DOCKETED	
Docket Number:	21-AFC-02
Project Title:	Gem Energy Storage Center
TN #:	240751-4
Document Title:	Section 3_Electric Transmission_Gem Energy Storage Center
Description:	Section 3 discusses the transmission interconnection between the Gem Project and the existing electrical grid, and the potential effects that operation of the facility will have on the flow of electrical power in the project region.
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Submitter Role:	Applicant Representative
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3.0 ELECTRIC TRANSMISSION

3.1 Introduction

This section discusses the transmission interconnection between the Gem Project (Gem) and the existing electrical grid, and the potential effects that operation of the facility will have on the flow of electrical power in the project region. The following topics are discussed:

- The proposed electrical interconnection between Gem and the electrical grid
- The impacts of the electrical interconnection on the existing transmission grid
- Potential nuisances (electrical effects, aviation safety, and fire hazards)
- Safety of the interconnection
- Description of applicable laws, ordinances, regulations, and standards (LORS)

The Gem will be located in unincorporated Kern County, California, on parcels totaling 71 acres approximately 10 miles east of the Southern California Edison (SCE) Whirlwind Substation. Gem will interconnect via a new 230 kilovolt (kV) overhead transmission line with the preferred route approximately 10.9 miles in length. An alternative interconnect via a new 230 kV overhead transmission line, ranging from approximately 2.5 to 35 miles in length, to the planned Los Angeles Department of Water and Power (LADWP) Rosamond Switching Station has also been studied.

Sections 3.2 and 3.3 discuss the details regarding the transmission alternatives investigated and the results of the transmission interconnection studies.

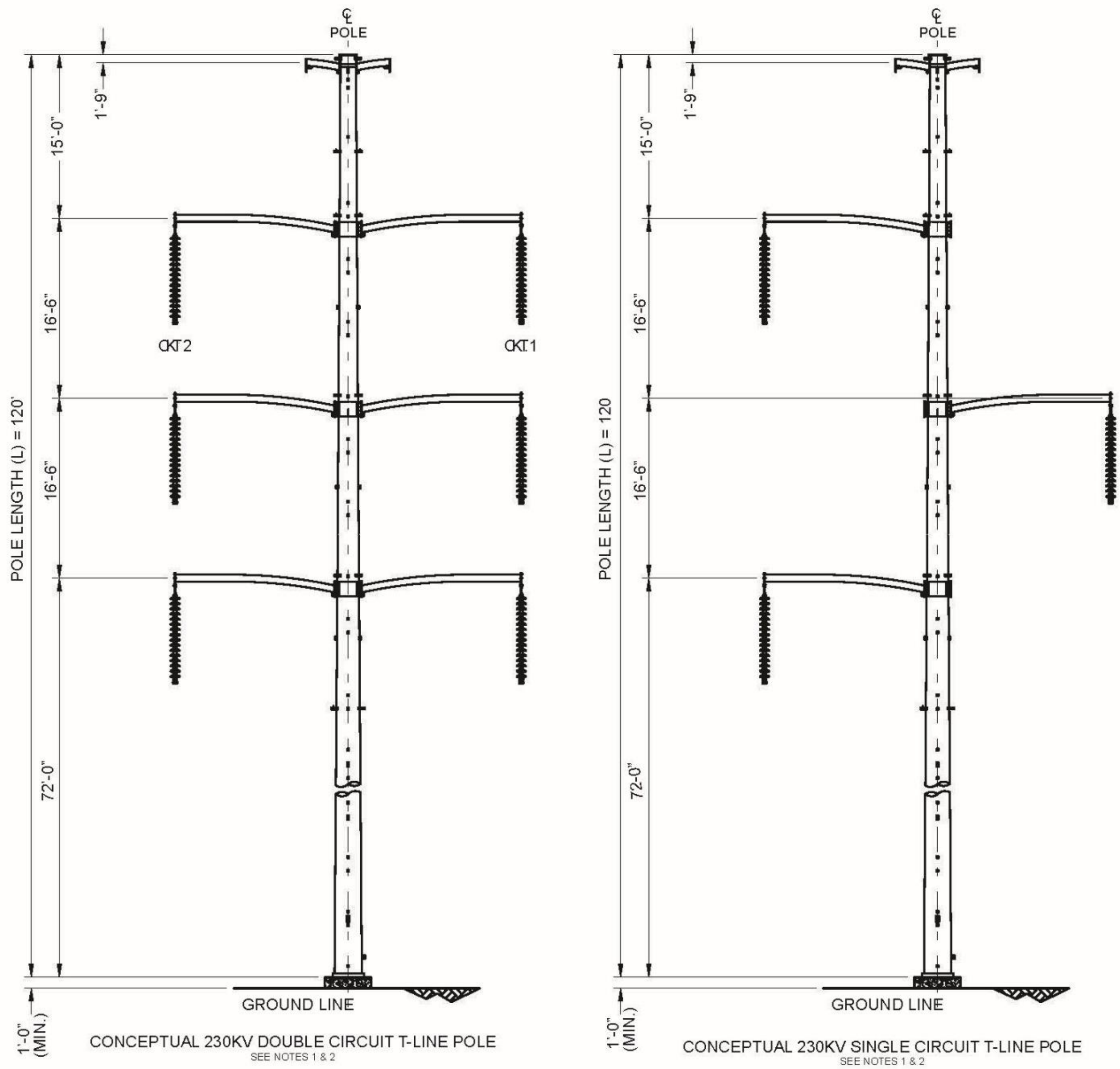
3.2 Transmission Lines Description, Design, and Operation

The Gem Project will be interconnected with the regional electrical grid by a new, single-circuit, three-phase, 230 kV generator tie-line with the preferred route approximately 10.9 miles in length and a right-of-way (ROW) width of between 75 to 125 feet total. The preferred 230 kV line runs east from the project site along Hamilton Road, south along 110th Street West, east along Irone Avenue, south along 140th Street West, west along Stetson Avenue, then turn approximately 0.4 miles past 170th Street West before terminating at the SCE Whirlwind Substation. Figure 1-4, Section 1, Introduction presents the preferred transmission route between the Gem site and the Whirlwind Substation along with numerous alternatives with approximately the same length.

