30% | 21.32 | 12.55% | 87.45% |
| Feb./2004 | 114.02 | 2.73% | 80.89% | 0 | 0.00% | 100.00% |
| Mar./2004 | 51.08 | 10.51% | 89.49% | 79.47 | 14.00% | 86.00% |
| Apr./2004 | 2.15 | 3.25% | 96.75% | 0 | 0.00% | 94.23% |
| May./2004 | 0 | 0.28% | 82.35% | 0 | 0.00% | 94.18% |
| Jun./2004 | 58.3 | 7.99% | 90.23% | 25.73 | 2.07% | 90.85% |
| Jul./2004 | 40.95 | 5.41% | 92.78% | 0 | 7.12% | 87.78% |
| Aug./2004 | 159.48 | 21.44% | 77.14% | 4.03 | 0.25% | 94.03% |
| Sep./2004 | 192 | 26.67% | 72.00% | 18.63 | 7.66% | 87.57% |
| **Total or Equivalent** | **933.76 Hours** | **12.00%** | **66.71%** | **176.95 Hours** | **4.72%** | **90.58%** |

Table 19. Fiscal Year 2003 Cabras Unit 1&2 Operational Performance

| MO./YR | #1 FOH | #1 EFOR | #1 EAF | #2 FOH | #2 EFOR | #2 EAF |
|---|---|---|---|---|---|---|
| Oct./2002 | 0 | 0.00% | 100.00% | 0 | 23.96% | 73.63% |
| Nov./2002 | 0 | 2.92% | 97.09% | 0 | 41.74% | 58.26% |
| Dec./2002 | 0 | 1.23% | 98.77% | 0 | 13.14% | 86.86% |
| Jan./2003 | 0 | 4.38% | 67.43% | 0 | 17.66% | 82.34% |
| Feb./2003 | 0 | 0.00% | 100.00% | 0 | 11.29% | 88.71% |
| Mar./2003 | 0 | 5.39% | 94.61% | 150.33 | 21.92% | 78.08% |
| Apr./2003 | 0 | 18.60% | 81.40% | 0 | 14.04% | 85.96% |
| May./2003 | 0 | 13.87% | 86.13% | 40.98 | 20.70% | 79.30% |
| Jun./2003 | 0 | 11.07% | 85.15% | 20.37 | 12.98% | 87.02% |
| Jul./2003 | 0 | 12.00% | 88.00% | 0 | 17.70% | 82.30% |
| Aug./2003 | 36.65 | 21.98% | 73.10% | 20.47 | 9.22% | 77.45% |
| Sep./2003 | 14.63 | 14.98% | 82.98% | 0 | 5.29% | 61.15% |
| **Total or Equivalent** | **51.28 Hours** | **8.87%** | **87.89%** | **232.15 Hours** | **17.47%** | **78.42%** |

***Expectations Assessment***: GPA is looking for improvements in plant performance well above the aforementioned items. For specific details as to the new desired performance levels please refer to Appendix H.

### 4.1.2. Performance Testing Results

***Description of test results***: McHale and Associates, Inc. conducted performance testing of Unit 1 in July 1998, March 2004, April 2005 and Unit 2 on December 1997, March 2004, April 2005. Unit net & gross heat rate testing in addition to individual component testing was performed. The following tables are the summary results of the latest tests:

***History***:

Table 20. 2005 Performance Test Summary Table – Unit 1

| Description | Units | 40 MW 3 Burners | 40 MW 4 Burners | 45 MW 4 Burners | 55 MW 4 Burners | 60 MW Average of 2 Tests | Peak Load Test |
|---|---|---|---|---|---|---|---|
| Measured Steam Turbine Gross Output | kW | 40,208 | 39,621 | 45,029 | 55,062 | 60,095 | 65,885 |
| Unit Net Output | kW | 37,380 | 36,824 | 42,098 | 51,861 | 56,723 | 62,295 |
| Steam Turbine Gross Heat Rate | Btu/kWh | 8,281 | 8,299 | 8,190 | 8,201 | 8,216 | 8,365 |
| Boiler Efficiency | % | 86.78% | 87.12% | 87.12% | 87.18% | 85.90% | 85.83% |
| Unit Net Heat Rate (Boiler Losses Method) | Btu/kWh | 10,538 | 10,518 | 10,380 | 10,271 | 10,416 | 10,596 |

Table 21. 2005 Performance Test Summary Table – Unit 2

| Description | Units | 40 MW 3 Burners | 40 MW 4 Burners | 45 MW 4 Burners | 55 MW 4 Burners | 60 MW Average of 2 Tests | Peak Load Test |
|---|---|---|---|---|---|---|---|
| Measured Steam Turbine Gross Output | kW | 40,970 | 40,711 | 45,840 | 55,720 | 60,855 | 64,551 |
| Unit Net Output | kW | 37,988 | 37,782 | 42,793 | 52,504 | 57,366 | 60,983 |
| Steam Turbine Gross Heat Rate | Btu/kWh | 8,597 | 8,507 | 8,441 | 8,601 | 8,406 | 8,379 |
| Boiler Efficiency | % | 86.47% | 87.10% | 86.89% | N/A(+) | N/A(+) | N/A(+) |
| Unit Net Heat Rate (Boiler Losses Method) | Btu/kWh | 10,985 | 10,826 | 10,763 | 10,373 | 10,387 | 10,352 |

***+The Air Heater O2 analyzer system developed leaks during the 55 MW Test. This affected***

***the boiler efficiency calculations at the 55 MW, 60 MW, and Peak Load Tests. In order to determine the Unit Net Heat Rate at the 55 MW, 60 MW, and Peak Load tests the 45 MW boiler efficiency of 86.89% was used.***

***Condition Assessment***: New heat rate testing is needed since, both turbines have been overhauled, both main condensers have been cleaned and both boilers and air preheaters have undergone major repairs since the 1997 and 1998 performance tests were performed. The heat rate of both units should have improved, but without current test results we cannot give a new base line of unit performance at this time. Both of the McHale unit performance test reports, should be reviewed by the prospective PMC proponents to gain a more complete understanding of the individual equipment performance and their short comings.

