CHAPTER 3.0 ENGINEERING

3.1 INTRODUCTION

In accordance with applicable California Energy Commission (CEC) regulations, this Chapter, together with the Chapter 2, Project Description, Appendices 2-1 through 2-7, and Chapters 4, 5, and 6 (Electric Transmission, Natural Gas Supply and Water Supply, respectively), presents information concerning the design and engineering of the Kings River Conservation District Community Power Plant (KRCD CPP). This section describes the design of the facility with reference to Chapter 2, Project Description and discusses the reliability and estimated thermal efficiency of the facility. The laws, ordinances, regulations, and standards (LORS) that are applicable to the engineering of the KRCD CPP are also provided as well as an identification of agencies that have jurisdiction over the project and the contact persons within those agencies and a list of the permits that will be required.

3.2 FACILITY DESIGN

A detailed description of the KRCD CPP is provided in Chapter 2, Section 2.5, Generating Facility Description, Design, and Operation. Design for safety is provided in Chapter 2, Section 2.8, Project Safety Design. Summary descriptions of the design criteria are included in Chapter 2, Project Description, and Appendices 2-1 through 2-7.

Design and engineering information and data for the following systems are found in the following sections of this Application for Certification (AFC):

- **Power Generation** - See Chapter 2, Section 2.5.3, Generating Facility Cycle; Section 2.5.4, Combustion Turbine Generators; Section 2.5.5 Heat Recovery Steam Generators; and Section 2.5.6 Steam Turbine Generator. Also see Appendix 2-3, Mechanical Engineering Design Criteria and Chapter 2, Section 2.5.7, Major Electrical Equipment and Systems which describe plant auxiliaries.
- **Heat Dissipation -** See Chapter 2, Section 2.5.9.5, Plant Cooling Systems, and Appendix 2-3, Mechanical Engineering Design Criteria.
- **Air Emission Control System** – See Chapter 2, Section 2.5.13, Emission Control and Monitoring, and Section 8.1, Air Quality.
- **Waste Disposal System** - See Chapter 2, Section 2.5.9.6, Waste Management and Section 8.9, Waste Management.
- **Noise Abatement System** - See Section 8.2, Noise.
- **Switchyards/Transformer Systems** - See Chapter 2, Section 2.5.7, Major Electrical Equipment and Systems; Section 2.5.15.2, Grounding; Section 2.5.7, Major Electrical

Equipment and Systems which describes alternating current power; Section 2.6, Interconnect to Electrical Grid; Chapter 4, Electric Transmission; and Appendix 2-4, Electrical Engineering Design Criteria.

3.3 EFFICIENCY

This section discusses plant efficiency, heat and mass balances, operating hours, energy production, fuel consumption and alternative generation technologies for the KRCD CPP.

3.3.1 Heat and Material Balance

Heat and material balances were prepared using for a wide range of operating cases for each of the two combustion turbine generator (CTG) options, the Siemens SGT6-5000F and the General Electric (GE) 7FA CTG. A flow diagram common to both options is included as Figure 3-1. Heat and material balance data for the Siemens and GE plant configurations are provided in Figures 3-2 and 3-3, respectively. The stream numbers on the heat and material balance data correspond to numbered circles on the flow diagram.

The maximum net thermal efficiency that can be expected from the KRCD CPP is approximately 50.5 and 49.2 percent, or 6,757 and 6,936 British thermal units per kilowatt hour (Btu/kWh) on a higher heating value (HHV) basis, for the Siemens and GE plant configurations, respectively.

3.3.2 Operating Hours and Modes

The KRCD CPP is expected to operate at a 92 to 98 percent annual capacity factor. This equates to 8060 to 8585 annual operating hours, respectively, at full load. The actual capacity factor and annual operating hours will be based on prevailing market rate for firm power.

The KRCD CPP will be designed for efficient electrical generation at full load during the entire year with a minimal number of starts. However, market and dispatch conditions may warrant partial load or cyclical operation. As a result, the plant will be designed for commercial flexibility and will be capable of operating between approximately 25 to 100 percent of full load. The KRCD CPP will also be designed to accommodate up to 175 starts per year.

