

## **5.19 RELIABILITY AND EFFICIENCY**

This section discusses the expected facility availability, equipment redundancy, ability to respond to varying utility needs for power, maintenance programs, fuel availability, water availability, project quality control measures and information regarding power plant efficiency.

### **5.19.1 Facility Availability**

The El Segundo Plant Units 5, 6, and 7 will employ natural gas fueled GE 7FA gas turbines configured in a 2 on 1 combined cycle arrangement. Generating plants with natural gas fired turbines have proven in the past several years to provide much higher availability than other types of power plants of comparable size. Combined cycle generating plants of similar size have demonstrated operating equivalent availability factors above 90 percent over several years.

#### **5.19.1.1 Range of Availability**

Availability varies from year to year due to both random causes and the structure of the turbine overhaul cycle. Forced unavailability changes somewhat from year to year because the numbers and lengths of forced outages vary in a random way. Planned unavailability varies also, but in a more predictable fashion, because the overhaul cycle requires different amounts of down time in different years. Typically, gas turbines are overhauled on a 6-year cycle. The gas turbine work scope usually controls the planned outage length. Overhaul outages during years 1, 2, 4, and 5 are relatively short and can be expected to be approximately two weeks in length. The outage in year 3 will be somewhat longer with an expected length of 4 weeks and the outage in year 6 will be a major outage with an expected length of 6 weeks. The equivalent availability factor, expressed as a percentage, for El Segundo Generating Station Units 5, 6, and 7 can be expected to be in the mid 90s in years 1, 2, 4, and 5; in the upper 80s to lower 90s in year 3; and in the mid 80s in year 6. All planned outage work will be performed in the spring season and most other maintenance and repair work will be performed during off-peak hours (weekends and 8 hours per night weekdays).

#### **5.19.1.2 Basis for Forecasts of Availability**

The equivalent availability factors stated above are based on forced outage and scheduled outage data from the North American Electric Reliability Council (NERC). There has not been sufficient operating time on advanced technology gas turbines such as the GE 7FA to provide data on forced outage rates and scheduled outage factors for the entire scheduled overhaul cycle. However, based on availability data from the NERC in a 4 year study of similar sized combined cycle generating plants, the expected scheduled outage times stated

above, and previous plant experience, estimations of forced outage rates and scheduled outage factors for a 6-year period may be made.

**5.19.1.2.1 Forced Outage Factor**. Combined cycle units in continuous duty service with one advanced technology turbine-generator operating in continuous service can be expected to have an equivalent forced outage rate (EFOR) of 2.8 percent for the entire combined cycle.

The forced outage factor (FOF) for the Frame F turbine alone can be expected to be 2.5 percent. Several components of a Frame F can be responsible for a forced outage. Most forced outages in heavy frame gas turbines of mature design are caused by their auxiliaries and controls. The heavy rotation machinery in mature gas turbine designs rarely experience catastrophic failure and hence forced outage. Any developing damage is usually found during regular inspections and the affected part is replaced with little delay. Finally, dry low NO<sub>x</sub> combustors are fairly complex and can slow the disassembly and reassembly of the gas turbine. Data from equipment suppliers indicate that such combustors have increased gas turbine repair times.

The balance of plant and support systems are assumed to have installed redundant equipment typical of combined cycle plants now operating. The FOF for the balance of plant is expected to be 0.5 percent. The FOF for the steam turbine is also expected to be 0.5 percent. This value is lower than the value for the combustion turbine because the steam turbine operates under less rigorous conditions.

**5.19.1.2.2 Scheduled Outage Factor**. The scheduled outage factor (SOF) is based on the time scheduled for planned outages, maintenance outages, and any scheduled outage extensions. Planned outage durations, as described earlier, vary from year to year based on the combustion turbine overhaul plan. Maintenance outages will include scheduled work such as minor maintenance and off-line water washing. Scheduled outage durations will vary with the size of the maintenance crews and the length of shifts worked. The SOF for the entire combined cycle for a 6-year period can be expected to be 6.0 percent.

### **5.19.1.3 Degradation in Output from Fouling and Wear**

All gas turbines degrade in output from their new and clean condition because of fouling and wear. “Non-recoverable” degradation from equipment wear increases rapidly in the first few thousand fired hours and then slows. Virtually all of the degradation due to wear will be recovered during the major overhaul conducted at the end of 6 years. Degradation due to fouling is minimized by frequent on-line and less frequent off-line water washing. The steam turbine also degrades, but at a slower rate and with less effect on total output.

#### **5.19.1.4 Summary of Availability**

The El Segundo Generating Station Units 5, 6, and 7 are expected to provide high availability and be more responsive to the needs of the system for power during periods of peak load. Outage rates are expected to be low and scheduled outages will be planned for off-peak periods.

#### **5.19.2 Annual and Lifetime Capacity Factors**

The ESPR will be operated as a merchant plant; as such, annual capacity factors will vary based on market conditions (i.e., demand cycles and power generation costs). An average annual capacity factor of 60-65 percent is predicted over the 30-year projected lifetime of the facility.

