Item F:

The forecasted impact of the proposed project on **service reliability performance**, using electric service reliability metrics where applicable.

Response to Item F:

1.0 Executive Summary

SCE interprets this data request as inquiring about the service reliability performance of the proposed Alberhill System Project (ASP)[1].

The proposed ASP was designed to mitigate the transformer capacity shortfall currently anticipated to occur in the Valley South System as early as 2022, while also addressing the long-standing need for system tie-lines to improve reliability and resiliency by providing the ability to transfer load to adjacent systems for maintenance and other activities (planned outages), and under abnormal system operating conditions (unplanned outages). To evaluate the impact of the proposed project on service reliability performance, the response to this data request uses forward-looking service reliability performance metrics, related to customers and energy at risk due to service interruption, to demonstrate that the ASP meets the identified project needs for capacity, reliability, and resiliency over both short-term (10 year) and long-term (30 year) horizons. These metrics demonstrate that the ASP reduces the customer risk of loss of service due to outages related to capacity, reliability, and resiliency issues by 97% through 2028, and by 96% through 2048[2]. These reductions sufficiently improve system performance to comply with SCE's planning standards[3] through 2038, with only one line reconductoring project needed to satisfy these criteria through 2048.

2.0 Introduction

As discussed throughout the ASP Certificate of Convenience and Necessity (CPCN) proceeding (A.09-09-022) and specifically highlighted in an earlier supplemental data request response[4], the reliability issues in the Valley South System are associated with a combination of characteristics related to its limited capacity[5] margin, configuration, and size that make the Valley South

[1] Service reliability results for alternatives to the Alberhill System Project, which were studied in the cost benefit analysis described in DATA REQUEST SET ED-Alberhill-SCE-JWS-4 Item C, can be found in Quanta Technology Report, *Benefit Cost Analysis of Alternatives.*

[2] These percentages capture the projected cumulative percent reduction in unserved customer energy needs for various line and transformer outage contingency conditions (through 2028 and 2048 respectively) that are achieved as a result of ASP being in service.

[3] See Southern California Edison Subtransmission Planning Criteria and Guidelines, September 24, 2015.

[4] See DATA REQUEST SET ED-Alberhill-SCE-JWS-2 Item B.

[5] *"Capacity"* is defined as the availability of electric power to serve load and is primarily comprised of two elements in a *radial transmission system*; a lack of capacity of either type will lead to reliability challenges in a radial subtransmission system: (1) "*transformation capacity"* – the ability to deliver power from the transmission system (through substation transformers); and (2) "*subtransmission system line capacity"* – the ability to deliver power to substations which directly serve the customer load in an area. Subtransmission system line capacity also includes "*system tie-line capacity*," which is the ability to transfer load to an adjacent subtransmission system to avoid, and reduce the number of customer's affected by, planned and unplanned outages in the system. Note, a *radial subtransmission system* is one that is provided power from a single source on the transmission system. This is in contrast to a networked system which has multiple transmission and subtransmission source connections. Almost all of SCE's subtransmission systems are of a radial design.

subtransmission system[6] much more vulnerable to future reliability[7] problems than any other Southern California Edison (SCE) subtransmission system. Specifically, in its current status, the Valley South System operates at or very close to its maximum operating limits, has no connections (system tie-lines) to other systems, and represents the largest concentration of customers on a single substation in SCE's entire system. These characteristics threaten the future ability of the Valley South System to serve load under normal and abnormal conditions.

Also discussed in this proceeding, in the case of a catastrophic event (such as a major fire, earthquake, or incident at Valley Substation), SCE's ability to maintain service or to restore power in the event of an outage is significantly limited by the concentration of source power in a single location at Valley Substation[8]. This characteristic, in combination with others described in this submittal, results in specific concerns for the Valley South System from a resiliency[9] perspective.

In an earlier supplemental data request response[10], SCE provided an analysis of several years of electric reliability performance for the Valley Systems to demonstrate existing customer service metrics. SCE provided data for Valley South (and Valley North) historical reliability metrics (SAIDI and SAIFI) compared to other SCE subtransmission systems. These data show that, to date, the capacity of the Valley South System has been sufficient to serve all system customers under commonly planned for normal and extreme weather conditions. SCE noted that while SAIDI and SAIFI data are the principal metrics used to report on historical system reliability, they are primarily influenced by events at the distribution system level and thus are less informative for planning at the subtransmission system level. This is because when an electric power system has sufficient substation transformer capacity and/or sufficient system tie-line capacity, and is properly maintained and operated, reliability performance is driven largely by random, distribution-level events. Importantly, as SCE stated, the past reliability performance of the Valley Systems is not a driver for the proposed ASP project.

