APPENDIX G: Description and Functional Specifications for Transmission Facilities Eligible for Competitive Solicitation

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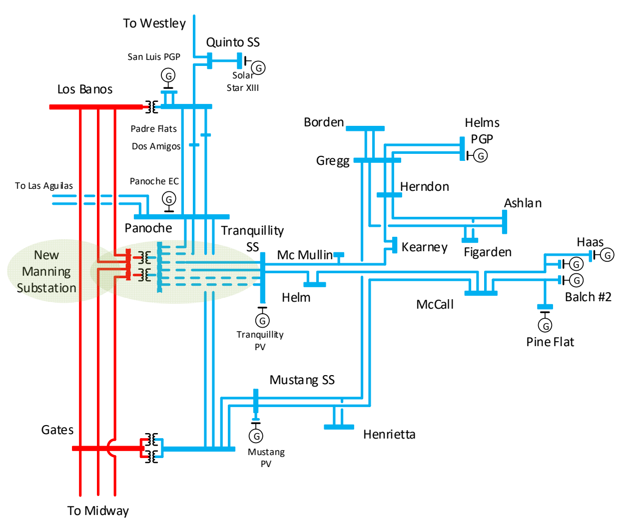
G.1 Description and Functional Specifications of Proposed Policy-Driven Manning 500/230 kV Substation Project

G1.1 Description

In the 2021-2022 Transmission Plan, the ISO has identified a policy-driven need for the Manning 500/230 kV substation project to address overloads on the Borden-Storey 230 kV lines under normal and N-1 contingency conditions. The project also provides benefit in allowing for the advancement of renewable generation within the Westlands / San Joaquin area. Figure G1.1. provides a schematic diagram of the transmission system in the area. As shown in the figure, the project scope includes the followings:

- A new Manning 500/230 kV substation
- 500/230 kV Transformers
- Two new 230 kV circuits between Manning and Tranquility substations
- Looping in the Los Banos – Midway #2 and the Los Banos – Gates #1 500 kV lines into Manning substation. Although this component is part of the overall scope of the project, because these are existing PG&E lines, this component will be assigned to PG&E. In post project configuration, series capacitors may need to be added/modified to ensure (a) no 500 kV line section is compensated above 70% to meet PG&E protection standards, and (b) the overall compensation on Los Banos - Gates and Los Banos – Midway paths will remain the same as the existing system at 55%. The project sponsor will install series capacitors on the Los Banos – Manning 500 kV lines at Manning substation, and PG&E will adjust the existing series capacitors on these lines to meet the above two requirements.
- Looping in two existing Panoche – Tranquility 230 kV line into Manning substation and reconductor the Manning – Tranquility 230 kV lines. Although this component is part of the overall scope of the project, because these are existing PG&E lines, this component will be assigned to PG&E.

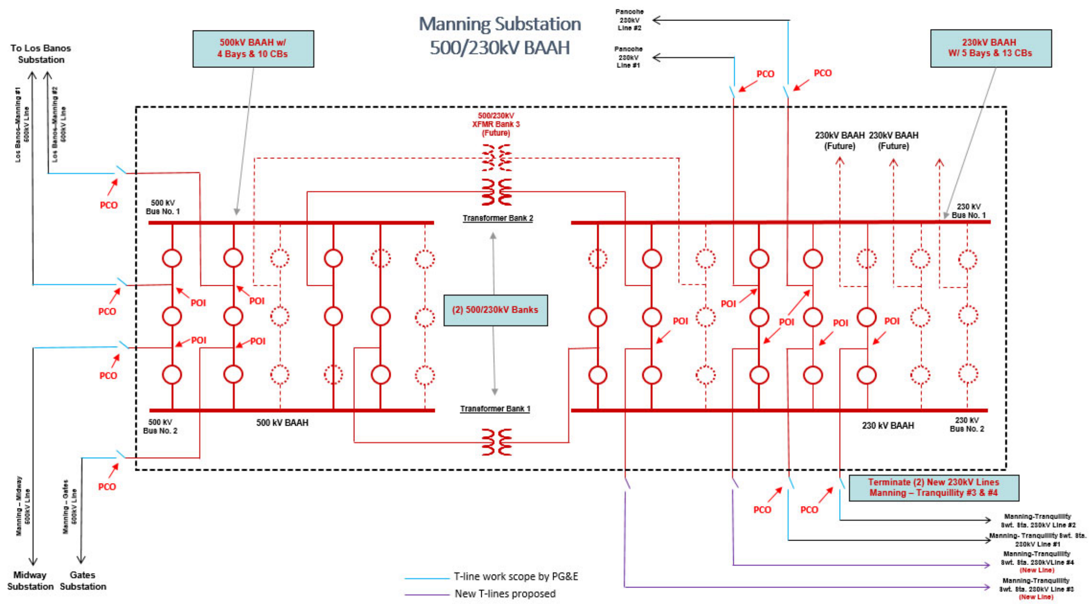
Figure G1-1: Location of Manning 500/230 kV Substation Project

