SUMMARY OF CONCLUSIONS

The proposed Ivanpah Solar Electric Generating System (ISEGS or “Project”) outlet lines and termination are acceptable and would comply with all applicable laws, ordinances, regulations, and standards (LORS). The analysis of project transmission lines and equipment, both from the three power plants up to the point of interconnection with the existing transmission network as well as upgrades beyond the interconnection that are attributable to the project, have been evaluated by U.S. Bureau of Land Management (BLM) and California Energy Commission staff (hereafter jointly referred to as staff) and are included in the environmental sections of this Final Staff Assessment/Draft Environmental Impact Statement (FSA/DEIS). Staff’s conclusions with respect to Transmission System Engineering result in the need for Ivanpah to provide the following mitigation measures:

- Mitigation of base case thermal overloads caused by Ivanpah #1 and #2 power plants, would require the replacement of the existing 115/220 kV transformer bank at the Eldorado substation and the upgrade from 115 to 220 kV of a 36 mile long segment of Eldorado-Baker-Cool Water-Dunn Siding-Mountain Pass transmission line between the new Ivanpah and existing Eldorado Substations. Ivanpah #3 would require the addition of a 115/220 kV transformer at the new Ivanpah substation.

- Mitigation of thermal overloads caused by the Ivanpah #3 under N-1 contingency analysis, would require modification of the existing Special Protection System (SPS) to reflect the topology change associated with the additional facility upgrades triggered by the Ivanpah #3 power plant.

Conditions of Certification referred to herein serve the purpose of both the Energy Commission’s Conditions of Certification for purposes of the California Environmental Quality Act (CEQA) and BLM’s Mitigation Measures for purposes of the National Environmental Policy Act (NEPA).

INTRODUCTION

STAFF ANALYSIS

This transmission system engineering (TSE) analysis examines whether this project’s proposed interconnection conforms to all LORS required for safe and reliable electric power transmission. Additionally, under CEQA, the Energy Commission must conduct an environmental review of the “whole of the action,” which may include facilities not licensed by the Energy Commission (Title 14, California Code of Regulations §15378). The BLM and California Energy Commission must therefore identify the system impacts and necessary new or modified transmission facilities downstream of the proposed interconnection that are required for interconnection and that represent the whole of the action.
Staff relies upon the responsible interconnecting authority for analysis of impacts on the transmission grid, as well as for the identification and approval of new or modified facilities required downstream from the proposed interconnection for mitigation purposes. The proposed project would connect to SCE’s 115-kV transmission network and requires both analysis by SCE and the approval of the California Independent System Operator (California ISO).

SCE’S ROLE

SCE is responsible for ensuring electric system reliability in its service territory for proposed transmission modifications. For the Ivanpah project, SCE performed the System Impact Study (SIS) used to determine whether or not the proposed transmission modifications conform to reliability standards. Because the project would be connected to the California ISO controlled transmission grid, the California ISO’s role is to review and approve the SIS and its conclusions.

CALIFORNIA ISO’S ROLE

The California ISO is responsible for ensuring electric system reliability for all participating transmission owners and is also responsible for developing the standards necessary to achieve system reliability. The project power will be dispatched to the California ISO grid via SCE’s newly built Ivanpah 115/220-kV substation. Therefore, California ISO will review the studies of the SCE system to ensure adequacy of the proposed transmission interconnection. The California ISO determines the reliability impacts of the proposed transmission modifications on the SCE transmission system in accordance with all applicable reliability criteria. According to the California ISO tariffs, the California ISO will determine the “need” for transmission additions or upgrades downstream from the interconnection point to insure reliability of the transmission grid. The California ISO reviewed the SIS performed by SCE and issued a preliminary approval to SCE. On completion of the SCE Facility Study, the California ISO will review the study results and provide its conclusions and recommendations. The California ISO may provide written and verbal testimony on its findings at the Energy Commission hearings.

LAWS, ORDINANCES, REGULATIONS, AND STANDARDS

- California Public Utilities Commission (CPUC) General Order 95 (GO-95), *Rules for Overhead Electric Line Construction*, sets forth uniform requirements for the construction of overhead lines. Compliance with this order ensures both adequate service and the safety of both the public and the people who build, maintain, and operate overhead electric lines.

- CPUC General Order 128 (GO-128), *Rules for Construction of Underground Electric Supply and Communications Systems*, sets forth uniform requirements and minimum standards for underground supply systems to ensure adequate service and the safety of both the public and the people who build, maintain, and operate underground electric lines.