An alternative interconnection to the planned LADWP Rosamond Switching Station has also been studied. The interconnection to the planned LADWP Rosamond Switching Station would be by a new single-circuit, three-phase, 230 kV generator tie-line with two alternative routes ranging from approximately 2.5 to 3.5 miles in length.

3.2.1 Overhead Transmission Line Characteristics

The interconnecting 230 kV transmission circuit will consist of a single-circuit configuration constructed overhead. Figure 3-1 shows a transmission pole like the Gem poles to be used as part of the overhead transmission interconnection. The 230 kV transmission line design was selected to match the voltages at both the Whirlwind Substation and the planned LADWP Rosamond Switching Station. In addition, the voltage will be able to carry the full capacity of the Gem Project whereas lower voltage lines based on based on typical line designs would not (e.g., the typical capacity of 115 kV – 161 kV lines is approximately 220 MW).



Notes

1. CONCEPTUAL TRANSMISSION LINE POLE DESIGN SHOWN IS TYPICAL. ACTUAL DESIGN WILL BE DETERMINED DURING DETAILED DESIGN.
2. APPROXIMATE DIAMETER OF CONCEPTUAL FOUNDATION IS 8'-0".

Figure 3-1 Representative Transmission Pole

Gem Energy Storage Center

3.2.2 Gem Switchyard Characteristics

A general arrangement for the proposed onsite Gem 230 kV switchyard is shown in Figure 2-2, Section 2, Project Description. Electrical one-line diagrams of the Gem 230 kV switchyard are shown in Figure 3-2, 3-3 and 3-4.

