Transmission Service Request Study

TSR-08-1023

May 21, 2009

Background

Tri-State received a Transmission Service Request, designated TSR-08-1023, and subsequent application for long-term firm transmission service in a letter dated October 24, 2008. The Transmission Customer requested 101 MW of Long-Term Firm Point-to-Point Transmission Service over Tri-State's system from a new 230kV interconnection point located between the existing Big Sandy and Burlington substations (Point of Receipt) to the Midway 230kV bus (Point of Delivery). The Transmission Customer executed a Transmission Service System Impact Study Agreement (TS-08-0073) received December 11, 2008.

The Transmission Customer submitted an Interconnection Request for a Large Generating Interconnection Project, designated TI-06-0929A, in the Tri-State Interconnection Request queue. Tri-State issued an Interconnection Feasibility Study for the Large Generating Interconnection Project on May 10, 2007. An Interconnection System Impact Study (SIS) for the Project was subsequently conducted and the preliminary results were issued on September 2, 2008. In response to the preliminary results, the Transmission Customer requested some additional study work which is currently in progress.

The Interconnection SIS should be referenced for a discussion of the performance of the transmission system with the proposed generation on the requested path. The Interconnection SIS identified transmission upgrades and facility additions required to interconnect the project to the Tri-State transmission system. Those facility additions are required to mitigate certain N-1 and fault conditions as identified in the power flow and transient stability analyses. The Interconnection SIS provides a list of those facilities, and a good faith estimate of cost and time required to interconnect the project.

In contrast to the Interconnection SIS, this Transmission Service Request Study evaluates the ability of the transmission system to provide the requested Long-Term Firm Point-to-Point Transmission Service taking into consideration Tri-State's native load requirements and existing committed uses (ETC) for the requested transmission path.

Scope

This study consists of the following:

- Evaluation of the Available Transfer Capability (ATC) of the requested path which begins at a new interconnection point 30 miles west of the Burlington Substation on the Big Sandy to Burlington 230kV line and continues to the Midway 230kV bus.

- Identification of thermal overloads or violations of voltage criteria resulting from providing Transmission Service over the requested path.

- Impacts of Tri-State native load growth through the ten year planning horizon as it will affect the committed uses on the path and the ability of Tri-State to provide the requested Transmission Service.

Methodology

Determining ATC for the requested path requires an analysis of the Total Transfer Capability (TTC) of the transmission system owned or available to Tri-State to meet the transmission request. The Big Sandy to Midway 230kV portion of the requested path is a primary contractual transmission source utilized by Tri-State to serve its native load in the geographical area south and west of the Midway Substation. Tri-State's native load obligation in this area consists of service to Mountain View Electric Association, San Isabel Electric Association, San Luis Valley Rural Electric Cooperative, Southeast Colorado Power Association and Gunnison County Electric Association. In addition to the Big Sandy to Midway 230kV source, Tri-State purchases firm transmission from CRSP (Western) and Public Service Company of Colorado. These transmission sources owned by or purchased by Tri-State comprise the TTC that Tri-State has available to serve it native load and meet other existing transmission commitments.

Equation 1: ATC Equation

ATC = Total Transfer Capability (TTC) – Existing Transmission Commitments (ETC) – Transmission Reliability Margin (TRM)

- TTC was determined in accordance with Tri-State's *Engineering Standards Bulletin – Reliability Criteria for System Planning and Service Standards* which states the maximum loading criteria for transmission lines as a percent of the continuous rating. Based on that criteria, TTC in this study was defined as 100 percent of the thermal rating of the line sections in the requested path.

- ETC is defined as Tri-State native load-serving needs, existing commitments for transmission service and existing commitments for purchase/exchange/delivery.

- TRM is defined as loop flow across the requested path and transfer capability required to ensure reliable system operation as system conditions change. WECC operating practice requires transmission providers to accommodate some through-flow which may decrease ATC. TRM is also utilized to deliver and receive reserve obligations associated with a Reserve Sharing Group.

This study was conducted in two steps:

1. A non flow-based analysis of the projected uses of the Burlington to Big Sandy to Midway 230kV system was conducted. The TTC available to Tri-State to serve its native load obligations and other existing commitments for transmission service was researched. ATC was calculated.

2. A flow-based analysis was also conducted to verify that actual system performance with the injection of 101 MW at the Point of Receipt was not more limiting than the results obtained from the non flow-based analysis. In order to maintain consistency with the

assumptions of the Interconnection SIS, the power flow analysis of the Interconnection SIS was used in this report for the flow-based evaluation.

For study purposes, the requested path was divided into two sections, 1) the Point of Receipt to the Big Sandy Substation, and 2) the Big Sandy Substation to the Point of Delivery (Midway). A non flow-based analysis and a flow-based analysis was conducted for both line sections.

Study Assumptions

Tri-State Power System Planning provided a 10 year native load forecast for Mountain View Electric Association, San Isabel Electric Association, San Luis Valley Rural Electric Cooperative, Southeast Colorado Power Association and Gunnison County Electric Association. Tri-State System Operations provided the firm committed uses for the Burlington to Big Sandy and the Big Sandy to Midway 230kV lines. Tri-State Energy Management confirmed Tri-State's reserve obligations. These values were used in the non flow-based analysis of ATC and are tabulated in the Results section of this report.

The Interconnection SIS power flows were used to conduct the flow-based analysis. The Interconnection SIS power flows were performed utilizing four WECC base cases and analyzing both summer and winter seasons for the pre-project and post-project system configurations. The assumptions in these cases were considered appropriate for the flow-based analysis of the requested transmission path. Specifically, the generation assumptions contribute to maximizing the loading on the Big Sandy to Midway portion of the requested path since proposed generation projects north of Big Sandy in the Tri-State, PSCo and Western Area Power Administration interconnection queues are included in the cases. In response to the draft Interconnection SIS, the Customer requested that a sensitivity study be conducted assuming that these proposed generation projects are offline. However, for this study and for purposes of maximizing power flows across the requested path, the assumptions in the Interconnection SIS were judged acceptable. Each base case generation dispatch assumption is summarized in the Interconnection SIS study report.

The study identified the N-1 contingency that maximized the flows across the requested path with the generation interconnection. The 101 MW generator was injected at the Point of Receipt and the worst N-1 contingency was simulated to determine if there was adequate transmission capacity with the interconnection. The study selected the N-1 contingency that maximized the loading on the requested path but did not evaluate all N-1 conditions. Other critical N-1 conditions that may require system upgrades were identified by the Interconnection SIS.

The Interconnection SIS power flow analysis was performed using the National Electric Reliability Corporation (NERC)/Western Electricity Coordinating Council (WECC) planning standards. The analysis identified any line loading exceeding 100% of its continuous thermal rating and monitored the voltage performance of the transmission system. Normal voltage violations were limited to the conditions where per unit voltages were between 0.95 and 1.05. Emergency voltage violations were limited to the conditions where per unit voltages were not less than 0.90 or greater than 1.10. In addition, voltage deviations greater than 5% between the pre and post-contingency were monitored.

Results

Non Flow-based Analysis:

A non flow-based analysis of ATC was conducted for the Point of Receipt to Big Sandy section of the requested path. The analysis used TTC available from all Tri-State transmission sources and subtracted native load obligations and other existing commitments.

Determination of ATC from the Point of Receipt to Big Sandy Substation:

Determination of TTC:

TTC is defined as the thermal rating of the line section from the Point of Receipt to the Big Sandy Substation. This rating is 284 MVA and is based on the 954 ACSR conductor constructed for 50 degrees C.