#### **5.19.3 Equipment Redundancy**

The following subsections identify equipment redundancy that will be used for the design of Units 5, 6, and 7. Proper equipment redundancy will be key in maintaining the availability described in Section 5.19.1.

##### **5.19.3.1 Combined-Cycle Power Block**

The proposed combined cycle power plant consists of a single steam turbine generator (STG), Unit 6, and two heavy-duty combustion turbine generators (CTGs), Units 5 and 7, paired with heat recovery steam generators (HRSGs). Heat from the CTG exhaust gas is transferred from each CTG to its respective HRSG. Steam from both of the HRSGs then drives the single condensing reheat steam turbine generator (STG). The CTGs are each equipped with an evaporative cooling system can be used when the ambient temperatures exceed 59°F. The CTGs will have the capability for power augmentation during peak load periods with steam injection. Each HRSG will also have duct firing available to increase output during peak loads.

While operating in the base load mode, each CTG and associated HRSG accounts for the production of about half of the output of the combined cycle plant. Failure of one CTG or HRSG will cause its respective portion of the power island to fail while the other portion of the power island continues to operate. Failure of the STG, condensate supply, or the steam delivery system will cause the companion CTG to shut down since the CTGs are not designed to operate in a simple cycle mode.

**5.19.3.1.1 Combustion Turbine Generator (CTG).** The combustion turbine-generator subsystems include the combustion turbine, inlet air cooling system, lube oil system, starting system, generator and excitation systems, and combustion turbine control and instrumentation. Redundancy is provided in combustion turbine subsystems where practical. For example, the lube oil system consists of redundant pumps, filters, and coolers, but redundant bearings are obviously impractical. The microprocessor based control system consists of redundant microprocessors as well as redundant sensors for critical measurements. Technology advancements, as well as redundancy as illustrated above, have led to extremely high reliability for the combustion turbines considered for this project.

**5.19.3.1.2 Steam Turbine Generator (STG).** The steam turbine-generator subsystems include the steam turbine generator and excitation system, lube oil system, and steam turbine control and instrumentation. Redundancy is provided in steam turbine subsystems where practical. For example, the lube oil system consists of redundant pumps, filters, and coolers. The microprocessor based control system consists of redundant microprocessors as well as redundant sensors for critical measurements. Technology advancements, as well as redundancy as illustrated above, have led to extremely high reliability for the steam turbine considered for this project.

**5.19.3.1.3 Heat Recovery Steam Generator (HRSG).** The HRSG subsystems include feedwater stop and check valves, steam stop valves, relief valves, selective catalytic reduction (SCR), oxidation catalyst, and control instrumentation. Subject to final equipment selection, it is expected that the system will require high pressure, intermediate pressure, and low pressure sections each consisting of an economizer, evaporator, and superheater section.

### **5.19.3.2 Balance-of-Plant Systems**

The power island is served by the following balance-of-plant systems:

- **Boiler Feed System:** A common condensate system will be installed to feed both HRSGs using two 100 percent capacity condensate pumps. Two 100 percent capacity boiler feedwater pumps will be installed to take suction from the LP drum to supply feedwater to the intermediate pressure and high-pressure sections of each HRSG.
- **Main Condenser:** The main condenser condenses the steam and deaerates the condensate to a level suitable for introduction into the steam generator. The condenser will be a single shell, two pass design with titanium tubes. The tube bundle is designed with extra capacity for fouling and to permit plugging of leaking tubes so that repair can be accomplished during scheduled outages. The condenser air removal system will consist of steam jet air ejectors or vacuum pumps for both hogging and holding of condenser vacuum.

- **Ocean Water Circulating Water System:** Ocean water will be used to cool the main condenser and auxiliary equipment. Return water will be routed to the circulating water system outfall and returned to the ocean. Four 25% capacity circulating water pumps will be utilized.
- **Component Cooling Water System:** This system provides water for cooling plant components. Ocean water from the circulating water system is passed through a component cooling water heat exchanger that cools the water in the closed loop, component cooling water system. Heat from the cooling loop is rejected to the ocean through the circulating water system. Booster pumps have been incorporated into the plant design to boost the circulating water pump pressure to serve the heat exchanger. The tube bundle in the heat exchanger will be designed to have extra capacity to allow plugging of tubes if leakage occurs. This will allow the heat exchanger to remain in service at the required capacity.
- **STG Cycle Makeup and Storage System:** Reclaim water treated by reverse osmosis prior to arrival at the plant will be used for cycle makeup water. At the plant, the water will be treated using a portable demineralizer system and then stored in a demineralized water storage tank. Redundancy will be provided for the pumps. In addition, the storage capacity in the demineralized water storage tank will be sufficient to provide feedwater makeup in the event that the reclaim water supply is temporarily disabled.
- **Compressed Air:** The compressed air system supplies dry compressed air at the required pressure and capacity for all instrument air demands, including pneumatic controls, transmitters, instruments, and valve operators. The existing instrument air systems are located in Units 1 and 3. The Unit 1 system provides instrument air and service air to Units 1 and 2. The Unit 3 system provides instrument air and service air to Units 3 and 4. Each system consists of two 100 percent capacity centrifugal compressors with one compressor operating as a standby. Each system also includes a single refrigerated dryer that may be bypassed, filters, air receivers, and distribution piping. Each system also operates as a backup system for the other system. The Unit 1 system will require relocation to the Units 3 and 4 area to continue serving the site and Units 5, 6, and 7.

