Tri-State

GENERATION AND TRANSMISSION ASSOCIATION, INCORPORATED

PV Study Report

San Luis Valley Substation Second 230 kV Source

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Executive Summary

For years the San Luis Valley peak load has exceeded the single contingency capability of the high voltage system. The resultant effects are voltage collapse in the San Luis Valley. In June 1997, interested stakeholders published a report[1] describing the problem in detail, and proposing several solutions. That report recommended the addition of the San Luis Valley – Walsenburg 230 kV line.

The primary finding of the report was the potential voltage collapse whenever the net San Luis Valley loads exceeded 65 MW and the Poncha – San Luis Valley 230 kV source experienced an outage[2]. The report documented that the loads in the valley exceeded 65 MW roughly 15% of the time in 1995. Xcel's Alamosa combustion turbine generators[3] provided additional support in the area. A combination of the local load serving and the reactive support from the Alamosa generation provides an incremental load serving capability of 46 MW in the valley, bringing the total single contingency load serving capability in the valley up to 111 MW before voltage collapse occurs. However, the peak load in the San Luis Valley in 2002 was estimated to be 146 MW, far above the single contingency point of collapse of 111 MW. And the San Luis Valley loads are estimated today to be above 65 MW approximately 20% of the time.

Low voltages, high voltages or facility overloads often can be mitigated with relatively minor system additions. However, voltage collapse is more severe and indicates the maximum capability of the system is being exceeded. Fundamentally, the valley requires the following to survive single contingency voltage collapse:

1. More transmission into the valley
2. More generation in the valley to offset the loads
3. Lower loads in the valley

Option three is not feasible, as loads in the valley are increasing and not projected to decrease in the foreseeable future. Option two is also not feasible as new generation in the valley is generally not economic, primarily because of the high elevation of the valley causing the equipment to be derated. Additional transmission, option one, is the only feasible approach.

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[1] San Luis Valley High Voltage System Study Report, prepared by Frank R. McElvain of Tri-State Generation and Transmission Association, Inc. on behalf of Tri-State, F. David Graeber & Associates (an Independent Power Producer), Public Service Company of Colorado (now Xcel Energy), San Luis Valley Rural Electric Cooperative, Inc. and Western Area Power Administration.

[2] An outage of either the Poncha – San Luis Valley 230 kV line or the San Luis Valley 230/115 kV transformer created the critical scenario for the valley. The single 230/115 kV transformer is being replace with two 230/115 kV transformers at this time, eliminating the transformer outage as a critical single contingency.

[3] The Alamosa generators have a maximum output of 30 MW, or 36 MW when utilizing #2 fuel oil.

The 1997 report investigated a short list of alternatives to solve the voltage collapse issue. Among these were the following:

A. A Pagosa – Ramon 115 kV transmission line addition.
B. A Lake City – Ramon 115 kV transmission line addition.
C. A Burro Canyon – San Luis 230 kV transmission line addition, with generation at Burro Canyon.
D. A San Luis – Walsenburg 230 kV transmission line addition.
E. Dispersed Static VAr[4] devices.

The conclusion that can be reached from the 1997 report is that 115 kV options will not sufficiently mitigate the potential single contingency voltage collapse in the valley. Successful mitigation requires 230 kV facilities or higher. Therefore, not only is additional transmission the most feasible solution, but the additional transmission must operate at 230 kV, minimally. This report seeks to investigate an exhaustive set of 230 kV transmission options.

This report supplements the 1997 study by determining the points-of-collapse for several other 230 kV alternatives into the San Luis Valley. The results of this study indicate that the San Luis Valley – Walsenburg 230 kV line is a superior option to any of the other alternatives considered. There are other acceptable alternatives to provide a second source of power into the valley, however, the San Luis Valley – Walsenburg option is the best value.

The San Luis Valley – Walsenburg option allows a total load of 286 MW to be served in the valley during system normal conditions. However, electrical systems are primarily measured by their ability to serve loads in single contingency conditions, or during the outage of the most critical facility. In the case of the San Luis Valley, the most critical outage is the Poncha – San Luis Valley 230 kV line. During this outage, the remaining system is only capable of serving a total load of 63 MW. This is unacceptable when the knowledge that the valley's total load is nearing 150 MW, and that the 63 MW level is currently exceeded approximately 20% of the time. The San Luis Valley – Walsenburg 230 kV line increases the single contingency capability of the system in the valley to 206 MW. Based on current annual load growth rates of 2.3%, this will be sufficient until 2017.

Purpose of the Report

Recent system outages have accelerated the need for a second source into the San Luis Valley substation. The 1997 report was not an exhaustive investigation of 230 kV options. This report provides a comprehensive investigation of all 230 kV alternatives for providing a second 230 kV source into San Luis Valley substation. If a better technical solution for improving load serving capability in the valley than the San Luis Valley – Walsenburg 230 kV line exists, it will be identified through this study.

[4] Volt-Amps Reactive, the imaginary component of the product of volts and amps, where watts are the real component of the same product.

Base Case

The originating case was a 2003 Heavy Summer case developed by WECC[5]. The study base case was developed by modifying the originating case by adding the proposed Gladstone – Walsenburg 230 kV line, as it is projected to be in service prior to the construction of the recommended San Luis Valley – Walsenburg 230kV line, or its alternate. Further, loads in the San Luis Valley were reduced to 50 MW, as a starting point for the PV curves[6]. Further, Alamosa generation was turned off in developing the PV output. Figure 1, below, indicates the relative geographical locations of the alternatives studied.

Study Methodology

An IPLAN program, written by Tri-State known as *REGIONOUT* was utilized to scale the valley's loads, increase generation, and to record bus voltages as the loads increased. The *REGIONOUT* program also automates the PV analysis for specified contingency simulations. The tabular PV output data created by *REGIONOUT* were imported to an Excel template to create the output curves in Appendix A. PV curves for normal system conditions were developed and for the Poncha – San Luis Valley 230 kV line outage, as this is the critical contingency in the valley.

Potential 230 kV interconnections were identified in every direction from San Luis Valley substation. Each potential interconnection was evaluated for its point-of-collapse in system normal conditions and during the outage of the Poncha – San Luis Valley 230 kV line, the most critical single contingency condition. Refer to the map on the following page for a geographical representation of the studied alternatives.

This report focuses only on voltage collapse, not on overloads or on voltages outside criteria. The reason for this is that voltage collapse defines the ultimate capability of the system. Even though the absolute voltage at a bus may be unacceptable, if the voltage is on the stable side of the PV curve, smaller capital additions can be made to bring the voltage into the acceptable range. So, even though the system may be voltage stable, further investment may be necessary to bring full compliance to the reliability criteria.

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[5] Western Electricity Coordinating Council.

[6] PV curves are Power – Voltage curves. They denote the cause-and-effect relationship between the loading of a system and the resultant voltage profile on that system. The stable region of a PV curve is where the region's voltage trend lower for increased power loading.