Transmission MW capacity of the Burlington to Big Sandy 230kV line:	284 MW

Transmission purchased from others by and for Tri-State:

Firm transmission from CRSP for Tri-State	100 MW
CRSP Preference Power delivered to Mountain View	43 MW
Firm transmission from PSCo (Ault-Comanche) to serve San Luis Valley	50 MW
Total TTC	477 MW

Determination of ETC:

ETC is the sum of native load demand, existing commitments for transmission service and existing commitments for reserves. Tri-State's 10 year projected coincident native load is as follows:

2019 Power System Planning Native Load Forecast

Member	Winter	Summer
San Isabel*	116 MW	119 MW
San Luis Valley	29 MW	67 MW
Mountain View	196 MW	158 MW
Gunnison County	35 MW	19 MW
Southeast Co Power	23 MW	54 MW
Total	399 MW	417 MW

* Includes 50 MW Pioneer load forecast

Firm Committed Uses by Others on the Burlington to Big Sandy Line

PSCo delivery to MEAN (City of Fountain)		40 MW
PSCo delivery to ARPA (Las Animas)		3 MW
ARPA existing firm use		3 MW
	Total	46 MW

Total ETC = 417 MW + 46 MW = 463 MW

Determination of TRM:

No significant variations in firm requirements for transmission capacity (reserve margin) are assumed, therefore for purposes of this study the TRM is 0 MW.

Based on the above, the ATC for the Point of Receipt to Big Sandy line section is calculated as follows:

ATC = TTC – ETC – TRM
ATC = 477 MW – 463 MW – 0 MW = 14 MW

Determination of ATC from the Big Sandy Substation to Midway (Point of Delivery):

Determination of TTC:

The Big Sandy to Lincoln to Midway 230kV line is presently being uprated by Tri-State to 1272 ACSR conductor and 100 degrees C. Upon completion, the line will have a thermal rating of 613 MVA. It is anticipated that the project will be completed by 3Q 2009.

Transmission MW capacity of the Big Sandy Midway 230kV line: 613 MW

Transmission purchased from others by and for Tri-State:

Firm transmission from CRSP for Tri-State		100 MW
CRSP Preference Power delivered to Mountain View		43 MW
Firm transmission from PSCo (Ault-Comanche) to serve San Luis Valley		50 MW
	Total TTC	806 MW

Determination of ETC:

ETC is the sum of native load demand and existing commitments for transmission service. The maximum forecasted (2019) coincident native load demand is 417 MW as tabulated above in the Determination of ATC for the Point of Receipt to Big Sandy Substation.

Firm Committed Uses by Others on the Lincoln to Midway Line

PSCo delivery to MEAN (City of Fountain)	40 MW
PSCo delivery to ARPA (Las Animas)	3 MW
ARPA existing firm use	3 MW
Delivery of LAP to Big Sandy for ARPA	33 MW
Wheeling of Colorado Springs Utilities WAPA power	60 MW
Tri-State Energy Management reservation for Limon generation	75 MW
Total	214 MW

Total ETC = 417 MW + 214 MW = 631 MW

Determination of TRM:

Transmission Reliability Margin (TRM) is made available to provide for variations in the use of the transmission system due to uncertainty in system configuration, load forecasting, unscheduled flows and the obligations of Reserve Sharing Groups to deliver and receive generator reserves. For the Big Sandy to Midway path, a TRM was assumed for delivery of operating reserves from the Limon generation to Midway.

Firm reserves delivery to Midway (Rocky Mountain Reserve Group): 66 MW

Based on the above, the ATC for the Big Sandy to Midway (Point of Delivery) line section is calculated as follows:

ATC = TTC – ETC – TRM
ATC = 806 MW – 631 MW – 66 MW = 109 MW

Flow-based Analysis:

A flow-based analysis was conducted to verify that transmission capacity was not limited by actual system performance with the injection of 101 MW at the Point of Receipt. This flow-based analysis is based on the Interconnection SIS power flow cases. The Interconnection SIS included all single element outages in Zones 700 (Denver Metro), 704 (South of Denver Metro), 706 (North of Denver Metro) and 752 (Eastern Colorado). A review of the Interconnection SIS cases lead to the following conclusions.

1. Light winter loading on the system resulted in a higher power flow across the requested path than heavy summer loading under normal system conditions. This was true for both the 2009-2010 light winter case and the 2013 light winter case.

2. The post-project loading across the requested path was higher than the pre-project loading. This was true for both the light winter and heavy summer cases.

3. The maximum pre-project power flow across the Burlington to Big Sandy 230kV line was 113 MVA (from the 2013 light winter system normal case).

4. The maximum pre-project power flow across the Big Sandy to Lincoln 230kV line was 246 MVA(from the 2013 light winter case with the Smoky Hill to Big Sandy 230kV line out). The Smoky Hill to Big Sandy 230kV line is not yet in-service but was modeled in the 2013 case.

5. The maximum pre-project power flow across the Lincoln to Midway 230kV line was 350 MVA (from the 2013 light winter case with the Smoky Hill to Big Sandy 230kV line out).

6. The maximum post-project power flow across the Point of Receipt to the Big Sandy line was 192 MVA (from the 2013 light winter system normal case).

7. The maximum post-project power flow across the Big Sandy Substation to Lincoln line was 305 MVA (from the 2013 light winter case with the Smoky Hill to Big Sandy 230kV line out).

8. The maximum post-project power flow across the Lincoln to Midway (Point of Delivery) line was 415 MVA (from the 2013 light winter case with the Smoky Hill to Big Sandy 230kV line out).

   Without the Limon generation, the power flow listed above for the Lincoln to Midway line section is reduced by approximately 50 MVA. Injecting the Limon generation into the system increases the flow on the Lincoln to Midway section of the requested path but reduces the flow on the Point of Receipt to Big Sandy section of the requested path. Since the Lincoln to Midway line section is the most limited element of the path, the Limon generation was modeled online to maximize the flow on that line section.

9. The injection of 101 MW at the Point of Receipt increases the flow on the Lincoln to Midway portion of the requested path by approximately 65 MVA over the system normal case (year 2013). However, acceptable steady state performance was achieved. No violations of the NERC/WECC or Tri-State system planning standards were observed and the rating of the lowest rated transmission line conductor in the requested path was not exceeded. These results are based on the assumptions used in the base cases as noted in the Study Assumptions portion of this report.

Conclusions

The Transmission Customer requested 101 MW of Long-Term Firm Point-to-Point Transmission Service over Tri-State's system from a new 230kV interconnection point located between the existing Big Sandy and Burlington substations (Point of Receipt) to the Midway 230kV bus (Point of Delivery).

Based on the results of this study, the Big Sandy to Midway section of the requested path has adequate transmission capacity to accommodate the transmission request. The non flow-based analysis determined that an ATC of 109 MW is available for the 10 year scope of this study. The flow-based analysis confirmed that steady state system performance was not more limiting than the results obtained from the non flow-based analysis.

The non flow-based analysis of ATC for the Point of Receipt to Big Sandy section of the requested path determined that only 14 MW is available without the addition of system upgrades. This study identified committed uses which, together with Tri-State's native load requirements and TRM, limit the ATC. Therefore, transmission system upgrades are required in order to accommodate the requested Transmission Service.