### **5.19.3.3 Distributed Control and Information System**

The distributed control system will be a redundant microprocessor-based system that will provide control, monitoring, and alarm functions for plant systems and equipment. The following functions will be provided:

- Control the heat recovery steam generator and other systems in response to unit load demands (the gas turbine-generator has its own control system).
- Provide control room operator interface.
- Monitor plant equipment and process parameters and provide this information to the plant operators in a meaningful format.
- Provide visual and audible alarms for abnormal events based on field signals or software-generated signals from plant systems, processes, or equipment.
- The DCS will have functionally distributed architecture comprised of a group of similar redundant processing units linked to a group of operator consoles and an engineering workstation by redundant data highways. Redundant processors will be identically programmed to perform the specific tasks for control information, data acquisition, annunciation, and historical purposes. Because of this redundancy, no single processor failure can cause or prevent a unit trip. Experience with similar systems has been that simultaneous malfunctions of two or more processors are very infrequent. DCS failures that have occurred have almost always been in communication between processors, or more importantly, between the DCS and the controlled equipment.

#### **5.19.4 Fuel Availability**

##### **5.19.4.1 Gas Supply**

The El Segundo Generating Station currently receives natural gas from the Southern California Gas Company (SoCalGas). SoCalGas will continue to provide natural gas to the plant through the existing 20 inch pipeline to the plant after Units 5, 6, and 7 are installed and operating. The El Segundo Generating Station will continue to have access to numerous supply sources via the extensive SoCalGas transmission and distribution system. Descriptions of the four most significant sources follow:

**California Gas.** California gas is defined as state onshore plus state/federal offshore supplies. California gas provided about 300 MMcf/day of supply on the Southern California Gas system in 1999. By late 2000, supplies from California sources are expected to increase due to additional deliveries from Elk Hills.

**Southwestern U.S. Gas.** Traditional Southwestern U.S. sources of natural gas, especially the San Juan basin, will continue to supply most of southern California's gas demand. This gas is delivered via the El Paso Natural Gas Company and Transwestern Pipeline Company pipelines. The majority of San Juan basin gas is coalbed methane production, which has

recently reached a plateau. Although the Unconventional Fuels Tax Credit (which expires in 2003) provides producers an incentive to produce as much gas as possible from wells drilled before 1993, coalbed methane drilling is still profitable in the San Juan Basin and parts of Utah and Wyoming. The San Juan Basin's conventionally produced gas supplies have increased since 1991 and are expected to help meet southern California's gas demand. Permian Basin gas will continue as the primary swing supply into California.

**Rocky Mountain Gas.** Rocky Mountain supply presents a viable alternative to traditional Southwestern U.S. gas sources for southern California. This gas is delivered to southern California primarily on the Kern River Gas Transmission Company's pipeline, although there is also access through the San Juan Basin. While the majority of Rocky Mountain gas is deemed conventional, substantial gas supplies also qualify for the Unconventional Fuels Tax Credit through year 2003 – mainly as tight formation gas and some coal seam gas. In recent years, Rocky Mountain gas has increasingly flowed to Midwestern and Pacific Northwest markets.

**Canadian Gas.** Reduced volumes of Canadian gas will supplement southern California's demand during the current California Gas Report forecast period. New pipeline capacity out of western Canada to the Midwest and eastern U.S. are likely to move Canadian gas away from California. Increased gas deliveries from the Permian Basin to California are expected to replace these supplies.

**Gas Transmission.** Southern California continues to operate in an environment of excess interstate pipeline capacity. Interstate pipeline delivery capability into southern California is over 4,000 MMcf/day, with approximately 3,230 MMcf/day available directly to SoCalGas customers. These pipeline systems provide access to several large supply basins located in New Mexico, West Texas, the Rocky Mountains, and Western Canada. This plus local California gas production is delivered to most Southern California gas users via SoCalGas transmission and distribution pipelines. The El Segundo Plant is served directly from a SoCalGas transmission line that is capable of providing the gas supplies required by the generating facility. In addition, the El Segundo Plant may have access to gas storage and hub services provided by SoCalGas which further enhance the reliability of gas supply for the generating facility.

**Conclusion.** Large and diverse gas supplies along with reliable transmission systems exist for supplying the El Segundo Plant with natural gas at competitive prices. Fuel availability and reliability are considered more than adequate.

### **5.19.5 Water Availability**

Sufficient water resources are available for the proposed project. Water supply for cooling is the greatest water use at the El Segundo Generating Station constituting approximately 99 percent of the water usage. Other types of water include potable and reclaimed water.