- The *National Electric Safety Code*, 1999, provides electrical, mechanical, civil, and structural requirements for overhead electric line construction and operation.
The combined NERC/WECC (North American Electric Reliability Corporation/Western Electricity Coordinating Council) planning standards provide system performance standards for assessing the reliability of the interconnected transmission system. These standards require continuity of service as their first priority and the preservation of interconnected operation as their second. Some aspects of NERC/WECC standards are either more stringent or more specific than the either agency’s standards alone. These standards are designed to ensure that transmission systems can withstand both forced and maintenance outage system contingencies while operating reliably within equipment and electric system thermal, voltage, and stability limits. These standards include reliability criteria for system adequacy and security, system modeling data requirements, system protection and control, and system restoration. Analysis of the WECC system is based to a large degree on Section I.A of WECC standards, NERC and WECC Planning Standards with Table I and WECC Disturbance-Performance Table, and on Section I.D, NERC and WECC Standards for Voltage Support and Reactive Power. These standards require that power flows and stability simulations verify defined performance levels. Performance levels are defined by specifying allowable variations in thermal loading, voltage and frequency, and loss of load that may occur during various disturbances. Performance levels range from no significant adverse effects inside and outside a system area during a minor disturbance (such as the loss of load from a single transmission element) to a catastrophic loss level designed to prevent system cascading and the subsequent blackout of islanded areas and millions of consumers during a major transmission disturbance (such as the loss of multiple 500-kV lines along a common right-of-way, and/or of multiple large generators). While the controlled loss of generation or system separation is permitted under certain specific circumstances, this sort of major uncontrolled loss is not permitted (WECC, 2002).

NERC’s reliability standards for North America’s electric transmission system spell out the national policies, standards, principles, and guidelines that ensure the adequacy and security of the nation’s transmission system. These reliability standards provide for system performance levels under both normal and contingency conditions. While these standards are similar to the combined NERC/WECC standards, certain aspects of the combined standards are either more stringent or more specific than the NERC performance standards alone. NERC’s reliability standards apply to both interconnected system operations and to individual service areas (NERC, 2006).

California ISO planning standards also provide the standards and guidelines that ensure the adequacy, security, and reliability of the state’s member grid facilities. These standards also incorporate the combined NERC/WECC and NERC standards. These standards are also similar to the NERC/WECC or NERC standards for transmission system contingency performance. However, the California ISO standards also provide additional requirements that are not found in either the WECC/NERC or NERC standards. The California ISO standards apply to all participating transmission owners interconnecting to the California ISO-controlled grid. They also apply to non-member facilities that impact the California ISO grid through their interconnections with adjacent control grids (California ISO, 2002a).

**PROJECT DESCRIPTION**

The applicant proposes to interconnect the 400 megawatt (MW) Ivanpah to SCE’s proposed newly built 220 kV Ivanpah substation near Nevada border, San Bernardino County, California. The proposed Ivanpah project would develop in three phases, two 100 MW phases known as Ivanpah #1 and #2, and one 200 MW phase known as Ivanpah #3. Construction is planned to take place over approximately 48 months, with the applicant’s desire that it could begin during the first quarter of 2010 and be completed during the fourth quarter 2013. Assuming the construction of Ivanpah 1, 2 and 3 were to begin in a sequential fashion during the first quarter of 2010 and be completed during the fourth quarter of 2013, the applicant would expect to commence commercial operation in the fourth quarter for each of the power plants beginning in 2011 at Ivanpah 1, in 2012 at Ivanpah 2, and in 2013 at Ivanpah 3.

Ivanpah is a solar concentrating thermal power plant, based on distributed power tower and heliostat mirror technology. The heliostat fields focus solar energy on the power tower receivers near the center of each of the heliostat arrays. The heliostat mirrors would be asymmetrically arranged around each solar power tower. Each mirror will track the sun throughout the day and reflect the solar energy to the receiver boiler within the power tower. In each plant, one Rankine-cycle reheat steam turbine receives live steam from the solar boilers and reheat steam from one solar reheater-located in the power block at the top of its own power tower. The solar field and power generation equipment would be started each morning after sunrise and insolation build-up, and shut down in the evening when insolation drops below the level required to maintain the turbine connected. Electricity would be produced by each plant’s solar receiver boiler and the steam turbine generator. Each of the three ISEGS projects would connect to its own 115 kV switchyard and from there to a proposed SCE Ivanpah 115/220 kV substation which would connect to the SCE system by looping an existing transmission line into the new substation (CH2ML2008g).

**SWITCHYARD AND INTERCONNECTION FACILITIES**

Each of the Project’s three generating units (1, 2, and 3) would be connected to the low side of its dedicated 13.8/115 kV generator step-up (GSU) transformer through 25 kV, 7,000-ampere gas-insulated (SF6) breaker. The high side of the generator step-up transformer would be connected to the project’s switchyard via 115 kV, 1200-ampere disconnect switch. The step-up transformer for the steam turbine generating unit would be rated at 13.8/115 kV and 72/96/120 megavolt ampere (MVA). Each project switchyard bay will consist of a 115 kV, 1200A single circuit breaker and two 1200A disconnect switches. The switchyard circuit breaker would interconnect to an overhead 115kV single circuit transmission line via 1200A disconnect switch. Each of the three phases will connect to a new Ivanpah substation via its own dedicated 115 kV generator tie line.
The Ivanpah #1 115 kV generator tie line would be approximately 5,800 feet long, built with 477 kcmil ACSR conductors and supported by single-pole structures. The Ivanpah #2 and #3 generator tie lines would share the same poles for the last 1,400 feet of their routes before they interconnect to SCE’s Ivanpah Substation. The Ivanpah #2 generator would connect to the Ivanpah Substation through 115kV, 3,900 feet-long single circuit generator tie line built with the last 1,400 feet merged with the Ivanpah #3 generator tie line to create a 1,400 feet long, overhead double circuit line prior to entering the Ivanpah Substation. The Ivanpah #3 generator tie line would be an approximately 14,100 feet long, single circuit, 115 kV line built with 1510 kcmil ACSR and would merge into a 115kV double circuit with the Ivanpah #2 generator tie line.