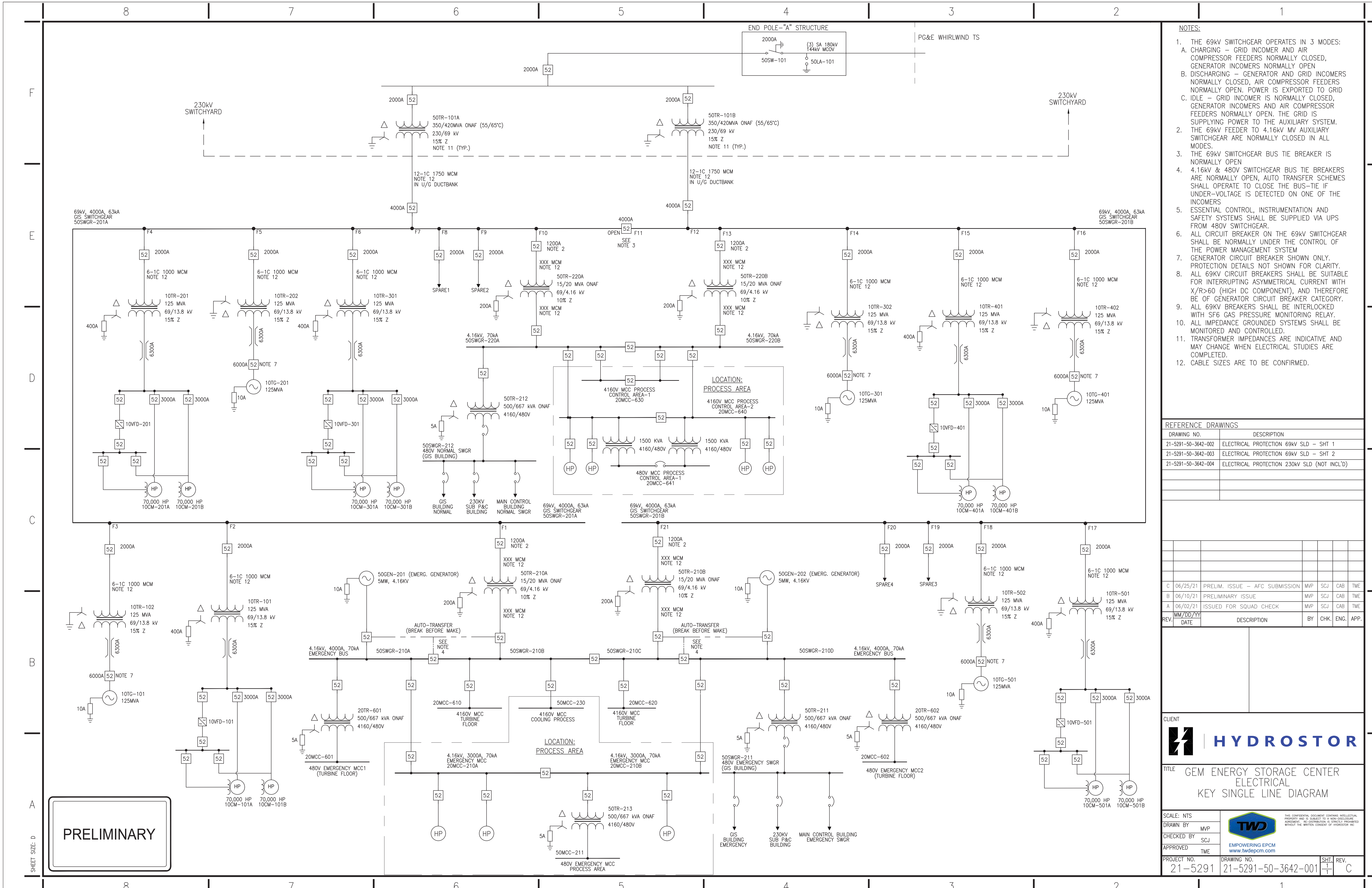


Figure 3-2: Electrical Key Single Line Diagram

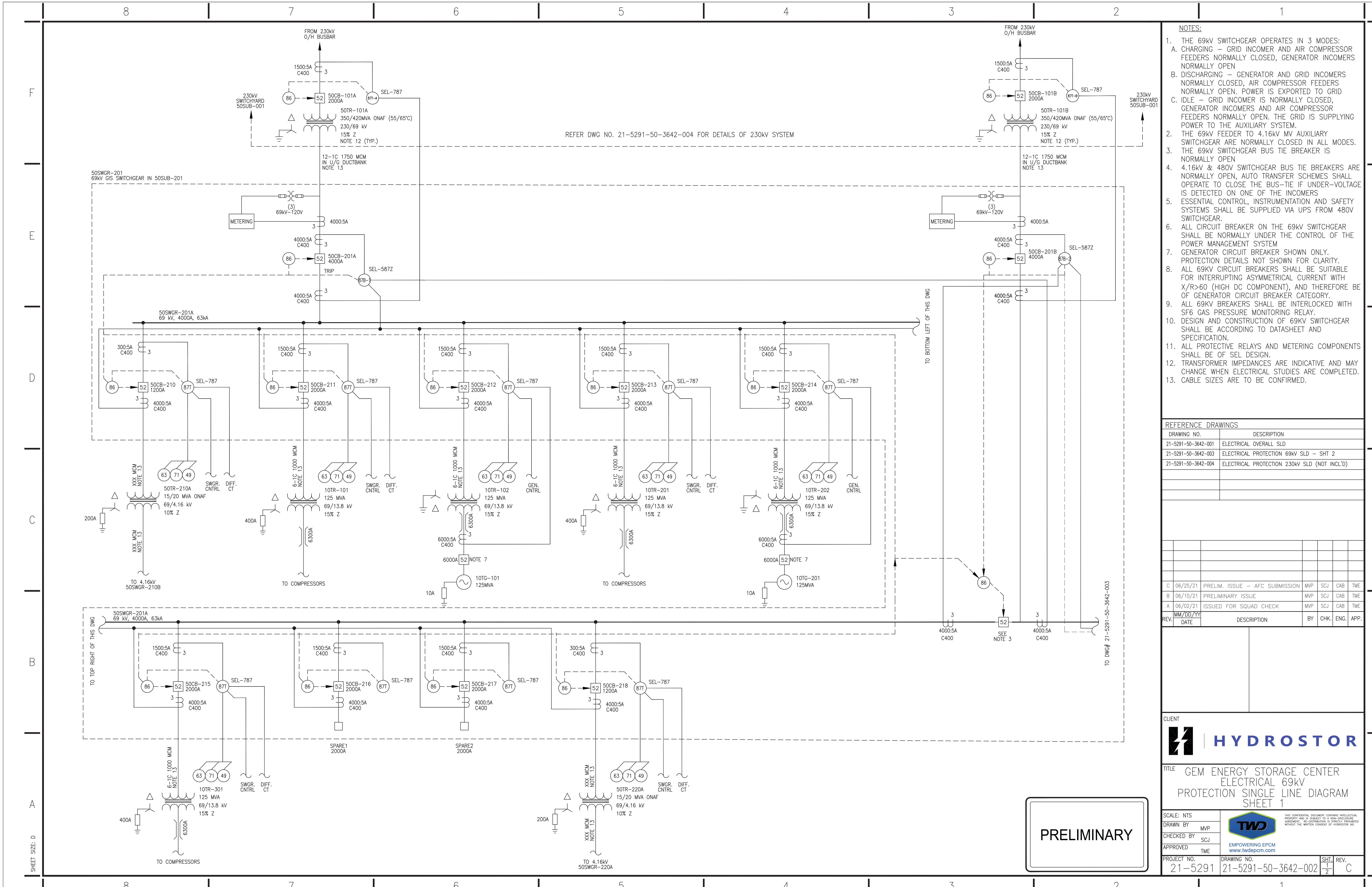
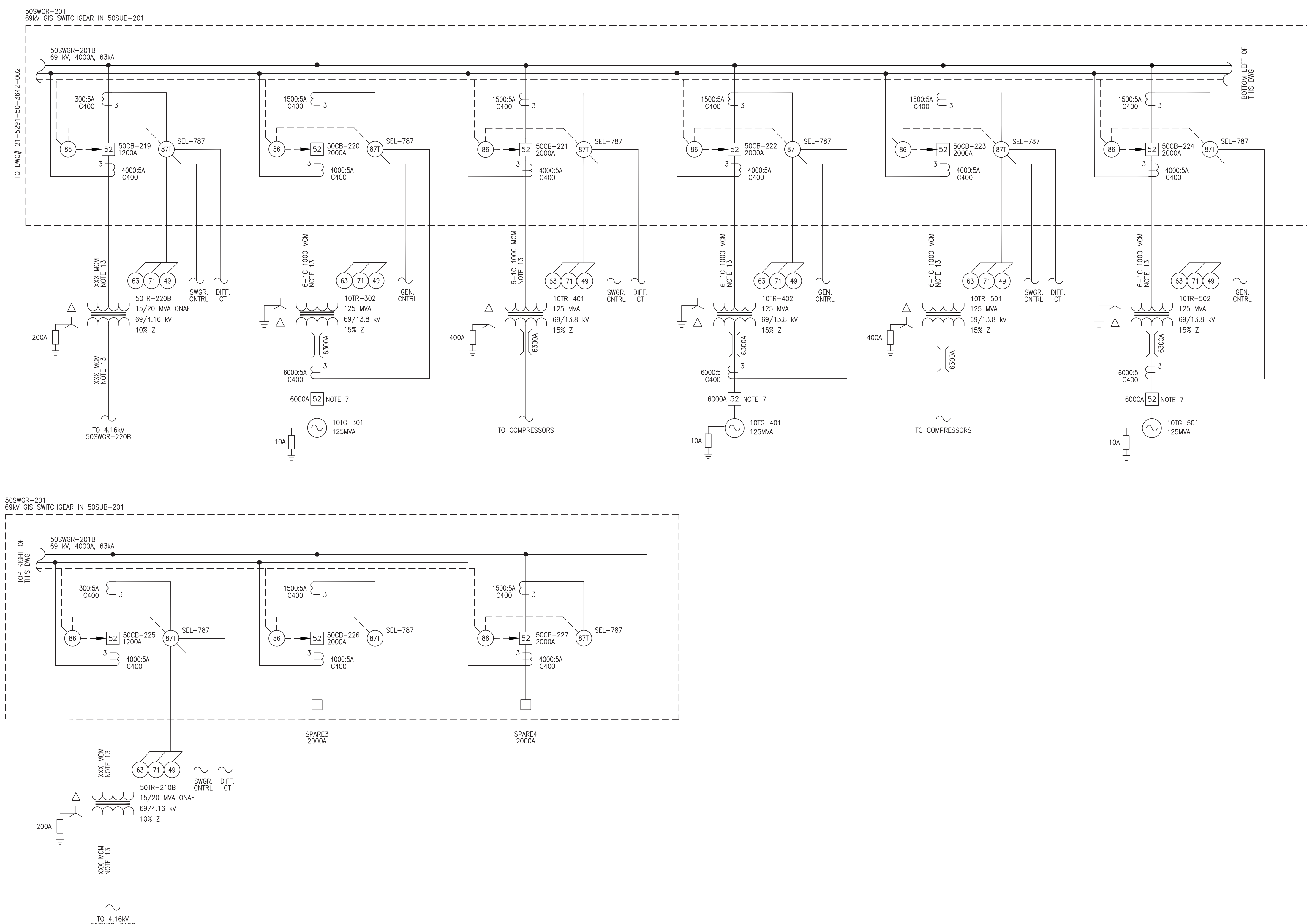