#### **Ocean Cooling Water**

The beneficial uses of Santa Monica Bay include industrial service supply, navigation, water contact recreation, non-contact water recreation, commercial and sport fishing, marine habitat, wild habitat, preservation of biological habitats, rare, threatened or endangered species, migration of aquatic organisms, spawning, and reproduction and/or early development. Industrial Service Supply. Cooling water supply is included in the category of Industrial Service Supply. The once-through cooling water system for ESGS Units 1 and 2 will be used without modification for the ESPR Project.

#### **Potable Water**

Potable water is supplied to the ESGS by the City of El Segundo. The City of El Segundo obtains potable water from the Metropolitan Water District of Southern California. The City provides water for commercial, industrial and domestic users within the City of El Segundo and plans to service the proposed units.. As stated in a letter for the City of El Segundo in Appendix O, “it is reasonable to assume the City can provide sufficient water (either potable or reclaimed), but that can only be confirmed at such time as an applications is received.”

#### **Reclaimed Water**

Reclaimed water is produced by the Hyperion Treatment Plant operated by the City of Los Angeles Bureau of Sanitation and further treated and distributed by the West Basin Municipal Water District. The reclaimed water is currently delivered to the ESGS in a six-inch line at 45-75 psi. Reclaimed water is currently used at ESGS for landscape irrigation and to augment “seal water”. The use of reclaimed water will be increased by the proposed project, as it will be used for boiler makeup.

### **5.19.6 Project Quality Assurance and Control**

This section summarizes the quality assurance and control program for the El Segundo Power Redevelopment Project. The objective of the quality control program is to ensure that all systems and components have the appropriate quality measures applied (during design, procurement, fabrication, construction, and operation) to achieve facility safety, reliability,

availability, operability, constructability, and maintainability. The quality program will be administered by a contractor that has a program comparable to the ISO 9000 criteria.

System quality is ensured by applying controls to various activities depending on the activity being performed. For example, the appropriate controls for design work are checking and review, and the appropriate controls for manufacturing and construction are inspection and testing. Appropriate controls will be applied to each of the various activities for the project.

#### **5.19.6.1 Quality Assurance**

For quality assurance planning purposes, the project activities have been divided into nine stages that apply to specific periods of time during the project. As the project progresses, the design, procurement, fabrication, erection, and checkout of each plant system proceeds through these stages and the appropriate quality assurance controls are administered.

The project stages are defined as follows:

- Conceptual Design – activities such as the definition of requirements and engineering analyses.
- Detail Design – activities such as the preparation of calculations, drawings, and lists needed to describe, illustrate, or define systems, structures, or components of the power plant.
- Procurement Specification Preparation – activities necessary to compile and document procurement specifications’ contractual, technical, and quality provisions for plant systems, components, or services.
- Manufacturers’ Control and Surveillance – activities necessary to ensure that the manufacturers conform to the procurement specification provisions.
- Manufacturer Data Review – activities required to review manufacturers’ drawings, data, instructions, procedures, plans, and other documents to ensure coordination of plant systems and components and conformance to procurement specifications.
- Receipt Inspection – inspection and review of products during manufacture at the time of delivery to the construction site.
- Construction/Installation – inspection and review of construction, storage, equipment and component installation, cleaning, and initial testing of systems and components at the plant site.

- System/Component Testing – documented controlled testing, commissioning and operation of plant components in a system to ensure that the performance conforms to specified requirements and all guarantees.
- Plant Operation – the actual operation of the plant system.

#### **5.19.6.2 Quality Control Records**

The following quality control records will be maintained as a minimum for review and reference:

- Approved Environmental Permits
- Project Procedures Instruction Manual
- Design Calculations
- Project Design Manual
- Quality Assurance Audit Reports
- Piping and Instrument Diagrams
- One-Line and Three-Line Diagrams
- Conformance to Construction Records Drawings
- Procurement Specifications (Contract Issue and Change Orders)
- Purchase Orders and Change Orders
- Manufacturers' Quality Assurance Program Manuals
- Construction Test Records
- Historical Operating and Maintenance Data.

For procured component purchase orders, a list of qualified suppliers is developed. Before contracts are awarded, supplier capabilities are evaluated. The evaluation considers the supplier's personnel, production capability, past performance, and quality assurance program.

Supplier quality assurance capabilities are reviewed with special consideration given to the program description, implementation procedures, and the suppliers' quality performance history. Before contracts are awarded, the suppliers' facilities may be surveyed to verify that their quality assurance program is effective and applicable to the materials, equipment, and services supplied.

Each procured component has adequate contractual requirements to ensure quality assurance. During construction, field quality assurance activities are accomplished during the last four stages of the project: receipt inspection, construction/installation, system/component testing, and plant operations. Suppliers will be contractually responsible for performing the work in accordance with the quality requirements specified by contract.

Quality compliance will be surveyed through inspections, audits, and administration of independent testing contracts.