SCE’s Ivanpah Substation would use a double-bus breaker-and-a-half configuration with 3 bays and 5 positions for outgoing transmission lines. The Ivanpah Substation would consists of 115kV, 1200A circuit breakers, 115kV disconnect switches and other switching gear that will allow delivery of the project’s output to the SCE grid. The existing Eldorado-Baker-Cool Water-Dunn Siding-Mountain Pass 115kV line would loop in and out through the newly built Ivanpah Substation to interconnect the project to the SCE transmission grid. (Ivanpah #2, 2007b section 3.2.2 pages 3-4 to 3-6 and Figure 01-PB-E-D-201).

ASSESSMENT OF IMPACTS AND DISCUSSION OF MITIGATION

For the interconnection of this proposed project to the grid, the interconnecting utility (SCE) and the control area operator (California ISO) are responsible for ensuring grid reliability. These two entities determine the transmission system impacts of the proposed project and any mitigation measures needed to ensure system conformance with utility reliability criteria, NERC planning standards, WECC reliability criteria, and California ISO reliability criteria. System impact and facilities studies are used to determine the impacts of the proposed project on the transmission grid. Staff relies on these studies and any review conducted by the California ISO to determine the effect of the project on the transmission grid and to identify any necessary downstream facilities or indirect project impacts required to bring the transmission network into compliance with applicable reliability standards. System impact and facilities studies analyze the grid both with and without the proposed project, under conditions specified in the planning standards and reliability criteria. The standards and criteria define the assumptions used in the study and establish the thresholds through which grid reliability is determined. The studies analyze the impact of the project for the proposed first year of operation, and are based on a forecast of loads, generation, and transmission. Load forecasts are developed by the interconnected utility. Generation and transmission forecasts are established by an interconnection queue. The studies focus on thermal overloads, voltage deviations, system stability (excessive oscillations in generators and transmission system, voltage collapse, loss of loads, or cascading outages), and short circuit duties. If the studies show that the interconnection of the project causes the grid to be out of compliance with reliability standards, then the study will identify mitigation alternatives or ways in which the grid could be brought into compliance with reliability standards.
When a project connects to the California ISO-controlled grid, both the studies and mitigation alternatives must be reviewed and approved by the California ISO. If either the California ISO or interconnecting utility determines that the only feasible mitigation includes transmission modifications or additions requiring CEQA review, the Energy Commission must analyze those modifications or additions according to CEQA requirements.

PROPOSED PROJECT - SCOPE OF SYSTEM IMPACT STUDIES

The system impact studies were performed by SCE at the request of Bright Source Energy, Inc, to identify the transmission system impacts of Ivanpah’s #1, #2 and #3 on SCE’s 115/220/500-kV system. The studies included power flow, sensitivity, and short circuit studies, and transient and post-transient analyses (Ivanpah #1, #2 and #3, 2008a, System Impact Studies). The studies modeled the proposed project for a net output of 100 MW for Ivanpah #1 and #2, 200 MW for Ivanpah #3. The base cases included all California ISO approved major SCE transmission projects, the transmission system for the Los Angeles Department of Water and Power, and major path flow limits of Southern California Import Transmission, East-Of-River, and West-of-River. The studies considered light load conditions with generation patterns and Path 46 imports maximized to identify the extent of potential congestion and fully stress the SCE system in the area where the Ivanpah project phases are interconnecting. The detailed study assumptions are described in the studies. The power flow studies were conducted with and without Ivanpah phases connected to SCE’s grid at the newly built Ivanpah Substation, using 2013 heavy summer and 2013 light spring base cases. The power flow study assessed the project’s impact on thermal loading of the transmission lines and equipment. Transient and post-transient studies were conducted for Ivanpah phases of the project using the 2013 heavy summer base case to determine whether the project would create instability in the system following certain selected outages. Short Circuit studies were conducted to determine if Ivanpah phases would overstress existing substation facilities.

Power Flow Study Results and mitigation measures (Ivanpah #1 and #2)

The study determined that the system between Mountain Pass and Eldorado substation is inadequate to accommodate the full output of all generation projects queued ahead of the Ivanpah #1 and #2 power plants.

Base Case Conditions (N-0):
Under base case conditions, a portion of the Eldorado-Baker-Cool Water-Dunn Siding-Mountain Pass 115 kV line as well as the existing 115/220 kV transformer at Eldorado were found to be loaded beyond the maximum allowable limits.