The plant will be configured with either inlet fogging or evaporative cooling for inlet air conditioning and steam injection for power augmentation. The KRCD CPP will utilize inlet fogging or evaporative cooling when warranted by ambient conditions. Power augmentation will be used only on occasion as market conditions dictate or as dispatched during emergency situation.

3.3.3 Energy Production

Assuming the operating hours and modes discussed above, the anticipated annual electrical production of the KRCD CPP based on 92 percent annual capacity factor (8060 operating hours) and average annual ambient conditions is 4,554 gigawatt hour (GWh) or 4,006 GWh for the Siemens and GE options, respectively.

3.3.4 Fuel Consumption

Given the assumptions above, the hourly average fuel consumption of the KRCD CPP is estimated to be 3,832 and 3,446 million British thermal units per higher heating value (MMBtu/hr HHV) basis for the Siemens and GE options, respectively, based on average annual ambient conditions. The annual fuel consumption of the plant is expected to be 309 and 278 million therms, respectively. For reasons discussed previously, the annual fuel consumption can vary based on market and other conditions.

3.3.5 Alternative Generation Technologies

KRCD has reviewed a number of alternative methods of generating electrical power, including coal, oil, biomass, solar, geothermal, and other renewable energy projects. A discussion on these alternatives is provided in Chapter 9, Section 9.14, Alternative Technologies. Other project configurations were also considered and are discussed in Section 9.13, Alternative Project Configurations.

3.4 RELIABILITY

This section discusses the availability of fuel, the expected service life of the plant, and the degree of reliability to be achieved by the KRCD CPP.

3.4.1 Fuel Availability

Fuel for the KRCD CPP will be natural gas supplied from a new approximately 26-mile long 20-inch underground pipeline interconnection to the Southern California Gas Company (SCG) Line 7000 near the City of Visalia, California. The gas pipeline closely follows existing road right-of-way corridors. The natural gas will be compressed and filtered on the KRCD CPP plant site to meet applicable pressure requirements. The proposed gas pipeline route is shown on Figure 1-3, in Chapter 1, Executive Summary.

There is sufficient capacity in SCG Line 7000 to deliver the required quantity of gas to the KRCD CPP. It is conceivable that fuel may become unavailable at the plant site if there is an upstream breach in the pipeline or the SCG line 7000, or if there is a SCG compressor failure. The KRCD CPP has no backup supply of natural gas or other fuel available, and therefore, it will have to be shut down until the situation is corrected. This is considered a remote possibility and

if it occurs, it is anticipated that the pipeline or compression equipment will be repaired as the SCG pipeline has a considerable service area.

3.4.2 Plant Availability

The percent of time that a power plant is projected to operate is defined as the "service factor." The service factor considers the amount of time that a unit is operating and generating power, whether at full or partial load. The projected service factor for a power plant, which considers projected percentage of time of operation, differs from the Equivalent Availability Factor (EAF), which considers the projected percentage of energy production capacity achievable. EAF is defined as a weighted average of the percentage of full energy production capacity achievable. The EAF differs from the "availability of a unit," which is the percentage of time that a unit is available for operation, whether at full load, partial load, or standby. The projected EAF for the KRCD CPP is estimated to be in the range of 92 to 98 percent.

The KRCD CPP will be designed for an operating life of 30 years. Operations and maintenance procedures will be consistent with industry standard practices to maintain the useful life of plant components.

3.4.3 Process Water Source Availability

The reliability of the process water source and treatment equipment will affect the overall reliability of the plant. The primary water supply source for the KRCD CPP will be reclaimed water from the City of Parlier Waste Water Treatment Plant (WWTP) and the Sanger WWTP effluent percolation and evaporation ponds located on Lincoln Avenue (i.e., Lincoln Ponds). Up to four shallow wells recovering percolated effluent will provide a back-up cooling water supply. A detailed description of the water conveyance and treatment process is provided in Chapter 2, Project Description. Further details regarding the availability of the water supply is also provided in Chapter 6, Water Supply and Section 8.5, Water Resources. A primary and backup water source has been identified which will ensure that an adequate supply of water will be available for all operating conditions.