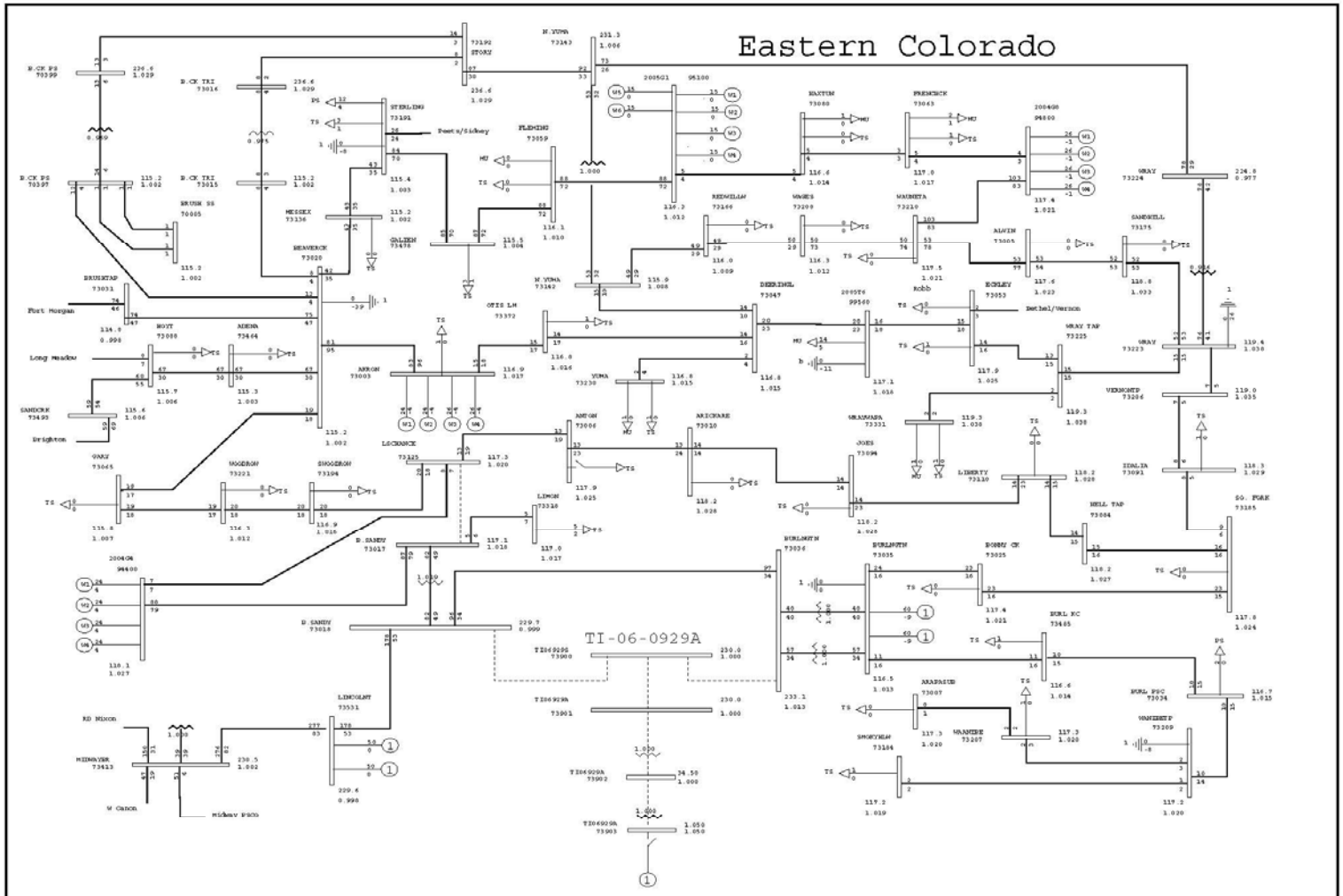
The Interconnection SIS identified network upgrades required to interconnect the project to the Tri-State transmission system. Those upgrades are required to mitigate certain N-1 and fault conditions. That study recommended the construction of a second 230 kV line from the Point of Receipt to the Big Sandy Substation as a part of certain mitigation scenarios in order to achieve acceptable steady state system performance. Therefore, consistent with the conclusions of the Interconnection SIS, the facility additions required to accommodate the full amount of requested Transmission Service would include approximately 49 miles of new 230kV line from the Point of Receipt to Big Sandy plus terminal equipment. The Interconnection SIS should be referenced for cost estimates and for a discussion of the network upgrades required to interconnect the project to the Tri-State transmission system.

The capacity of the Point of Receipt to Big Sandy line used in this study is based on the current conductor thermal rating of 50 degrees C. A possible alternative to new line construction is to upgrade the existing line to 100 degrees C operation. However, a second Point of Receipt to Big Sandy line may be preferred anyway to mitigate an outage of the existing line as discussed in the Interconnection SIS. Additionally, Tri-State should monitor the 230kV metering CT's located at Big Sandy for upgrade/replacement as required so as not to limit the thermal rating of the line.

The flow-based analysis demonstrated that the proposed interconnection does not adversely affect neighboring Transmission Providers. It also demonstrated that the requested path can accommodate some non-firm transmission service. This study leaves open the possibility that non-firm ATC could be provided under certain system conditions without the facility additions discussed above. However, it should be noted that Tri-State does not presently offer Conditional Firm transmission service.