Given the limited remaining transformer capacity serving the Valley South System and its lack of system tie-lines, the future reliability performance of the Valley South System will be driven less by random, distribution level events, and more by subtransmission level events that cannot be mitigated due to the lack of capacity margin and/or system tie-lines. These events would otherwise be mitigated by operational flexibility enabled by available transformer and system tie-line capacity to allow for

---

[6] While Southern California Edison typically considers a planning area to be at the substation level, for the purpose of this data request, the discussion herein focuses on the Valley South System, as it is most relevant to the Alberhill System Project proceedings. Certain characteristics discussed here may have broader impacts (on the Valley North System specifically, given the split nature of these systems), but the focus of this response remains on the Valley South System.

[7] "*Reliability*" is defined as a utility's ability to meet service requirements under normal and N-1 contingency conditions, both on a short-term and long-term basis. The ability to meet long-term capacity needs of a given system is an important aspect of reliability. This definition is consistent with IEEE 1366*, "IEEE Guide for Electric Power Distribution Reliability Indices"* which excludes extraordinary events from reliability data reporting.

[8] The source of power to the Valley South System passes through a single point of delivery at Valley Substation, which is connected to the CAISO-controlled Bulk Electric System at the 500 kV voltage level.

[9] "*Resiliency"* is defined as how well a utility anticipates, prepares for, mitigates, and recovers from effects of extraordinary events (such as wildfires, earthquakes, cyberattacks, and other potential high impact, low probability (HILP) events) which can have widespread impact on its ability to serve customers. This definition is consistent with IEEE PES-TR65 "*The Definition of Quantification of Resilience*" (April 2018).

[10] See DATA REQUEST SET ED-Alberhill-SCE-JWS-2 Item D.

short-term line and transformer overloads (per standards) to be addressed through the transfer of distribution substations to an adjacent system. This data request response evaluates the Valley South System with and without the ASP and compares the reliability performance of the two system configurations using a set of *forward-looking* reliability and resiliency metrics related directly to SCE's ability to serve customer load throughout this specific electrical needs area. The analysis presented herein was developed and implemented collaboratively between SCE and a contractor, Quanta Technology[11], and documented in the attached report by Quanta Technology (see Appendix A).

3.0 Methodology

In order to compare the impact of the ASP to the current Valley South System configuration[12] on a technical basis, a time-series power flow analysis was performed using the GE-PSLF (Positive Sequence Load Flow) analysis software. PSLF is commonly used by power system engineers throughout the utility power systems industry, including many of the California utilities and the CAISO, to simulate electrical power transmission networks and evaluate system performance.

Models for the existing Valley South System and the proposed ASP[13], were developed in the PSLF software tool. An 8,760-hour load profile was used to simulate the annual forecasted load and power flows in each of the models, and identified thermal overload and voltage violations based on the following analysis criteria, which are consistent with SCE standards[14].

- No potential for N-0 transformer overloads in the system.
- Voltage remains within 95%-105% of nominal system voltage under N-0 and N-1 operating configurations.
- Voltage deviations remain within established limits of +/-5% post contingency.
- Thermal limits (i.e., ampacity) of conductors are maintained for N-0 and N-1 conditions.

For each hour analyzed, the model determines how much, if any, load is required to be transferred to an adjacent system (if system tie-line capacity is available) or dropped (if system tie-line capacity is not available) to maintain the system within the specified operating limits. The dropped (or unserved) load is summed over the 8,760 hours of the simulation for each year, for base (N-0) and (N-1, N-1-1, or N-2) contingencies[15]. The calculated unserved load is then used to calculate the specific metrics

---

[11] Quanta Technology is an expertise-based, independent technical consulting and advisory services company specializing in the electric power and energy industries.

[12] For purposes of this comparison, the current configuration of the Valley South System includes the Valley-Ivyglen 115 kV Line Project (VIG) and the Valley South 115 kV Subtransmission Line Project (VSSP), both of which are in construction and anticipated to be completed in 2022 and 2021 respectively. See Valley-Ivyglen project CPUC Decision 18-08-026 (issued August 31, 2018) and Valley South 115 kV Subtransmission Project ("VSSP") CPUC Decision 16-12-001 (issued December 1, 2016).

[13] The ASP PSLF model includes both the new Alberhill System, and the Valley South System with the required modifications to implement the ASP. This allows the PSLF model to evaluate the performance of the entire Valley South System Electrical Needs Area with and without the ASP.

[14] See Southern California Edison Subtransmission Planning Criteria and Guidelines, September 24, 2015.