### 4.2. Operating Limitations

***Description of current operating limits***: Both units are available for full load but Unit 2 is currently operating at lower operating temperature due to a weak boiler arch way section. Plans are such to replace several of the worn out tubes in this year's outage.

### 4.3. Minimum Load and Ramp Rates

***History***: Currently both units can change load at 7 MW per minute from the 20 MW to 66 MW load range. With all four burners in service and the unit at 40 MW the units can ramp up to 66 MW at a rate of 5 MW per minute.

***Expectations Assessment***: Both units can operate at a current low load of 20 MW gross, however this low limit may not be low enough for cost effective system wide operation if economic conditions force loads to decrease significantly. If this should occur, the PMC may be required to operate each Cabras units at 16 MW gross or lower if possible at extremely light loads.

## 5. Operations and Maintenance

### 5.1. Operational Characteristics

***History***: When the Cabras facility began operation over 30 years ago, it was the largest pair of electric production units on the island. With its reheat cycle and new equipment, the plant was a very good, low cost producer because:

1) Cabras 1 &2 had a better heat rate than any other unit on the island;
2) Cabras 1&2 could burn low cost #6 residual fuel oil; and,

3) Cabras 1&2 achieved an impressively large economy of scale advantage when compared to the other generating units on the island based on the number of personnel to operate and maintain the unit versus its large output capability.

With the advent of the large slow speed diesels of Cabras 3 & 4 and the recent additions of the MEC 8 & 9 units, Cabras 1 & 2 is required to take on a new operating role. Since Cabras 3 & 4 and MEC 8 & 9 have lower heat rates, and burn the same high sulfur, #6 residual fuel oil as that of Cabras 1 & 2, they are now the islands base load units. Thus, Cabras 3 & 4 and MEC 8 & 9 are dispatched before Cabras 1 & 2 due to over all system economics. For this reason Cabras 1 & 2 are now required to operate efficiently at a different mode that being cycling, compared to its past method of operation, that of a base loaded unit.

***Needs Assessment***: The aforementioned operating requirements will be one of the PMC's challenges in the near future. Improvements in equipment reliability and operator techniques will be required to achieve these results.

## 5.2. Cabras Operations/Maintenance Practices

### 5.2.1. Operations Procedures Index

***Description of system***: Cabras has a Table of Standard Operating Procedures, to guide employees through various issues associated with daily production. Many of these procedures are general to the company but a few assist in the day-to-day operation of the plant. A complete listing of these procedures will be made available for review through a CD-ROM provided as part of the RFP documents and the Virtual Website that GPA has developed.

Cabras employees continue to utilize the original Operation Manual, dated July 1974, as provided by Mitsui and Co. Inc., New York, U.S.A. & Tokyo Electric Power Services CO., LTD., of Tokyo, Japan. The manual covers issues such as:

- Starting of unit when Cold, Warm or Hot, with curves and limits
- Continuous operation
- Increasing and decreasing load
- Shutdown of unit
- Plant auxiliaries
- Operator equipment check points and inspections
- Normal operating ranges of temperatures, pressures and flows
- Lead and Lag operations
- Power transformer operation

***History***: The Cabras operations department has relied on the original Operation Manual for operating procedures.

***Needs Assessment***: The next PMC will need to continue with the future training functions in support of operational excellence goals and develop detailed procedures to support long term operation.

**5.2.2. Maintenance Procedures**

***Description of system & History***: The Cabras maintenance departments rely on the OEM manuals and employee's historical knowledge and learned skills to perform required maintenance activities.

***Needs Assessment***: Certain maintenance procedures need to be developed to support future maintenance activities.

**5.2.3. Water Production Procedures**

***Description of system & History***: The Cabras operation department does not have specifically developed water production procedures. They rely on the OEM manuals and employee's historical skills to perform required maintenance activities.

***Needs Assessment***: Certain water production procedures need to be developed to support future operations activities. All water production procedures will be the property of GPA and transferred to GPA for use, and are to be developed in electronic format such as Microsoft Word.

**5.2.4. Boiler Water Treatment Procedures**

***Description of system & History***: The Cabras operation department has specifically developed boiler water treatment procedures, but requires revision.

***Needs Assessment***: Certain boiler water treatment procedures need to be developed/revised to support future operations activities. The PMC will be required to better organize this function during the life of the contract. All boiler water treatment procedures will be the property of GPA and transferred to GPA for use, and are to be developed in electronic format such as Microsoft Word. The Microsoft Word documents shall be archived as development copies. Most documents will be delivered to users as Adobe PDF files or in hardcopy.

**5.3. Central Support Services**

**5.3.1. Central Maintenance Capabilities**

***Description of department & capabilities of personnel***: The Central Maintenance department (CM) supports Cabras 1, 2, 3 & 4 in addition to the fleet of combustion turbines and medium speed diesels across the entire island. Central Maintenance, has good in-house maintenance capabilities for a plant this size with the following equipment and shop support:

- Three engine lathes capable of turning 40+ inches, 15 feet in length;
- Milling machine;
- Surface grinder;
- A pair of band saws;
- Two drill presses (one large radial and one small);
- Four electric welding machines rated at 300 amps;
- Two portable (diesel powered) welding machines with AD/DC power and compressed air capabilities;
- Plasma cutter;
- Tool storage locks up with various portable hand tools, estimated value approximately $100,000.