Appendix 1

Steady State Power Flow Diagrams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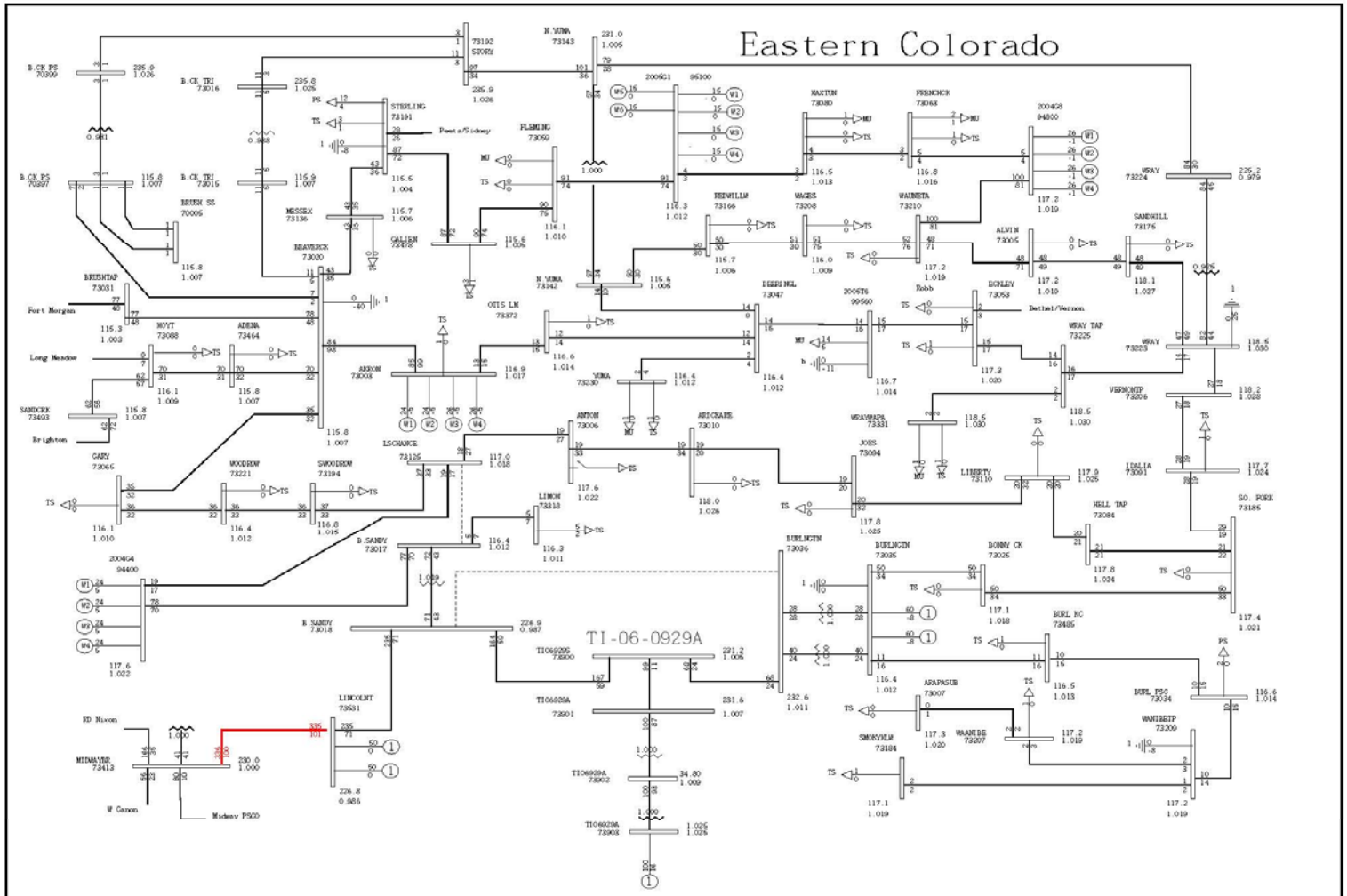
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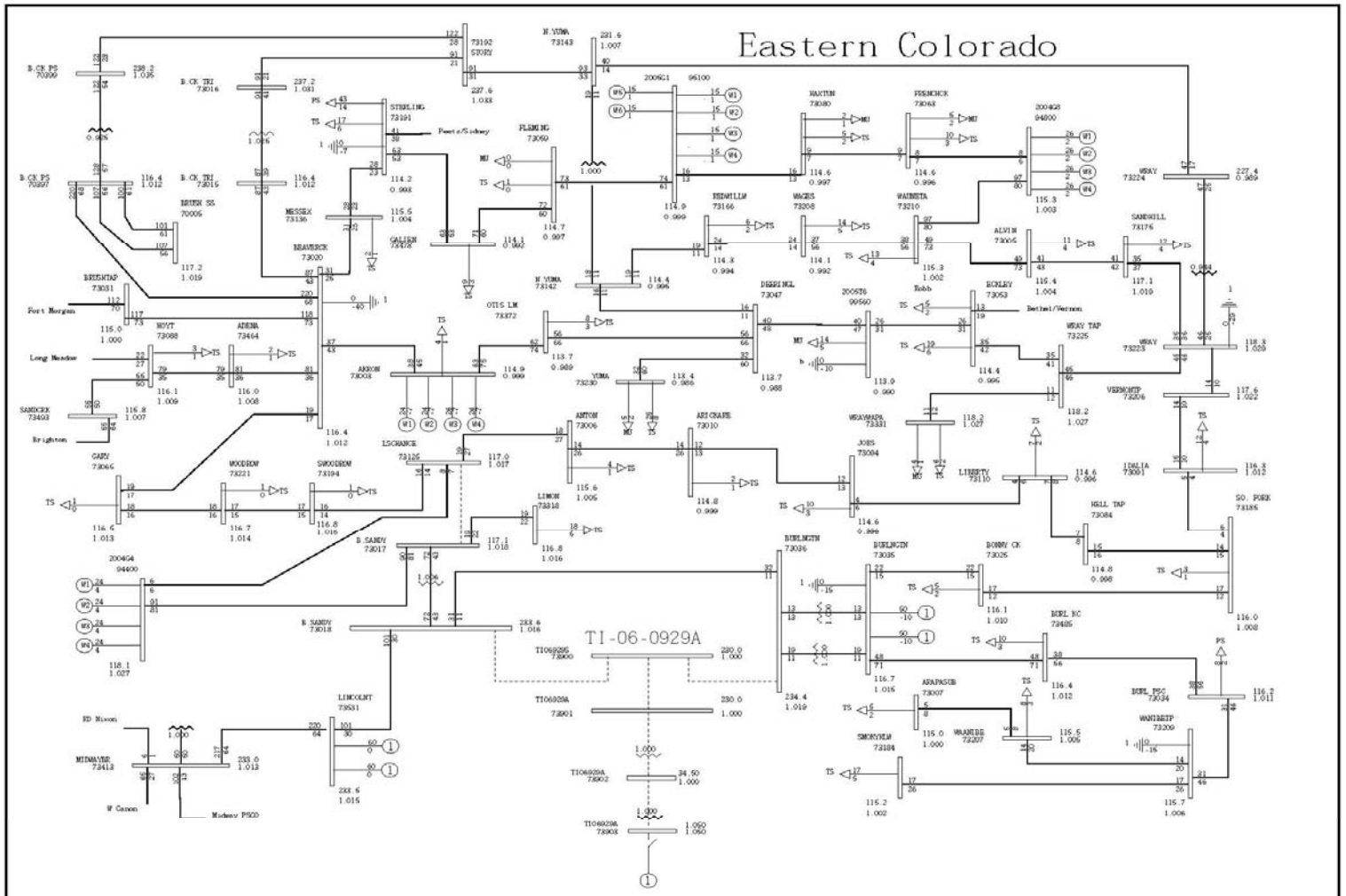