### **5.19.6.3 Operations and Maintenance Plan**

**5.19.6.3.1 General Approach.** During the operations phase, the operator will perform all tasks necessary to operate and maintain Units 5, 6, and 7 in accordance with an Operating Plan, approved procedures, and prudent industry standards including:

- Operations Management
  - Schedules, Shift Routines, Manloadings
  - Plant Operations and Supervision
  - Ongoing Operations Training
  - Fuel Management
  - Plant Chemistry Control
  
- Maintenance Management
  - Preventive Maintenance
  - Predictive Maintenance
  - Corrective Maintenance
  - Outage Management
  - Spare Parts Inventory Control
  
- Administrative Support
  - Administrative Planning
  - Computer Systems and Communications
  - Budget and Accounting Controls
  - Records Management
  - Plant Safety Program
  - Plant Security.

Quality administrative support and maintenance management systems are currently in place at the plant and will continue to be used. These systems will be modified only where necessary to incorporate Units 5, 6, and 7. The existing operations management system will be modified to incorporate the transition from operating Units 1 and 2 to operating Units 5, 6, and 7. Details of the operations management system are given below.

**5.19.6.3.2 Operations Management.** Effective operations management will provide the planning, scheduling, and training necessary for efficient and profitable operation of Units 5, 6, and 7.

**Schedules, Shift Routines, Manloadings.** Staffing plans for Units 5, 6, and 7 are designed for the ongoing operational and maintenance requirements of the facility. All periodic testing, inspections and maintenance activities will be identified as well as those operational and maintenance requirements that require specialized and extra assistance at specific times during the maintenance cycle of the plant.

The staffing plan for Units 5, 6, and 7 includes a permanent staff that will be fully responsive to all electrical and thermal load demands and will be responsible for the performance of all preventive maintenance and routine repairs.

The plant will be staffed 24 hours per day, 7 days per week. All operating personnel and most maintenance personnel work a rotating shift schedule. This schedule coincides with the peak load hours and provides for minimal shift changes and interruptions during the high load periods. The remaining plant staff works a normal 5 day, 40 hour week, but may be rescheduled as needed. The plant will arrange for any needed outside assistance.

Associated technical and specialized vendor support will be subcontracted as needed during planned outages, inspections, and overhauls.

**Plant Operations and Supervision.** The Operating Plan will require the following:

- 1) Operate the facility in accordance with the Operating Plan, O&M Manual, an approved annual budget, and prudent industry standards.
- 2) Perform and record periodic operational checks and test of equipment in accordance with approved maintenance procedures, the equipment manufacturer's specifications, and applicable laws and regulations.
- 3) Maintain operating logs, records, and reports for the facility.
- 4) Coordinate scheduled shutdowns or other modifications in basic plant operations with expected dispatch.

**Ongoing Operations Training.** The existing operations training program will be modified for use with Units 5, 6, and 7 and will continue to be administered. The continued use of this program will ensure a high level of reliability, availability, and capacity following start-up.

Manufacturers' representatives and other sources of operations, maintenance, and overhaul literature will provide up-to-date information and techniques to the plant staff. Key staff

members will also attend industry conferences and seminars to exchange information with other operators.

### **5.19.7 Power Plant Performance and Efficiency**

For the El Segundo Power Redevelopment Project, a new combined cycle power plant is to be constructed on the El Segundo Generating Station (ESGS) site with the addition of Units 5, 6, and 7 in the location previously occupied by Units 1 and 2.

Units 5 and 7 will be General Electric Model PG7241FA combustion turbine generators (CTGs), each with an ISO base load gross output of 171.7 MW. Each CTG will be equipped to burn a single fuel (i.e., natural gas) with an evaporative cooling system installed on the inlet air for use when the ambient temperature exceeds 59°F. Gross output of each CTG will be increased to a peak load of 183.4 MW with steam injection (at 59°F and site elevation).

A combined cycle configuration will be established with the addition of heat recovery steam generators (HRSGs) to the exhaust outlets of Units 5 and 7 and the addition of the Unit 6 steam turbine generator (STG). Unit 6 will be equipped with a General Electric reheat, double flow, down exhausting condensing steam turbine with nominal throttle steam conditions of : 1,815 psia; 1050°F; and 1,050°F reheat temperature and a hydrogen-cooled generator with a peak generating output of approximately 288 MW. Peak generating output of the STG will be accomplished with supplemental firing of the HRSGs.

Design performance estimates for the combined cycle plant are summarized in Figure 3.4-1 of Section 3.0. The summaries shown in Figure 3.4-1 include design performance estimates for a hot day (ASHRAE summer 1.0- percent design condition), an average day (ISO condition), and a cold day (ASHRAE winter 99.0 percent design condition).

In this subsection, performance estimates for off design conditions for the proposed combined cycle plant are presented to provide a better understanding of its overall performance and efficiency. The power cycle is depicted on Figure 5.19-1 (Sheet 1 of 6). Four off design cases, Cases 1, 3, 4, and 5, have been presented along with the peak load design case, Case 2, which has been provided for comparison purposes.

Performance estimate cases presented in this subsection include the following:

**Case 1** - STG operating with both CTGs operating at 100 percent load with the inlet air evaporative cooling systems in service. In this case, no CTG power augmentation with steam injection or HRSG supplemental duct firing is included. The feedwater heaters are also out of service.