Mitigation:

- Removal of approximately 36 miles of a portion of the Eldorado – Ivanpah leg of the existing Eldorado-Baker-Cool Water–Dunn Siding-Mountain Pass 115 kV line and construction of a new 36 mile long, 220 kV double circuit line, with 1590 kcmil ACSR conductors. (The circuit would initially energized at 115 kV)
• Replacement of the existing 115/220 kV, 102 MVA transformer bank at the Eldorado Substation with 115/220 KV, 280 MVA bank.

**Power Flow Study Results and mitigation measures (Ivanpah #3)**

The study determined that the system between Ivanpah and Eldorado substation is inadequate to accommodate the full output of all generation projects queued ahead of the Ivanpah #3 power plant.

**Base Case Conditions (N-0):**
Under the base case conditions, the study determined that the modified Eldorado 115/220 kV transformer bank is insufficient to accommodate Ivanpah #3. The existing Eldorado substation design does not provide the ability to install an additional 115/220 kV transformer bank without causing significant changes at the site. Adding a second transformer bank at the Eldorado substation is not a viable alternative.

Mitigation: Therefore, an additional transformer bank should be installed at proposed Ivanpah substation to increase the operating voltage from 115 kV to 220 kV of the Eldorado-Ivanpah 220 kV transmission line. This will also require the construction of two new 220 kV line positions on the west side of Eldorado substation within the existing fence line.

With the additional upgrades triggered by the Ivanpah #3, the study identified the continued need for a Special Protection System (SPS) in order to mitigate thermal overloads identified under N-1 contingency analysis. The study did not identify any N-2 thermal overloads.

**Single Outage Contingency (N-1):**
The loss of the new 36 mile Eldorado-Ivanpah 220 kV transmission line under N-1 contingency conditions would disconnect the Ivanpah and Mountain Pass areas from the Eldorado substation thereby triggering voltage collapse and thermal overload problems.

Mitigation: To mitigate this criteria violation, a previously implemented SPS will need to be modified to reflect the changes associated with the facility upgrades triggered by the Ivanpah #3. The SPS should be capable of tripping Mountain Pass 115 kV line, the new Ivanpah substation, the new Ivanpah 220 kV transmission line and the Ivanpah #3.

**Single Outage Contingency (N-1):**
Loss of one Ivanpah 115/220kV transformer bank results in loading the remaining transformer bank beyond its maximum emergency capability.

Mitigation: To mitigate this criteria violation, a previously implemented SPS will need to be modified. The SPS should be capable of tripping Mountain Pass 115 kV new Ivanpah substation, New Ivanpah 220 kV transmission line or the Ivanpah #3 of the project under loss of one Ivanpah 115/220 kV transformer bank by opening the corresponding unit circuit breaker.
**Transient Stability Results**

Transient stability studies identified that the Ivanpah #1, #2 and #3 power plants of the project steam generators experience transient instability under 15 cycle closed-in (three-phase-to-ground) system faults located at or near the proposed Ivanpah 115kV substation. To mitigate the transient stability problem, the following upgrades are proposed:

- Upgrade SCE 115 kV relay protection near the proposed Ivanpah substation to provide for primary protection fault clearing time of less than 8 cycles.
- Ensure project developer installs out-of-step protection on the Ivanpah #1, #2 and #3 steam turbine-generators.

**Post-Transient Stability Results**

Depending on the amount of generation resource on line, loss of either Eldorado-Ivanpah transmission line or loss of the 115/220 kV transformer at Eldorado resulted in a significant voltage deviation including a voltage collapse, in the Dunn Siding and Baker substation areas. To mitigate this problem, the following reliability upgrades are proposed.

- Install a Special Protection System (SPS) that trips the Ivanpah #1, #2 and #3 projects under outages of transmission facilities connecting the proposed Ivanpah substation to the Eldorado substation (transmission line and transformer bank at Eldorado substation).

**Short-Circuit Duty Study Results**

Short circuit studies were performed to determine the degree to which the addition of Ivanpah project increases fault duties at SCE substations, and other 115 kV, 220 kV, and 220 kV busses within the study area. The busses at which faults were simulated, the maximum three-phase and single-line-to-ground fault currents at these busses both with and without the project, and information on the breaker duties at each location are summarized in the Short Circuit Study results tables of the System Impact Study Report (Ivanpah #3, 2008b, SIS, tables 2-3, Pages 38 and 39).

The results of the three-phase-to-ground and single-phase-to-ground short-circuit duty studies identified that three 220kV 50kA circuit breakers at the Lugo Substation will need to be replaced and that two 220 kV 50kA circuit breakers also at the Lugo Substation will need to be upgraded to 63 kA rating by installing Transient Recovery Voltage (TRV) capacitor banks. Additionally, the Eldorado 220 kV substation will needed to be upgraded to 80 kA design standard as the current 63 KA capability was identified to be exceeded by a queued ahead generation projects. The breaker upgrades would occur within the fence line of existing substations and would not trigger CEQA review. Detailed Short Circuit study results will be provided as a part of the Facilities Study.