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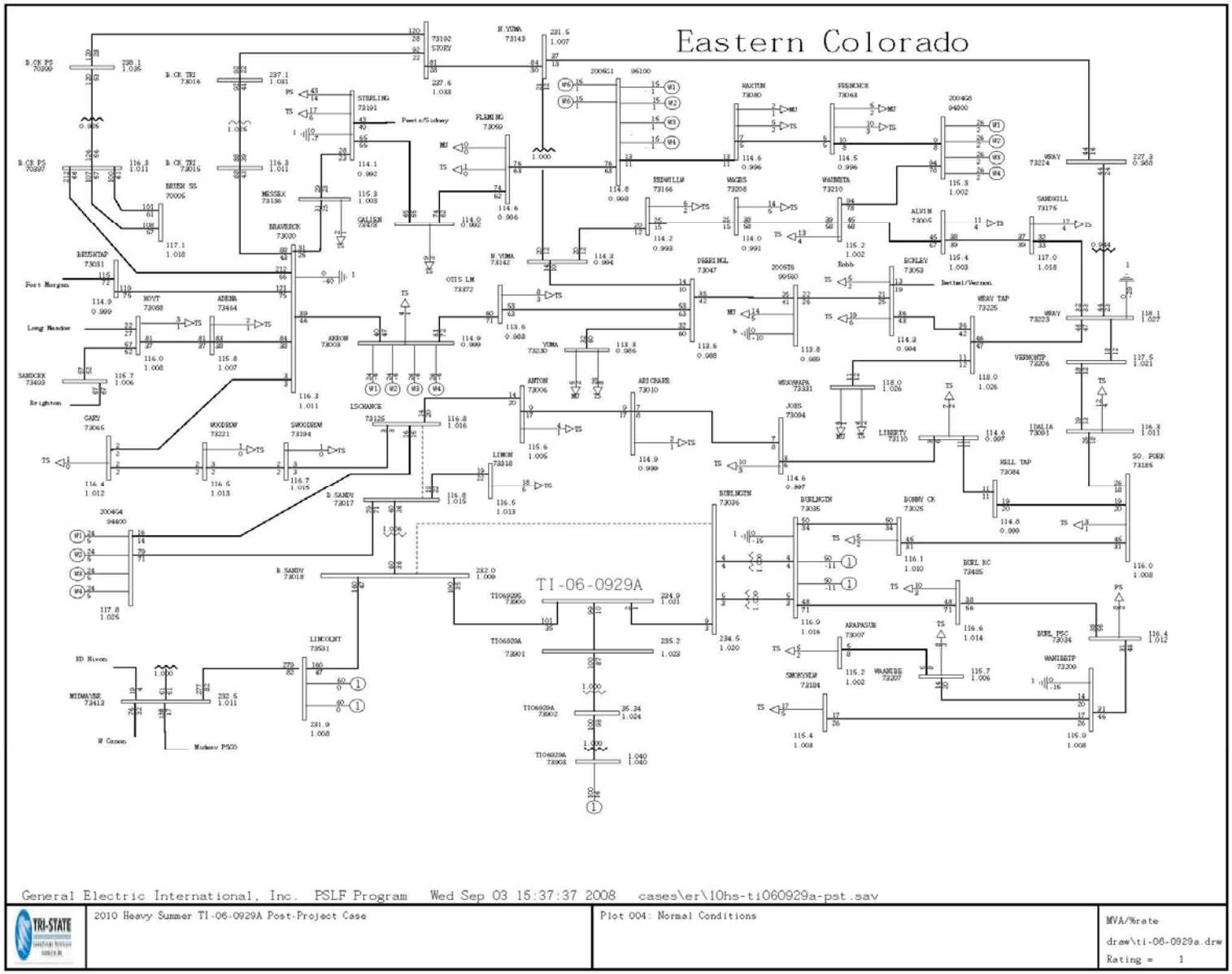
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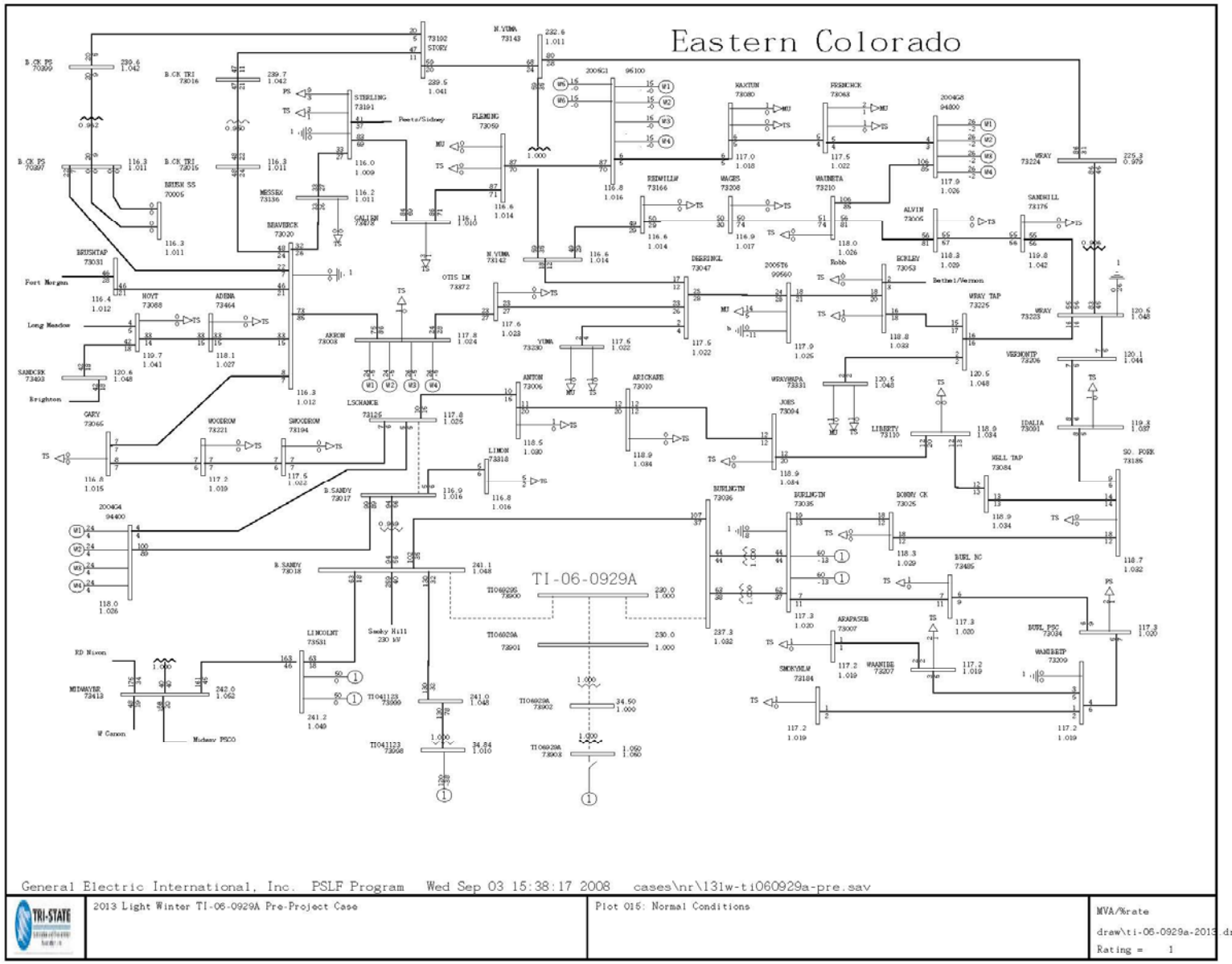
