ELECTRICAL ENGINEERING DESIGN CRITERIA

TABLE OF CONTENTS

Appendix F - Electrical Engineering Design Criteria

Tables

F.1 INTRODUCTION

This appendix summarizes the codes, standards, criteria, and practices that will be generally used in the design and construction of electrical engineering systems for the Bullard Energy Center (BEC). More specific project information will be developed prior to construction of the project to support detailed design, engineering, material procurement, and construction specifications as required by the California Energy Commission (CEC).

F.2 CODES AND STANDARDS

The design of the electrical systems, subsystem, and components will be in accordance with the laws and regulations of the federal government, State of California, County of Fresno, and City of Fresno local agencies and industry standards. The most current issue or revision of rules, regulations, codes, ordinances, and standards at the time of the filing of this Application for Certification (AFC) will apply, unless otherwise noted. If there are conflicts between the cited documents, the more conservative requirement shall apply.

The following codes and standards are applicable to the electrical aspects of the power facility:

- American National Standards Institute (ANSI)
- American Society for Testing and Material (ASTM)
- Anti-Friction Bearing Manufacturers Association (AFBMA)
- Insulated Cable Engineers Association (ICEA)
- Institute of Electrical and Electronics Engineers (IEEE)
- Illuminating Engineering Society (IES)
- California Electrical Code (CEC)
- National Electrical Manufacturers Association (NEMA)
- National Electrical Safety Code (NESC)
- National Fire Protection Association (NFPA)
- Underwriters Laboratories, Inc. (UL)

F.3 SWITCHYARD AND TRANSFORMERS

F.3.1 Switchyard

The facility switchyard will be located on the western portion of the site. It will be interconnected to the Pacific Gas and Electric (PG&E) transmission grid through a newly constructed Bullard switching station located on-site. The facility's 230 kilovolt (kV) outdoor switchyard will connect directly to the PG&E Bullard switching station with overhead bare aerial cables. The switchyard will be of the air-insulated aluminum bus type and will consist of high voltage SF6-insulated dead-tank circuit breakers arranged in a radial configuration. Connections to the nodes will be provided for each generator and for interconnecting to the utility grid. Each circuit breaker will be equipped with a no load break, air-insulated, disconnect switch on each side. Air-insulated aluminum strain bus will be used as the primary bus construction and interconnection material within the switchyard. The strain buses will be attached to strain insulators on structural steel H-frame supports.

Current and voltage transformers will be located at points within the switchyard to provide for metering and relaying.

Control, protection, and monitoring panel or devices for the switchyard will be located in the electrical building and generation control module. Monitoring and alarms will be available to the programmable logic controller (PLC) operator workstations in the control room. The 125 volt direct current (Vdc) battery system will provide control and protection voltage to circuit breakers.

The switchyard design will meet the requirements of the NESC-ANSI C2.

A grounding grid will be provided to control step and touch potentials in accordance with IEEE Standard 80, Safety in Alternating Current (AC) Substation Grounding. All equipment, structures, and fencing will be connected to the grounding grid of buried bare copper conductors and ground rods, as required. The substation ground grid will be tied to the plant ground grid.

Lightning protection will be provided by shield wires and/or lightning masts for any overhead lines. The lightning protection system will be designed in accordance with IEEE 998 guidelines.

All electrical faults shall be detected, isolated, and cleared in a safe and coordinated manner as soon as practical to ensure the safety of Equipment, Personnel, and the Public. Protective relaying will meet IEEE requirements and will be coordinated with PG&E's requirements.

The protection will be designed to maintain integrity when isolating a faulted node. Each circuit breaker will be provided with independent breaker failure relay protection scheme. Breaker failure protection will be accomplished by protective and timing relays for each breaker. Each 230 kV circuit breaker will have 2 redundant trip coils.

Interface with PG&E's supervisory control and data acquisition (SCADA) system will be provided. Interface will be at the interface terminal box and remote terminal unit (RTU). Communication between the facility switchyard and the control building to which it is connected will be included.