**Closure and Decommissioning Impacts and Mitigation**

Closure and decommissioning activities associated with Ivanpah would involve the removal of the three power plants (Ivanpah # 1, 2 and 3), their switchyards and generation tie lines from the respective switchyards to the Ivanpah Substation. Ivanpah
Substation would not be affected, and thus the integrity of the Eldorado-Baker-Cool Water-Dunn Siding-Mountain Pass transmission line would not be affected. Therefore, there would not be any significant adverse environmental effects or LORS conformance issues associated with the Ivanpah closure and decommissioning.

NO PROJECT/NO ACTION ALTERNATIVE

In the No Project / No Action Alternative, the proposed action would not be undertaken. The BLM land on which the project is proposed would continue to be managed within BLM’s framework of a program of multiple use and sustained yield, and the maintenance of environmental quality [43 U.S.C. 1781 (b)] in conformance with applicable statutes, regulations, policy and land use plan.

The results of the No Project / No Action Alternative would be the following:

- The impacts of the proposed project would not occur. However, the land on which the project is proposed would become available to other uses that are consistent with BLM’s land use plan, including another solar project.
- The benefits of the proposed project in reducing greenhouse gas emissions from gas-fired generation would not occur. Both State and Federal law support the increased use of renewable power generation.

If this project is not approved, renewable projects would likely be developed on other sites in the Mojave Desert or in adjacent states as developers strive to provide renewable power that complies with utility requirements and State/Federal mandates. For example, there are three large solar projects proposed on BLM land in Nevada within a few miles of the Ivanpah site. In addition, there are currently 66 applications for solar projects covering 611,692 acres pending with BLM in the California Desert District.

CUMULATIVE IMPACTS AND MITIGATION

Staff has reviewed the lists of existing and foreseeable projects as presented in the Cumulative Scenario section of this FSA/DEIS. Staff’s review considers whether the interconnection of Ivanpah to SCE’s transmission system along with other existing and foreseeable generation projects would conform to all LORS required for safe and reliable electric power transmission. The analysis described above under the heading Proposed Project – Scope of System Impact Studies is conducted in coordination with, and the approval of, California ISO to consider existing and proposed generator interconnections to the transmission grid and their potential safety and reliability impacts under a number of conservative contingency conditions. The results of this study conclude that with implementation of the mitigation measures recommended by staff and required by California ISO as a condition of Ivanpah interconnection, Ivanpah will not contribute to a cumulative impact to the safety and reliability of the transmission system.

COMPLIANCE WITH LORS

The studies indicate that the three phases of the project would comply with NERC/WECC planning standards and California ISO reliability criteria. The applicant will design and fund construction of the proposed 220 kV Ivanpah substation and a new
36-mile long segment of Eldorado-Baker-Cool Water-Dunn Siding-Mountain Pass transmission line between Eldorado and Ivanpah Substations. Staff concludes that, assuming the proposed conditions of certification are met, the project would likely meet the requirements and standards of all applicable LORS.

NOTEWORTHY PUBLIC BENEFITS

Staff has not identified any noteworthy public benefits associated with Transmission System Engineering.

RESPONSE TO AGENCY AND PUBLIC COMMENTS ON THE PSA

No agency or public comments related to the TSE discipline have been received.

CONCLUSIONS AND RECOMMENDATIONS

The proposed Ivanpah outlet lines and termination are acceptable and would comply with all applicable laws, ordinances, regulations, and standards (LORS). The analysis of project transmission lines and equipment, both from the power plant up to the point of interconnection with the existing transmission network as well as upgrades beyond the interconnection that are attributable to the project have been evaluated by staff and are included in the environmental sections of this staff assessment. Staff’s conclusions with respect to Transmission System Engineering result in the need for Ivanpah to provide the following mitigation measures:

- Mitigation of base case thermal overloads caused by Ivanpah #1 and Ivanpah #2 of the project, would require the replacement of the existing 115/220 kV transformer bank at the Eldorado substation and the upgrade of a 36 mile long segment of Eldorado-Baker-Cool Water-Dunn Siding-Mountain Pass transmission line between Eldorado and Ivanpah Substations. Ivanpah #3 would require the addition of a 115/220 kV transformer at the new Ivanpah substation.

- Mitigation of thermal overloads caused by the Ivanpah #3 under N-1 contingency analysis, would require modification of the existing Special Protection System (SPS) to reflect the topology change associated with the additional facility upgrades triggered by the Ivanpah #3 power plant.

MITIGATION MEASURES/PROPOSED CONDITIONS OF CERTIFICATION

If BLM grants a Right-of-Way and the Energy Commission approves this project, staff recommends that the following conditions of certification be met to ensure both system reliability and conformance with LORS.

**TSE-1** The project owner shall furnish to BLM’s Authorized Officer and the Compliance Project Manager (CPM) and to the Chief Building Official (CBO) a schedule of transmission facility design submittals, a Master Drawing List, a Master Specifications List, and a Major Equipment and Structure List. The
schedule shall contain a description and list of proposed submittal packages for design, calculations, and specifications for major structures and equipment. To facilitate audits by BLM and Energy Commission staff, the project owner shall provide designated packages to BLM’s Authorized Officer and the CPM when requested.

