2020 Annual Planning Assessment

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1 Executive Summary

Grant County PUD (District) completed the 2020 Annual Planning Assessment of its portion of the Bulk Electric System (BES) in compliance with the North American Electric Reliability Cooperation (NERC) Standard TPL-001-4 (R2). Assessment of the District transmission system based on technical studies shows the system exhibits adequate performance over all scenarios simulated in compliance with NERC Standard TPL-001-4. No corrective action plans are required.

Steady state studies subjected the system to over 17,000 power flow contingencies for seasonal cases out to the year 2030, and no performance violations were identified in this study.

Transient stability studies validate adequate system performance for all required fault types studied in this report.

Short circuit studies of the near-term system model show no circuit breakers exceeding their equipment ratings for fault current performance. No corrective actions plans are required.

2 Introduction

NERC Standard TPL-001-4 *Transmission System Planning Performance Requirements* seeks to, "develop a Bulk Electric System (BES) that will operate reliably over a broad spectrum of System conditions and following a wide range of probable Contingencies."[1] Requirement 2 (R2) of TPL-001-4 states, "Each Transmission Planner and Planning Coordinator shall prepare an annual Planning Assessment of its portion of the BES."[2] This report documents the District's compliance to requirements of TPL-001-4, providing the methodology, modelling, assumptions, criteria, technical studies and engineering analysis used in this study.

The District's transmission system serves over 50,000 customers with a peak load of nearly 1000 MW forecasted for the summer of 2022. The system includes almost 500 miles of high voltage transmission line, 3,900 miles of distribution line, and nearly 2,200 MW of generation provided by Priest Rapids and Wanapum hydroelectric generating stations. The District Transmission System is modelled within a larger interconnection-wide model, often termed a 'case', including facilities throughout the Western United States.

Computer simulations of the western interconnected transmission system provide data for the assessment. These simulations cover summer and winter peak load scenarios for the years 2022, 2025, and 2030, and light spring scenarios for 2022. There are also several sensitivity simulations analyzing impacts of increasing load in the Quincy area for both summer and spring scenarios. The simulation software utilizes triggers to monitor facilities and system performance against NERC and WECC criteria, logging for further analysis any violations found during normal and outage conditions.

Violations are mitigated using either system adjustments or corrective action plans. System operators can use system adjustments to mitigate violations for some types of outages, while other outage events require transmission planners to create corrective action plans. Both types of mitigating steps are presented in the assessment, with the goal being the documentation of a planned system that does not experience any criteria violations in any of the seasonal scenarios studied in this assessment. The planned system includes the current system and documentation of all system adjustments and corrective action plans necessary to maintain adequate performance through the long-term planning horizon.

Throughout the assessment, TPL-001-4 requirements are referenced by a capital 'R' followed by the requirement number (i.e. R1.1.1), and WECC criteria are referenced by a capital 'WR' followed by the criteria number (i.e. WR5.3). These reference designators allow for quick cross referencing of the applicable standard or criteria.

[1] http://www.nerc.com/pa/Stand/Reliability%20Standards/TPL-001-4.pdf
[2] Ibid.

3 Transmission System Modelling

For the purposes of NERC TPL-001-4, the District Transmission System Planning engineers perform the duties and responsibilities of both the Planning Coordinator (PC) and Transmission Planner (TP) for this annual assessment (R7).

3.1 Modeling Methodology

The interconnection-wide modelling data used in this analysis is maintained as described in the District's compliance with NERC Standard MOD-032-1 *Data for Power System Modelling and Analysis* (R1).

In general, NERC's Regional Entity for the Western Interconnection – the Western Electricity Coordinating Council (WECC) – manages a year-round case building process generating the modelling data used by transmission planning engineers for various types of planning studies. The District participates in this process through ColumbiaGrid: the sub-regional planning organization for WECC's Northwest Area 40. ColumbiaGrid passes WECC case building announcements and seasonal transmission models (cases) to the District, and the District updates the cases with District facilities, load, and generation dispatch through the case building methodology described in the District's MOD-032-1 methodology.

3.2 Software Used

PowerWorld Simulator (v21 November, 2020) is used for this assessment. Simulator is an interactive power system simulation package designed to simulate high voltage power system operation on a time frame ranging from several minutes to several days. The software contains a highly effective power flow analysis package capable of efficiently solving systems of up to 250,000 buses. Specific tools used in this analysis include: Steady State Contingency Analysis, Transient Stability Analysis, Voltage Stability Analysis (PVQV), and Distributed Computing. Each seasonal scenario is stored in a single database file (*.pwb), and these files include all modelling and analysis information necessary for the technical studies performed in the assessment.