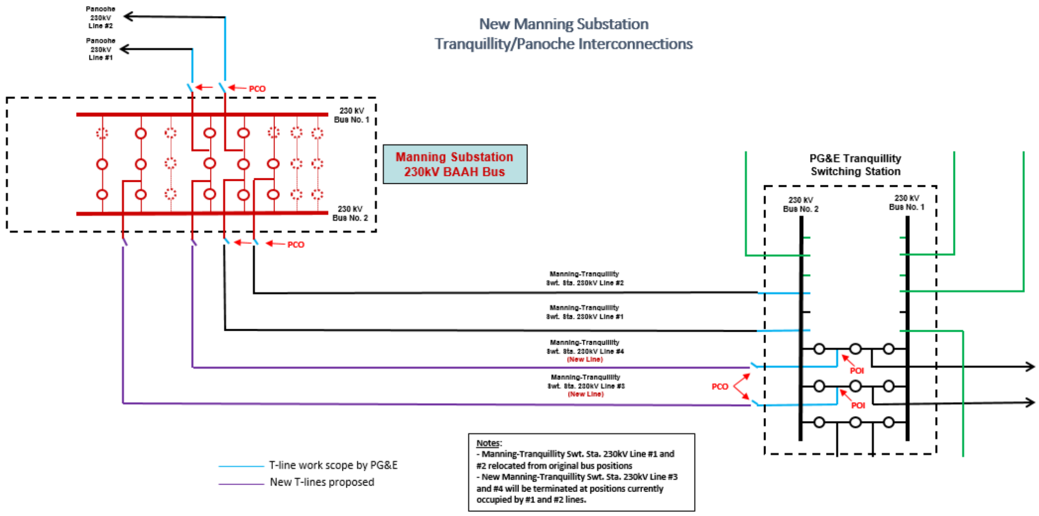


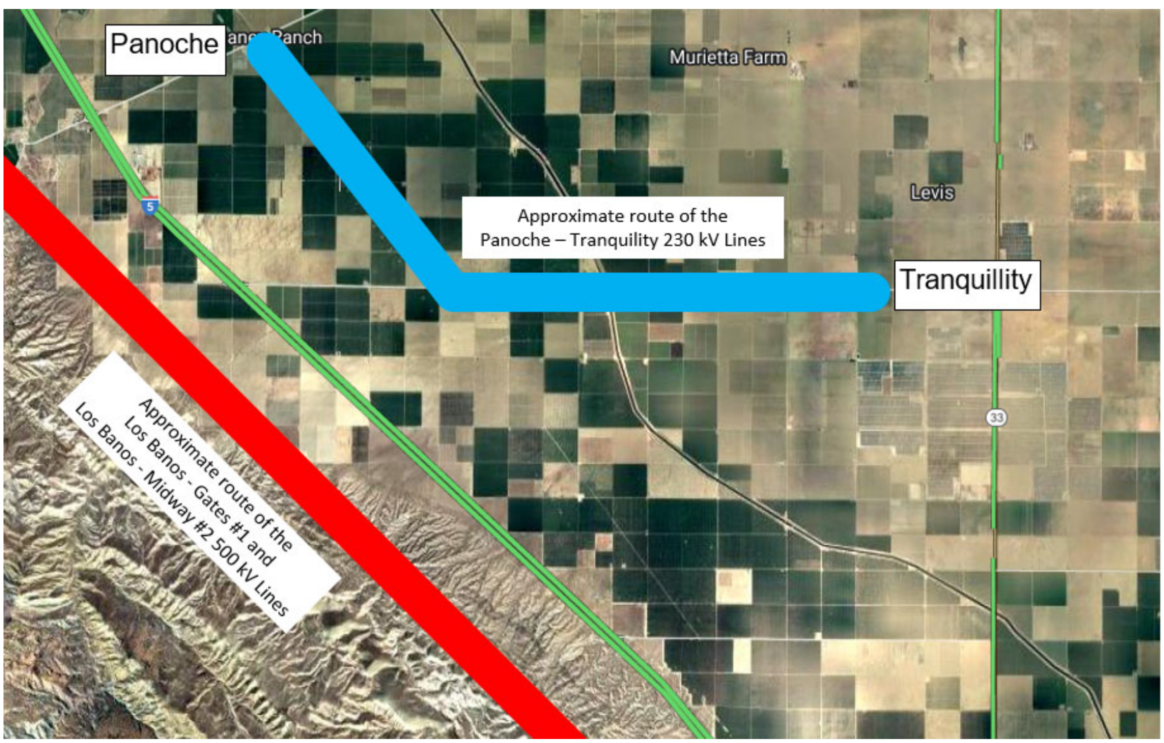
The ISO estimates that the proposed project – including both the competitive and directly assigned components --will approximately cost $325 to $485 million. The project must be in-service no later than June 1st 2028. Figure G1-2 provides a schematic diagram of the interconnection to Tranquility 230 kV substation and an approximate area for the location of the Manning substation.

To facilitate looping the existing Panoche – Tranquility 230 kV lines into Manning substation, the location of the Manning substation shall be on an approximately 10 mile stretch (5 miles north and south from approximately 36°36'17.6"N 120°35'08.9"W) along the Los Banos – Midway #2 and Los Banos – Gates #1 500 kV lines shown on the map below.

Figure G1-2: Interconnection to Manning 500/230 kV, Tranquility 230 kV Substation and Approximate Area for the Location of Manning Substation







The facilities in the Manning 500/230 kV Substation project that are eligible for competitive solicitation are the 500 kV and 230 kV bus-work and termination equipment, the 500/230 kV transformers, the interconnection of the existing 500 kV and 230 kV transmission lines, installation of 500 kV series capacitors and the new interconnections to Tranquility switching station.

For the interconnection of the existing Los Banos – Midway #2 and Los Banos – Gates #1 500 kV lines, the incumbent PTO (PG&E) will be responsible to bring the transmission line extensions up to a point within 100 feet of the new substation fence. The line extensions will terminate on a dead end structure(s), to be owned by PG&E. The approved project sponsor will be responsible (and will own and maintain) the facilities from this last dead end structure(s) into the Manning Substation. The cost estimate for PG&E's scope of work depends on the distance of the interconnection point to the existing 500 kV lines. The cost estimate for the line extensions is $5.0M per mile per circuit.

For the interconnection of the existing Panoche – Tranquility #1 and #2 230 kV lines, the incumbent PTO (PG&E) will be responsible to bring the transmission line extensions up to a point within 100 feet of the new substation fence. The new line extensions will terminate on a dead end structure(s), to be owned by PG&E. The approved project sponsor will be responsible (and will own and maintain) the facilities from this last dead end structure(s) into the Manning Substation. The cost estimate for PG&E's scope of work depends on the distance of the interconnection point to the existing 230 kV lines. The cost estimate for the line extensions is $4.0M per mile double circuit.

The reconductoring of the existing Panoche – Tranquility 230 kV lines and modifications to existing facilities are not eligible for competitive solicitation. The cost estimate for PG&E's scope of work depends on the distance of the interconnection point to the existing 230 kV lines. The cost estimate for the reconductor scope is $2.5M per mile.

For the adjustment of the existing series capacitors on the Los Banos – Midway #2 and Los Banos – Gates #1 500 kV lines, the incumbent PTO (PG&E) will be responsible to adjust the series capacitors to be in the range of 10-15 ohms depending on the location of the Manning substation. The approved project sponsor will be responsible for installing (and will owning and maintaining) 12 – 17 ohms series capacitors on the Los Banos – Manning lines.

For the interconnection of the new Manning – Tranquility 230 kV lines, the incumbent PTO (PG&E) will be responsible for installing the new transmission line segments from the Tranquility 230 kV bus up to a point within 100 feet of the Tranquility switching station property line. These new line segments will terminate on a dead end structure(s), to be owned by PG&E. The approved project sponsor will be responsible for (and will own and maintain) the facilities from this last dead end structure(s) into the Manning Substation.

The approved project sponsor, who will own the Manning substation, will be responsible for owning, operating, and maintaining the protection equipment located within the substation that is designated for the protection of the incoming transmission lines. The approved project sponsor will coordinate with PG&E for the specifications and the details of the associated line protection (e.g. current differential, directional comparison) etc. and will work with PG&E to develop relay logic and detailed relay settings.

As the project loops in the lines that are part of the WECC Path 15, the approved project sponsor will be responsible to complete the WECC path rating process and other processes required for this project.

G1.2 Functional Specification for Manning 500/230 kV Substation Project

Manning Substation:

Nominal Phase to Phase Operating Voltage: 500 kV and 230 kV. Typical Phase to Phase Operating Voltage: 535 kV & 230 kV

500 kV and 230 kV Initial Bus Configuration: Breaker and a half (BAAH)

500 kV and 230 kV Ultimate Bus Configuration: BAAH

Initial Number of 500 kV Lines: 4

Ultimate Number of 500 kV Lines: 8

Initial Number of 500 kV CBs: 10

Ultimate Number of 500 kV CBs: 18

Initial Number of 230 kV Lines: 6

Ultimate Number of 230 kV Lines: 10

Initial Number of 230 kV CBs: 13

Ultimate Number of 230 kV CBs: 24

Initial Minimum Bus Ampacity: ___4000A ___ Ultimate Bus Ampacity: ____4000A___

Minimum CB Ampacity: ____3000A ___ Minimum CB Interrupting Capability: ___63 kA__

Transfer Bus Required (SBSB only): N/A

Station Minimum BIL: 900 kV for 230 kV and 1,800 kV for 500 kV side

Minimum Bank Connection Bay Continuous Ampacity - Summer: 4000 Amps

Minimum Bank Connection Bay Continuous Ampacity – Winter: 4000 Amps

Initial Reactive Power Requirements: None

Ultimate Reactive Power Requirements: None

Telemetering Requirements: Install necessary equipment, including RTUs to monitor the typical bulk power elements such as MW, MVAr, and phase currents (Amps) at each line and also voltages (kV)[1] at lines and buses and all circuit breaker (CB) status/control, protection relays statuses and alarms. The installed equipment must be capable of transmitting information to the appropriate Control Center.

Protection Requirements: Meet incumbent PTO (PG&E) protection requirements including single pole tripping designs for all 500kV circuit breakers and RTDS testing of protection schemes. No transmission line shall be compensation over 70%. The approved project

[1] California ISO - Metering and telemetry (caiso.com)

sponsor owning the 500 kV station shall own the NERC requirements for any associated RAS and will become a “RAS-ENTITY”.