**Verification:** At least 60 days prior to the start of construction (or a lesser number of days mutually agreed to by the project owner and the CBO), the project owner shall submit the schedule, a Master Drawing List, and a Master Specifications List to the CBO, BLM’s Authorized Officer and to the CPM. The schedule shall contain a description and list of proposed submittal packages for design, calculations, and specifications for major structures and equipment (see a list of major equipment in Table 1: Major Equipment List below). Additions and deletions shall be made to the table only with CPM, BLM’s Authorized Officer and CBO approval. The project owner shall provide schedule updates in the Monthly Compliance Report.

**TRANSMISSION SYSTEM ENGINEERING Table 1**

<table>
<thead>
<tr>
<th>Major Equipment List</th>
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<tr>
<td>Breakers</td>
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<td>Step-Up Transformer</td>
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<td>Switchyard</td>
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<td>Busses</td>
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<td>Surge Arrestors</td>
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<td>Disconnects</td>
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<td>Take Off Facilities</td>
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<td>Electrical Control Building</td>
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<td>Switchyard Control Building</td>
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<tr>
<td>Transmission Pole/Tower</td>
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<td>Grounding System</td>
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</table>

**TSE-2** Prior to the start of construction, the project owner shall assign an electrical engineer and at least one of each of the following to the project: A) a civil engineer; B) a geotechnical engineer or a civil engineer experienced and knowledgeable in the practice of soils engineering; C) a design engineer who is either a structural engineer or a civil engineer fully competent and proficient in the design of power plant structures and equipment supports; or D) a mechanical engineer. (Business and Professions Code Sections 6704 et seq. require state registration to practice as a civil engineer or structural engineer in California.

The tasks performed by the civil, mechanical, electrical, or design engineers may be divided between two or more engineers, as long as each engineer is responsible for a particular segment of the project (e.g., proposed earthwork, civil structures, power plant structures, equipment support). No segment of the project shall have more than one responsible engineer. The transmission line may be the responsibility of a separate California-registered electrical
engineer. The civil, geotechnical or civil, and design engineer assigned in conformance with Facility Design condition GEN-5, may be responsible for design and review of the TSE facilities.

The project owner shall submit to the CBO for review and approval, the names, qualifications, and registration numbers of all engineers assigned to the project. If any one of the designated engineers is subsequently reassigned or replaced, the project owner shall submit the name, qualifications, and registration number of the newly assigned engineer to the CBO for review and approval. The project owner shall notify BLM’s Authorized Officer and the CPM of the CBO’s approval of the new engineer. This engineer shall be authorized to halt earthwork and to require changes if site conditions are unsafe or do not conform with predicted conditions used as a basis for design of earthwork or foundations.

The electrical engineer shall:

1. Be responsible for the electrical design of the power plant switchyard, outlet and termination facilities; and

2. Sign and stamp electrical design drawings, plans, specifications, and calculations.

Verification: At least 30 days prior to the start of rough grading (or a lesser number of days mutually agreed to by the project owner and the CBO), the project owner shall submit to the CBO for review and approval, the names, qualifications, and registration numbers of all the responsible engineers assigned to the project. The project owner shall notify BLM’s authorized officer and the CPM of the CBO’s approvals of the engineers within five days of the approval.

If the designated responsible engineer is subsequently reassigned or replaced, the project owner has five days in which to submit the name, qualifications, and registration number of the newly assigned engineer to the CBO for review and approval. The project owner shall notify BLM’s Authorized Officer and the CPM of the CBO’s approval of the new engineer within five days of the approval.

TSE-3

If any discrepancy in design and/or construction is discovered in any engineering work that has undergone CBO design review and approval, the project owner shall document the discrepancy and recommend corrective action (California Building Code, 1998, Chapter 1, Section 108.4, Approval Required; Chapter 17, Section 1701.3, Duties and Responsibilities of the Special Inspector; Appendix Chapter 33, Section 3317.7, Notification of Noncompliance). The discrepancy documentation shall become a controlled document and shall be submitted to the CBO for review and approval and shall reference this condition of certification.

Verification: The project owner shall submit a copy of the CBO’s approval or disapproval of any corrective action taken to resolve a discrepancy to BLM’s Authorized Officer and the CPM within 15 days of receipt. If disapproved, the project owner shall advise BLM’s Authorized Officer and the CPM, within five days, the reason for disapproval, and the revised corrective action required obtaining the CBO’s approval.
For the power plant switchyard, outlet line, and termination, the project owner shall not begin any increment of construction until plans for that increment have been approved by the CBO. These plans, together with design changes and design change notices, shall remain on the site for one year after completion of construction. The project owner shall request that the CBO inspect the installation to ensure compliance with the requirements of applicable LORS. The following activities shall be reported in the Monthly Compliance Report:

1. Receipt or delay of major electrical equipment;

2. Testing or energization of major electrical equipment; and

3. The number of electrical drawings approved, submitted for approval, and still to be submitted.

Verification: At least 30 days prior to the start of each increment of construction (or a lesser number of days mutually agreed to by the project owner and the CBO), the project owner shall submit to the CBO for review and approval the final design plans, specifications, and calculations for equipment and systems of the power plant switchyard, outlet line, and termination, including a copy of the signed and stamped statement from the responsible electrical engineer attesting to compliance with the applicable LORS, and send BLM’s Authorized Officer and the CPM a copy of the transmittal letter in the next Monthly Compliance Report.