F.3.2 Transformers

Each generator will be connected to the 230 kV switchyard through a separate 230 – 13.8 kV, generator step-up transformer (GSU). The GSU will be designed in accordance with ANSI standards C57.12.00, C57.12.90, and C57.116. The transformers will be two-winding, delta-wye, Oil Non Forced Air Non Forced (ONAN)/Oil Non Forced Air Forced (ONFA)/ONFA cooling, and 65 degrees Celsius (°C) rises. The neutral point of the high voltage (HV) wye-connected winding will be solidly grounded. Each GSU will have metal oxide surge arrestors adjacent to the HV bushing terminals. The GSUs will have manual de-energized ("no-load") tap changers located in the HV windings.

Each generator will be connected to each GSU through low-side generator breakers to allow taps for unit auxiliary transformers. The unit auxiliary transformers step the 13.8 kV down to 4,160V and connect to 4,160V switchgear via a non-segregated phase bus duct by way of main circuit breakers to supply the facility 4,160V loads. A normally open tiebreaker between the two 4,160V switchgear will allow a single unit auxiliary transformer to supply the entire facility load. The unit auxiliary transformer 4,160V winding neutrals will be connected to ground grid through low-impedance grounding resistors to limit system ground fault current.

TABLE F1
DESIGN AND CONSTRUCTION LORS

LORS	Applicability	Compliance
Go-128, CPUC, "Rules for Underground Electric Line Construction"	CPUC rule covers required clearances, grounding techniques, maintenance, and inspection requirements.	3.6.2: 3.5.4 3.9.3: 3.4.11.2
Title 8 CCR, Section 2700 et seq. "High Voltage Electrical Safety Orders"	Establishes essential requirements and minimum standards for installation, operation, and maintenance of electrical installation and equipment to provide practical safety and freedom from danger.	3.6 3.9.3
GO-52, CPUC, "Construction and Operation of Power and Communication Lines"	Applies to the design of facilities to provide or mitigate inductive interference.	3.6. 3.9.3 3.4.5

TABLE F2
ELECTRIC AND MAGNETIC FIELD LORS

LORS	Applicability	Compliance
Decision 93-11-013, CPUC	CPUC position on EMF reduction.	3.6.4.3
GO-131-D, CPUC, "Rules for Planning and Construction of Electric Generation, Line, and Substation Facilities in California"	CPUC construction application requirements, including requirements related to EMF reduction.	3.6 3.4.5
ANSI/IEEE 544-1994, "Standard Procedures for Measurement of Power Frequency Electric and Magnetic Fields from AC Power Lines"	Standard Procedure for measuring EMF from an electric line that is in service.	3.6.4.3

TABLE F3
HAZARDOUS SHOCK LORS

LORS	Applicability	Compliance
8 CCR 2700 et seq. "High Voltage Electrical Safety Orders"	Establishes essential requirements and minimum standards for installation, operation, and maintenance of electrical equipment to provide practical safety and freedom from danger.	3.6.4.3 3.6.5.3 3.6.2
ANSI/IEEE 80, "IEEE Guide for Safety in AC Substation Grounding"	Presents guidelines for assuring safety through proper grounding of AC outdoor substations.	3.6.2
NESC, ANSI C2, Section 9, Article 92, Paragraph E; Article 93, Paragraph C	Covers grounding methods for electrical supply and communications facilities.	3.6.2:

TABLE F4
COMMUNICATIONS INTERFERENCE LORS

LORS	Applicability	Compliance
47 CFR 15.25, "Operating Requirements, Incidental Radiation"	Prohibits operations of any device emitting incidental radiation that causes interference to communications; the regulation also requires mitigation for any device that causes interference.	3.6.4.3: 3.6.5:
GO-52, CPUC	Covers all aspects of the construction, operation, and maintenance of power and communication lines, and specifically applies to the prevention or mitigation of inductive interference.	3.6. 3.9.3 3.4.5
CEC staff, Radio Interference and Television Interference (RI-TVI) Criteria (Kern River Cogeneration) Project 82-AFC-2, Final Decision, Compliance Plan 13-7	Prescribes the CEC's RI-TVI mitigation requirements, developed and adopted by the CEC in past citing cases.	3.6.4.3