TRANSMISSION SYSTEM ENGINEERING

Testimony of Sudath Edirisuriya and Mark Hesters

SUMMARY OF CONCLUSIONS

The proposed Hidden Hills Solar Electric Generating Station System (HHSEGS) outlet lines and termination are acceptable and would comply with all applicable laws, ordinances, regulations, and standards (LORS). The analysis of environmental impacts for 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 and located in California have been evaluated by staff and are included in the environmental sections of this staff assessment.

- HHSEGS project should design and construct with adequate reactive power resources to compensate the consumption of Var by the generator step-up transformers, distribution feeders and generator tie-lines.
- The identified new Special Protection Systems (SPS) should be implemented to curtail the generation of the Queue Cluster Alpha Phase One (QCA) projects to mitigate the overload criteria violations caused by the projects on the Valley Electric Association (VEA) system.
- The identified conceptual interconnection facilities, Reliability network upgrades and Delivery network upgrades are necessary to safely and reliably interconnect the QCA projects.

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 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.

Commission 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 the VEA's 230-kV transmission network and requires both analysis by VEA and the approval of the California ISO.

VEA'S ROLE

VEA is responsible for ensuring electric system reliability in its service territory for the proposed transmission modifications. For the HHSEGS project and at the request of the applicant, Navigant Consulting Inc. performed the QCA interconnection study 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 QCA study 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 VEA's Crazy Eyes Tap 230kV substation. Therefore, California ISO reviews the studies of the VEA system to ensure adequacy of the proposed transmission interconnection. The California ISO determines the reliability impacts of the proposed transmission modifications on the VEA 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. On completion of the VEA's QCA study, the California ISO will review the study results, provide its conclusions and recommendations, and issue a final approval/disapproval letter for the interconnection of the proposed HHSEGP project. 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).
- California ISO/FERC (Federal Energy Regulatory Commission) electricity tariffs contain guidelines for building all transmission additions/upgrades within the California ISO-controlled grid. (California ISO, 2003a).

PROJECT DESCRIPTION

The HHSEGS would utilize heliostat solar thermal technology which consists of elevated mirrors guided by tracking system mounted on a pylon. The heliostats will focus the sun's rays on solar receiver steam generator (SRSG) mounted on a solar power tower near the center of each solar field.

The two 270 MW SRSGs will generate maximum plant net output of 500 MW. The auxiliary load for each SRSG would be 20 MW, resulting in a maximum net output of

250 MW at a 90 percent power factor. Each SRSG unit would be connected to the low side of its dedicated 18/230kV and 210/280/350 megavolt ampere (MVA) generator step-up (GSU) transformer through 18kV, 12,000 ampere gas-insulated (SF6) breakers. The high side of each generator step-up transformer would be connected to the HHSEGS switchyard through an underground segment of 230kV, 1000 kcmil, copper per phase cable and overhead segment of 230kV, 795 kcmil ACSR per phase conductors. Power would be transmitted from plant one to the onsite switchyard via an approximately 3,800 foot underground cable and a 10,275 foot overhead transmission line. Plant Two would be connected to the switchyard via a 7,300 foot underground cable and a 3,270 foot overhead transmission line. The project's HHSEGS switchyard would use a breaker and-a-half configuration with six 230-kV circuit breakers, disconnect switches, and other switching gear that will allow delivery of the project's output to the proposed Crazy Eyes Tap 230kV substation. The proposed commercial operation date of the project is June 30, 2015. (HHSEGS, 2011a section 3.0 pages 3-1 to 3-10 and Figure 3.2-1, 3.2-2R, TSE-1 and TSE-2)

INTERCONNECTION FACILITIES

The applicant proposes to build a 230kV single circuit, with 795 kcmil, "Drake" ACSR conductor (generator-tie line) to interconnect the power plant switchyard to the grid. The proposed generator tie-line is rated to carry the full output of the project. The generator tie-line leaves the State of California boarder 900 feet from the HHSEGS switchyard when it crosses over the eastern border of the project site. The interconnection would require an approximately 10 mile long generation tie line from the HHSEGS to the proposed Crazy Eyes Tap substation where the project would interconnect to the VEA electric grid. The generator tie line would originate at the HHSEGS's onsite switchyard, cross the state line into Nevada, and continue east for approximately 1.5 miles until reaching Tecopa Road (also known at Old Spanish Trail Highway). At Tecopa Road, the route would head northeast paralleling Tecopa Road until it reaches the Crazy Eyes Tap Substation, which would be located immediately east of the Tecopa Road/SR 160 intersection. The Crazy Eyes Tap substation would interconnect to the existing VEA's Pahrump Bob Tap 230kV line.