[15] N-0 refers to operating conditions when all facilities are in-service. N-1 refers to operating conditions when a single subtransmission system component is out-of-service. N-1-1 refers to operating conditions when there is an N-1 contingency followed by a second subsequent N-1 contingency. N-2 refers to operating conditions when two subtransmission system components are simultaneously out-of-service.

described below. Results for both 10-year and 30-year horizons[16] are presented in this response to assess both near-term and long-term reliability impacts of the proposed ASP.

4.0 Definition of Metrics

The performance of each system configuration was evaluated using the following reliability and resiliency metrics:

- Expected Energy Not Served (EENS)
  - Quantified by the number of megawatt-hours (MWh) at risk during thermal overload and voltage violation periods.
  - Calculated for N-0 and all possible N-1 contingencies.
  - For N-1 contingencies, credits the available system tie-line capacity that can be used to reduce EENS.
- Maximum Interrupted Power (IP)
  - Maximum power to be curtailed during thermal overload and voltage violation periods.
  - Calculated for N-0 and N-1 contingencies.
- SAIDI (System Average Interruption Duration Index)
  - Sum of total customers interrupted per outage x number of outage hours / total number of customers served.
  - Calculated for N-0 and N-1 contingencies.
- SAIFI (System Average Interruption Frequency Index)
  - Sum of total customers interrupted due to outage / total number of customers served.
  - Calculated for N-0 and N-1 contingencies.
- CAIDI (Customer Average Interruption Duration Index)
  - SAIDI / SAIFI.
  - Calculated for N-0 and N-1 contingencies.
- Flexibility 1 (Flex-1)
  - Accumulation of EENS for all possible combinations of N-1-1 (or N-2) contingencies related to line outages.
  - Credits the available system tie-line capacity that can be used to reduce EENS.
  - Results for each N-1-1 contingency simulation are probabilistically weighted to reflect the actual frequency of occurrence of N-1-1 contingencies.
- Flexibility 2 (Flex-2)
  - Flex-2-1
    - Amount of EENS in the Valley South System under a complete Valley Substation outage condition (loss of all transformers at Valley Substation) due to a high impact, low probability event.
    - EENS accumulated over a two-week period around the peak summer day in the service area of the Valley South System.
    - Credits the available system tie-line capacity that can be used to reduce EENS.

[16] These horizons correspond to the 10-year and 30-year load forecasts which project future load in the Valley South System in 2028 and 2048, respectively. See DATA REQUEST SET ED-Alberhill-SCE-JWS-4 Item A for the 10-year forecast, and DATA REQUEST SET ED-Alberhill-SCE-JWS-4 Item C for the 30-year load forecast.

  - Flex-2-2
    - Amount of EENS under a scenario in which one Valley South System transformer is out-of-service without an available spare (for example, if the existing on-site spare is serving the Valley North System), leaving only one transformer available to serve load in the Valley South System.
    - Observe 1 hour (Short-Term Emergency Load Limit) of 896 megavolt-amperes (MVA)[17] (160% of the 560 MVA transformer nameplate rating). Following this, 24-hour rating (Long-Term Emergency Loading Limit) rating of 672 MVA (120%).
    - EENS accumulated over 8,760 hours.
    - Credits the available system tie-line capacity that can be used to reduce EENS.
- Period of Flexibility Deficit (PFD)
  - Maximum number of hours when the available flexibility capacity offered by system tie-lines was less than the required, resulting in EENS.
  - Calculated for N-0 and N-1 contingencies.

Note that these metrics represent future projections of system performance, and the results of each system configuration should be reviewed relative to the other.

5.0 Results

The attached Quanta Technology report demonstrates that the ASP provides substantial benefit relative to the current Valley South System configuration. The study compares the performance of the Valley South System in its current configuration to the performance of the system after implementing the ASP using forward-looking, quantitative, and customer-benefit driven metrics. Table 1 shows the results for each of the metrics described above for the years 2028 and 2048[18] with and without the ASP and demonstrates the positive impact the ASP has on service reliability performance.

[17] For simplicity, within this document it is assumed that MW = MVA.
[18] These dates represent the end of the 10 year and 30 year horizon starting in 2018, respectively, which are consistent with the load forecast addressed in other data responses. See DATA REQUEST SET ED-Alberhill-SCE-JWS-4 Item A and DATA REQUEST SET ED-Alberhill-SCE-JWS-4 Item G.