**Case 2** - STG and both CTGs operating at peak load (same peak load design case as that shown in Figure 3.4-1). The CTG inlet air evaporative cooling system is in service along with steam injection for power augmentation. Supplemental firing was used to increase steam turbine output and the feedwater heaters are in service to limit heat rejection to Santa Monica Bay.

**Case 3** - STG operating with one CTG operating at 100 percent load with the inlet air evaporative cooling system in service. In this case, no CTG power augmentation with steam injection or HRSG supplemental duct firing is included. The feedwater heaters are also out of service.

**Case 4** - STG operating with one CTG operating at 50 percent load with the inlet air evaporative cooling system out of service. In this case, no CTG power augmentation with steam injection or HRSG supplemental duct firing is included. The feedwater heaters are also out of service.

**Case 5** - STG operating with one CTG operating at 100 percent load with the inlet air evaporative cooling system in service and one CTG operating at 50 percent load without inlet air cooling. In this case, no CTG power augmentation with steam injection or HRSG supplemental duct firing is included. The feedwater heaters are also out of service.

In all cases, the performance estimates considered combined cycle plant operation on a hot day (ASHRAE summer 1.0 percent design condition) with atmospheric pressure at 14.7 psia. For ESGS, the dry bulb and wet bulb temperatures for the ASHRAE 1.0 percent hot summer day are 83°F and 68°F, respectively.

#### **5.19.7.1 Performance and Efficiency Overview**

Case 1 represents the plant at base load operation. Both CTGs are operating at 100 percent load with the inlet air evaporative cooling systems in operation. The HRSG duct burners are turned off and the feedwater heater train is bypassed. The plant is operating at its maximum efficiency with a net plant heat rate of 6,164 Btu/kW-hr (LHV) and a net plant output of approximately 501 MW. The gross STG output is 189 MW.

Case 2 represents a scenario where additional plant output is required. The combined cycle plant is operating at its peak capacity with a net plant output of approximately 632 MW. Both CTGs are operating at 100 percent load with the inlet air evaporative cooling systems and steam injection for power augmentation in operation. Maximum HRSG duct firing is used to recover the steam that is injected into the CTG for power augmentation and to further increase the main steam flow to the STG. The steam turbine throttle pressure is close to

maximum throttle pressure and the gross STG output is maximized at 288 MW. Due to the increased steam flow, the feedwater heater train is in operation to reduce the condenser heat load and thus to limit the heat rejection into Santa Monica Bay. The operation of the feedwater heaters, duct burners and steam injection increases the net plant heat rate to 6,880 Btu/kW-hr (LHV).

Case 5 represents a plant operating scenario where less plant power output is required and the plant is operating at a part load condition. One CTG is operating at 100 percent load with its inlet air evaporative cooler in operation. The other CTG is operating at 50 percent load and its inlet air evaporative cooling system is out of service. The HRSG duct burners are not in operation and the feedwater heater train is bypassed. The steam turbine (ST) will operate at throttle control at a minimum throttle pressure of 1,000 psia, resulting in a gross STG output of 163 MW. The net combined cycle plant output is approximately 391 MW and the net plant heat rate is 6,434 Btu/kW-hr (LHV). Due to the fact that one CTG is operating at part load condition, which results in a low CTG heat rate, and the low steam turbine throttle flow, which results in lower ST efficiency, the heat rate significantly increases in comparison with the heat rate at base load (Case 1).

Case 3 represents a scenario where the plant load is further reduced. Only one CTG is operating at 100 percent load with its inlet air evaporative cooler in operation. The other CTG is not in service. The HRSG duct burners are not in operation and the feedwater heater train is bypassed. The ST operates at throttle control at a minimum throttle pressure of 1,000 psia with a resulting gross STG output of 92 MW. The condenser operates at minimum pressure of 1 inch of mercury. The net plant heat rate of this scenario is slightly lower than the net plant heat rate of Case 5 due to the fact that the one operating CTG is at 100 percent load, which provides for a high CTG efficiency. However, the net plant heat rate is higher than at base load due to the fact that the ST will be operating at a part load condition. The net plant output is estimated at approximately 244 MW with a net plant heat rate of 6,320 Btu/kW-hr (LHV).

Case 4 represents the minimum expected plant load for continuous operation. Only one CTG is in operation at 50 percent load. The second CTG is turned off. The CTG inlet air evaporative cooler and the HRSG duct burners are not in operation and the feedwater heater train is out of service. The ST will operate at throttle control at a minimum throttle pressure of 1000 psia, resulting in a gross STG output of 64 MW. The condenser operates at minimum pressure of 1 inch of mercury. The low load condition of the CTG increases its heat rate and due to the low plant load, the steam turbine efficiency also decreases. The net plant output is approximately 132 MW and the net plant heat rate is 7,344 Btu/kW-hr (LHV).

Table 5.19-1 provides a summary of the plant performance estimates for the cases described in this subsection.