Latest In Service Date: June 1, 2028

Low Profile Required: Subject to local permitting requirements

Gas Insulation Required: No, but if proposed shall be enclosed

Initial Number of Transformers: Two 3–phase banks with an installed spare, single phase units are permissible with one single phase spare

Ultimate Number of Transformers: Three 3–phase banks with an installed spare, single phase units are permissible with one single phase spare

Transformer Nominal Low Winding Phase to Phase Voltage: 235 kV to match PG&E’s operation

Tertiary Winding Required: ___No____ Nominal Voltage Rating: __N/A______

Primary Voltage Winding (wye, grounded wye, delta, etc): Grounded Wye

Secondary Voltage Winding: Grounded Wye Tertiary Voltage Winding: Corner Grounded Delta

Maximum Transformer % IZ: ____ 17% ______ Minimum Transformer %IZ: ___ 13% ___

Minimum Transformer Normal Rating: ___ 1100 MVA ____ Minimum Transformer 4-hour Emergency Rating: ___ 1300 MVA _____ LTC Required: ___ No ______

No Load Taps Required: 5 NLTs with two 2.5% taps above & below nominal voltage of 235 kV

CIP 14 requirement: The substation perimeter shall be fenced by a solid wall

Series Compensation: 12 – 17 ohms depending of the location of the Manning Substation.

Minimum Series Capacitor Continuous Ampacity - Summer: 2700 A

Minimum Series Capacitor Continuous Ampacity – Winter: 4000 A

Minimum Series Capacitor 30 Minute Emergency Ampacity – Summer: 3600 A

Minimum Series Capacitor 30 Minute Emergency Ampacity – Winter: 4000 A

230 kV Transmission Line Functional Specifications - new Manning – Tranquility lines

Overhead Line Construction

Line Terminus 1: Manning Substation 230 kV Bus

Line Terminus 2: Tranquility Substation 230 kV Bus

Nominal Phase to Phase Voltage: 230 kV

Minimum Line Continuous Ampacity - Summer: 3000 Amps

Minimum Line Continuous Ampacity – Winter: 3000 Amps

Minimum Line 4 Hour Emergency Ampacity – Summer: 3000 Amps

Minimum Line 4 Hour Emergency Ampacity – Winter: 3000 Amps

Approximate Line Impedance: (0.00010 to 0.00014) + j(0.0009 to 0.0013) pu/mile (100 MVA base).

Approximate Line Length: TBD depending on the location of the Manning Substation

Latest In Service Date: June 1, 2028

Support Structures: Single or double circuit structures

Shield Wire Required: Optical ground wire (minimum 6 pairs of fibers)

Failure Containment Loading Mitigation (anti-cascade structures, etc.): Per applicable codes

Shield Wire Ground Fault Withstand Ampacity: Coordinate with interconnecting entities

Aeolian Vibration Control (Conductor and Shield Wire): Vibration dampers must be installed on all conductors and overhead shield wires, with the exception of slack spans.

Transmission Line Minimum BIL: 900 kV with solidly grounded systems

Minimum ROW Width: Per applicable codes

Governing Design and Construction Standards: (GO 95, NESC Code, applicable municipal codes)

Design Temperature: 50°C

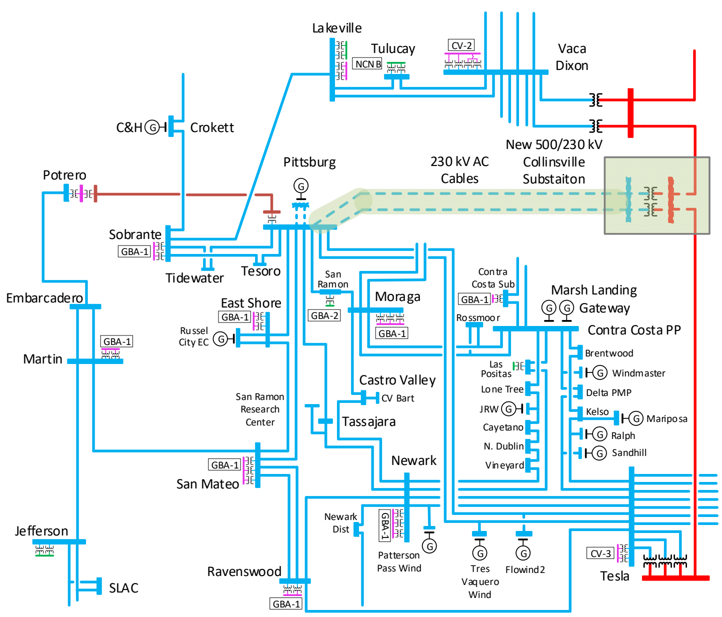
G.2 Description and Functional Specifications of Proposed Policy-Driven Collinsville 500/230 kV Substation Project

G2.1 Description

In the 2021-2022 Transmission Plan, the ISO has identified a policy-driven need for the Collinsville 500/230 kV substation project to address multiple overloads on the 230 kV corridor between Contra Costa and Newark under normal, N-1, and N-2 contingency conditions. This project provides an additional supply from the 500 kV system into the northern Greater Bay Area to increase reliability to the area and advance additional renewable generation in the northern area. Figure G2.1. provides a schematic diagram of the transmission system in the area. As shown in the figure, the project scope includes the followings

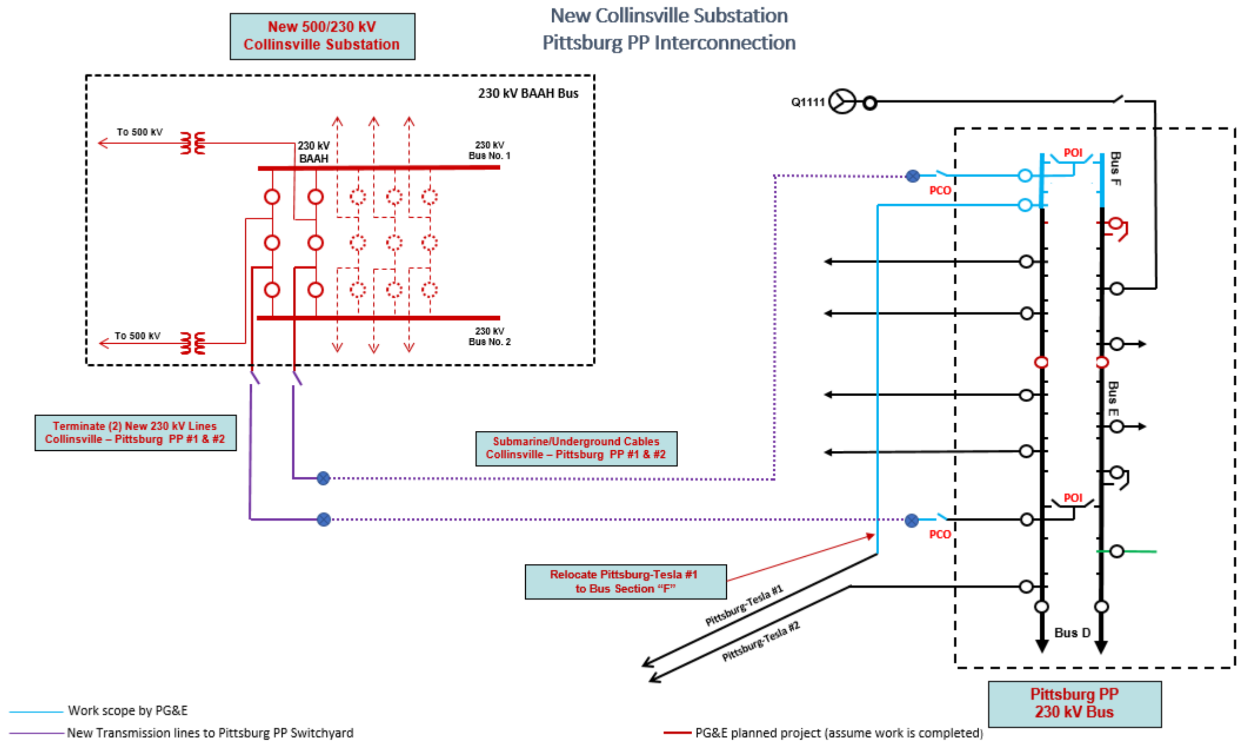
- A new Collinsville 500/230 kV substation
- Looping in the Vaca – Tesla 500 kV line into Collinsville substation. In post project configuration, series capacitors may need to be added/modified to ensure (a) no 500 kV line section is compensated above 75% to meet PG&E protection standards, and (b) the overall compensation on Vaca Dixon – Tesla path will remain the same as the existing system at 75%. The project sponsor will install series capacitors on the Collinsville – Tesla 500 kV lines at Collinsville substation, and PG&E will adjust the existing series capacitors at Vaca Dixon to meet the above two requirements. In addition, PG&E will also upgrade the terminal equipment that is currently limiting the line rating.
- 500/230 kV Transformers
- Two new 230 kV circuits from Collinsville to Pittsburg
- The Collinsville substation shall be configured to permit the installation of a 20 ohm series reactors on each 230 kV circuit in the future.