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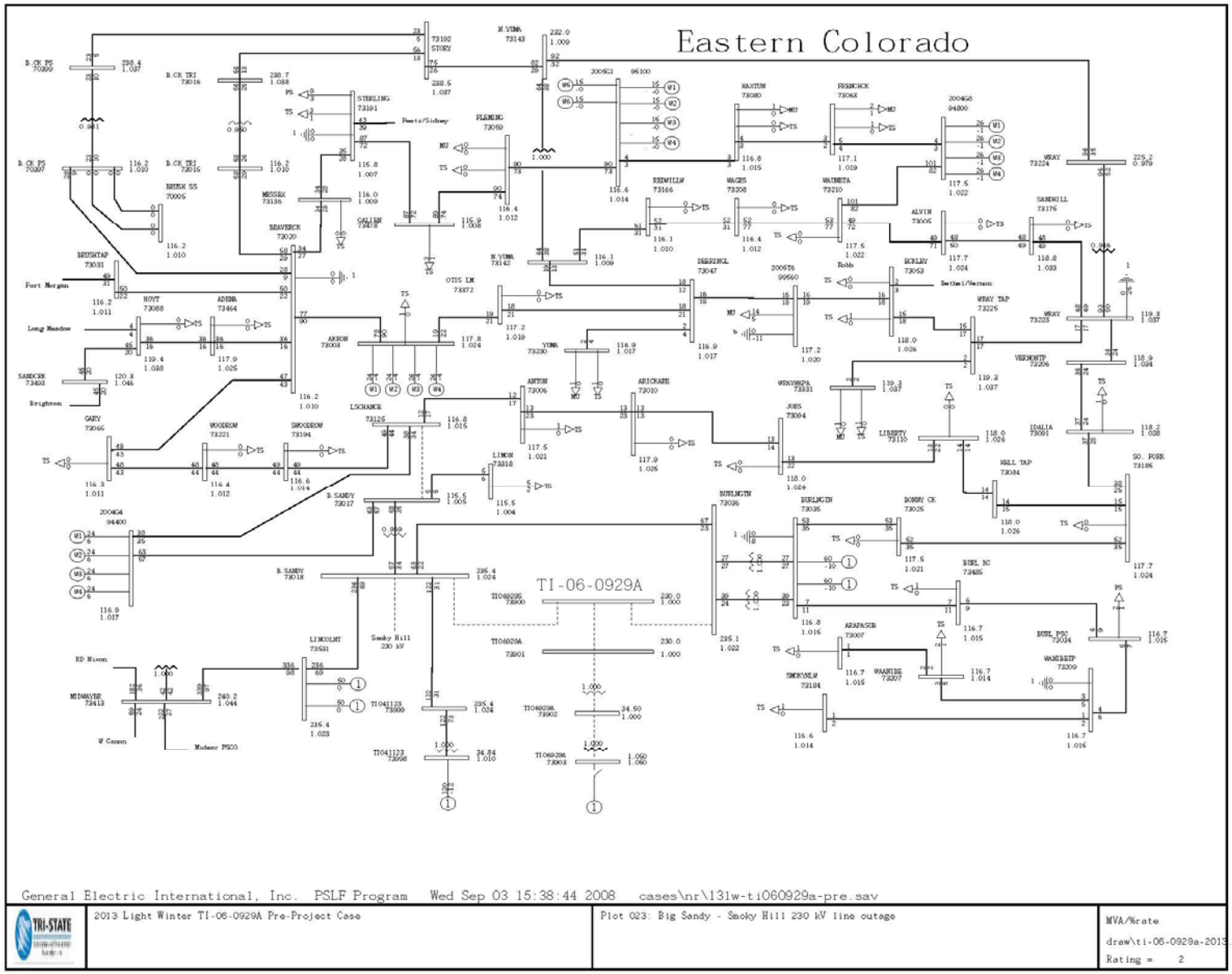
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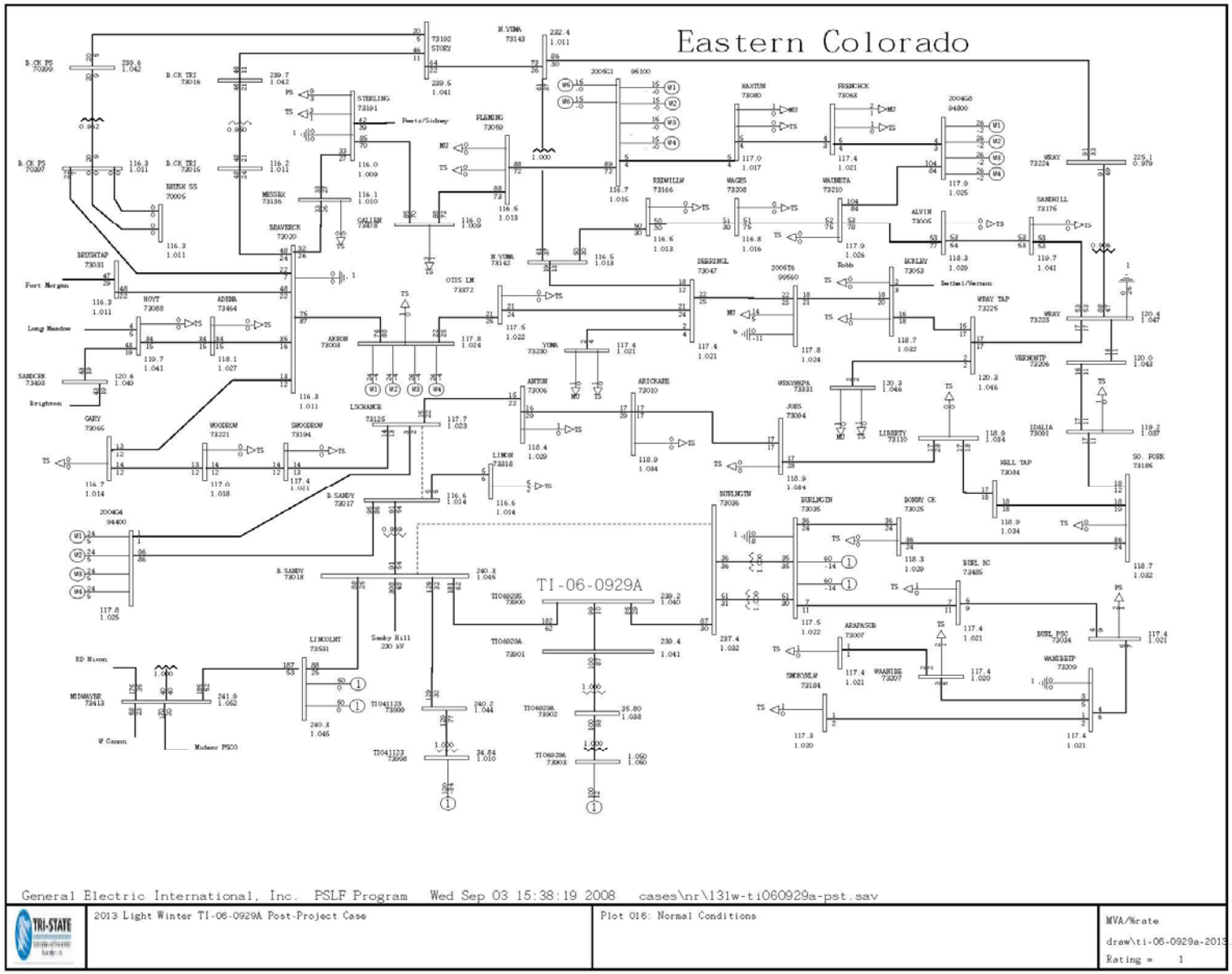
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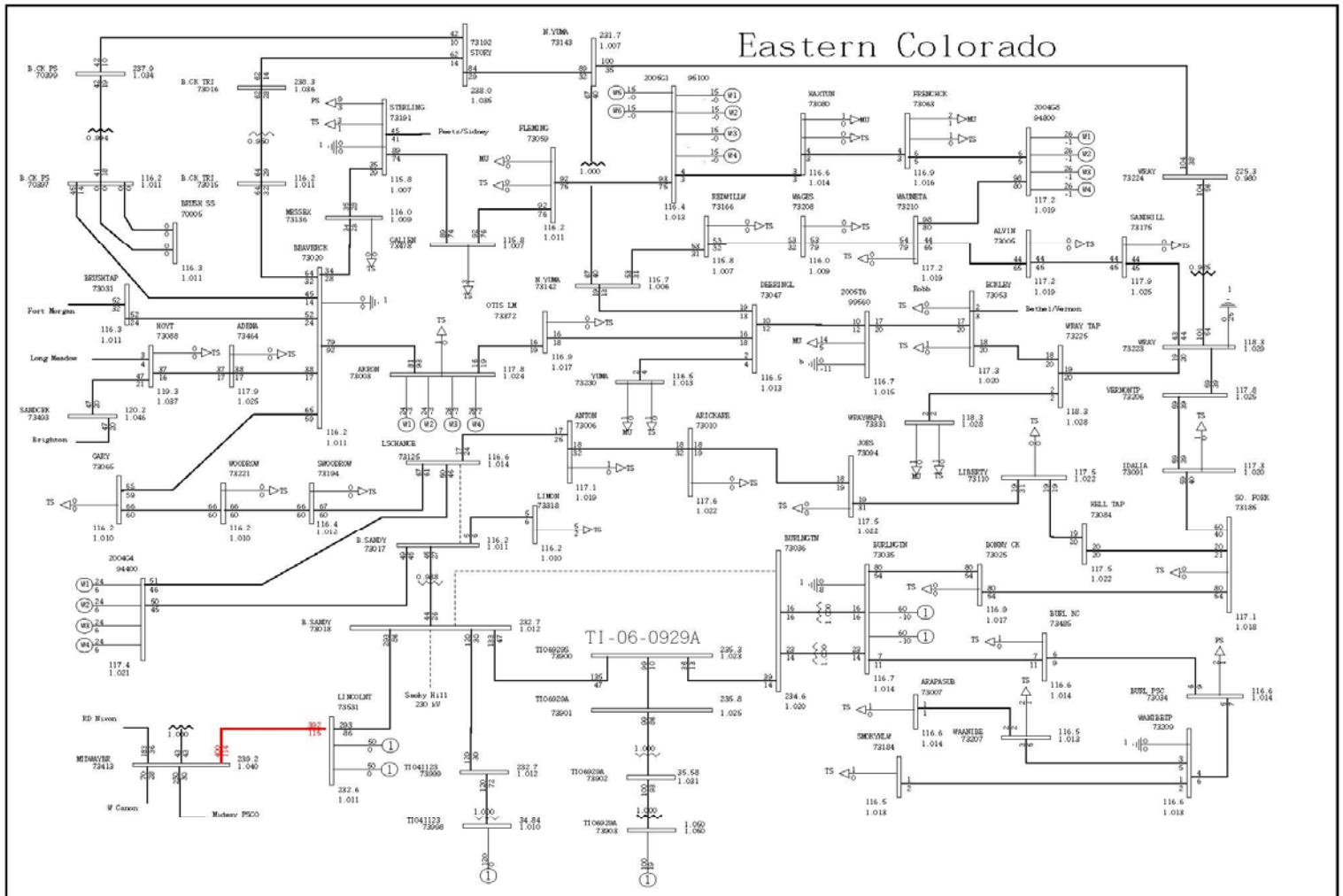