Assessment of Impacts and discussion of mitigation

For the interconnection of this proposed project to the grid, the interconnecting utility VEA 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.

SCOPE OF INTERCONNECTION STUDY

The individual study QCA was performed by Navigant Consulting Inc. for VEA due to on-going effort to merge VEA generation queue and the transmission facilities with California ISO. The study identified operational constraints of transmission facilities of VEA, SCE and NV energy systems. The study is based upon the power flow data files used in the California ISO's Queue Cluster Four (QC4) Phase One study for the East-of-Pisgah area undertaken in 2011. The study included two new solar thermal projects in the capacity of 540MW and 270 MW to be interconnected to the proposed VEA's 230kV Crazy Eyes Tap substation.

Power Flow Study Assumptions:

The QCA study base cases were developed from the on-peak and off-peak base cases used by Southern California Edison (SCE) and the California ISO in the QC4 studies for the East-of –Pisgah (EOP) area and reflected the generation dispatch assumptions applied in and the new transmission projects identified as part of the QC4 studies.
The QC4 base cases were modified, as necessary, to create reference cases in which VEA system and its existing and planned interconnection points with the California ISO controlled grid were model at Eldorado, the Western Area Power Administration (WAPA) system at Mead and Amargosa, and the NV Energy system at Northwest and Jackass Flats. Additionally, pertinent levels of on-peak and off-peak loads within the VEA system were modeled. The project power flow studies were conducted with and without HHSEGS connected to VEA's grid at the Crazy Eyes Tap 230kV substation, using peak and off-peak conditions. 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 using the 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 HHSEGS would overstress existing substation facilities. The detailed study assumptions are described in the study.

Power Flow Study results:

Base case with no upgrades of the VEA system:

The initial step in identifying the system upgrades and additions required to facilitate the delivery of the proposed projects from the VEA system to the balance of the California ISO controlled grid consisted of developing on-peak and off-peak power flow cases with no upgrades or additions to the VEA system and assessing the resultant Category A loadings on the VEA system.

Following facilities are identified as Category "A" normal overloads in the existing VEA system without any system upgrades.

Over Load facilities:

- Crazy Eyes Tap-Bob Tap 230kV line was overloaded by 130% under on-peak conditions and 156% overloaded under off-peak condition.
- Crazy Eyes Tap-Pahrump 230kV line was overloaded by 147% under on-peak condition and 118% under overloaded off-peak condition.
- Pahrump #1 230/ 138 kV transformer was overloaded by 116% under on-peak condition and less than 90% loaded under off-peak condition.
- Pahrump #2 230/ 138 kV transformer was overloaded by 110% under on-peak condition and less than 90% loaded under off-peak condition.

Study has identified two mitigation measures for the above overload criteria violations

Mitigations:

- Re-conductoring of the impacted 230kV lines or
- Developing a new 230kV line between the Crazy Eyes Tap and Eldorado.

The reconductoring option has been selected due to cost effectiveness and ability to meet the project in-service date. As a result, the post-QCA on-peak and off-peak base cases were modified to reflect reconductoring of the Pahrump-Crazy Eyes tap, the Crazy Eyes Tap-Bob Tap, and the Bob Tap-Mead 230kV line sections with 3M "Drake" ACCR conductor. Reconductoring above facilities would increase the conductor normal rating by 700 MW and emergency rating by 750 MW.

Power Flow Studies with Pahrump-Mead 230kV line sections reconductored:

VEA system overloads for category A, B and C contingencies for the modified base cases are summarized below;

- Pahrump #1 230/138kV transformer was overloaded under on-peak category A, B and C and off-peak category B conditions.
- Pahrump #2 230/138kV transformer was overloaded under on-peak category A, B and C and off-peak category B conditions.