**TABLE 5.19-1**

**PLANT PERFORMANCE SUMMARY**

<b>Case</b>	<b>Description</b>	<b>CTG-5 Gross Output MW</b>	<b>CTG-7 Gross Output MW</b>	<b>STG-6 Gross Output MW</b>	<b>Net Plant Output MW</b>	<b>Net Plant Heat Rate Btu/kW-hr (LHV)</b>
1	2x1 at base load with both CTGs operating. No steam injection or duct firing. FW heaters out of service.	162.5	162.5	188.88	501.17	6,164
2	2x1 at peak load with both CTGs operating. Steam injection, duct firing, and FW heaters in service.	179.4	179.4	288.39	631.46	6,880
3	1x1 with CTG operating at 100% load. No steam injection or duct firing. FW heaters out of service.	162.5	0	91.5	244.39	6,320
4	1x1 with CTG operating at 50% load. No steam injection or duct firing. FW heaters out of service.	77.5	0	63.57	132.44	7,344
5	2x1 with one CTG operating at 100% load and one CTG operating at 50% load. No steam injection or duct firing. FW heaters out of service.	162.5	77.5	163.36	391.21	6,434

<sup>1</sup> Based on atmospheric pressure of 14.7 psia, ambient temperature of 83°F, and relative humidity of 47%.

**5.19.8 References**

El Segundo Power LLC. ND. *NRG Safety Program Elements & Description*.

North American Electric Reliability Council. 2000. *Unit Year Average Report (from 1994 to 1998 for gas fired combined cycle plants from 450 MW to 700 MW)*.

NRG El Segundo Plant. 2000 Revision. *El Segundo Generating Station Emergency Preparedness and Emergency Response Plan*.

Adequacy Issue: Adequate \_\_\_\_\_ Inadequate \_\_\_\_\_

### DATA ADEQUACY WORKSHEET

Revision No. 0 Date \_\_\_\_\_

Technical Area: **Reliability**

Project: \_\_\_\_\_

Technical Staff: \_\_\_\_\_

Project Manager: \_\_\_\_\_

Docket: \_\_\_\_\_

Technical Senior: \_\_\_\_\_

SITING REGULATIONS	INFORMATION	AFC PAGE NUMBER AND SECTION NUMBER	ADEQUATE YES OR NO	INFORMATION REQUIRED TO MAKE AFC CONFORM WITH REGULATIONS
Appendix B (g) (1)	...provide a discussion of the existing site conditions, the expected direct, indirect and cumulative impacts due to the construction, operation and maintenance of the project, the measures proposed to mitigate adverse environmental impacts of the project, the effectiveness of the proposed measures, and any monitoring plans proposed to verify the effectiveness of the mitigation.	Section: 3.3, 3.4 Section: 5.2 through 5.20		
Appendix B (i) (3) (A)	A discussion of the sources and availability of the fuel or fuels to be used over the estimated service life of the facilities.	Section: 5.19.3		
Appendix B (i) (3) (B)	A discussion of the anticipated service life and degree of reliability expected to be achieved by the proposed facilities based on a consideration of:	Section: 3.1		
Appendix B (i) (3) (B) (i)	Expected annual and lifetime capacity factors;	Section: 5.19.2		
Appendix B (i) (3) (B) (ii)	The demonstrated or anticipated feasibility of the technologies, systems, components, and measures proposed to be employed in the facilities, including the power generation system, the heat dissipation system, the water supply system, the reinjection system, the atmospheric emission control system, resource conveyance lines, and the waste disposal system;	Sections: 3.4.3, 4.3, 4.4, 4.7.7.2		

Adequacy Issue: Adequate \_\_\_\_\_ Inadequate \_\_\_\_\_

## DATA ADEQUACY WORKSHEET

Revision No. 0 Date \_\_\_\_\_

Technical Area: **Reliability** \_\_\_\_\_

Project: \_\_\_\_\_

Technical Staff: \_\_\_\_\_

Project Manager: \_\_\_\_\_

Docket: \_\_\_\_\_

Technical Senior: \_\_\_\_\_

SITING REGULATIONS	INFORMATION	AFC PAGE NUMBER AND SECTION NUMBER	ADEQUATE YES OR NO	INFORMATION REQUIRED TO MAKE AFC CONFORM WITH REGULATIONS
Appendix B (i) (3) (B) (iii)	Geologic and flood hazards, meteorologic conditions and climatic extremes, and cooling water availability;	Section: 5.2.2, 5.3.1, 5.19.3.2		
Appendix B (i) (3) (B) (iv)	Special design features adopted by the applicant or resource supplier to ensure power plant reliability; and	Sections: 5.19.1.3, 5.19.3, 5.19.4		
Appendix B (i) (3) (B) (v)	The expected power plant maturation period.	Section: 5.19.2		
Appendix B (h) (1) (A)	Tables which identify laws, regulations, ordinances, standards, adopted local, regional, state, and federal land use plans, and permits applicable to the proposed project, and a discussion of the applicability of each. The table or matrix shall explicitly reference pages in the application wherein conformance, with each law or standard during both construction and operation of the facility is discussed;	Not applicable		
Appendix B (h) (1) (B)	Tables which identify each agency with jurisdiction to issue applicable permits and approvals or to enforce identified laws, regulations, standards, and adopted local, regional, state and federal land use plans, and agencies which would have permit approval or enforcement authority, but for the exclusive authority of the commission to certify sites and related facilities.	Not applicable		
Appendix B (h) (2)	A discussion of the conformity of the project with the requirements listed in subsection (h)(1)(A).	Not applicable		