The CM department personnel receive their training through on-the-job efforts. There is no formal training or apprenticeship program. The majority of the CM personnel are currently Journeymen mechanics. Currently there is only one Utility Worker position employee in the CM department.

***History***: the CM department personnel typically have supported the major outages and large equipment repair activities at Cabras such as:

- Air heater basket and seal repairs;
- Boiler welding and repairs;
- Turbine / Generator outages;
- Pump, motors, fans;
- Piping, valves, condenser, feedwater heaters.

The CM department has a staff of 22 employees, with a Superintendent, support staff, 2 foremen and 18 hourly employees.

### 5.3.2. Central Planning Capabilities

***Description of department & capabilities of personnel***: In 1997 GPA initiated the implementation of the Computerized Maintenance Management System (CMMS) under the J.D. Edwards (JDE) Financial Management Software for all operations division sections, but primarily for generation, T&D and transportation. Prior to this program, GPA tracked maintenance with a simple database or spreadsheet program, with no standardized maintenance management program in place. History files were not easily accessible and most history resources were retiring. In addition, labor and other project costs tracking became difficult tasks when projects were not setup with appropriate tracking accounts.

Currently, there are two full time dedicated maintenance planners at the Cabras 1 & 2 plant that handle the processing, coordinating, scheduling and closing of maintenance work orders.

The planner's areas of responsibilities are generally split to handle either mechanical or electrical/instrument work orders. Planning meetings for each discipline occurs two to three times a week to review work order backlog, scheduling and work order progress. These meetings typically involve the planners, assistant plant superintendent of maintenance and maintenance supervisors.

### 5.3.3. Central Warehousing Capabilities

***Description of department & capabilities of personnel***: The warehouse stores spare and replacement parts and components required for reliable operation of the Cabras facility. One full time employee staffs the warehouse. GPA will continue to provide this person since the warehouse stores parts for Cabras 3 & 4 and other operating units within the GPA system.

Currently there is an estimated total valuation of $3.100,000 in spare parts assigned to the Cabras 1 & 2 plant. However, these is also a large degree of obsolete, and unusable items that need to be identified by the PMC in order to determine the actual value of inventory for tracking, future incentive payments and control purposes.

### 5.3.4. Station Engineering Capabilities

***Description of department & capabilities of personnel***: The station-engineering department is located next to the planning department on the Cabras plant property. The group is comprised of six mechanical engineers:

***History***: This department's employees handle projects to improve the long term reliability and operation /maintenance of the plant. Department personnel also coordinate with contractors, determine budget inputs, support major outages, monitor heat rate and determine what needs to be accomplished to help the long-term viability of the plant.

### 5.3.5. General Engineering Capabilities

***Description of department***: The Engineering Division is responsible for the overall implementation of new capital improvements projects for the Guam Power Authority. These projects range from multi-million dollar construction projects such as the installation of Cabras 3 & 4 Slow-speed Diesel Plant to the line extensions for individual customer services. Additionally, the Division is responsible for managing the Authority's, Demand Side Management (DSM) program in addition to performing various system planning studies such as the Long Range Transmission Study and the Integrated Resource Plan. Lastly, General Engineering is also responsible for the overall system protection needs.

The General Engineering Division is comprised of eight sections:

- Engineering Administration;
- Customer Service;
- Distribution;
- Project Management;
- Real Estate;
- Substation / Transmission;

The Division has 35 personnel with varying skill levels from the licensed professional engineers to engineering technicians and the field survey crews.

## 5.4. Computerized Maintenance Management System (CMMS)

***Description of department & capabilities of personnel***: In 1997 GPA initiated the implementation of the Computerized Maintenance Management System (CMMS) under the J.D. Edwards (JDE) Financial Management Software for all operations division sections, but primarily for generation, T&D and transportation. Prior to this program, GPA tracked maintenance with a simple database or spreadsheet program, with no standardized maintenance management program in place. History files were not easily accessible and most history resources were retiring. In addition, labor and other project costs tracking became difficult tasks when projects were not setup with appropriate tracking accounts.
The CMMS provided an on-line access to equipment for completed, ongoing and upcoming maintenance work orders with an up to date status. Backlog, project costs and labor tracking were easily available through system reporting. The integrated inventory program allowed parts to be viewed on-line and staged before they were to be picked up from the warehouse. The CMMS also provided the capability of downloading system data onto a spreadsheet to graph equipment readings or test results for trending analysis.

Formal and onsite CMMS training has been conducted to all positions at Cabras for work order entry and backlog review. For other positions a more detailed training was provided for adding labor routing and parts, plus the closing of work orders.

A computer network was developed to provide access to the CMMS as well as the financial management system. This allows for system access in almost all plant office areas. In the Cabras plant, there are 12 computers and three network printers, which all access the JDE system. Six computers and one network printer are located in the Administrative Offices on the first floor. One computer is located in the control room on the second floor. Three computers and one printer are located in the Electrical/Instrument shop on the third floor. Two computers and one printer are located in the plant maintenance shop, on the northeast side of the plant. The central maintenance office has four computers and one printer on the second floor in the plant. This equipment may be moved with the Central Maintenance staff should this section be relocated from the Cabras office area.

The CMMS still has a number of pending installations for the JDE system as well as equipment nameplate data to be input. This includes the integration of the spare parts component listing and inventory identification. In order to complete this, a component parts list must be developed for all major/critical equipment and matched with inventory part numbers. Additionally, the inventory items should be reviewed and obsolete items cleared out of the warehouse inventory system. This will be a large undertaking but is required for proper material management and control.