Figure 3-3: Electrical 69kW Protection Single Sheet Line Diagram (sheet 1)



NOTES:

1. THE 69kV SWITCHGEAR OPERATES IN 3 MODES:
   A. CHARGING – GRID INCOMER AND AIR COMPRESSOR FEEDERS NORMALLY CLOSED, GENERATOR INCOMERS NORMALLY OPEN
   B. DISCHARGING – GENERATOR AND GRID INCOMERS NORMALLY CLOSED, AIR COMPRESSOR FEEDERS NORMALLY OPEN. POWER IS EXPORTED TO GRID
   C. IDLE – GRID INCOMER IS NORMALLY CLOSED, GENERATOR INCOMERS AND AIR COMPRESSOR FEEDERS NORMALLY OPEN. THE GRID IS SUPPLYING POWER TO THE AUXILIARY SYSTEM.
2. THE 69kV FEEDER TO 4.16kV MV AUXILIARY SWITCHGEAR ARE NORMALLY CLOSED IN ALL MODES.
3. THE 69kV SWITCHGEAR BUS TIE BREAKER IS NORMALLY OPEN
4. 4.16kV & 480V SWITCHGEAR BUS TIE BREAKERS ARE NORMALLY OPEN, AUTO TRANSFER SCHEMES SHALL OPERATE TO CLOSE THE BUS-TIE IF UNDER-VOLTAGE IS DETECTED ON ONE OF THE INCOMERS
5. ESSENTIAL CONTROL, INSTRUMENTATION AND SAFETY SYSTEMS SHALL BE SUPPLIED VIA UPS FROM 480V SWITCHGEAR.
6. ALL CIRCUIT BREAKER ON THE 69kV SWITCHGEAR SHALL BE NORMALLY UNDER THE CONTROL OF THE POWER MANAGEMENT SYSTEM
7. GENERATOR CIRCUIT BREAKER SHOWN ONLY. PROTECTION DETAILS NOT SHOWN FOR CLARITY.
8. ALL 69KV CIRCUIT BREAKERS SHALL BE SUITABLE FOR INTERRUPTING ASYMMETRICAL CURRENT WITH X/R>60 (HIGH DC COMPONENT), AND THEREFORE BE OF GENERATOR CIRCUIT BREAKER CATEGORY.
9. ALL 69KV BREAKERS SHALL BE INTERLOCKED WITH SF6 GAS PRESSURE MONITORING RELAY.
10. DESIGN AND CONSTRUCTION OF 69KV SWITCHGEAR SHALL BE ACCORDING TO DATASHEET AND SPECIFICATION.
11. ALL PROTECTIVE RELAYS AND METERING COMPONENTS SHALL BE OF SEL DESIGN.
12. TRANSFORMER IMPEDANCES ARE INDICATIVE AND MAY CHANGE WHEN ELECTRICAL STUDIES ARE COMPLETED.
13. CABLE SIZES ARE TO BE CONFIRMED.

REFERENCE DRAWINGS

DRAWING NO.	DESCRIPTION
21-5291-50-3642-001	ELECTRICAL OVERALL SLD
21-5291-50-3642-002	ELECTRICAL PROTECTION 69kV SLD – SHT 2
21-5291-50-3642-004	ELECTRICAL PROTECTION 230kV SLD (NOT INCL'D)

REV.	MM/DD/YY DATE	DESCRIPTION	BY	CHK.	ENG.	APP.
C	06/25/21	PRELIM. ISSUE – AFC SUBMISSION	MVP	SCJ	CAB	TME
B	06/10/21	PRELIMINARY ISSUE	MVP	SCJ	CAB	TME
A	06/02/21	ISSUED FOR SQUAD CHECK	MVP	SCJ	CAB	TME

CLIENT
HYDROSTOR

TITLE
GEM ENERGY STORAGE CENTER
ELECTRICAL 69kV
PROTECTION SINGLE LINE DIAGRAM
SHEET 2

SCALE: NTS
DRAWN BY MVP
CHECKED BY SCJ
APPROVED TME

EMPOWERING EPCM
www.twdepcm.com

PROJECT NO. 21-5291
DRAWING NO. 21-5291-50-3642-003
SHT. 2/2
REV. C

SHEET SIZE: D

PRELIMINARY

Figure 3-4: Electrical 69kW Protection Single Line Diagram (sheet 2)

The Gem switchyard will be on the western end of the project site. The substation will be of the tubular IPS bus type with interconnecting conductors and will consist of high-voltage SF6-insulated dead-tank circuit breakers and no-load switches.

Connections to the aerial conductor cable will be provided from the two dual-winding transformers for the inter-tie to the utility grid. The high-voltage circuit breaker will be equipped with a no-load break, air-insulated, disconnect switch. A transformer circuit breaker and isolating disconnect switch will also be installed in each transformer connection to allow for transformer protection and isolation when the corresponding transformer is out of service. Tubular IPS bus type with interconnecting conductors will be used as the primary interconnection material within the switchyard. The IPS and conductors will be attached to post-insulator columns on structural steel supports. The main substation transforms power from/to 230 kV to/from 69 kV.