- Crazy Eyes Tap-Pahrump 230kV line was overloaded under on-peak category B and C and off-peak category B and C conditions.
- Pahrump-Desert View 230kV line was overloaded under on-peak category B and C and off-peak category B and C conditions.
- Amargosa 230/138kV transformer was overloaded under on-peak category B and C and off-peak category A, B and C conditions.
- Pahrump-Gamebird 138kV line was overloaded under on-peak category B and C and off-peak category A, B and C conditions.
- Pahrump-Vista 138kV line was overloaded under on-peak category B and C conditions.
- Crazy Eyes Tap-Bob Tap 230kV line was overloaded under on-peak category B and C and off-peak category B and C conditions
- Valley Tap-Johnnie 138kV line was overloaded on-peak category C and off-peak category C conditions.
- Pahrump-Gamebird 138kV line was overloaded on-peak category C conditions.
- Gamebird-Sandy 138kV line was overloaded off-peak category B conditions.
- Gamebird-Amargosa 138kV line was overloaded off-peak category B conditions.

Proposed Mitigation:

With respect to the post-contingency overloads noted on the reconductored Crazy Eyes Tap-Bob Tap and Crazy Eyes Tap-Pahrump lines, VEA has determined that the application of Special Protection Schemes (SPS) which would drop one of the three QCA 270MW units is the most cost effective way of mitigation.

The following SPS would be applied for the Category B and C outages.

Category B:

Crazy Eyes Tap-Bob Tap 230kV line.

Crazy Eyes Tap-Pahrump 230kV line.

Category C:

Crazy Eyes Tap-Bob Tap 230kV line and Gamebird-Sandy 138 kV line.

Crazy Eyes Tap-Pahrump 230kV line and Pahrump-Gamebird 138kV line.

Crazy Eyes Tap-Pahrump 230kV line and Pahrump 230kV transformer #1

The application of such SPS would also mitigate any other overloads resulting from these five outages. Additionally, the following upgrades are required to mitigate the overloads resulting from outages other than the five contingencies listed above.

- Pahrump #1 230/138kV transformer overload could be mitigated by replacing transformer with unit rated at 176 MVA normal and 220MVA emergency.
- Pahrump #2 230/138kV transformer overload could be mitigated by replacing transformer with unit rated at 176 MVA normal and 220MVA emergency.
- Amargosa 230/138kV transformer overload could be mitigated by installing 138kV Pase Shifting Transformer (PST) 75MVA at Gamebird on line to Sandy/Amargosa to limit post-contingency flows through transformer.
- Pahrump-Vista 138kV line overload could be mitigated by installing 138kV PST (75MVA) at Gamebird on line to Sandy/Amargosa to limit post-contingency flows through transformer.
- Pahrump-Gamebird 138kV line overload could be mitigated by reconductoring using ACCR conductor.

Impacts on the SCE system:
Categorey B and C contingencies were simulated on the SCE 500kV and 230kV facilities located in the East-of-Pisgah (EOP) area on the on-peak and off-peak cases with the VEA 230kV line reconductoring model. These studies indicated that the QCA projects interconnection with the VEA system had no impacts on the SCE system in the EOP area.

Impacts on other systems:
New overloads were found on certain Nevada Energy 138kV lines between VEA's Lathrop Wells Substation and Nevada Energy's Northwest Substation for the Category B and C outages involving the Crazy Eyes Tap-Bob Tap 230kV line. These overloads could be mitigated by the proposed application of SPS for these outages. The simulation of Category B and C outages on the NVE and WAPA systems did not indicate that the interconnection of the QCA generation with the VEA system had any negative impacts on the NVE and WAPA system.

Dynamic Stability Study results:

Dynamic stability analyses were conducted on both the QCA peak and off-peak base cases with the above noted upgrades modeled to ensure that the transmission system remains stable with the addition of QCA projects. These analyses assessed the impacts of the outages of VEA system, SCE system and other systems. The disturbance simulations were performed for a study period of 10 seconds and monitored bus voltages and frequencies at several buses of the VEA, SCE and NV energy systems. The study monitored the generator angles of the QCA and the adjacent generator units of the Southern Nevada. These simulations indicated that, with the addition of QCA projects and the identified upgrades in place there are no Dynamic instability problems for the selected outages of VEA, SCE or NV energy systems.