The project owner shall ensure that the design, construction, and operation of the proposed transmission facilities will conform to all applicable LORS, including the requirements listed below. The project owner shall submit the required number of copies of the design drawings and calculations as determined by the CBO.

1. The Ivanpah 1 will be interconnected to the SCE grid via a segment of 115kV, 477 kcmil-ACSR, approximately 5,800 feet long single circuit.

The Ivanpah #2 will be interconnected to the SCE grid via a segment of 115-kV, 477 kcmil-ACSR, approximately 3900 feet long single circuit and a segment of 115kV, 477-kcmil, approximately 1400 feet long double circuit generator tie-line.

The Ivanpah #3 generator tie line would be approximately 14,100 feet long, single circuit, 115kV line built with 1510 kcmil ACSR and would merge into a 115kV double circuit with the Ivanpah #2 generator tie line.

The proposed Ivanpah substation would use a double bus breaker- and-a half configuration with 3-bays and 5 positions.

2. The power plant outlet line shall meet or exceed the electrical, mechanical, civil, and structural requirements of CPUC General Order 95 and General Order 98 or National Electric Safety Code (NESC), Title 8 of the California Code and Regulations (Title 8), Articles 35, 36, and 37 of...
the “High Voltage Electric Safety Orders”, California ISO standards, National Electric Code (NEC), and related industry standards.

3. Breakers and busses in the power plant switchyard and other switchyards, where applicable, shall be sized to comply with a short-circuit analysis.

4. Outlet line crossings and line parallels with transmission and distribution facilities shall be coordinated with the transmission line owner and comply with the owner’s standards.

5. The project conductors shall be sized to accommodate the full output from the project.

6. Termination facilities shall comply with applicable SCE interconnection standards.

7. The project owner shall provide to BLM’s Authorized Officer and the CPM:
   a. The final Detailed Facility Study (DFS) including a description of facility upgrades, operational mitigation measures, and/or Special Protection System (SPS) sequencing and timing if applicable,
   b. Executed project owner and California ISO Facility Interconnection Agreement.

Verification: At least 60 days prior to the start of construction of transmission facilities (or a lessor number of days mutually agree to by the project owner and CBO), the project owner shall submit to the CBO for approval:

1. Design drawings, specifications, and calculations conforming with CPUC General Order 95 and General Order 98 or NESC; Title 8, California Code of Regulations, Articles 35, 36, and 37 of the “High Voltage Electric Safety Orders”; NEC; applicable interconnection standards, and related industry standards for the poles/towers, foundations, anchor bolts, conductors, grounding systems, and major switchyard equipment.

2. For each element of the transmission facilities identified above, the submittal package to the CBO shall contain the design criteria, a discussion of the calculation method(s), a sample calculation based on “worst-case conditions,” and a statement signed and sealed by the registered engineer in responsible charge, or other acceptable alternative verification, that the transmission element(s) will conform with CPUC General Order 95 or NESC; Title 8, California Code of Regulations, Articles 35, 36, and 37 of the “High Voltage Electric Safety Orders”; NEC; applicable interconnection standards, and related industry standards.

3. Electrical one-line diagrams signed and sealed by the registered professional electrical engineer in responsible charge, a route map, and an engineering description of equipment and the configurations covered by requirements TSE-5 through 5) above.

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1 Worst-case conditions for the foundations would include for instance, a dead-end or angle pole.
4. The final Detailed Facility Study, including a description of facility upgrades, operational mitigation measures, and/or SPS sequencing and timing if applicable, shall be provided concurrently to BLM’s Authorized Officer and the CPM.

**TSE-6**
The project owner shall provide the following Notice to the California Independent System Operator (California ISO) prior to synchronizing the facility with the California transmission system:

1. At least one week prior to synchronizing the facility with the grid for testing, provide the California ISO a letter stating the proposed date of synchronization; and

2. At least one business day prior to synchronizing the facility with the grid for testing, provide telephone notification to the California ISO Outage Coordination Department.

**Verification:** The project owner shall provide copies of the California ISO letter to BLM’s Authorized Officer and the CPM when it is sent to the California ISO one week prior to initial synchronization with the grid. A report of the conversation with the California ISO shall be provided electronically to BLM’s Authorized Officer and the CPM one day before synchronizing the facility with the California transmission system for the first time.

**TSE-7**
The project owner shall be responsible for the inspection of the transmission facilities during and after project construction, and any subsequent BLM authorized officer, CPM and CBO approved changes thereto, to ensure conformance with CPUC GO-95 or NESC; Title 8, CCR, Articles 35, 36 and 37 of the “High Voltage Electric Safety Orders”; applicable interconnection standards; NEC; and related industry standards. In case of non-conformance, the project owner shall inform BLM’s Authorized Officer, the CPM and CBO in writing, within 10 days of discovering such non-conformance and describe the corrective actions to be taken.