Current and voltage transformers will be located at points within the substation to provide for metering and relaying. Control, protection, and monitoring for the substation will be located in the substation protection and control building. Monitoring and alarms will be available to the supervisory control system operator workstations in the control module. All protection and circuit breaker control will be powered from the station battery-backed 125V DC system.

Each motor/generator substation will have two dual-winding transformers with wye-delta for the generator and delta-wye for the motors. The HV (69 kV) side will be fed with underground cables and the 13.8 kV side will be ISO Phase Bus Duct connections with SF6 circuit breakers.

3.2.3 230 kV Whirlwind Substation Interconnection

At this time, SCE has not provided detailed drawings of the Whirlwind Substation. Hydrostor anticipates providing a one-line diagram of the proposed interconnection at the Whirlwind Substation in conjunction with the pending Phase II interconnection study results.

3.3 Transmission Interconnection Studies

Hydrostor A-CAES USA Inc., parent company to GEM A-CAES LLC filed an Interconnection Request (IR) with the California Independent System Operator (CAISO) on April 15, 2020 (in the Cluster 13 Interconnection Request window). CAISO, in cooperation with SCE, prepared the Phase I Interconnection Study (dated January 25, 2021, as modified by Addendum #1 dated March 10, 2021), which considered the potential system impacts of the proposed Gem interconnect (See Appendix 3A). As part of the Cluster 13 study process, Gem was studied alongside other interconnection requests in Cluster 13 and, therefore, the Phase I Interconnection Study results represents the worst-case scenario in terms of potential effects on the transmission system. The results of the Phase I study provide the California Energy Commission (CEC) with the information that it needs to conduct an environmental assessment of the impacts of the transmission and interconnection facilities. As part of the interconnection process with CAISO and SCE, GEM A-CAES LLC will update the IR through the Material Modification Assessment (MMA) process to align the IR with the current proposed design. It is expected that the Phase II results will be issued in the late 2021-early 2022 timeframe and the results will be provided to the Commission when available.

A separate interconnection request was submitted on October 2, 2020 to LADWP for the potential interconnection of the project to LADWP's planned Rosamond Switching Station. The LADWP IR has not yet been studied by LADWP.

3.3.1 New Equipment Installation

The IR Studies indicate that the following equipment will be installed by SCE:

- Facilities for a new 230 kV switch rack position to terminate the new gen tie-line including one (1) 230 kV dead-end switchyard structure; three (3) 230 kV voltage transformers with steel pedestal support structures; and three (3) 230 kV line drops.
- Two (2) line current differential relays to protect the new gen tie-line.
- The appropriate number of 230 kV transmission structures including insulator/hardware assemblies and appropriate number of spans of conductor between the last structure owned by Gem A-CAES USA, and the dead-end substation structure at Whirlwind Substation.
- All required lightwave, channel banks, and associated equipment (including terminal equipment), supporting protection and the remote terminal units (RTU) requirements at the Gem and Whirlwind Substation.
- The appropriate length of fiber optic cable (both main and diverse), including conduit and vaults from the point designated by SCE to the communication room at Whirlwind Substation.
- All required lightwave, channel banks, fiber optic cable and associated equipment (including terminal equipment) supporting the centralized Remedial Action Scheme (RAS) requirements.
- The revenue load meters and meters for the charging capacity.
- One RTU at the project to monitor typical generation elements such as MW, mega volt amps (reactive) (MVAR), terminal voltage and circuit breaker status.

The following will be installed by GEM A-CAES LLC:

- The substation as described in the IR, and which will be amended through the MMA to align with the current proposed design.
- The 230 kV generation tie line from Gem to the last structure, as designated by SCE, outside of Whirlwind Substation.
- The optical ground wire and single mode fiber optic cable to provide the two separately routed telecommunications paths.
- The CAISO-approved compliant metering equipment in accordance with Section 10 of the CAISO Tariff.
- The metering cabinet and metering equipment (potential and current transformers) to meter the retail load and charging capacity.
- Two (2) line current differential relays. The make and type of current differential relays will be specified by SCE during final engineering.

3.3.2 System Impact Studies

The IR Studies assessed the effects of the addition of Cluster 13, including Gem (at 500 MW), to the local electrical system under various conditions of stress.

It is anticipated that many of the overloads and issues identified as part of the Cluster 13 Phase I will be reduced when Cluster 13 proceeds through Phase II of the interconnection process.

3.3.2.1 Power Flow Reliability Assessment

3.3.2.1.1 Discharging Analysis

Thermal Overloads: The IR Studies indicate that Gem, along with the other projects in Cluster 13 Phase I, contributes to overloads on certain facilities under normal, single contingency and multiple contingency conditions.

Normal Conditions

- Whirlwind 500/220 kV No.1 and No.3 and No.4 AA Transformer Bank.
- Midway-Whirlwind 500 kV Transmission Line.

Single Contingency

- Whirlwind 500/220 kV No.1 AA Transformer Bank under the loss of the Whirlwind 500/220 kV No.3 or No. 4 AA Transformer Bank.
- Whirlwind 500/220 kV No.3 AA Transformer Bank under the loss of the Whirlwind 500/220 kV No.1 or No. 4AA Transformer Bank.
- Whirlwind 500/220 kV No.4 AA Transformer Bank under the loss of the Whirlwind 500/220 kV No.1 or No. 3AA Transformer Bank.
- Antelope-Vincent No.1 500 kV Transmission Line under the loss of the Antelope-Vincent No. 2 500 kV Transmission Line.
- Antelope-Vincent No.2 500 kV Transmission Line under the loss of the Antelope-Vincent No. 1 500 kV Transmission Line.
- Antelope-Whirlwind 500 kV Transmission Line under the loss of the Antelope-Windhub 500 kV Transmission Line.
- Midway-Whirlwind 500 kV Transmission Line under the loss of the Vincent-Whirlwind 500 kV Transmission Line.

Multiple Contingency

- Antelope-Vincent No.1 500 kV Transmission Line under loss of Antelope-Vincent No.2 and Vincent-Whirlwind 500 kV Transmission Lines.
- Antelope-Vincent No.2 500 kV Transmission Line under loss of Antelope-Vincent No.1 and Vincent-Whirlwind 500 kV Transmission Lines.
- Midway-Whirlwind 500 kV Transmission Line under loss of Antelope-Vincent No.1 and No.2 500 kV Transmission Lines.
- Midway-Whirlwind 500 kV Transmission Line under loss of Antelope-Vincent No.2 and Vincent-Whirlwind 500 kV Transmission Lines.