Transient and Post Transient Stability Analysis:

NERC/WECC planning standards require that the system maintain post-transient voltage stability when either critical path transfers or area loads increase by 5 percent for category ”B” contingencies, and 2.5 percent for category ”C” contingencies. Transient stability analysis was conducted using both the peak and off-peak full loop base cases to ensure that the transmission system remains stable with the addition of QCA generation projects. Transient stability simulations also indicated that there are some stability issues such as low bus voltages and frequencies or excessive angular changes at the QCA projects on the VEA system without the application of the SPS. These stability problems could be mitigated by the proposed SPS.

Reactive Power Deficiency Analysis:

The power flow base cases are built assuming that dynamic reactive power support will be available for all the cluster 4 projects. With this assumption, there were no reactive power deficiencies identified with the addition of the QCA projects in the EOP area.

Short Circuit Study results:

Short circuit studies were performed on VEA system to determine the fault duty impact of adding the QCA projects to the transmission system and to ensure system coordination. The fault duties were calculated with and without the projects to identify any equipment overstress conditions. Once overstressed circuit breakers are identified, the fault current contribution from each individual project in QCA is determined. All bus locations where the QCA projects increase the short circuit duty by 0.1kA or more and where duty is in excess of 60% of the minimum breaker nameplate rating are listed in Table 7. The information summarized in Table 7 regarding the estimated fault currents at the VEA busses indicates that the only significant differences between the pre-QCA and post-QCA fault levels are at the proposed Bob Tap and Crazy Eyes Tap substations and the equipments at these substations can be sized to accommodate the estimated fault currents.

With respect to the information for the three SCE busses summarized in Table 7 pre- and post-studies indicates that the interconnection of the QCA projects with the VEA system would result in a 5% increase in the fault currents at existing Eldorado 220kV bus. Therefore breaker ratings and other relevant protection equipments should be further evaluated in the existing Eldorado 220kV substation.

COMPLIANCE WITH LORS

The QCA study indicates that the project interconnection would comply with NERC/WECC planning standards and California ISO reliability criteria. The applicant will design and build the proposed 230-kV overhead transmission lines.

Staff concludes that assuming the proposed conditions of certification are met; the project would likely meet the requirements and standards of all applicable LORS.

RESPONSE TO AGENCY AND PUBLIC COMMENTS

Please see **Appendix 1** for Preliminary Staff Assessment (PSA) Response to Comments – TSE.

CONCLUSIONS AND RECOMMENDATIONS

- HHSEGS project should design and construct with adequate reactive power resources to compensate the consumption of Var by the generator step-up transformers, distribution feeders and generator tie-lines.
- The identified new SPS should be implemented to curtail the generation of the QCA projects to mitigate the overload criteria violations caused by the projects on Valley Electric Association system.
- The identified conceptual interconnection facilities, Reliability network upgrades and Delivery network upgrades are necessary to safely and reliably interconnect the QCA projects.

CONDITIONS OF CERTIFICATION FOR TSE

TSE-1 The project owner shall furnish to 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 Energy Commission staff, the project owner shall provide designated packages to 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 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 and CBO approval. The project owner shall provide schedule updates in the Monthly Compliance Report.

TRANSMISSION SYSTEM ENGINEERING Table 1
Major Equipment List

Breakers
Step-Up Transformer
Switchyard
Busses
Surge Arrestors
Disconnects
Take Off Facilities
Electrical Control Building
Switchyard Control Building
Transmission Pole/Tower
Grounding System

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.

<u>Protocol:</u> 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.

<u>Protocol:</u> 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 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.

<u>Protocol:</u> 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.

<u>Verification:</u> 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 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 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, 2010, 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.

<u>Verification:</u> The project owner shall submit a copy of the CBO's approval or disapproval of any corrective action taken to resolve a discrepancy to the CPM within 15 days of receipt. If disapproved, the project owner shall advise the CPM, within five days, the reason for disapproval, and the revised corrective action required obtaining the CBO's approval.

TSE-4 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.

<u>Verification:</u> 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 the CPM a copy of the transmittal letter in the next Monthly Compliance Report.

TSE-5 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 HHSEGS project will be interconnected to the VEA grid via a 220-kV, 795 kcmil per phase, and approximately 10 miles long single circuit (generator- tie line). The proposed HHSEGS switching station would construct with six 230kV breakers, breaker- and- a- half configuration with 3- bays and 4 positions. 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.