The payroll module has not been integrated with the CMMS module either. This requires all actual labor hours to be manually inputted into each work order as opposed to an automatic CMMS update from the payroll module. Presently, actual hours are being entered against work orders in the payroll time entry and this information can be reported through a custom made report.

## 5.5. Plant Organizational

### 5.5.1. Existing Organization Chart

The organization chart will be available upon request.

### 5.5.2. Optimal Organization Chart

The optimal organization chart will be available upon request.

## 5.6. Training Requirements

***Description of Personnel Training Capabilities***: Currently, the Performance Management Contract (PMC) provides training to the Cabras operation and maintenance employees. A detailed listing of all the training modules and who is to receive which level of training will be provided. From this listing, the PMC will be required to develop and present an on-going training program in their proposal package.

### 5.6.1. Operations Department

#### 5.6.1.1. Control Board Operators

***Description of Department Structure & Capabilities***: Two Control Board Operators (CBO) staff the plants per shift. The CBO's are responsible for bringing the units up and down, or, on and off-line as requested by the system dispatch operators and ensuring the safe and reliable operation of the major and auxiliary equipment of the plant. Specific operational duties are described in the Operation Manual for Cabras Steam Power Plant, dated July 1974. Specific job duties are described in the GPA position descriptions. These descriptions will be made available at the plant indicative proposal and plant tour meetings.

***Skill Levels***: CBO's are the highest trained operating personnel, excluding the shift leaders.

The CBO will understand all operational functions for the plant and that of the power plant operators.

***Formal Training summary***: There is no formal documented training program for the CBO's. CBO's receive on the job training from other GPA employees who have established the required skills to perform the work requirements. The IMC will provide specific training to the CBO's as part of their 2001 contract. Details of this training will be provided.

#### 5.6.1.2. Power Plant Operators

***Description of Department Structure & Capabilities***: Current staffing has two Power Plant Operators (PPO) per shift. The PPO's are responsible for operating all the equipment outside the control center area. These operators inspect, operate and turn on and off the auxiliary equipment as requested by the CBO and ensure the safe and reliable operation of the major and auxiliary equipment of the plant. Specific operational duties are described in the Operation Manual for Cabras Steam Power Plant, dated July 1974.

Specific job duties are described in the GPA position descriptions. These descriptions will be made available at the plant indicative proposal and plant tour meetings.

***Skill Levels***: PPO's are the second highest trained operating personnel, excluding the shift leaders. The PPO will understand all operational functions of the auxiliary equipment and report to and receive direction and skills training from the CBO and Shift Leaders.

***Formal Training summary***: There is no formal documented training program for the PPO's. AO's receive on-the job training from other GPA employees who have established the required skills to perform the work requirements. The IMC will provide specific training to the AO's as part of their 2001 contract. Details of this training will be provided.

### 5.6.2. Maintenance Department

#### 5.6.2.1. Plant Maintenance Mechanic

***Description of Department Structure & Capabilities***: The plant maintenance mechanic employees (PMM) work a normal eight-hour day shift, Monday through Friday. No second or third shift exists, and any work beyond the basic shift requires over time or the possibility of changing shift schedules within the pre-established work rules. Plant maintenance mechanic employees provide repair services of the mechanical nature to all the plant equipment as required. They also help to ensure the safe and reliable operation of the major and auxiliary equipment of the plant. Specific maintenance duties are described in the GPA established position descriptions for Cabras Steam Power Plant. GPA will provide these descriptions.

***Skill Levels***: Skill levels were determined through testing by the IMC in 2001. These results will be forwarded to GPA who will make them available for summary review.

***Formal Training summary***: There is no formally documented, on-going training program for the PMM. PMM receive on-the job training from other GPA employees who have established the required skills to perform the work requirements. The IMC will provide specific training to the PMM as part of their 2001 contract. Details of this training will be provided.

#### 5.6.2.2. Electrical Maintenance Employees

***Description of Department Structure & Capabilities***: The electrical maintenance employees (EME) work a normal eight-hour day shift, Monday through Friday. No second or third shift exists, and any work beyond the basic shift requires over time or the possibility of changing shift schedules within the pre-established work rules. Electrical maintenance employees provide repair services of the electrical nature of all the plant equipment as required. They also help to ensure the safe and reliable operation of the major and auxiliary equipment of the plant. Specific maintenance duties are described in the GPA established position descriptions for Cabras Steam Power Plant. These descriptions will be made available.

***Skill Levels***: Skill levels will be determined through testing by the IMC. These results will be forwarded to GPA who will make them available for summary review.

***Formal Training summary***: There is no formal documented training program for the EME's. EME's receive on-the job training from other GPA employees who have established the required skills to perform the work requirements. The IMC will provide specific training to the EME's as part of their 2001 contract. Details of this training will be provided.

#### 5.6.2.3. Instrument & Control Maintenance Employees

***Description of Department Structure & Capabilities***: The Instrument and Control (I&C) maintenance employees work a normal eight-hour day shift, Monday through Friday. No second or third shift exists, and any work beyond the basic shift requires over time or the possibility of changing shift schedules within the pre-established work rules. I&C maintenance employees provide repair services to the instrument and control nature of all the plant equipment as required. They also help to ensure the safe and reliable operation of the major and auxiliary equipment of the plant. Specific maintenance duties are described in the GPA established position descriptions for the Cabras Steam Power Plant. These descriptions will be made available at the plant indicative proposal and plant tour meetings.

***Skill Levels***: Skill levels will be determined through testing by the IMC. These results will be forwarded to GPA who will make them available for summary review.

***Formal Training summary***: There is no formally documented, on-going training program for the I&C's. I&C's receive on-the job training from other GPA employees who have established the required skills to perform the work requirements. The IMC will provide specific training to the EME's as part of their 2001 contract. Details of this training will be provided.