3.4.4 Water Treatment Reliability

Process makeup water will be treated as necessary at the site prior to use. Failure of water treatment equipment or process upset in the treatment process can potentially cause a reduction in plant availability. To reduce the risk of loss in plant availability, redundancy and additional capacity has been considered in the design of the water treatment processes including the tertiary treatment process, demineralization process, and the zero liquid discharge (ZLD) process. These considerations are discussed in Chapter 2, Project Description.

3.4.5 Waste Management Reliability

An inability to adequately manage waste may also adversely affect KRCD CPP availability. Water treatment wastes consist primarily of the non-hazardous solids produced from the ZLD system. Solid waste will be collected by the local non-hazardous waste collector. Most hazardous wastes will be collected and recycled by permitted recycling firms, and non-recyclable hazardous wastes will be collected by a licensed hazardous waste hauler and deposited in a hazardous waste landfill. Sanitary sewer wastes will be discharged back to the City of Parlier WWTP. For detailed information, see Section 8.8, Hazardous Materials and Section 8.9, Waste Management. An interruption of these disposal streams is unlikely as these facilities are reliable in nature and/or alternate facilities are available. Therefore, waste management is not expected to affect plant reliability.

3.4.6 Inavailability Due to Geologic Hazards and Extreme Climatic Conditions

There are no known geologic hazards in the KRCD CPP area other than the remote possibility of a major earthquake. For additional information see Section 8.11, Geologic Resources and Hazards. The plant will be designed to resist extreme climatic conditions as may be encountered in the region including wind and temperature extremes. Plant operations have been modeled for conditions ranging from 112 degrees Fahrenheit (˚F) to 26 ˚F. The plant will be designed to operate in temperature extremes ranging from 120 ˚F to 15 ˚F.

3.4.7 Equipment Redundancy

The KRCD CPP will be designed to ensure high plant reliability, including the redundancy of critical components. Equipment redundancy is discussed in Chapter 2, Section 2.9.2, Redundancy of Critical Components.

3.4.8 Performance Degradation

Deterioration of output capacity and efficiency of the KRCD CPP over time, called performance degradation, is expected to be on the order of two to three percent over a three-year period, depending on the amount of time the unit is operated. Cleaning, maintenance, or overhaul will recapture most of the loss. Over the expected 30-year life of the plant, the estimated total, non-recoverable loss in output and efficiency is anticipated to be on the order of one to two percent.

3.5 LAWS, ORDINANCES, REGULATIONS, AND STANDARDS

The LORS described below in Table 3-1 are generally applicable to the KRCD CPP. Industrial engineering codes and standards are described in the engineering design Appendices 2-1 through 2-7 in Chapter 2, Project Description.

Table 3-1 Applicable Laws, Ordinances, Regulations, and Standards KRCD CPP		
Regulation/Standard	**Applicable LOR**	**Requirement/Compliance & AFC Conformance**
Federal		
Occupational Safety and Health Act (OSHA)	Title 29, Code of Federal Regulations (CFR), Part 1910.	The KRCD CPP will comply with all minimum Federal OSHA regulations for the general industry. See Chapter 2, Project Description and Section 8.10, Worker Health and Safety.
	Title 29, CFR Part 1926.	The KRCD CPP will comply with all minimum federal health and safety regulations for the construction industry. See Chapter 2, Project Description and Section 8.10, Worker Health and Safety.
United States Environmental Protection Agency (USEPA)	40CFR 50, 60, 75, 100, 112,260, 200, 302, 400 and 423.	The KRCD will comply with all USEPA requirements. See Section 8.1, Air Quality.
State		
California Code of Regulations (CCR)/ California OSHA (Cal/OSHA) Regulations and Standards	Title 8, Sections 450 and 750 and Title 24, 1995, Titles 14, 17, 19, 20, 22, 23, and 26.	The KRCD CPP will comply with all establishes Cal/OSHA and the minimum health and safety standards for construction and general industry operations in California. See Chapter 2, Project Description and Section 8.10, Worker Health and Safety.
California Department of Transportation (Caltrans) District Office 6	Encroachment Permit.	The KRCD CPP will comply with all applicable requirements of Caltrans. See Section 8.4, Land Use and Agriculture.
California Business and Professions Code	Sections 6704, 5730, 7028.15(d) and 6736.	The KRCD CPP will only employ contractors whose qualification comply with applicable establishes appropriate licensing requirements for persons which practice civil, electrical, mechanical and structural engineering. These criterion have been established in order to safeguard life, health, property, and public welfare. See Chapter 2, Project Description and Chapter 3, Engineering.