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

3. 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.

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

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

6. The project owner shall provide to 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.

<u>Verification:</u> 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,”[1] 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

[1] Worst-case conditions for the foundations would include for instance, a dead-end or angle pole.

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** 1) through 5) above.

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 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 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 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 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 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 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 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

California ISO (California Independent System Operator). 1998a. Cal-ISO Tariff Scheduling Protocol. Posted April 1998, Amendments 1,4,5,6, and 7 incorporated.

California ISO (California Independent System Operator). 1998b. Cal-ISO Dispatch Protocol. Posted April 1998.

California ISO (California Independent System Operator). 2002a. Cal-ISO Grid Planning Standards. February 2002.

HHSEGS (Hidden Hills Solar Electric Generating Station System-Q714). 2012a. Brightsource Energy, Inc., Hidden Hills Ranch (Queue Cluster 4 Phase One Interconnection Study Report) submitted to the California Energy Commission.

HHSEGS (Hidden Hills Solar Electric Generating Station System). 2012b. Brightsource Energy, Inc., Hidden Hills Ranch (Queue Cluster 4 phase One Draft Report) submitted to the California Energy Commission.

HHSEGS (Hidden Hills Solar Electric Generating Station System). 2012b. Brightsource Energy, Inc., Hidden Hills Ranch (Queue Cluster Alpha phase One Interconnection Study Report) submitted to the California Energy Commission.

HHSEGS (Hidden Hills Solar Electric Generating Station System). 2012c. Brightsource Energy,Inc., Hidden Hills Ranch Application for Certification. Submitted to the California Energy Commission.

NERC/WECC (North American Reliability Council/Western Electricity Coordinating Council). 2002. NERC/WECC Planning Standards. August 2002.

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.

Megavolt 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.

TRANSMISSION SYSTEM ENGINEERING

List of Comment Letters

		TSE Comments?
1	Inyo County	
2	Bureau of Land Management	
3	National Park Service	
4	The Nature Conservancy	
5	Amargosa Conservancy	
6	Basin & Range Watch	
7	Pahrump Paiute Tribe	
8	Richard Arnold, Pahrump Piahute Tribe	
9	Big Pine Tribe of Owens Valley	
10	Intervenor Cindy MacDonald	X
11	Intervenor Center for Biological Diversity	
12	Intervenor, Old Spanish Trail Association	
13	Applicant, BrightSource Energy, Inc.	X

Comment #	DATE	COMMENT TOPIC	RESPONSE
10	**July 21, 2012**	**Intervenor Cindy MacDonald**	
10.1	**p. 16-2 #1**	Determine the project switchyard location on-site or off-site	On-site
10.2	**p. 16-2 #2**	Not applicable	
10.3	**p. 16-2 #1**	feasibility of a construction traffic route to be utilized as transmission route after the construction work completed.	TSE staff does not determine the transmission route of the project. It can be utilized as a transmission route, if proper Right Way (R/W), G.O. 95 and 128 standards are satisfied.
10.4	**p. 16-2 #2**	Would utilizing the alternative route reduce or prevent adverse impacts to the vegitable, wildlife and critical habitat resources.	TSE staff does not evaluate the environmental impacts.

Comment #	DATE	COMMENT TOPIC	RESPONSE
13	July 23, 2012	Applicant, BrightSource Energy	
13.1	p. 259 #1	State the correct name of the project.	Agree to use the project name as "Hidden Hills Solar Electric Generating System (HHSEGS)"
13.2	p. 259 #2	Find the attached Valley Electric Associated Queue Cluster Alpha Phase One Study.	The applicant submitted Phase One Interconnection Study Report on July 23, 2012
13.3	p. 259 #3	Modify the project description passage	Agree to modify the paragraph to a certain extent.
13.4	p. 260 #4	Correct the conductor size of the Generator tie line.	Agree to use the correct conductor size as 795 kcmil "Drake" ACSR ,conductor per phase.
13.5	p. 260 #5	Include the modified Generator tie line route.	The new proposed generator tie line route which interconnect the Crazy Eyes tap 230kV substation will be included into the **Final Staff Assessmen**t.