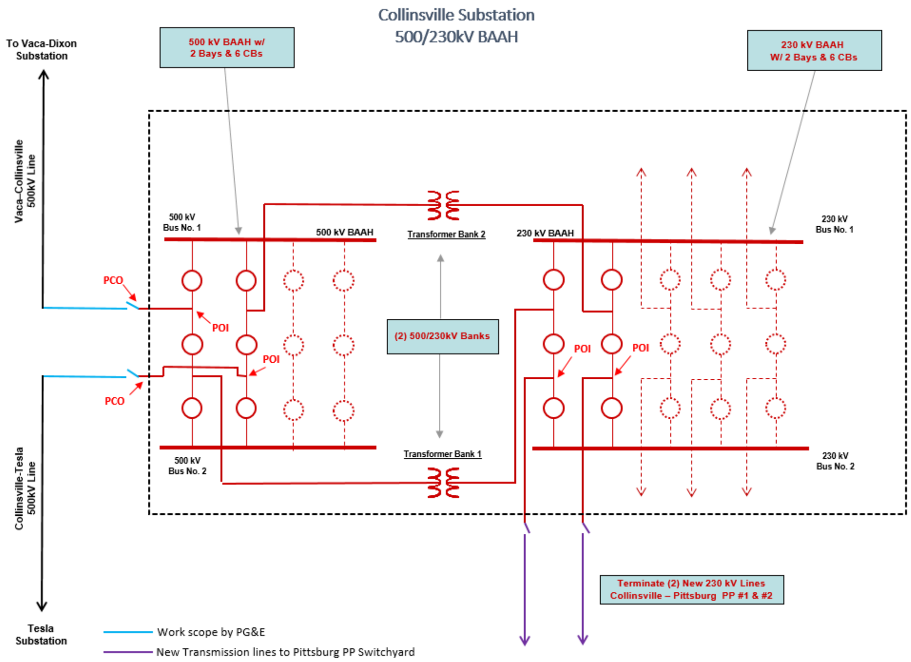
Figure G2-1: Location of Collinsville 500/230 kV Substation Project



The ISO estimates that the proposed project will approximately cost $475 to $675 million including both the competitive solicitation and directly assigned components. The project must be in-service no later than June 1st 2028. Figure G2-2 provides a schematic diagram of the Collinsville substation, interconnection to the Pittsburg 230 kV substation, and general area of the Collinsville substation.

Figure G2-2: Interconnection to Collinsville 500 kV and Pittsburg 230 kV Substation





The facilities in the Collinsville 500/230 kV Substation project that are eligible for competitive solicitation are the 500 kV and 230 kV bus-work and termination equipment, the 500/230 kV transformers at Collinsville Substation, the interconnection of the existing Vaca – Tesla 500 kV transmission line, the installation of 500 kV series capacitor on the Collinsville – Tesla transmission line, and the new 230 kV interconnections to Pittsburg Substation.

For the interconnection of the existing Vaca - Tesla 500 kV line, the incumbent PTO (PG&E) will be responsible for bringing the new transmission line extensions up to a point within 100 feet of the new substation fence. The new line extensions will terminate on a dead end structure(s), to be owned by PG&E. The approved project sponsor will be responsible for (and will own and maintain) the facilities from this last dead end structure(s) into the Collinsville Substation. The cost estimate for PG&E's scope of work depends on the distance of the interconnection point to the existing Vaca - Tesla 500 kV line. The cost estimate for the line extensions is $5.0M per mile per circuit.

For the interconnection of the new Collinsville – Pittsburg 230 kV lines, the incumbent PTO (PG&E) will be responsible for installing the new transmission line segments from the Pittsburg 230 kV bus up to a point within 100 feet of the Pittsburg substation property line. These new line segments will terminate on a dead end structure(s), to be owned by PG&E. The approved project sponsor will be responsible for (and will own and maintain) the facilities from this last dead end structure(s) back to the Collinsville Substation.

The approved project sponsor, who will own the Collinsville substation, will be responsible for owning, operating and maintaining the protection equipment located within the substation that is designated for the protection of the incoming transmission lines. The approved project sponsor will coordinate with PG&E regarding the specifications and the details of the associated line protection (*e.g.* current differential, directional comparison) etc. and will work with PG&E to develop relay logic and detailed relay settings.

For the adjustment of the existing series capacitors on the Vaca – Tesla 500 kV line, the incumbent PTO (PG&E) will be responsible for adjusting the series capacitors to be in the range of 10-12 ohms depending on the location of the Collinsville substation. The approved project sponsor will be responsible for installing (and will own and maintain) 15 – 17 ohms series capacitors on the Collinsville – Tesla line to be installed at Collinsville.

As the project includes building new transmission facility with voltage level over 200 kV, the approved project sponsor will be responsible for completing the WECC Progress Report and other processes required for this project.

G2.2 Functional Specification for Collinsville 500/230 kV Substation Project

Collinsville Substation

Nominal Phase to Phase Voltage: 500 kV and 230 kV. Typical Phase to Phase Operating Voltage: 535 kV & 230 kV

500 kV and 230 kV Initial Bus Configuration: Breaker and a half (BAAH)

500 kV and 230 kV Ultimate Bus Configuration: BAAH

Initial Number of 500 kV Lines: 2

Ultimate Number of 500 kV Lines: 6

Initial Number of 500 kV CBs: 6

Ultimate Number of 500 kV CBs: 12

Initial Number of 230 kV Lines: 2

Ultimate Number of 230 kV Lines: 6

Initial Number of 230 kV CBs: 6

Ultimate Number of 230 kV CBs: 15

Initial Minimum Bus Ampacity: ___4000A___ Ultimate Bus Ampacity: ____4000A___

Minimum CB Ampacity: ____3000A ___ Minimum CB Interrupting Capability: ___63 kA__

Transfer Bus Required (SBSB only): N/A

Station Minimum BIL: 900 kV for 230 kV and 1,800 kV for 500 kV side.

Initial Reactive Power Requirements: None

Ultimate Reactive Power Requirements: None

Telemetering Requirements: Install necessary equipment, including RTUs to monitor the typical bulk power elements such as MW, MVAr, and phase currents (Amps) at each line and also voltages (kV)[2] at lines and buses and all circuit breaker (CB) status/control, protection relays statuses and alarms. The installed equipment must be capable of transmitting information to the appropriate Control Center.