- Midway-Whirlwind 500 kV Transmission Line under loss of Antelope-Vincent No.1 and Vincent-Whirlwind 500 kV Transmission Lines.
- Midway-Whirlwind 500 kV Transmission Line under loss of Antelope-Windhub and Antelope-Whirlwind 500 kV Transmission Lines.
- Vincent-Whirlwind 500 kV Transmission Line under loss of Antelope-Vincent No.1 and No.2 500 kV Transmission Lines.
- Vincent-Whirlwind 500 kV Transmission Line under loss of Antelope-Windhub and Antelope-Whirlwind 500 kV Transmission Lines.
- Antelope-Whirlwind 500 kV Transmission Line under loss of Whirlwind-Vincent and Whirlwind-Midway 500 kV Transmission Lines.

See the Area Report of the IR Studies (included as part of Appendix 3A) for additional details.

- **Power Flow Non-Convergence:** The IR Studies indicate that Gem, along with the other projects in Cluster 13 Phase I, resulted in power flow non-convergence issues. The Area Report of the IR Studies (See Appendix 3A) for additional details.
- **Voltage Performance**: The IR Studies indicate that Gem, along with the other projects in Cluster 13 Phase I, resulted in voltage performance issues. See the Area Report of the IR Studies (included as part of Appendix 3A) for additional details.
- **Mitigation:** The IR Studies indicate that a combination of congestion management, Area Deliverability Network Upgrade (ADNU), and General Reliability Network Upgrade (GRNU) are required to accommodate the Cluster 13 Phase I projects.

These upgrades include:

- Tehachapi Area 500 kV Upgrade (an ADNU).
- Adding the project to the proposed Tehachapi centralized RAS.
- Adding the project to the proposed Whirlwind centralized RAS.
- Adding the project to the proposed New South of Vincent centralized RAS.

It should be noted that the project selected Transmission Plan Deliverability (TPD) Option A as part of the Phase II Study and will not be funding the identified ADNU. See Appendix 3A for additional details.

3.3.2.1.2 Charging Analysis

The IR Studies indicated that there were no adverse impacts from the Generating Facility under charging analysis given that the energy storage follows CAISO market dispatch instruction.

3.3.2.2 Short Circuit Duty

3.3.2.2.1 Short circuit Study Results

The IR Studies determined the impact on circuit breakers of adding the Cluster 13 Phase I projects. The IR Studies found that the project contributes to over duty issues identified at the following locations:

- Pardee 220 kV Substation.
- Vincent 220 kV Substation.
- Windhub 220 kV Substation.
- Antelope 66 kV Switch rack.

Therefore, the project has be assigned costs for the following short circuit duty (SCD) mitigation upgrades as part the Phase I study:

- Pardee 220 kV SCD mitigation.
- Vincent 220 kV SCD mitigation.
- Windhub 220 kV 80 kA Upgrade/SCD mitigation.
- Antelope 66 kV Rebuild/SCD mitigation.

Additionally, the project was found to contribute, along with other Cluster 13 projects, to SCD issues at Pacific Gas and Electric Company's Midway Substation (an adjacent system) and was assigned SCD mitigation upgrades as part of the Phase I Study.

The project is being studied again as part of Phase II and each project in the cluster will be responsible for its share of the upgrade cost after Phase II. It is expected that the issues identified as part of Cluster 13 Phase I will be reduced when Cluster 13 proceeds through Phase II of the interconnection process.

See Appendix 3A for additional details.

3.3.2.2.2 Substation Ground Grid Duty

The IR Studies flagged certain existing substations for further review where the Cluster 13 Phase I projects increased the substation ground grid duty by at least 0.25 kA. Additional review will be performed as part of Phase II to determine if any of these locations will require a detailed ground grid analysis.

3.3.2.3 Transient Stability Evaluation

The IR Studies find transient stability performance to be acceptable.

3.3.2.4 Power Factor Requirements

Gem will be designed to maintain a composite power delivery at continuous rated power at the Point of Interconnection at a power factor within the range of 0.95 lead/lag for asynchronous generation and

0.90 lagging to 0.95 leading at generator terminals for synchronous generators. Additionally, the Gem will be designed to accommodate a voltage-ampere reactive schedule provided by SCE. SCE will determine whether the voltage-ampere reactive schedule is necessary based on future rearrangements of SCE's transmission.

3.3.2.5 Deliverability Assessments

Gem, along with the other projects in Cluster 13 Phase I, contributed to the following overloads that were identified in the Phase I Study.

Contingency	Overloaded Facility	Flow %
Antelope – Windhub 500kV	Windhub – Whirlwind 500kV	127.14
Antelope – Windhub 500kV	Whirlwind – Antelope 500kV	115.74
Antelope – Vincent 500kV No. 1	Antelope – Vincent 500kV No. 2	122.86
Antelope – Vincent 500kV No. 1 & 2	Whirlwind – Vincent 500kV	116.99
Antelope – Vincent 500kV No. 1 & 2	Whirlwind – Midway 500kV	113.89
Antelope – Vincent 500kV No. 2 & Whirlwind – Vincent 500kV	Antelope – Vincent 500kV No. 1	176.17
Antelope – Vincent 500kV No. 1 & Whirlwind – Vincent 500kV	Antelope – Vincent 500kV No. 2	176.11
Lugo – Vincent 500kV No. 1 & 2	Vincent – Mesa 500kV	109.31
Whirlwind 500/220kV No. 1	Whirlwind 500/220kV No. 3 & 4	121.63
Base Case	Windhub 500/220kV Transformer No. 1 & 2	109.89
Base Case	Windhub 500/220kV Transformer No. 3 & 4	109.62

The mitigation identified and assigned to the project is the Tehachapi Area 500 kV Upgrade (an Area Deliverability Network Upgrade).