Adequacy Issue: Adequate \_\_\_\_\_ Inadequate \_\_\_\_\_

## DATA ADEQUACY WORKSHEET

Revision No. 0 Date \_\_\_\_\_

Technical Area: **Reliability** \_\_\_\_\_

Project: \_\_\_\_\_

Technical Staff: \_\_\_\_\_

Project Manager: \_\_\_\_\_

Docket: \_\_\_\_\_

Technical Senior: \_\_\_\_\_

<b>SITING REGULATIONS</b>	<b>INFORMATION</b>	<b>AFC PAGE NUMBER AND SECTION NUMBER</b>	<b>ADEQUATE YES OR NO</b>	<b>INFORMATION REQUIRED TO MAKE AFC CONFORM WITH REGULATIONS</b>
Appendix B (h) (3)	The name, title, phone number, and address, if known, of an official within each agency who will serve as a contact person for the agency.	Not applicable		
Appendix B (h) (4)	A schedule indicating when permits outside the authority of the commission will be obtained and the steps the applicant has taken or plans to take to obtain such permits.	Not applicable		

Adequacy Issue: Adequate \_\_\_\_\_ Inadequate \_\_\_\_\_  
 Technical Area: Efficiency  
 Project Manager: \_\_\_\_\_

**DATA ADEQUACY WORKSHEET**

Revision No. 0 Date \_\_\_\_\_  
 Technical Staff: \_\_\_\_\_  
 Technical Senior: \_\_\_\_\_

SITING REGULATIONS	INFORMATION	AFC PAGE NUMBER AND SECTION NUMBER	ADEQUATE YES OR NO	INFORMATION REQUIRED TO MAKE AFC CONFORM WITH REGULATIONS
Appendix B (g) (1)	...provide a discussion of the existing site conditions, the expected direct, indirect and cumulative impacts due to the construction, operation and maintenance of the project, the measures proposed to mitigate adverse environmental impacts of the project, the effectiveness of the proposed measures, and any monitoring plans proposed to verify the effectiveness of the mitigation.	Sections: 3.3, 3.4 Sections: 5.2 through 5.20		
Appendix B (i) (4) (A)	Heat and mass balance diagrams for design conditions for each mode of operation.	Sections: 5.19.2, 5.19.7		
Appendix B (i) (4) (B)	Annual fuel consumption in BTUs for each mode of operation.	Sections: 5.19.2, 5.19.7.1		
Appendix B (i) (4) (C)	Annual net electrical energy produced in MWh for each mode of operation.	Sections: 5.19.2, 5.19.7		
Appendix B (i) (4) (D)	Number of hours the plant will be operated in each mode of operation in each year.	Sections: 5.19.2, 5.19.7		
Appendix B (i) (4) (E)	If the project will be a cogeneration facility, calculations showing compliance with applicable efficiency and operating standards.	Not Applicable		
Appendix B (i) (4) (F)	A discussion of alternative generating technologies available for the project, including the projected efficiency of each, and an explanation why the chosen equipment was selected over these alternatives.	Section 4.2 through 4.5		

Adequacy Issue: Adequate \_\_\_\_\_ Inadequate \_\_\_\_\_  
 Technical Area: **Efficiency** \_\_\_\_\_  
 Project Manager: \_\_\_\_\_

**DATA ADEQUACY WORKSHEET**

Revision No. 0 Date \_\_\_\_\_  
 Technical Staff: \_\_\_\_\_  
 Technical Senior: \_\_\_\_\_

Project: \_\_\_\_\_  
 Docket: \_\_\_\_\_

SITING REGULATIONS	INFORMATION	AFC PAGE NUMBER AND SECTION NUMBER	ADEQUATE YES OR NO	INFORMATION REQUIRED TO MAKE AFC CONFORM WITH REGULATIONS
Appendix B (h) (1) (A)	Tables which identify laws, regulations, ordinances, standards, adopted local, regional, state, and federal land use plans, and permits applicable to the proposed project, and a discussion of the applicability of each. The table or matrix shall explicitly reference pages in the application wherein conformance, with each law or standard during both construction and operation of the facility is discussed;	Not applicable		
Appendix B (h) (1) (B)	Tables which identify each agency with jurisdiction to issue applicable permits and approvals or to enforce identified laws, regulations, standards, and adopted local, regional, state and federal land use plans, and agencies which would have permit approval or enforcement authority, but for the exclusive authority of the commission to certify sites and related facilities.	Not applicable		
Appendix B (h) (2)	A discussion of the conformity of the project with the requirements listed in subsection (h)(1)(A).	Not applicable		
Appendix B (h) (3)	The name, title, phone number, and address, if known, of an official within each agency who will serve as a contact person for the agency.	Not applicable		
Appendix B (h) (4)	A schedule indicating when permits outside the authority of the commission will be obtained and the steps the applicant has taken or plans to take to obtain such permits.	Not applicable		