## 5.7. Capital and O&M Performance Improvement Projects

Table 22 summarizes the Performance Improvement Project assignments.

The following is a brief description of the estimated outstanding activities to be accomplished by the new PMC:

R1. Boiler Chemical Cleaning – Routine chemical cleaning of the boiler. Last cleaning was done using the alkaline copper removal (ACR) process.
R2. Turbine Generator Overhaul – Perform the overhaul for the turbine generators in 2008 (unit 2) and 2009 (unit 1).
R5. Boiler Condition Assessment – Perform detailed NDE activities on all major components of both boilers, to determine remaining useful life & budgeting.
R6. Reheater Tubes Replacement – Install owner furnished reheater tubes. It was recommended by B&W (Boiler & major Steam Piping Assessment Study – Unit 1, 2003) to replace the entire tube bank due its poor condition.
R18. Water Treatment Facility – Construct a new reverse osmosis (RO) water treatment facility.
R27. Hydrogen Piping Replacement - Replace hydrogen piping on both units to improve usability, avoid costly leakage and upgrade the system.
R30. Turbine Overhaul Parts – Purchase turbine blades and necessary spare parts in conjunction with the 2008 turbine outage. It was recommended by TEMES and GE to replace the turbine blades of HP 2$^{nd}$ and 3$^{rd}$ stage, IP 11$^{th}$ stage for unit #2.
R32. DCS and BMS Upgrade – Replace the existing unit boiler control system with a new digital control system and upgrade the boiler management system for both units.
R33. AGC Implementation Activities – Integrate Boiler and Turbine Controls with SCADA/EMS EMSYS.
R39. Foam-Water Fire Protection System – Purchase and install a foam-water fire protection system for the fuel oil storage tanks.
R41. Fire Protection System for the Boilers – Purchase and install fire detection and alarm system at the boiler burner.
R42. Fire Protection for the Transformers – Purchase and install fire detection and alarm system at the generator transformer.
R46. Safety Valve Routine Inspection – Perform the routine inspection of the safety valves on the boilers and other auxiliary equipment.
R48. Air Pre-heater Cold & Hot End Basket Replacement – Replace cold end baskets in Unit 1 and hot end baskets in Unit 2 for the 2007 outages.
R49. Instrument Air Compressor Replacement – Purchase and install new instrument air compressor.

R56. Plant Paging System Replacement – Purchase and install new paging system for the plant. Existing system is in bad condition.
R62. Boiler Arch Tube Replacement – Install owner furnished tubes in the archway in the boiler furnace for the 2007 outages. Replace the entire archway tubes in Unit 2 and half of the tubes in Unit 1.
R66. Condenser Re-tubing – Purchase and install stainless tubes for Unit #2.
R71. Plant Major Equipment & Structural Painting – Painting of turbine/generator, MCC, control panel, and the building structural.
R72. Establish QA Function & SOP's – Establish the plant's Quality Assurance process, update and establish standard operation procedures for the plant.
R77. Generator Rotor Rewinding – Perform rotor rewinding on Unit #2 generator during the 2008 overhaul.
R79. Smoke Stack Refurbishment – Replace the inner lining of the smoke in phases for both units. Phase 1 – repair of the bottom half portion of the stack. Phase 2 – repair of the remaining portion of the stack.
R80. Assorted Pumps/Motors Replacement – Replace various pumps and motors that are in severe condition. It has become difficult and costly to repair them.
R81. New Economizer Header for Unit 1– Install owner furnished economizer header for Unit 1.
R82. Air Pre-heater Assembly Replacement – Replace complete assembly for both units. Air pre-heater components are badly deteriorated.
R83. Fuel Oil Tank Inspection – Perform the inspection of the fuel oil day tanks in accordance to the requirements of the API. Inspection is done every 5 years. The last one was in 2006.
R84. Boiler Casing & Refractory Renewal – Remove and replace any damaged refractory on the boiler. Inspect the casing including buck stay and perform repairs as necessary.
R85. Turbine EHC Piping Replacement – Purchase, remove and install piping for the electrohydraulic control in the turbine control system.
R89. Asbestos Abatement Work – Removal and disposal of asbestos contaminated material throughout the plant.
R90. Upgrade Control Valves – Upgrade the major boiler control valves for both units such as main feedwater control valves, superheater sprays, sootblower control valves, auxiliary control valves, minimum flow control valves, etc.
R91. Raw Water System Renovation – Repair the leaks on the piping for the Raw Water system (city water) to lessen the plant's water consumption.
R92. Boiler Drum Internal Parts Preparation – Purchase the internal parts (stock parts) for the boiler steam drum.
R93. No. 2 Low Pressure Heater Inspection & Repair – Inspect the no. 2 low pressure feedwater heater on Unit 1. Perform repairs based on the result of inspection. Inspection results will be used to determine replacement will be needed.
R95. D.C. Battery Cell Replacement – Replace the D.C. battery cells including racks for Unit 1.
R96. Plant Power Block Lighting Refurbishment – Replace lighting fixtures, electrical outlets and upgrade the power block circuits. Several areas in the plant have

inadequate lighting or lighting fixtures are old and in bad condition. The existing electrical circuits have become inadequate for the electrical load.

R97. Construction of Maintenance Shop – Construct a new shop for the plant maintenance section.

R99. Service Water Cooler Retubing – Purchase and install new tubes in the service water cooler. Several tubes are plugged with marine debris that is extremely difficult to remove.

Boiler Routine Inspection – Routine internal and external examination to determine the operating condition of the boiler and to ascertain the true condition of the boiler.

New. Distributed Control System (DCS) and Burner Management System (BMS) Upgrade Feasibility Study – Perform an economic feasibility study for the upgrades. Preliminary study was done in 2007 for the DCS.