Latest In Service Date: June 1, 2028

Low Profile Required: Subject to local permitting requirements

Gas Insulation Required: No, but if proposed shall be enclosed

Initial Number of Transformers: Two 3–phase banks with an installed spare, single phase units are permissible with one single phase spare

[2] California ISO - Metering and telemetry (caiso.com)

Ultimate Number of Transformers: Two 3–phase banks with an installed spare, single phase units are permissible with one single phase spare

Transformer Nominal Low Winding Phase to Phase Voltage: 235 kV to match PG&E operation

Tertiary Winding Required: ___No____ Nominal Voltage Rating: __N/A______

Primary Voltage Winding (wye, grounded wye, delta, etc): Grounded Wye

Secondary Voltage Winding: Grounded Wye Tertiary Voltage Winding: Corner Grounded Delta

Maximum Transformer % IZ: ____ 19% ______ Minimum Transformer %IZ: ___ 15% ___

Minimum Transformer Normal Rating: ___ 1500 MVA ____ Minimum Transformer 4-hour Emergency Rating: ___ 1800 MVA _____ LTC Required: ___ No ______

No Load Taps Required: 5 NLTs with two 2.5% taps above & below nominal voltage of 235 kV

CIP 14 requirement: The substation perimeter shall be fenced by a solid wall

Minimum Series Capacitor Continuous Ampacity - Summer: 2700 A

Minimum Series Capacitor Continuous Ampacity – Winter: 3000 A

Minimum Series Capacitor 30 Minute Emergency Ampacity – Summer: 3600 A

Minimum Series Capacitor 30 Minute Emergency Ampacity – Winter: 4000 A

230 kV Transmission Line Functional Specifications - Collinsville – Pittsburg lines

Line Terminus 1: Collinsville 230 kV Bus

Line Terminus 2: Pittsburg Substation 230 kV Bus

Nominal Phase to Phase Voltage: 230 kV

Minimum Line Continuous Ampacity - Summer: 2100 Amps per circuit

Minimum Line Continuous Ampacity – Winter: 2100 Amps per circuit

Minimum Line 4 Hour Emergency Ampacity – Summer: 3500 Amps per circuit

Minimum Line 4 Hour Emergency Ampacity – Winter: 3500 Amps per circuit

Approximate Line Impedance: (0.000016 to 0.00002) + j(0.00026 to 0.00032) pu/mile (100 MVA base).

Approximate Line Length: TBD depending on the location of the Collinsville substation

Latest In Service Date: June 1, 2028

Transmission Line Minimum BIL: 900 kV with solidly grounded systems

Minimum ROW Width: Per applicable codes

Governing Design and Construction Standards: (GO 95, NESC Code, applicable municipal codes)

Overhead Line Construction Requirements

Support Structures: Single or double circuit structures

Shield Wire Required: Optical ground wire (minimum 6 pairs of fibers)

Failure Containment Loading Mitigation (anti-cascade structures, etc.): Per applicable codes

Shield Wire Ground Fault Withstand Ampacity: Coordinate with interconnecting entities

Aeolian Vibration Control (Conductor and Shield Wire): Vibration dampers must be installed on all conductors and overhead shield wires, with the exception of slack spans.

Underground / Submarine Line Construction Requirements

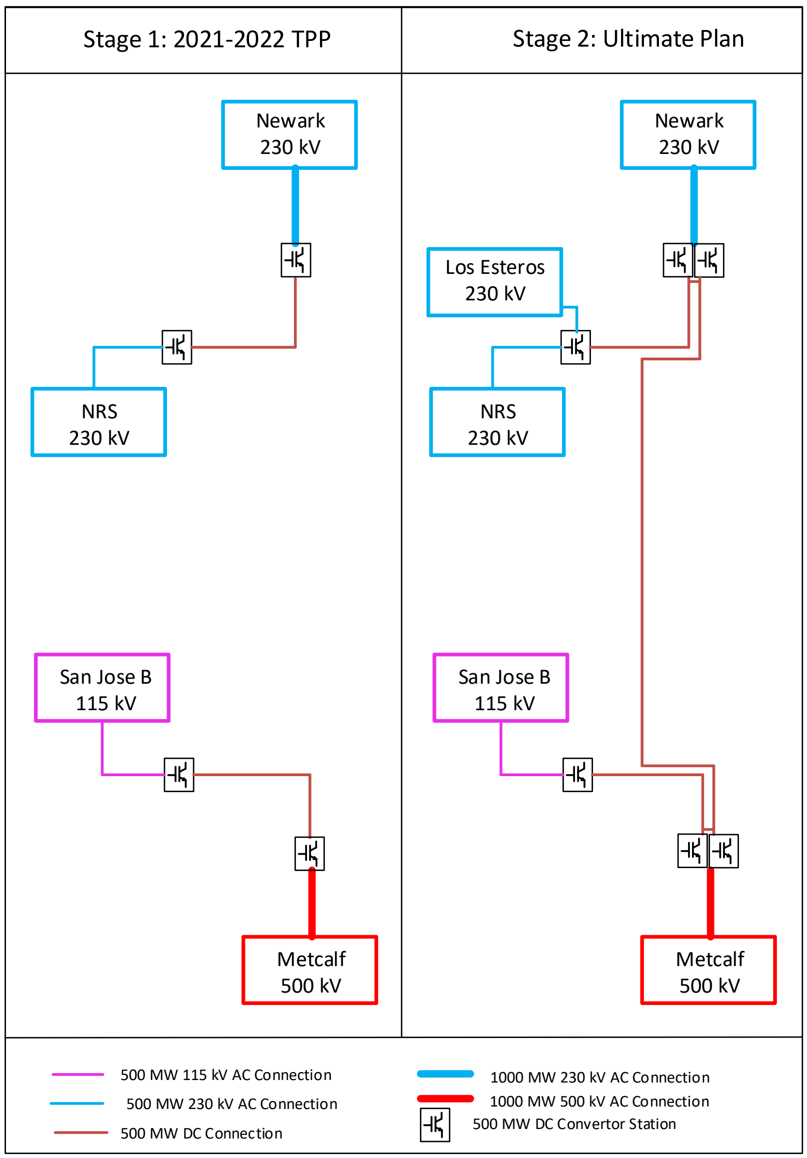
Duct Bank: With the exception of the submarine portion, the underground cable shall be located in a duct back with a minimum of one additional spare conduit per circuit.

Design Temperature: 40°C

G.3 San Jose Area HVDC Projects – Ultimate Plan

Figure G3-1 shows the ultimate HVDC development plan for the San Jose area and Stage 1 development. The ultimate plan includes a 4-terminal Voltage-Sourced Converter (VSC)-HVDC link. Two independent HVDC lines will be built in Stage 1 with the ultimate development plan to be implemented in future. In the ultimate development plan, a 230 kV connection between Los Esteros 230 kV station and the NRS converter station would be required. Although the initial capacity of the converter station connected to Newark 230 kV and Metcalf 500 kV will be 500 MW, sufficient land must be procured and be available at the converter station to expand the capacity to 1,000 MW in future for the implementation of the ultimate development plan.

Figure G3-1: Stage 1 and Ultimate HVDC Development Plan for San Jose Area

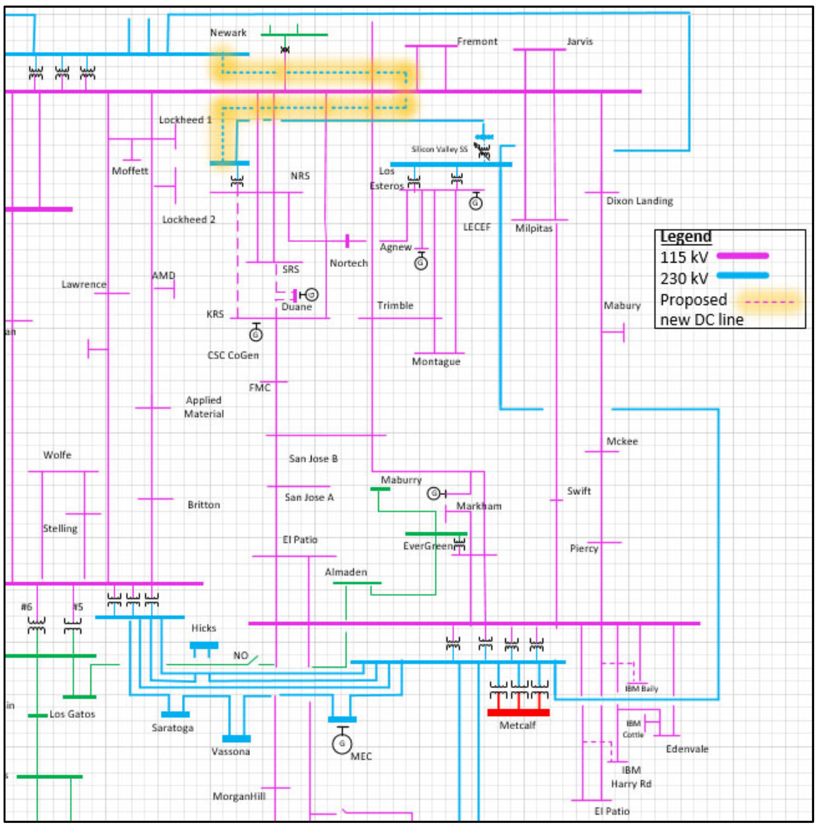


G3.1 Description and Functional Specifications of Proposed Reliability-Driven Newark – Northern Receiving Station HVDC Project