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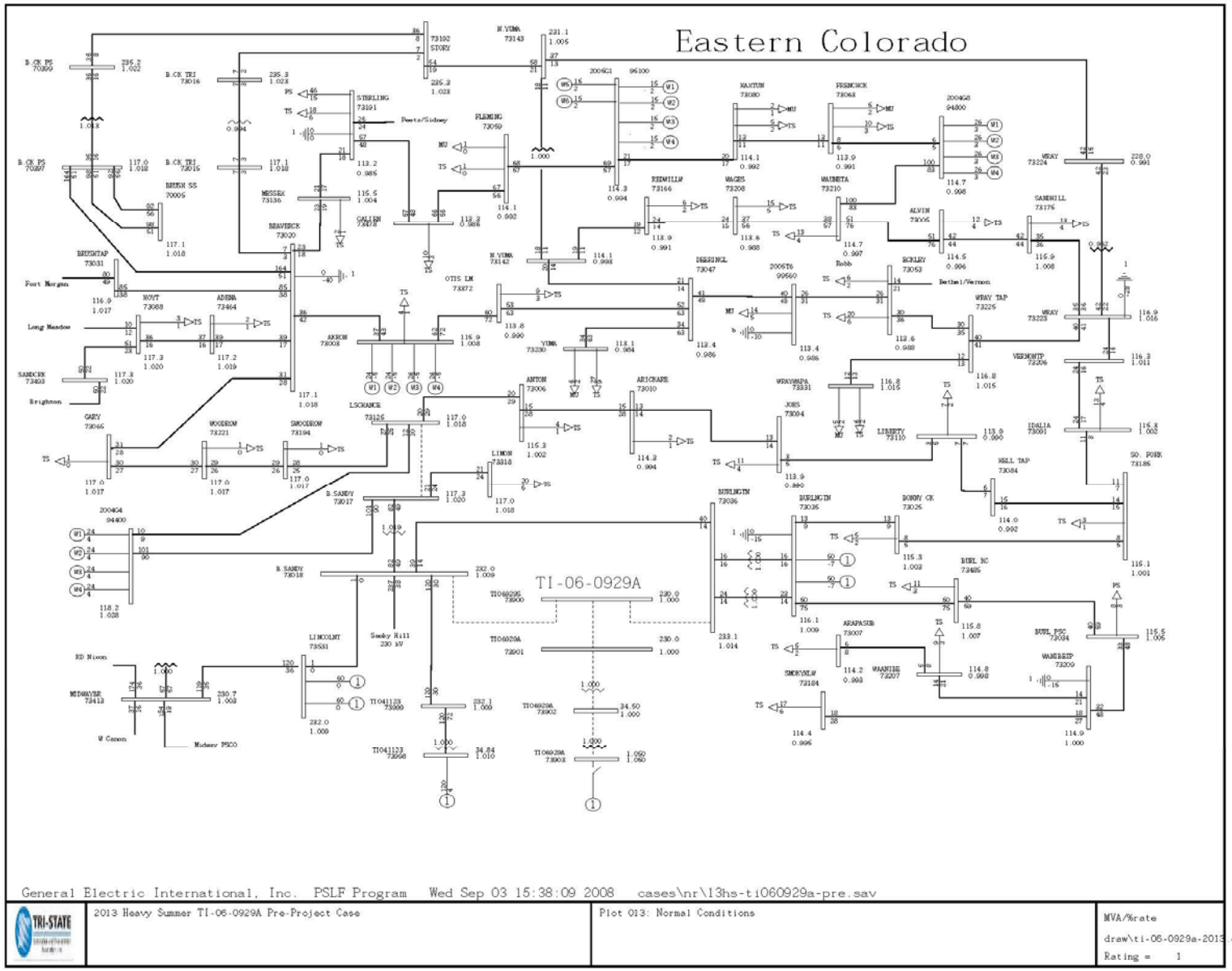
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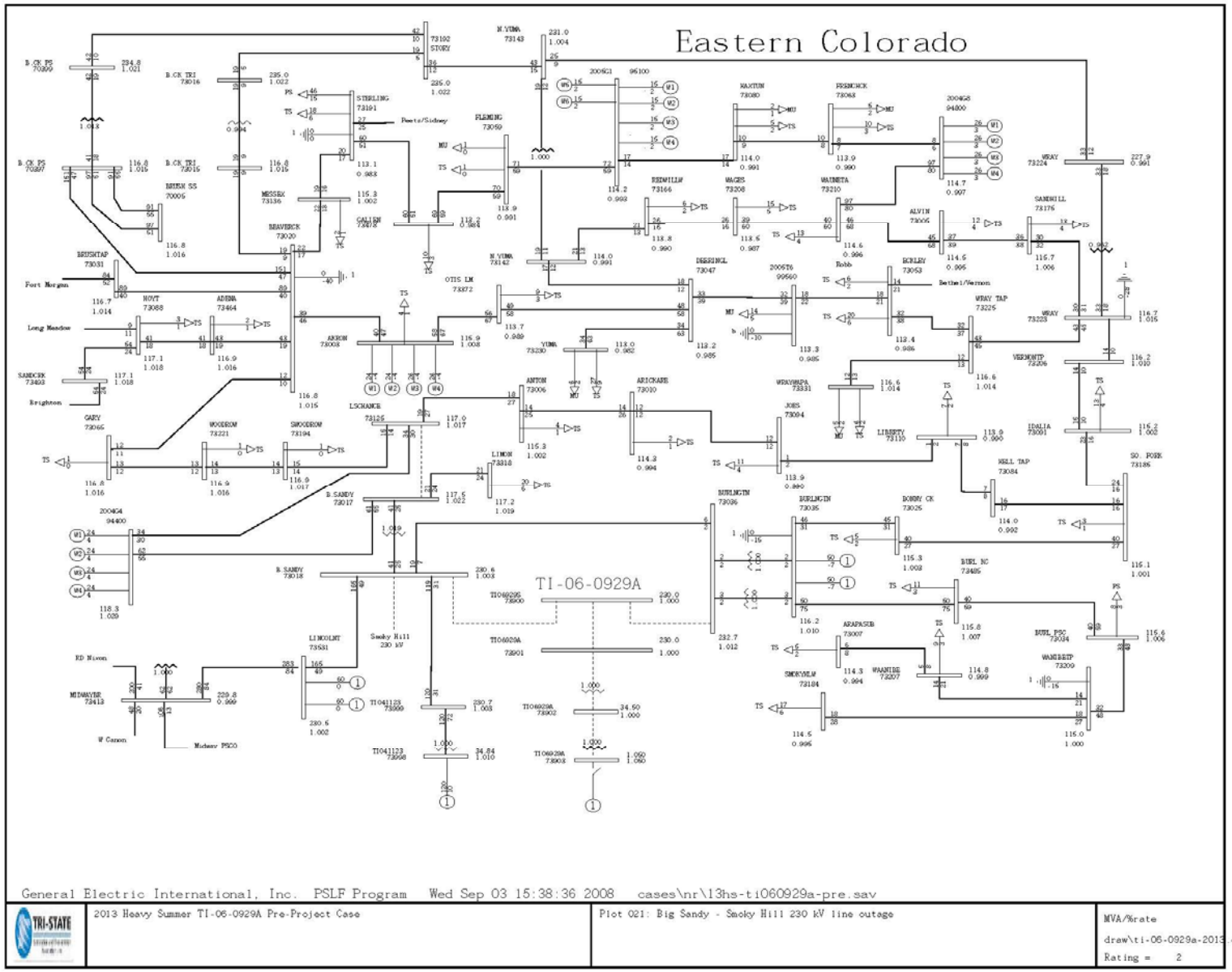