New. New Valve Lapping Facility – Construct a new valve lapping facility. This type of facility is needed to facilitate the valve work during overhauls and regular maintenance.

New. Heater Drain Pump Assembly – Purchase and install new heater drain pump assembly. Obtaining parts for this pump has become difficult and expensive.

New. No. 4 Feedwater Heater Replacement – Purchase and install new feedwater heater for unit 1.

New. Main A/C System - Upgrade the main A/C system for the plant. The existing system is undersized and it can't handle the load.

New. New Force Draft Fan (FDF) Motor – Purchase a new motor for the FDF. This is a spare motor.

New. Plant External Lighting – Upgrade and/or install new external lighting around the Cabras Compound to meet Homeland Security requirements.

New. New Boiler Feed Pump (BFP) Motor – Purchase a new motor. This is a spare motor.

New. Turbine Room Window Repairs – Replace or repair several damaged windows on the turbine deck.

New. Plant Elevator Replacement – Replace the existing elevator with an upgrade model. The existing one is in bad conditions. It has become difficult and costly to repair it.

New. New Circulating Water Pump (CWP) Motor – Purchase a new motor. This is a spare motor

Table 22. Performance Improvement Projects Assignments By Calender Year

| Item # | Item Description | Capital or O&M | Items Completed | TEMES 2007 | PMC 2008 | PMC 2009 | PMC 2010 | PMC 2011 |
|---|---|---|---|---|---|---|---|---|
| R1 | Boiler Chemical Cleaning | O&M | | | | | Unit 2 | Unit 1 |
| R2 | Turbine Generator Overhaul | O&M | | | Unit 2 | Unit 1 | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| R5 | Boiler Condition Assessment | O&M | | | | Unit 1 | Unit 2 | |
| R6 | Reheater Tubes Replacement | O&M | | Unit 1 | Unit 2 | | | |
| R18 | Water Treatment Facility | Capital | | | Unit 1&2 | | | |
| R27 | Hydrogen Piping Replacement | O&M | | | | | Unit 1&2 | |
| R30 | Turbine Overhaul Parts & Materials | O&M | | Unit 2 | Unit 1 | | | |
| R32 | DCS & BMS Upgrade | Capital | | | | Unit 1&2 | | |
| R39 | Foam-Water Fire Protection System | Capital | | | Unit 1&2 | | | |
| R41 | Fire Protection System for the Boilers | Capital | | | | Unit 1&2 | | |
| R42 | New Generator Transformer Fire Protection | Capital | | | | Unit 1&2 | | |
| R46 | Safety Valve Routine Inspection | | | | Unit 2 | Unit 1 | | |
| R48 | Air Pre-heater Cold and Hot End Basket Replacement | Capital | | Unit 1&2 | | | | |
| R49 | Instrument & Service Air Compressor Replacement | Capital | Unit 1 | | | | Unit 2 | |
| R56 | Plant Paging System Replacement | Capital | | | | Unit 1&2 | | |
| R62 | Boiler Arch Tube Replacement | O&M | | Unit 1&2 | | | | |
| R66 | Condenser Retubing | Capital | Unit 1 | | Unit 2 | | | |
| R71 | Plant Major Equipment & Structural Painting | O&M | | | | Unit 1&2 | Unit 1&2 | |
| R72 | Establish QA Function & SOP's | O&M | | Unit 1&2 | Unit 1&2 | | | |
| R77 | Generator Rotor Rewinding | O&M | | | Unit 2 | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| R79 | Smoke Stack Refurbishment | O&M | | Unit 2 | | | | |
| R80 | Assorted Pumps/Motors Replacement | Capital | | Unit 1 | | | | |
| R81 | New Economizer Header for Unit 1 | O&M | Unit 2 | Unit 1 | | | | |
| R82 | Air Pre-heater Assembly Replacement | Capital | | | | | Unit 2 | Unit 1 |
| R83 | Fuel Oil Tank Inspection | | | | | | Unit 2 | Unit 1 |
| R84 | Boiler Casing & Refractory Renewal | O&M | | Unit 1&2 | | | Unit 2 | Unit 1 |
| R85 | Turbine EHC Piping Replacement | O&M | | | Unit 2 | Unit 1 | | |
| R89 | Asbestos Abatement Work | O&M | | Unit 1&2 | Unit 1&2 | Unit 1&2 | Unit 1&2 | Unit 1&2 |
| R90 | Upgrade Control Valves | Capital | | Unit 1&2 | | | | |
| R91 | Raw Water System Renovation | Capital | | Unit 2 | | | | |
| R92 | Boiler Drum Internal Parts Preparation | O&M | | Unit 1&2 | | | | |
| R93 | No. 2 Low Pressure Heater Inspection & Repair | O&M | | Unit 1 | | | | |
| R95 | D.C. Battery Cell Replacement | O&M | | Unit 1 | | | | |
| R96 | Plant Power Block Lighting Refurbishment | Capital | | | | | Unit 1&2 | |
| R97 | Construction of Maintenance Shop | Capital | | | | Unit 1&2 | | |
| R99 | No. 1 Service Water Cooler Replacement | Capital | | | Unit 2 | Unit 1 | | |
| New | DCS & BMS Upgrade Feasibility Study | Capital | | | Unit 1&2 | | | |
| New | New Valve Lapping Facility | Capital | | Unit 1&2 | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| New | Heater Drain Pump Assembly | O&M | | | Unit 1&2 | | | |
| New | No. 4 Feedwater Heater Replacement | Capital | | | | Unit 1 | Unit 2 | |
| New | Main A/C System | Capital | | | | | Unit 1&2 | |
| New | New Force Draft Fan (FDF) Motor | Capital | | | | | | Unit 1&2 |
| New | Fuel Oil Tank Inspection | O&M | | | | | | Unit 1&2 |
| New | Plant External Lighting | O&M | | | | | | Unit 1&2 |
| New | New Boiler Feed Pump (BFP) Motor | Capital | | | | | | Unit 1&2 |
| New | Turbine Room Window Repairs | O&M | | | | | | Unit 1&2 |
| New | Plant Elevator Replacement | Capital | | | | | | Unit 1&2 |
| New | New Circulating Water Pump (CWP) Motor | Capital | | | | | | Unit 1&2 |
| | Boiler Routine Inspection | O&M | | Unit 1&2 | Unit 2 | Unit 1 | | |