It is anticipated that many of the overloads and issues identified as part of the Cluster 13 Phase I will be reduced when Cluster 13 proceeds through Phase II of the interconnection process. It should also be noted that the project selected Transmission Plan Deliverability (TPD) Option A as part of the Phase II Study and will not be funding the identified ADNU and will seek Deliverability through the TPD allocation.

See Appendix 3A for additional details.

3.4 Transmission Line Safety and Nuisances

This section discusses safety and nuisance issues associated with the proposed electrical interconnection.

3.4.1 Electrical Clearances

Typical high-voltage overhead transmission lines are composed of bare conductors connected to supporting structures by means of porcelain, glass, or plastic insulators. The air surrounding the energized conductor acts as the insulating medium. Maintaining sufficient clearances, or air space, around the conductors to protect the public and utility workers is paramount to the safe operation of the line. The required safety clearance required for the conductors is determined by considering factors such as the normal operating voltages, conductor temperatures, short-term abnormal voltages, windblown swinging conductors, contamination of the insulators, clearances for workers, and clearances for public safety. The line will conform to the minimum clearances specified in the California Public Utilities Commission (CPUC) General Order (GO) 95. Electric utilities, state regulators, and local ordinances may specify additional (more restrictive) clearances. Typically, clearances are specified for the following:

- Distance between the energized conductors themselves
- Distance between the energized conductors and the supporting structure
- Distance between the energized conductors and other power or communication wires on the same supporting structure, or between other power or communication wires above or below the conductors
- Distance from the energized conductors to the ground and features such as roadways, railroads, driveways, parking lots, navigable waterways, and airports
- Distance from the energized conductors to buildings and signs
- Distance from the energized conductors to other parallel power lines

The transmission interconnection for Gem will be designed to meet applicable national, state, and local clearance requirements.

3.4.2 Electrical Effects

The electrical effects of high-voltage transmission lines fall into two broad categories: corona effects and field effects. Corona is the ionization of the air that occurs at the surface of the energized conductor and

suspension hardware attributable to high electric field strength at the surface of the metal during certain conditions. Corona may result in radio and television reception interference, audible noise, light, and production of ozone. Field effects are the voltages and currents that may be induced in nearby conducting objects. A transmission line's inherent electric and magnetic fields cause these effects.

3.4.2.1 Electric and Magnetic Fields

Operating power lines, like energized components of electrical motors, home wiring, lighting, and other electrical appliances, produce electric and magnetic fields commonly referred to as an electromagnetic field (EMF). The EMF produced by the alternating current (AC) electrical power system in the U.S. has a frequency of 60 hertz, meaning that the intensity and orientation of the field changes 60 times per second.

Electric fields around transmission lines are produced by electrical charges on the energized conductor. Electric field strength is directly proportional to the line's voltage (i.e., increased voltage produces a stronger electric field). At a given distance from the transmission line conductor, the electric field is inversely proportional to the distance from the conductors, so that the electric field strength declines as the distance from the conductor increases. The strength of the electric field is measured in units of kV per meter. The electric field around a transmission line remains steady and is not affected by the common daily and seasonal fluctuations in usage of electricity by customers.

Magnetic fields around transmission lines are produced by the level of current flow, measured in terms of amperes, through the conductors. The magnetic field strength is also directly proportional to the current (i.e., increased amperes produce a stronger magnetic field). The magnetic field is inversely proportional to the distance from the conductors. Thus, like the electric field, the magnetic field strength declines as the distance from the conductor increases. Magnetic fields are expressed in units of milligauss. The amperes, and therefore the magnetic field around a transmission line, fluctuate daily and seasonally as the usage of electricity varies.

Considerable research has been conducted over the last 30 years on the possible biological effects and human health effects from EMFs. This research has produced many studies that offer no uniform conclusions about whether long-term exposure to EMFs is harmful. In the absence of conclusive or evocative evidence, some states, including California, have chosen not to specify maximum acceptable levels of EMF. Instead, these states mandate a program of prudent avoidance whereby EMF exposure to the public would be minimized by encouraging electric utilities to use cost-effective techniques to reduce the levels of EMFs.

3.4.2.2 Audible Noise and Radio and Television Interference

Corona from a transmission line may result in the production of audible noise or radio and television interference. Corona is a function of the voltage of the line, the diameter of the conductor, and the condition of the conductor and suspension hardware. The electric field gradient is the rate at which the electric field changes and is directly related to the line voltage.

The electric field gradient is greatest at the surface of the conductor. Large-diameter conductors have lower electric field gradients at the conductor surface and, hence, lower corona than smaller conductors, everything else being equal. Also, irregularities (such as nicks and scrapes on the conductor surface) or sharp edges on suspension hardware concentrate the electric field at these locations and, thus, increase corona at these spots. Similarly, contamination on the conductor surface such as dust or insects can cause irregularities that are a source for corona. Raindrops, snow, fog, and condensation are also sources of irregularities.

3.4.2.3 EMFs, Audible Noise, and Radio and Television Interference Assumptions

It is important to remember that EMFs, audible noise, and radio and television interference near power lines vary regarding the line design, line loading, distance from the line, and other factors.

Electric fields, corona, audible noise, and radio and television interference depend on line voltage and not on the level of power flow. Because line voltage remains nearly constant for a transmission line during normal operation, the audible noise associated with the 230 kV lines in the area will be of the same magnitude before and after the project.

Corona typically becomes a design concern for transmission lines having voltages of 345 kV and above. Since Gem will be connected at 230 kV voltage level, it is expected that no corona-related design issues will be encountered.

The magnetic field is proportional to line loading (amperes), which varies as demand for electrical power varies and as generation from the generating facility is changed by the system operators to meet changes in demand.

Construction and operation of Gem, including the interconnection of the facility with SCE'S transmission system, are not expected to result in significant increases in EMF levels, corona, audible noise, or radio and television interference.

3.4.2.4 Induced Current and Voltages

A conducting object such as a vehicle or person in an electric field will experience induced voltages and currents. The strength of the induced current will depend on the electric field strength, the size and shape of the conducting object, and the object-to-ground resistance. When a conducting object is isolated from the ground and a grounded person touches the object, a perceptible current or shock may occur as the current flows to ground. The mitigation for hazardous and nuisance shocks is to ensure that metallic objects on or near the right-of-way are grounded and that sufficient clearances are provided at roadways and parking lots to keep electric fields at these locations low enough to prevent vehicle short-circuit currents from exceeding 5 milliamperes.