**Verification:** Within 60 days after first synchronization of the project, the project owner shall transmit to BLM’s Authorized Officer, the CPM and CBO:

1. “As built” engineering description(s) and one-line drawings of the electrical portion of the facilities signed and sealed by the registered electrical engineer in responsible charge. A statement attesting to conformance with CPUC GO-95 or NESC; Title 8, California Code of Regulations, Articles 35, 36 and 37 of the “High Voltage Electric Safety Orders”; applicable interconnection standards; NEC; and related industry standards, and these conditions shall be provided concurrently.

2. An “as built” engineering description of the mechanical, structural, and civil portion of the transmission facilities signed and sealed by the registered engineer in responsible charge or acceptable alternative verification. “As built” drawings of the electrical, mechanical, structural, and civil portion of the transmission facilities shall be maintained at the power plant and made available, if requested, for BLM’s Authorized Officer or CPM audit as set forth in the “Compliance Monitoring Plan.”
3. A summary of inspections of the completed transmission facilities, and identification of any nonconforming work and corrective actions taken, signed and sealed by the registered engineer in charge

REFERENCES


Ivanpah #1 and 2 (Ivanpah Solar Energy Generating Station 1 and 2). 2008a. Bright Source Energy, Inc. DPT1 and DPT2 project (System Impact Study) submitted to the California Energy Commission.


DEFINITION OF TERMS

AAC - All aluminum conductor

ACSR - Aluminum conductor steel-reinforced

ACSS - Aluminum conductor steel-supported

Ampacity - Current-carrying capacity, expressed in amperes, of a conductor at specified ambient conditions, at which damage to the conductor is nonexistent or deemed acceptable based on economic, safety, and reliability considerations.

Ampere - The unit of current flowing in a conductor.

Bundled - Two wires, 18 inches apart.

Bus - Conductors that serve as a common connection for two or more circuits.

Conductor - The part of the transmission line (the wire) that carries the current.

Congestion management – A scheduling protocol, which provides that dispatched generation and transmission loading (imports) will not violate criteria.

Emergency overload – See “Single Contingency.” This is also called an L-1.

Kcmil or KCM – Thousand circular mil. A unit of the conductor’s cross sectional area When divided by 1,273, the area in square inches is obtained.

Kilovolt (kV) - A unit of potential difference, or voltage, between two conductors of a circuit, or between a conductor and the ground.

Loop - An electrical cul de sac. A transmission configuration that interrupts an existing circuit, diverts it to another connection, and returns it back to the interrupted circuit, thus forming a loop or cul de sac.

Megavar - One megavolt ampere reactive.

Megavars - Mega-volt-Ampere-Reactive. One million Volt-Ampere-Reactive. Reactive power is generally associated with the reactive nature of motor loads that must be fed by generation units in the system.

Megawatt ampere (MVA) – A unit of apparent power. It equals the product of the line voltage in kilovolts, current in amperes, and the square root of 3, divided by 1,000.

Megawatt (MW) – A unit of power equivalent to 1,341 horsepower.
Normal operation/normal overload – The condition arrived at when all customers receive the power they are entitled to, without interruption and at steady voltage, and with no element of the transmission system loaded beyond its continuous rating.

N-1 condition – See “single contingency.”

Outlet - Transmission facilities (circuit, transformer, circuit breaker, etc.) linking generation facilities to the main grid.

Power flow analysis – A forward-looking computer simulation of essentially all generation and transmission system facilities that identifies overloaded circuits, transformers, and other equipment and system voltage levels.

Reactive power – Generally associated with the reactive nature of motor loads that must be fed by generation units in the system. An adequate supply of reactive power is required to maintain voltage levels in the system.

Remedial action scheme (RAS) – An automatic control provision, which, for instance, will trip a selected generating unit upon a circuit overload.

SF6 (sulfur hexafluoride) – An insulating medium.

Single contingency – Also known as “emergency” or “N-1 condition,” the occurrence when one major transmission element (circuit, transformer, circuit breaker, etc.) or one generator is out of service.

Solid dielectric cable – Copper or aluminum conductors that are insulated by solid polyethylene type insulation and covered by a metallic shield and outer polyethylene jacket.

Switchyard - An integral part of a power plant and used as an outlet for one or more electric generators.

Thermal rating – See “ampacity.”

TSE - Transmission system engineering.

Tap - A transmission configuration creating an interconnection through a sort single circuit to a small or medium sized load or a generator. The new single circuit line is inserted into an existing circuit by utilizing breakers at existing terminals of the circuit, rather than installing breakers at the interconnection in a new switchyard.

Undercrossing – A transmission configuration where a transmission line crosses below the conductors of another transmission line, generally at 90 degrees.

Underbuild - A transmission or distribution configuration where a transmission or distribution circuit is attached to a transmission tower or pole below (under) the principle transmission line conductors.