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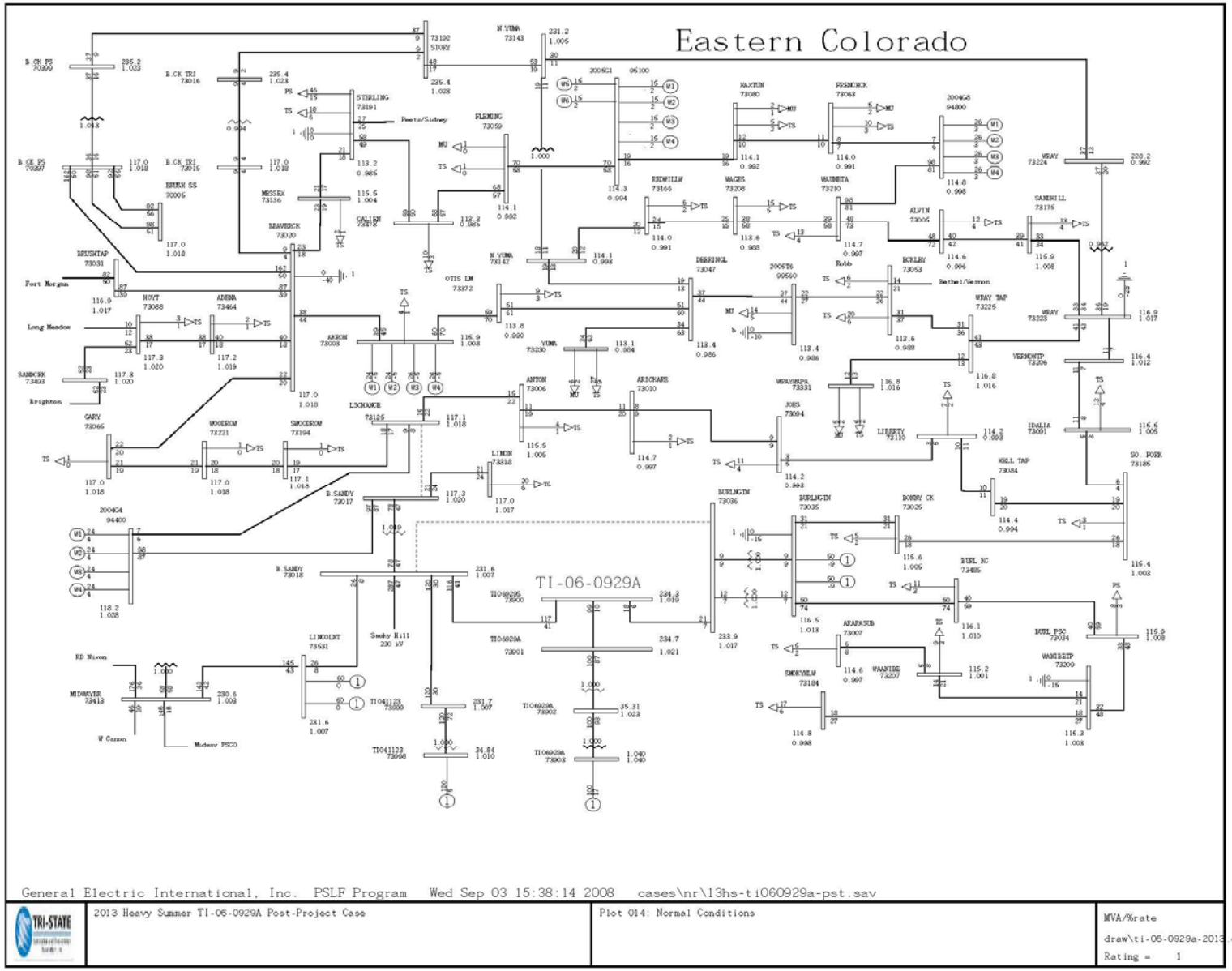
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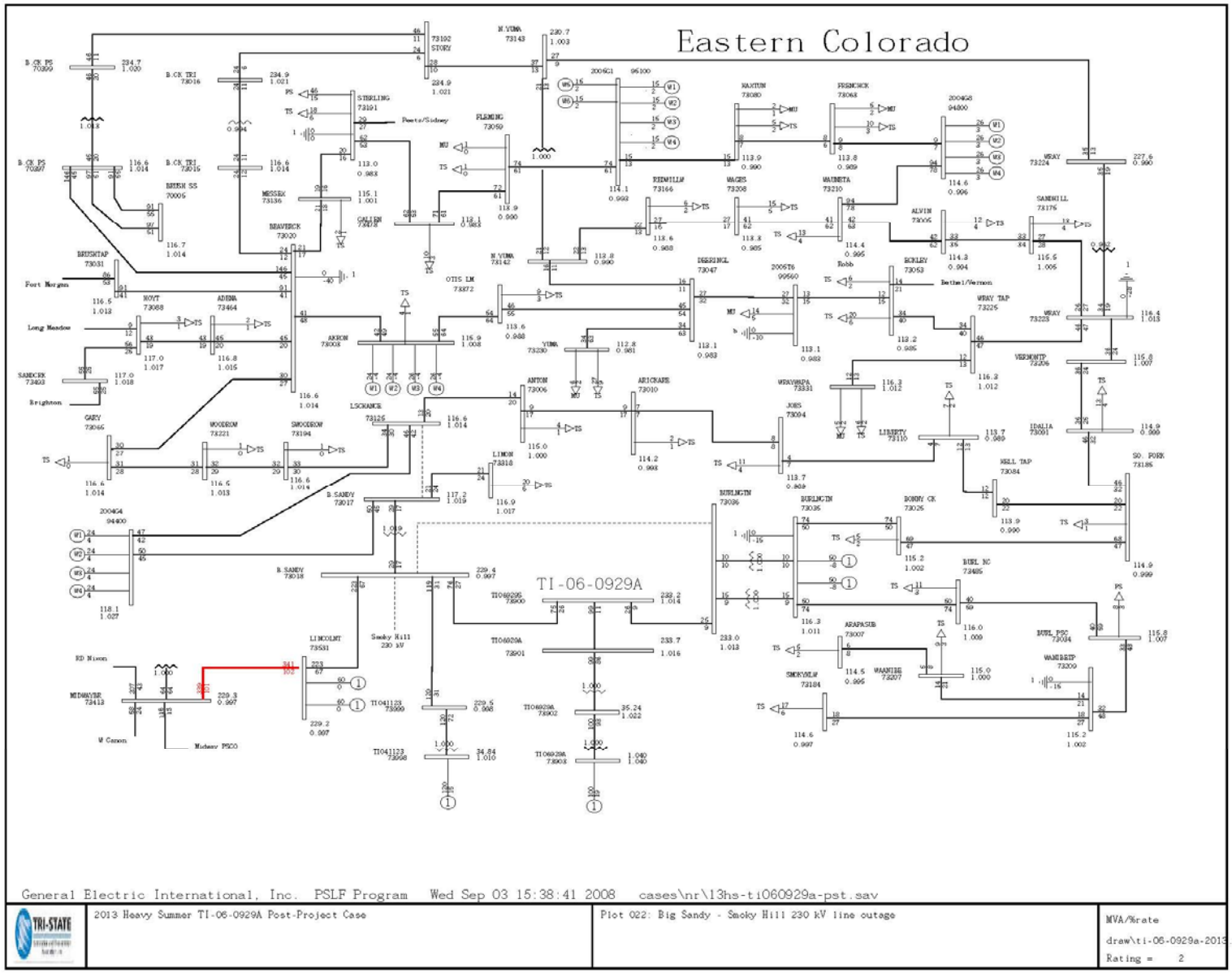
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