Simulator includes a Limit Monitor function allowing users to set multiple limit monitor instances with various criteria to track and log when performance metrics violate each monitor. Limit monitoring is the primary means of tracking system performance during analysis.

3.3 Cases Used in the Assessment

Cases used in this analysis are specific to a unique year and season, and they include transmission system facilities (R1.1.1), forecasted load (R1.1.4), seasonal generation dispatch (R1.1.6), and assumed firm and non-firm transmission specific to the year and season (R1.1.5). Each case represents a seasonal P0 condition, or one with all lines in service. The District system is a summer peaking system, but winter peaking cases are included for completeness.

Table 1 documents the cases used for this assessment, showing the WECC cases created specifically to be used during Annual Planning Assessments (R2.2.1). The table also presents the TPL requirements satisfied for selection of the Steady State (SS) and Transient Stability (TS) analysis. As the District has no plans to add or change generation in the Long-Term horizon, no cases are analyzed for transient stability in the Long-Term (R2.5).

Table 1: Annual Planning Assessment Cases

WECC Seed Case	Assessment Case	SS Req.	TS Req.
2020 HS3 Ops	**22_HS**	2.1.1	2.4.1
2020 HS3 Ops	**22_HS_Sensitivity**	2.1.4	2.4.3
2018-19 HW3 Ops	**22_HW**	2.1.1	
2020 LSP1 Scenario	**22_LSP**	2.1.2	2.4.2
2020 LSP1 Scenario	**22_LSP_Sensitivity**	2.1.4	2.4.3
2025 HS2	**25_HS**	2.1.1	
2025 HS2	**25_HS_Sensitivity**	2.1.4	
2025 HW2	**25_HW**	2.1.1	
2030 HS1 ADS	**30_HS**	2.2.1	
2029-30 HW1	**30_HW**	2.2.1	

3.4 District Modelling Assumptions

3.4.1 Projects

The District has no current project plans with acknowledged commitment dates that would justify being modelled in any of the cases used in this analysis (R1.1.3). Corrective action plans created in former studies are only modelled if performance violations exist specific to those corrective action plans in the cases studied in this assessment. This allows the current studies to validate a continuing need for an existing corrective action plan.

3.4.2 Load

Table 2 (R1.1.4) presents District load in each case, and Table 3 presents loads added to three (3) cases to form sensitivity cases (R2.1.4 and R2.4.3). For sensitivity cases, heavy loads are added to the Quincy area to stress the system and model potential and credible load forecast for the 2022 and 2025 heavy summer cases and the 2022 light spring case. The loads are added 5 (five) busses in the Quincy area, and the increased load is balanced by raising the output of Priest Rapids and Wanapum hydro generation facilities.

For Transient Stability analysis, the WECC Composite Load Model provides expected dynamic behavior for all loads during analysis (R2.4.1).

Table 2: Base Case Loads

	HS Load		HW Load		LSP Load	
	MW	MVar	MW	MVar	MW	MVar
2022	906	247	894	145	684	185
2025	1053	287	1028	179		
2030	1137	312	1090	185		

Table 3: Sensitivity Case Loads

Bus Name	MW	MVar
CLD VIEW	6.93	2.3
QPLAINS	10.74	3.61
NQUINCY	57.75	19.1
MNT VIEW	137.4	45.0
WQUINCYT	57.25	18.7

3.4.3 Area Resources

The following tables present area generation including that owned by the District and used for load service (R1.1.6). For each of the seasonal cases, the case building process within ColumbiaGrid and WECC balance forecasted load and generation to create the implied firm transmission and area interchange based on historic and projected power flows within the Western Interconnection (R1.1.5 and R1.1.6).

Table 4: Summer Generation Dispatch

	Total Output MW / % Max Output					
	22 HS		25 HS		30 HS	
Grand Coulee	4526	66	4462	65	4555	67
Chief Joseph	1533	59	1610	62	1610	62
Wells	640	75	480	56	480	56
Rocky Reach	966	70	987	72	987	72
Rock Island	358	53	358	53	358	53
Wanapum	845	75	845	76	845	75
Priest Rapids	614	65	614	65	614	65
McNary	687	61	777	69	777	69
John Day	1663	67	1663	67	1663	67
The Dalles	1375	66	1433	69	1433	69
Bonneville	667	53	588	47	586	47
Columbia River	**13873**	**65**	**13818**	**65**	**13908**	**65**