### 5.8. Historic Spending Patterns

Table 23 summarizes the FY 2003 through FY 2006 historic spending patterns for the Cabras 1&2 Power Plant.

Table 23. Cabras 1&2 Power Plant Historic Spending Patterns

| Object Code | Description | FY 2003 Actual $ | FY 2004 Actual $ | FY 2005 Actual $ | FY 2006 Actual $ | 4-Year $ Average |
|---|---|---|---|---|---|---|
| 2 | Overtime | 714,302 | 754,333 | 769,336 | 721,347 | 739,830 |
| | | | | | | |
| 15 | Heavy equipment | 14,174 | 5,194 | 231 | | 6,533 |
| 17 | Other Rental | | 43,004 | 5,820 | | 24,412 |
| 25 | Technical Service | 64,920 | | | | 64,920 |
| 26 | E.P.A. | | 45,641 | 75,393 | | 60,517 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 27 | Professional services | | 406,032 | 760,083 | 19,016 | 395,044 |
| 29 | Grounds Maintenance | | 21,784 | 53,025 | | 37,405 |
| 32 | Maintenance of Office Equipment | 4,890 | | 842 | | 2,866 |
| 33 | Maintenance of Accessory Equipment | | 11,328 | 41,710 | | 26,519 |
| 35 | Other maintenance | -2,085 | 43,091 | 1,485,713 | 96,562 | 405,820 |
| 38 | Water | 218,645 | 263,631 | 287,197 | 319,307 | 272,195 |
| 40 | Telephone - Overseas | | 5,416 | 9,778 | | 7,597 |
| 43 | Other Contractual Services | 14,213 | 40,010 | 124,617 | | 59,613 |
| 44 | Parts | 529,866 | 588,795 | 287,700 | 290,639 | 424,250 |
| 45 | Turbine & Assoc. Equipment | -18,881 | | 2,457 | 286 | -5,379 |
| 46 | Accessory Equipment | | 150,302 | 183,593 | | 166,948 |
| 48 | EPA & Others | | | | | |
| 49 | Conductors, Poles & lights | | 212 | | 38 | 125 |
| 55 | Other Parts | | 188 | 827 | | 508 |
| 56 | Chemicals | 64,360 | 251,814 | 295,496 | | 203,890 |
| 57 | Gases | 2,980 | 43,302 | 66,230 | | 37,504 |
| 58 | Lubricants | 28,156 | 23,862 | 35,010 | | 29,009 |
| 62 | Other materials | 8,318 | 133,696 | 218,915 | | 120,310 |
| 64 | Janitorial supplies | | 7,309 | | | 7,309 |
| 65 | Office Supplies | | 5,847 | 5,628 | | 5,738 |
| 66 | Safety Supplies | | 11,022 | 28,958 | | 19,990 |
| 67 | Printed Forms | | 5,257 | 7,937 | | 6,597 |
| 68 | Xerox Supplies | | 1,738 | | | 1,738 |
| 69 | Uniforms, Coveralls | | 3,564 | 996 | | 2,280 |
| 70 | Tools | | 26,592 | 28,250 | | 27,421 |
| 72 | Other Supplies | | 38,391 | 35,401 | | 36,896 |
| 77 | Training & materials | | 286 | 115,949 | 41,890 | 52,708 |
| 82 | Steam Other - Travel | | 463 | 6,050 | | 3,257 |
| 550 | PMC -Temes Charges (Undistributed Costs) | | | | 1,711,851 | 1,711,851 |
| **Total Non-Labor (Codes 15 - 550)** | | **929,556** | **2,177,771** | **4,163,806** | **2,479,589** | **2,437,681** |

| | | | | | |
|---|---|---|---|---|---|
| **CIPs/PIPs** | | **3,728,651** | **7,491,571** | **4,478,989** | **5,233,070** |
| **Fixed Management Fees** | **1,177,500** | **1,590,017** | **1,617,048** | **1,644,538** | **1,507,276** |
| | | | | | |
| **Grand Total** | **2,107,056** | **7,496,439** | **13,272,425** | **8,603,116** | **7,869,759** |

## 6. Plant Documentation Summary

The Authority has provided, on CD-R media, the following Cabras 1&2 Plant documents listed in Table 24.