Table 3-1 Applicable Laws, Ordinances, Regulations, and Standards KRCD CPP		
Regulation/Standard	**Applicable LOR**	**Requirement/Compliance & AFC Conformance**
California Vehicle Code	California Vehicle Code Section 35780; California Streets and Highways Code, Sections 660-711; 21 CCR 1411.1-1411.6.	Requires permits for any load exceeding Caltrans weight, length, or width standards for public roadways. The KRCD CPP will comply with all requirements of Caltrans. See Section 8.6, Traffic and Transportation.
California Labor Code	Section 6500-6510.	To protect employees whose worksite potentially involves a substantial risk of injury, KRCD will require permits prior to the initiation of any practices, work, method, operation, or process of employment for: (1) Construction of trenches or excavations that are five feet or deeper and into which a person is required to descend. (2) The construction of any building, structure, falsework, or scaffolding more than three stories high or the equivalent height. (3) The demolition of any building, structure, falsework, or scaffold more than three stories high or the equivalent height. (4) The underground use of diesel engines in work in mines and tunnels. See Section 8.10, Worker Health and Safety.

3.6 REQUIRED PERMITS AND AGENCY CONTACTS

Permits that will likely be required by the proposed KRCD CPP are discussed below in Table 3-2.

Table 3-2 Applicable Engineering Permits KRCD CPP			
Permit	**Issuing Agency**	**Application Requirements**	**Schedule**
Encroachment Permit	Tulare County	Required for the installation of the proposed gas pipeline in County road right-of-way.	Submit plans showing work 90 days prior to construction work in public right-of-way.
Encroachment Permit	Fresno County	Required for the installation of the proposed gas and water pipelines in County road right-of-way.	Submit plans showing work 90 days prior to construction work in public right-of-way.

Table 3-2
Applicable Engineering Permits
KRCD CPP

Permit	Issuing Agency	Application Requirements	Schedule
Encroachment Permit	City of Parlier	Required for the installation of the proposed water pipeline in City road right-of-way.	Submit plans showing work 90 days prior to construction work in public right-of-way.
Encroachment Permit	City of Sanger	Required for the installation of the proposed water pipeline in City road right-of-way.	Submit plans showing work 90 days prior to construction work in public right-of-way.
Encroachment Permit	Caltrans District Office 6	Required for installation of gas pipeline under state Highways.	Submit plans showing work approximately three to six months prior to construction work.

There are also several regulatory agencies responsible for ensuring worker health and safety and implementing the LORS addressed previously in Table 3-1. Contact information for applicable agencies is included in Table 3-3 below.

Table 3-3
Agency Contacts –Engineering
KRCD CPP

Agency Name and Address	Telephone
Fresno County Environmental Health Services 1221 Fulton Mall, Third Floor Fresno, CA 93775	(559) 445-3357
Fresno County Fire Protection District #84 Selma 11500 Mountain View Avenue Selma, CA 93662	(559) 896-3378
Cal-OSHA-District Office-Sacramento 2424 Arden Way, Suite 165 Sacramento, CA 95825	(916) 263-0704
Cal-OSHA-Central Valley-Fresno 2550 Mariposa Street, Suite 4000 Fresno, CA 93721	(559) 454-1295
Fresno County Department of Public Works and Planning Development Services Division 2220 Tulare Street, Suite A Fresno, California 93721	(559) 262-4242

Table 3-3 **Agency Contacts –Engineering** **KRCD CPP**	
Agency Name and Address	**Telephone**
City of Sanger 1700 7th Street Sanger, CA 93657-6513	(559) 876-6300 Extension 1540
City of Parlier 1100 East Parlier Avenue Parlier, CA 93648	(559) 256-4250
Tulare County Government Plaza 5961 South Mooney Boulevard Visalia, California 93277	(559) 733-6291

3.7 REFERENCES

California Codes – Multiple Sections. Website at: http://www.leginfo.ca.gov. January 2007.