Magnetic fields can also induce voltages and currents in conducting objects. Typically, this requires a long metallic object, such as a wire fence or aboveground pipeline that is grounded at only one location. A person who closes an electrical loop by grounding the object at a different location will experience a shock like that described for an ungrounded object. Mitigation for this problem is to ensure multiple grounds on fences or pipelines, especially those oriented parallel to the transmission line.

The proposed 230 kV transmission interconnection line will be constructed in conformance with CPUC GO-95 and Title 8 California Code of Regulations (CCR) 2700 requirements. Therefore, hazardous shocks are unlikely to occur because of project construction, operation, or maintenance.

3.4.3 Fire Hazards

The proposed 230 kV transmission interconnection will be designed, constructed, and maintained in accordance with applicable standards including GO-95, which establishes clearances from other man-made and natural structures as well as tree-trimming requirements to mitigate fire hazards.

The project will maintain the gen-tie corridor and immediate area in accordance with existing regulations and accepted industry practices that will include identification and abatement of fire hazards.

3.5 Laws, Ordinances, Regulations, and Standards

This section provides a list of applicable LORS that apply to the proposed transmission line, substations, and engineering.

3.5.1 Design and Construction

Table 3-1 lists the LORS for the design and construction of the proposed transmission line and switchyard.

Table 3-1: Design and Construction LORS for the Proposed Transmission Line and Switchyard

LORS	Applicability
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.
Title 8 CCR, Section 2700 et seq. “High Voltage Electrical Safety Orders”	Applies to the design of facilities subject to CPUC’s jurisdiction to provide or mitigate inductive interference.
ANSI/IEEE 593, “IEEE Recommended Practices for Seismic Design of Substations”	Recommends design and construction practices.
IEEE 1119, “IEEE Guide for Fence Safety Clearances in Electric-Supply Stations”	Recommends clearance practices to protect persons outside the facility from electric shock. Applies to the design of facilities subject to CPUC’s jurisdiction to provide or mitigate inductive interference.
IEEE 980, “Containment of Oil Spills for Substations”	Recommends preventions for release of fluids into the environment.

ANSI = American National Standards Institute; IEEE = Institute of Electrical and Electronics Engineers

3.5.2 Electric and Magnetic Fields

The LORS pertaining to EMF are listed in Table 3-2.

Table 3-2: Electric and Magnetic Fields LORS

LORS	Applicability
Decision 93-11-013, CPUC	CPUC position on EMF reduction.
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.
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.

3.5.3 Hazardous Shock

Table 3-3 lists the LORS regarding hazardous shock protection that apply to the transmission interconnection and the overall project.

Table 3-3: Hazardous Shock LORS

LORS	Applicability
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.
ANSI/IEEE 80, “IEEE Guide for Safety in AC Substation Grounding”	Presents guidelines for assuring safety through proper grounding of AC outdoor substations.
NESC, ANSI C2, Section 9, Article 92, Paragraph E; Article 93, Paragraph C	Covers grounding methods for electrical supply and communications facilities.

NESC = National Electrical Safety Code

3.5.4 Communications Interference

The LORS pertaining to communications interference are listed in Table 3-4.

Table 3-4: Communications Interference

LORS	Applicability
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.
GO-52, CPUC	Covers all aspects of the construction, operation, and maintenance of power and communication lines, and

LORS	Applicability
	specifically applies to the prevention or mitigation of inductive interference.

3.5.5 Aviation Safety

Table 3-5 lists the aviation safety LORS that may apply to the proposed transmission interconnection and the overall project.

Table 3-5: Aviation Safety LORS

Title 14 CFR, Part 77, "Objects Affecting Navigable Airspace"	Describes the criteria used to determine whether a "Notice of Proposed Construction or Alteration" (FAA Form 7450-1) is required for potential obstruction hazards.
FAA Advisory Circular No. 70/7450-1G, "Obstruction Marking and Lighting"	Describes the FAA standards for marking and lighting of obstructions as identified by FAA Regulations Part 77.

NPCA = Notice of Proposed Construction or Alteration

3.5.6 Fire Hazards

Table 3-6 lists the LORS governing fire hazard protection for the proposed transmission interconnection and the overall project.

Table 3-6: Fire Hazard LORS

LORS	Applicability
14 CCR Sections 1250-1258, "Fire Prevention Standards for Electric Utilities"	Provides specific exemptions from electric pole and tower firebreak and electric conductor clearance standards and specifies when and where standards apply.
GO-95, CPUC, "Rules for Overhead Electric Line Construction," Section 35	CPUC rule covers all aspects of design, construction, operation, and maintenance of electric transmission line and fire safety (hazards).
ANSI/IEEE 80, "IEEE Guide for Safety in AC Substation Grounding"	Presents guidelines for assuring safety through proper grounding of AC outdoor substations.

3.5.7 Jurisdiction

Table 3-7 identifies national, state, and local agencies with jurisdiction to issue permits or approvals, conduct inspections, or enforce the above-referenced LORS. Table 3-7 also identifies the responsibilities of these agencies as they relate to Gem Project construction, operation, and maintenance.

Table 3-7: National, State and Local Jurisdiction over Applicable LORS

Agency or Jurisdiction	Responsibility
FAA	Establishes regulations for marking and lighting of obstructions in navigable airspace (AC No. 70/7450-1G).
CEC	Jurisdiction over new transmission lines associated with thermal power plants that are 50 MW or more (PRC 25500).
CEC	Jurisdiction of lines out of a thermal power plant to the first point of interconnection with the grid (PRC 25107).
CPUC	Regulates construction and operation of overhead transmission lines (GO-95).
CPUC	Regulates construction and operation of power and communications lines for the prevention of inductive interference (GO-52).
Local Electrical Inspector	Jurisdiction over safety inspection of electrical installations that connect to the supply of electricity (NFPA 70).
Kern County	Establishes and enforces zoning regulations for specific land uses. Issues variances in accordance with zoning ordinances. Issues and enforces certain ordinances and regulations concerning fire prevention and electrical inspection

PRC = Public Resources Code