G3.1.1 Description

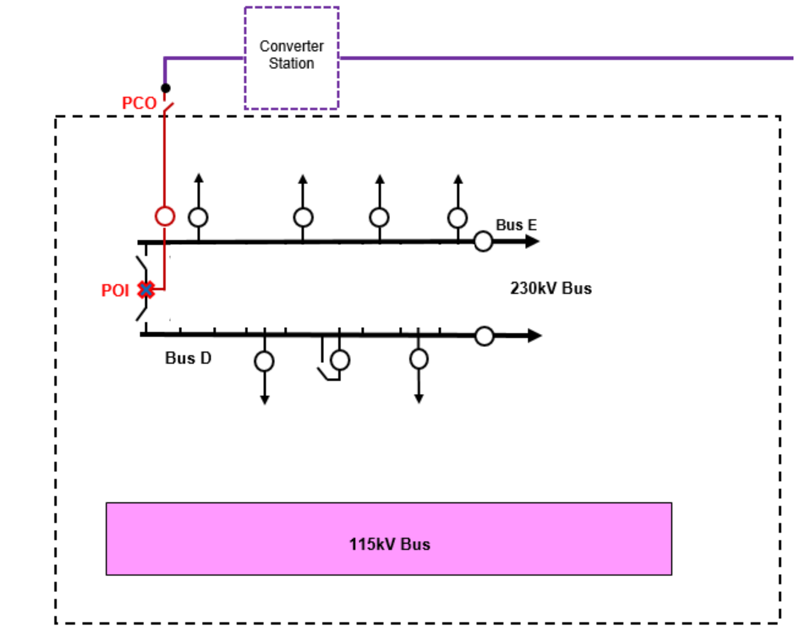
In the 2021-2022 Transmission Plan, the ISO has identified a reliability-driven need for a 500 MW VSC-HVDC project from Newark 230 kV to Northern Receiving Station (NRS) 230 kV substation to serve the load in the area. Figure G3.1. provides a schematic diagram of the transmission system in the area.

Figure G3-2: Location of Newark to NRS HVDC Project

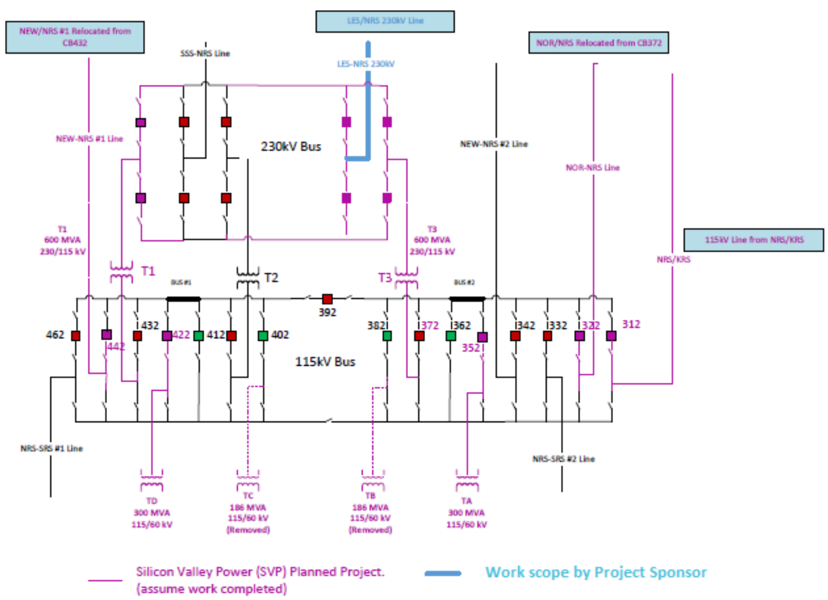


The VSC-HVDC link shall provide continuous flow on the complete range of the capability (unless the facility experienced a planned or forced outage). Subsynchronous Resonance (SSR), subsynchronous Tortional Interaction (SSTI), harmonics and other required studies to be completed and any identified mitigation shall be implemented as part of this project. Regardless of HVDC control characteristics and functions, in case of high potential SSTI risk, additional mitigation measures may be required for redundancy in addition to the control characteristics intended to avoid SSTI. The ISO estimates that the proposed project will approximately cost $325 to $510 million. This includes all competitive solicitation and directly assigned components. The project must be in-service not later than June 1, 2028. Figure G3-2 provides a schematic diagram of the Interconnection of the project to Newark 230 kV and NRS 230 kV substations.

Figure G3-2: Interconnection to Newark 230 kV and NRS 230 kV Substations



Newark Substation



Interconnection to Norther Receiving Station (NRS) 230 kV

NRS 230 kV Substation

For the interconnection of to the Newark substation, the incumbent PTO (PG&E) will be responsible for installing the new transmission line segment from the Newark 230 kV bus up to a point within 100 feet of the substation's property line. This new line segment will terminate on a dead end structure, to be owned by PG&E. The approved project sponsor will be responsible for (and will own and maintain) the facilities from this last dead end structure into the converter station.

The facilities in the Newark – Northern Receiving Station HVDC project that are eligible for competitive solicitation are the new HVDC converter stations connected to Newark and Northern Receiving Station substations, the new +/- 320 kV DC bus-work and termination equipment at each converter station, the new 230 kV AC bus-work and termination equipment at each converter station switchyard, the new +/- 320 kV HVDC transmission line, the new 1000 MW 230 kV AC interconnection to the Newark substation and the new 500 MW 230 kV AC interconnection to the Northern Receiving Station substation. The approved project sponsor will be responsible for acquiring the converter station land and necessary environmental permits from the applicable siting agency for both the current project scope and future expansion capacity identified in the ultimate plan.

For the interconnection to the Northern Receiving Station 230 kV station, Silicon Valley Power (SVP) will be responsible for installing a new gantry (dead end) structure within the Northern Receiving Station substation, and ISO metering. SVP will also be responsible for installing the new transmission line segment to the new dead end structure and will install the jumpers between the two line terminations and thru the ISO meters. This new dead structure will be owned by SVP. The approved project sponsor will be responsible for (and will own and maintain) the facilities from this dead end structure into the NRS Converter Station Switchyard.

The approved project sponsor, who will own the Newark and NRS converter stations and switchyards, will be responsible for owning, operating, and maintaining the protection equipment located within the substation that is designated for the protection of the incoming transmission lines. The approved project sponsor will coordinate with PG&E and SVP regarding the specifications and the details of the associated line protection (*e.g.* current differential, directional comparison) etc. and will work with PG&E and SVP to develop relay logic and detailed relay settings.

As the project includes building new transmission facility with voltage level over 200 kV, the approved project sponsor will be responsible for completing the WECC Progress Report and other processes required for this project.

G3.1.2 Functional Specification for Newark – NRS HVDC Project

Rated Real Power: The power flow will only be from Newark to NRS with rated power of 500 MW measured at NRS 230 kV substation.

Rated Reactive Power: ±150 MVAR measured at Newark 230 kV and NRS 230 kV substations.

The entire inductive (absorption) range shall be continuously available when the AC voltage is in the 230 kV – 242 kV range and the entire capacitive (injection) range shall be available when the voltage is in the 207 kV – 238 kV range. To support voltage in the area, the reactive output range shall be available independent of the real power flow on the VSC-HVDC. If the DC link is out of service, the converters shall be able to operate as STATCOM to support the voltage. Both constant reactive power and closed-loop ac bus voltage regulation with droop modes to be available.