Table 1. Service Reliability Performance of the Valley South System with and without the ASP, 2028 and 2048

Metric	Unit	2028		2048	
		Without ASP	With ASP	Without ASP	With ASP
EENS N-0	MWh	250	0	6,310	3[19]
EENS N-1	MWh	67	0	2,823	202
Flex-1	MWh	16,219	0	52,128	0
Flex-2-1	MWh	201,538	9,814	234,771	19,302
Flex-2-2	MWh	74,821	0	159,823	138
IP N-0	MW	65	0	288	2
IP N-1	MW	11	0	68	24
SAIDI N-0	Minutes	112.2	0	31024	1.2
SAIDI N-1	Minutes	43.8	0	15233	543.6
SAIFI N-0	Customer Interruptions / Year	0.27	0	6.72	0.01
SAIFI N-1	Customer Interruptions / Year	0.05	0	2.53	0.51
CAIDI N-0	Minutes	420	0	4620	120
CAIDI N-1	Minutes	810	0	6010	1058.4
PFD N-0	Hours	7	0	77	2
PFD N-1	Hours	32	0	153	14

While the ASP results in substantial improvement in all metrics, the most significant from the perspective of customer impact are the metrics that directly address potential dropped load due to capacity, reliability, and resiliency concerns (i.e., EENS N-0, EENS N-1, Flex-1, Flex-2-1 and Flex-2-2 calculated in units of potential lost MW-hours of service). Table 2 provides comparative results of the cumulative dropped load from the EENS N-0, EENS N-1, Flex-1, Flex-2-1 and Flex-2-2 metrics from 2022[20] through the years 2028 and 2048.

Table 2 – Total Cumulative Dropped Load with and without the ASP, 2028 and 2048

Metric Category	Metric	2022 - 2028			2022 - 2048		
		Without ASP (MWh)	With ASP (MWh)	*% Reduction*	Without ASP (MWh)	With ASP (MWh)	*% Reduction*
Capacity	EENS N-0	971	0	*100*	56,581	6	*99.9*
	EENS N-1	274	0	*100*	21,684	1,035	*95.2*
Reliability & Resiliency	Flex-1	75,826	0	*100*	777,347	0	*100*
	Flex-2-1	1,382,419	62,023	*95.5*	5,787,562	361,323	*93.8*
	Flex-2-2	466,803	0	*100*	2,873,360	584	*99.9*

Through 2048, the ASP effectively eliminates the capacity (99.9% reduction in EENS N-0) and reliability (100% reduction in Flex-1) concerns associated with line failures, and substantially mitigates the resiliency concerns associated with loss of transformers serving the Valley South System (93.8% and 99.9% reductions in Flex-2-1 and Flex-2-2, respectively).

[19] The 3 MWh of EENS N-0 in 2048 is caused by an overload on the Alberhill-Fogarty 115 kV Line (the line is first overloaded in 2046), which is correctable by reconductoring. At no time through 2048 are the ASP transformers overloaded under N-0 conditions.

[20] These metrics begin to accrue coincident with the project need year of 2022, and continue to the end of the 10-year horizon (2028) and the 30-year horizon (2048).

Other key highlights of the projected service reliability performance for the area served by the current Valley South System with ASP in service are as follows:

- The ASP eliminates transformer capacity shortfalls under N-0 conditions on the Valley South System transformers over the entire 30-year study horizon.
- The ASP eliminates subtransmission line capacity shortfalls under N-0 conditions until 2046, when the Alberhill-Fogarty 115 kV Line is forecasted to become overloaded.
- The ASP eliminates subtransmission line capacity shortfalls under N-1 conditions until 2038, when the Alberhill-Fogarty 115 kV Line is forecasted to become overloaded. Additional 115 kV lines are overloaded under N-1 conditions in 2043 (Alberhill-Skylark) and 2048 (Auld-Moraga #1). As such, requirements for system planning consistent with SCE's Subtransmission Planning Criteria and Guidelines are met until 2038. These shortfalls could be corrected by reconductoring each of the three lines to restore the subtransmission line loading to within capacity limits.
- The ASP creates system tie-line capacity which significantly improves the reliability and resiliency performance during N-1 and N-2 conditions in the area served by the current Valley South System. As demonstrated by the Flex-1 and Flex-2 metrics, the ASP provides the ability to transfer load between the Valley South System and the Alberhill System during these contingency conditions.

Important notes regarding the projected service reliability performance for the current Valley South System *without* any project in service include:

- The Valley South System transformers are projected to overload by year 2022.
- By 2028, over 250 MWh of EENS are observable in the system under N-0 conditions. This extends to 6,310 MWh by 2048 with no project in service.
- Between 2028 and 2048, the flexibility deficit duration in the system increases from 7 hours to 77 hours under N-0 conditions.

A Appendix: Quanta Reliability Analysis of Alberhill System Project

The Quanta Technology *Reliability Analysis of Alberhill System Project* is attached as Appendix A to this data submittal.