Table 24. Cabras 1&2 Plant Document List

| NO. | DESCRIPTION | TYPE |
|---|---|---|
| 1 | Auxilary One Line Diagram, EA-1010S1-7 | DRAWING |
| 2 | Auxilary One Line Diagram, EA-1010S2-5 | DRAWING |
| 3 | Cabras 1 Main Condenser A-Box Eddy Current Report | DOCUMENT |
| 4 | Cabras 1 Main Condenser B-Box Eddy Current Report | DOCUMENT |
| 5 | Cabras 1&2 Inventory Listing (10-23-01) | |
| 6 | Cabras 2 Feedwater Heaters 1,2,4,5 Eddy Current Report | DOCUMENT |
| 7 | Cabras 2 Main Condenser A-Box Eddy Current Report | DOCUMENT |
| 8 | Cabras 2 Main Condenser B-Box Eddy Current Report | DOCUMENT |
| 9 | Cabras Unit 1 Component and Net Unit Performance Test Report | DOCUMENT |
| 10 | Cabras Unit 1 Heat Exchanger Examination & Long Term Strategies | DOCUMENT |
| 11 | Cabras Unit 2 Heat Exchanger Inspection & Long Term Strategies | DOCUMENT |
| 12 | Circulating Water & Misc Piping at Intake Structure - Plan & Section, MT-1002-3 | DRAWING |
| 13 | Circulating Water Piping Plan - Section & Detail, MT-1001-1 | DRAWING |
| 14 | City Water & Misc Fire Protection - Piping Plan, Section & Details (Original), MT-1003-6 | DRAWING |
| 15 | Diagram of Steam Seal Piping, MT-1005-2 | DRAWING |
| 16 | Drainage Pit & Piping-Ground Floor Plan, MB-1009-8 | DRAWING |
| 17 | Flow Diagram -Aux. Steam System, GPA-002-6, MB-1011 | DRAWING |
| 18 | Flow Diagram -Boiler Drain & Blow-Off System, GPA-003-3, MB-1012 | DRAWING |
| 19 | Flow Diagram -Chemical Feed & Sampling System, MG-3002-3 | DRAWING |
| 20 | Flow Diagram - City, Fire, & Misc. Water, MG-1012-5 | DRAWING |
| 21 | Flow Diagram - Cooling Water System, GPA-006-4, MB-1015 | DRAWING |
| 22 | Flow Diagram - Drainage, MG-1013-5 | DRAWING |
| 23 | Flow Diagram -Feedwater & Steam Flow, GPA-001-5, MB-1010 | DRAWING |
| 24 | Flow Diagram -Flue Gas & Air Duct, GPA-004-2, MB-1013 | DRAWING |
| 25 | Flow Diagram - Fuel & Ignition Oil System, GPA-005-4, MB-1014 | DRAWING |
| 26 | Flow Diagram - Fuel & Ignition Oil System, MG-1011-1 | DRAWING |

**Cabras 1&2 Plant Document List**

| NO. | DESCRIPTION | TYPE |
|---|---|---|
| 27 | Flow Diagram - Instrument & Service Air. GPA-007-4, MB-1016 | DRAWING |
| 28 | Flow Diagram - Instrument Supply Air, MC-2003-0 | DRAWING |
| 29 | Flow Diagram -Seal & Aspirating Air System, GPA-009-5, MB-1018 | DRAWING |
| 30 | Flow Diagram -Shaft Seal Oil & Bearing Drain Enlargement Vent System, MT-1004-0 | DRAWING |
| 31 | Flow Diagram - Washing Water System, GPA-008-4, MB-1017 | DRAWING |
| 32 | Fuel System Misc. Details, MB-1003-2 | DRAWING |
| 33 | Fuel System Storage Tank Yard Plan, MB-1001-3 | DRAWING |
| 34 | General Arrangement - Boiler Area-Upper Platform (#1), MG 1006-2 | DRAWING |
| 35 | General Arrangement - Boiler Area-Upper Platform (#2), MG 1006-2 | DRAWING |
| 36 | General Arrangement - Deaerator Floor Plan, MG-1005-2 | DRAWING |
| 37 | General Arrangement - Ground Floor Plan, MG-1002-6 | DRAWING |
| 38 | General Arrangement - Laboratory, MG-3005-0 | DRAWING |
| 39 | General Arrangement - Mezzanine Floor Plan, MG-1004-3 | DRAWING |
| 40 | General Arrangement - Operating Floor Plan, MG-1003-2 | DRAWING |
| 41 | General Arrangement - Section A-A, MG-1007-3 | DRAWING |
| 42 | General Arrangement - Section B-B, MG 1008-1 | DRAWING |
| 43 | General Arrangement - Section C-C, MG-1009-1 | DRAWING |
| 44 | Key Aux One Line Wiring Diagram, EA-1005-6 | DRAWING |
| 45 | Machine Shop Layout Plan, MG-3004-1 | DRAWING |
| 46 | Main One Line Wiring Diagram, EA 1001-7 | DRAWING |
| 47 | Phasor Diagram, EA-1002-4 | DRAWING |
| 48 | Plant Interlock Diagram, ED-1003-2 | DRAWING |
| 49 | Power Plant Site Layout Plan (Original), MG-1001-5 | DRAWING |
| 50 | Raw Water, Makeup Water, & Condensate Water Piping - Plan Section & Details, MT-1006-3 | DRAWING |
| 51 | Typical Hanger & Support Details, MG-1015-0 | DRAWING |
| 52 | Weld End Preparation & Backing Ring Detail, MG-1014-0 | DRAWING |
| 53 | Yard Piping - Fuel Oil & Drainage, MB-1008-6 | DRAWING |
| 54 | Boiler & Major Steam Piping Condition Assessment Study – Cabras Power Plant, Unit 1 | DOCUMENT |
| 55 | Boiler Tube, Outlet Headers and Major Steam Piping Condition Assessment Study - Cabras Power Plant, Unit 2 | DOCUMENT |
| 56 | Cabras Unit 2 Economizer Replacement, Report No. 22128 | DOCUMENT |
| 57 | Component And Net Unit Performance Test Report Volume 1, Cabras Power Plant Unit 1 (2005) | DOCUMENT |
| 58 | Component And Net Unit Performance Test Report Volume 1, Cabras | DOCUMENT |

| | | |
|---|---|---|
| | Power Plant Unit 2 (2005) | |
| 59 | Maintenance Skill & Training Needs Assessment, Cabras Units 1 & 2 | DOCUMENT |