Response time: In responding to set point changes and in recovery from faults, the time required for the output to go from 10% of the required change to 90% of the required change shall be less than 150 ms.

AC Fault Recovery: Following a fault in the AC system, the HVDC link shall recover to 90% of the pre-fault active power within 150 ms of fault clearing.

DC Fault Clearing: Clearing of the DC faults by opening the breakers on the AC side is permissible.

Nominal Terminal AC Voltage: 230 kV

Nominal DC voltage at NRS converter station: ±320 kV

Latest in Service Date: June 1, 2028

Inverter Ride Through Capability: NERC PRC-024 requirements and NERC industry recommendation on momentary cessation [3]

Availability and Reliability requirements: The project shall be designed for high availability of at least 97%. All proposals shall provide a calculation identifying the designed annual availability of the system proposed.

Gas Insulation Required: No, but if proposed shall be enclosed

CIP 14 requirement: The substation perimeter shall be fenced by a solid wall

Runback capability: The HVDC controls shall be able to receive signals for line statuses, and line loadings and implement a logic that will run HVDC back to preset power levels to address overloads. The approved project sponsor owning the facilities associated with the runback scheme shall own the NERC requirements for any associated RAS and will become a “RAS-ENTITY”.

[3] https://www.nerc.com/pa/rrm/bpsa/Alerts%20DL/NERC_Alert_Loss_of_Solar_Resources_during_Transmission_Disturbance-II_2018.pdf

Multi-terminal Capability: Newark convertor station shall have space for the 1,000 MW capacity required in the ultimate plan. Project sponsor shall demonstrate how the link will operate in the multi-terminal configuration in the ultimate plan shown in Figure G3.1.

VSC-HVDC configuration: Symmetrical monopole, bipole, back-to-back, and point-to-point configurations are acceptable.

Newark Converter Station and NRS Converter Station AC Switchyards

The continuous and emergency ampacity of the components in the AC switchyards shall not impose any restrictions on the active and reactive power specified at Newark and NRS 230 kV substations.

The bus configuration at both Converter Station AC Switchyards shall be breaker and a half and the NRS Converter Station AC Switchyard shall have an additional bay for interconnecting a new 230 kV connection from Los Esteros as part of the development of the ultimate plan. The 230 kV interconnection of the Los Esteros to NRS Converter Station in the ultimate plan will be through a flow control device to ensure the flow on the 230 kV line section from NRS Converter Station to NRS substation will not go over normal and emergency ratings of the line section.

Transmission Line Functional Specifications – Newark Converter Station – Newark 230 kV and NRS Converter Station – NRS 230 kV line sections

The continuous and emergency ampacity of the line sections connecting the converter stations to the system shall not impose any restrictions on the active and reactive power specified at Newark 230 kV and NRS 230 kV substations

Nominal Phase to Phase Voltage: 230 kV

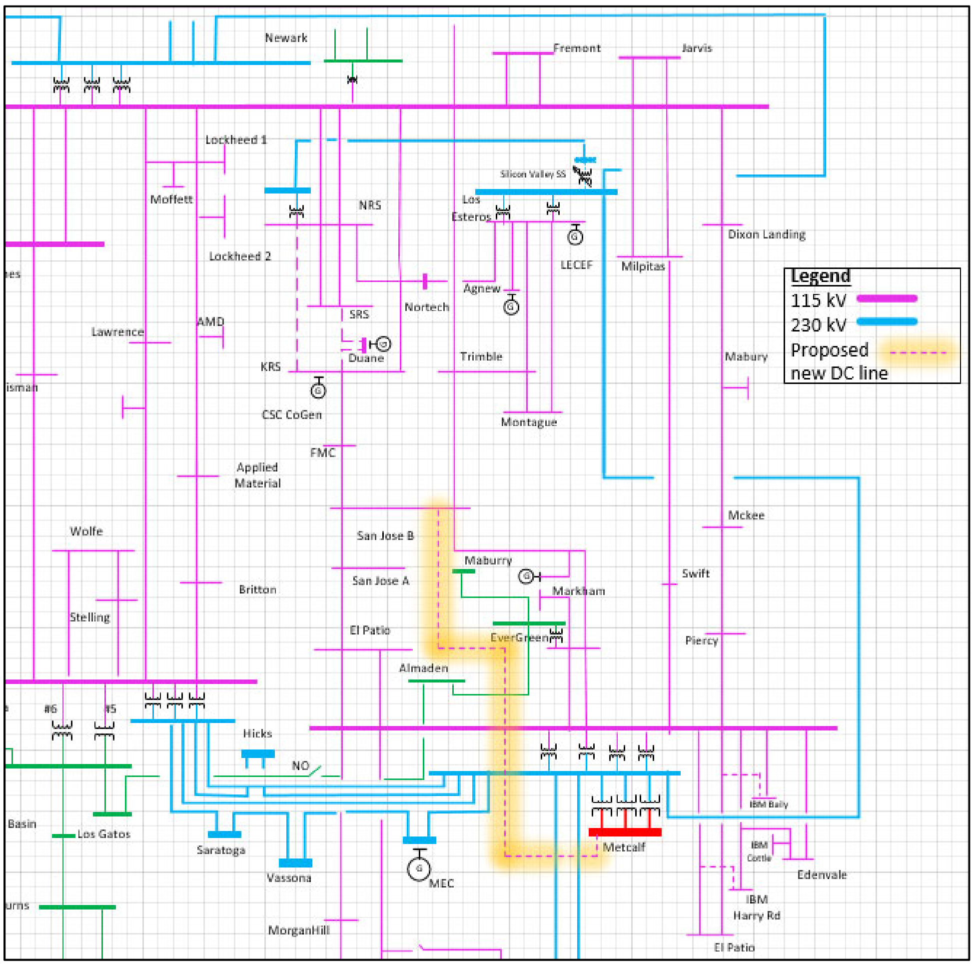
Design Temperature: 40°C

G3.2 Description and Functional Specifications of Proposed Reliability-Driven Metcalf – San Jose B HVDC Project

G3.2.1 Description

In the 2021-2022 Transmission Plan, the ISO identified a reliability-driven need for a 500 MW VSC-HVDC project from Metcalf 500 kV to San Jose B 115 kV substation to serve the load in the area. Figure G4.1. provides a schematic diagram of the transmission system in the area.

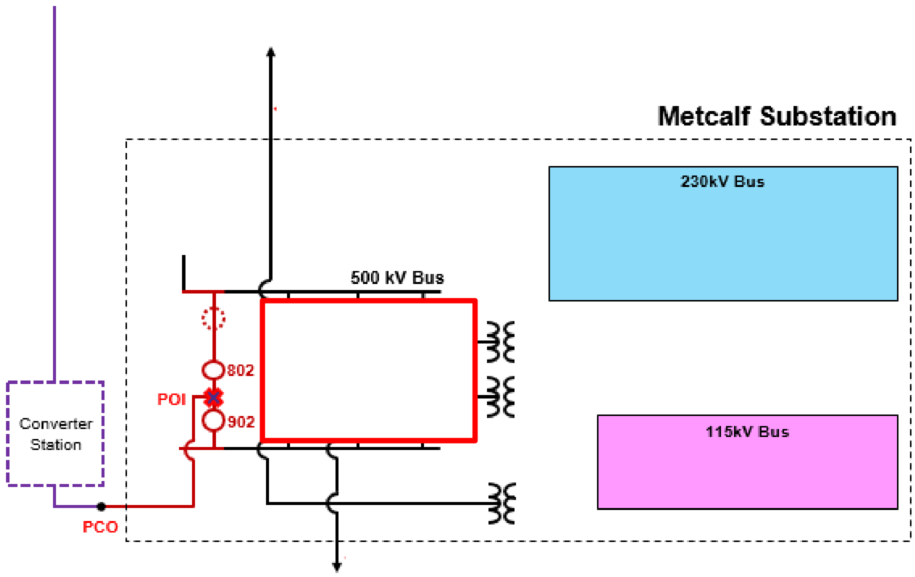
Figure G3-3: Location of Metcalf 500 kV to San Jose B 115 kV HVDC Project



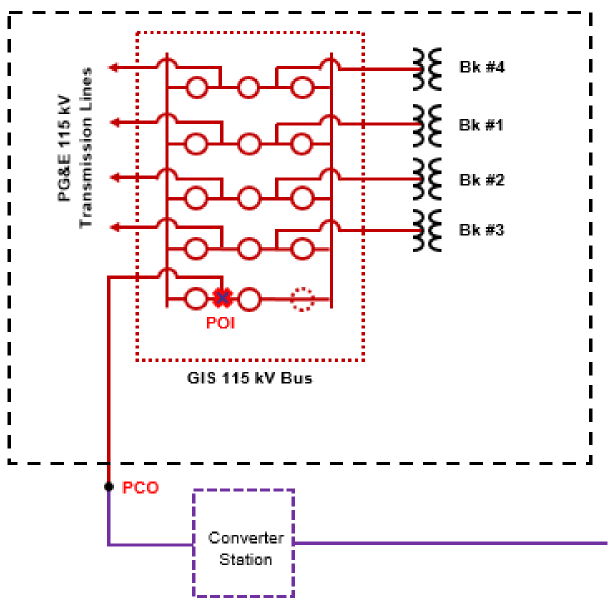
The VSC-HVDC link shall provide continuous flow on the complete range of the capability (unless the facility experienced a planned or forced outage). Subsynchronous Resonance (SSR), Subsynchronous Tortional Interactions (SSTI), harmonics, and other required studies to be completed and any identified mitigation shall be implemented as part of this project. Regardless of HVDC control characteristics and functions, in case of high potential SSTI risk, additional mitigation measures may be required for redundancy in addition to the control characteristics intended to avoid SSTI. The ISO estimates that the proposed project will approximately cost $525 to $615 million. This includes both the directly assigned components and the components subject to competitive solicitation. The project must be in-service no later than June1, 2028. Figure G4-2 provides a schematic diagram of the Interconnection of the project to Metcalf 500 kV and San Jose 115 kV substations.

PG&E has indicated that they need to convert the San Jose B substation to a GIS BAAH in order to create a terminal for the HVDC interconnection. PG&E is currently performing detailed engineering review to confirm the feasibility of undertaking this work at the San Jose B substation. The ISO expects to provide update on this situation around mid-May. This potentially could affect the scope and requirements of the project.

Figure G4-2: Interconnection to Metcalf 500 kV and San Jose B 115 kV Substations



San Jose B Substation (Conceptual and Preliminary)



For the interconnection of the new Metcalf – Metcalf Converter Switching Station 500 kV line, the incumbent PTO (PG&E) will be responsible for installing the new transmission line segment from the Metcalf 500 kV bus up to a point within 100 feet of the Metcalf substation property line. This new line segment will terminate on a dead end structure, to be owned by PG&E. The approved project sponsor will be responsible for (and will own and maintain) the facilities from this last dead end structure into the Metcalf Converter Switching Station.

The facilities in the Metcalf – San Jose B Station HVDC project that are eligible for competitive solicitation are both new HVDC converter stations connected to Metcalf and San Jose B, the new +/- 320 kV DC bus-work and termination equipment at each converter station, the new 500 kV AC bus-work and termination equipment at the Metcalf converter station and 1000 MW 500 kV AC interconnection to the Metcalf substation, the new +/- 320 kV HVDC transmission line, the new 115 kV AC bus-work and termination equipment at the San Jose B converter station and 500 MW 115 kV interconnection to San Jose B substation. The approved project sponsor will be responsible for acquiring the converter station land and necessary environmental permits from the applicable siting agency for both the current project scope and future expansion capacity identified in the ultimate development plan.

For the interconnection of the new San Jose B Converter Station – San Jose B Station 115 kV line, PG&E will be responsible for installing a new gantry (dead end) structure within the San Jose B substation. The approved project sponsor will be responsible for (and will own and maintain) the facilities from this dead end structure into the San Jose B Converter Station Switchyard.

The approved project sponsor, who will own the Metcalf and San Jose B converter stations and switchyards, will own, operate, and maintain the protection equipment located within the substation that is designated for the protection of the incoming transmission lines. The approved project sponsor will coordinate with PG&E regarding the specifications and the details of the associated line protection (e.g. current differential, directional comparison) etc. and will work with PG&E to develop relay logic and detailed relay settings.

As the project includes building new transmission facility with voltage level over 200 kV, the approved project sponsor will be responsible for completing the WECC Progress Report and other processes required for this project.

G3.2.2 Functional Specification for Metcalf – San Jose B HVDC Project

Rated Real Power: 500 MW measured at San Jose B 115 kV substation.

Rated Reactive Power: ±150 MVAR measured at Metcalf 500 kV and San Jose B 115 kV substations.

At Metcalf 500 kV end, the entire inductive (absorption) range shall be continuously available when the AC voltage is in the 500 kV – 550 kV range and the entire capacitive (injection) range shall be available when the voltage is in the 473 kV – 540 kV range.

At San Jose B 115 kV end, the entire inductive (absorption) range shall be continuously available when the AC voltage is in the 115 kV – 126 kV range and the entire capacitive (injection) range shall be available when the voltage is in the 104 kV – 121 kV range.

To support voltage in the area, the reactive output range shall be available independent of the real power flow on the HVDC. If the DC link is out of service, the converters shall be able to operate to support the voltage.

Both constant reactive power and closed-loop ac bus voltage regulation with droop modes to be available.

Response time: In responding to set point changes and in recovery from faults, the time required for the output to go from 10% of the required change to 90% of the required change shall be less than 150 ms.

AC Fault Recovery: Following a fault in the AC system, the HVDC link shall recover to 90% of the pre-fault active power within 150 ms of fault clearing.

DC Fault Clearing: Clearing of the DC faults by opening the breakers on the AC side is permissible.

Nominal Terminal AC Voltage: 500 kV at Metcalf and 115 kV at San Jose B. Typically the bus voltage at Metcalf 500 kV bus is at 525 kV.

Latest in Service Date: June 1, 2028

Inverter Ride Through Capability: NERC PRC-024 requirements and NERC industry recommendation on momentary cessation [4]

Availability and Reliability requirements: The project shall be designed for high availability of at least 97%. All proposals shall provide a calculation identifying the designed annual availability of the system proposed.

Gas Insulation Required: No, but if proposed shall be enclosed

CIP 14 requirement: The substation perimeter shall be fenced by a solid wall

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[4] https://www.nerc.com/pa/rrm/bpsa/Alerts%20DL/NERC_Alert_Loss_of_Solar_Resources_during_Transmission_Disturbance-II_2018.pdf

Runback capability: The HVDC controls shall be able to receive signals for line statuses, and line loadings and implement a logic that will run HVDC back to preset power levels to address overloads. The approved project sponsor owning the facilities associated with the runback scheme shall own the NERC requirements for any associated RAS and will become a "RAS-ENTITY".

Multi-terminal Capability: Newark convertor station shall have space for the 1,000 MW capacity required in the ultimate plan. Project sponsor shall demonstrate how the link will operate in the multi-terminal configuration in the ultimate plan shown in Figure G3.1.

VSC-HVDC configuration: Symmetrical monopole, bipole, back-to-back, and point-to-point configurations are acceptable.

Metcalf Converter Station and San Jose B Converter Station AC Switchyards

The continuous and emergency ampacity of the components in the shall not impose any restrictions on the active and reactive power specified at Metcalf 500 kV and San Jose B 115 kV substations.

Transmission Line Functional Specifications – Metcalf Converter Station – Metcalf 500 kV and San Jose B Converter Station – San Jose B 115 kV line sections

The continuous and emergency ampacity of the line sections connecting the converter stations to the system shall not impose any restrictions on the active and reactive power specified at Metcalf 500 kV and San Jose B 115 kV substations

Nominal Phase to Phase Voltage: 500 kV at Metcalf and 115 kV at San Jose B

Design Temperature: 40°C