Table 5: Winter Generation Dispatch

	Total Output MW / % Max Output					
	22 HW		25 HW		30 HW	
Grand Coulee	4731	69	4783	70	4705	69
Chief Joseph	1706	65	2089	80	2089	80
Wells	640	75	720	84	720	84
Rocky Reach	998	73	859	63	998	73
Rock Island	416	62	367	55	419	62
Wanapum	845	71	748	67	845	75
Priest Rapids	790	83	790	83	790	83
McNary	619	55	847	75	847	75
John Day	1801	73	1938	78	1938	78
The Dalles	1519	73	1604	77	1604	77
Bonneville	846	67	891	71	891	71
Columbia River	**14910**	**70**	**15637**	**73**	**15846**	**74**

Table 6: Light Spring Generation Dispatch

	Total Output MW / % Max Output	
	21 LSP	
Grand Coulee	394	6
Chief Joseph	384	15
Wells	320	37
Rocky Reach	503	37
Rock Island	189	28
Wanapum	470	42
Priest Rapids	525	55
McNary	325	29
John Day	555	22
The Dalles	386	19
Bonneville	272	22
Columbia River	**4321**	**20**

3.4.4 Known Outages

The District's outage planning process does not forecast any outages of a duration of at least six months in the near-term or long-term planning horizon; therefore, no planned outages are modelled in any of the cases used in this analysis (R1.1.2).

3.4.5 Spare Equipment Strategy

The District maintains spare equipment for all transmission system facilities that could have an order lead time of one year or more; therefore, no additional analysis is required or performed to determine system performance impacts due the lack of spare equipment (R2.1.5).

3.4.6 Long-Term Planning Horizon Material Generation Changes

The District has no plans for any generation changes in the long-term planning horizon; therefore, no cases are created or analyzed for transient stability performance due to material generation changes (R2.5).

3.5 Contingency Definitions

Steady state and transient stability contingency definitions are created using both manual and automated process in compliance with TPL-001-4 Table 1.

3.5.1 Steady State

P1 (N-1) contingency definitions are created for every generator, line, transformer, and shunt owned by the District and connected to the transmission system. Simulation software automatically combines the P1 events into a full list of P3 and P6 events (N-1-1). P2, P4, P5, P7, and Extreme Event contingency definitions are created for outages that historical, regional, and other studies show produce the most severe system impacts on the District system (R3.4, R3.5). Additionally, the contingency list includes definitions for neighboring systems collected at Columbia Grid, resulting in a list of 17,014 contingencies.

Each contingency includes expected actions of the protection system for the outage under study (R3.3.1), and simulation software is set to allow automated shunt capacitors to function as expected (R3.3.2). Additionally, P3 and P6 definitions do not include system adjustments between the first and second event, and any need for system adjustments is discussed in the analysis section of the assessment.

3.5.2 Transient Stability

The stability contingency list includes both Planning and Extreme event definitions (R4.1, R4.2). Planning and Extreme events are chosen based on severe system responses noted in historic, regional, and other studies (R4.4, R4.5), and several regional contingency definitions are included in this list (R4.4.1). Contingency definitions include the removal of all elements expected to be removed by the protection system (R4.3.1), and high-speed reclosing (<1s) is included in several definitions (R4.3.1.1). Additionally, generation resources in the Western Interconnection include dynamic models, and these models are enabled to provide automatic and dynamic control of system quantities during the run of each contingency (P4.3.2).

Where simulation shows generator bus voltages lower than the expected trip for low voltage ride through or protection element tripping indicated by the modelled distance relays, those contingency definitions will be edited to include the indicated facility tripping and run again (R4.3.1.2, R4.3.1.3).

4 Performance Criteria

Almost all performance criteria required by NERC TPL-001-4 and WECC TPL-001-WECC-CRT-3 are stored in the database file (.pwb) for each seasonal case. The criteria establish software triggers set to log performance violations when simulations are run in both the steady state and transient stability analyses. The following sections present criteria for the different types of analysis done in this assessment.

4.1 Steady State Criteria

4.1.1 Thermal and Voltage Performance

District Transmission lines and transformers have continuous and emergency facility thermal ratings stored in each case. Simulations will log performance violations when transmission line or transformer power flow exceeds 100% of the continuous rating during steady state contingency analysis. Facility voltage performance is determined by the event analyzed from TPL-001-4 Table 1. For P0 conditions, voltage violations are logged for any load bus voltage recorded outside the range of 95% to 105% of nominal (R5, WR1.1.1). For P1-P7 outage events, load bus voltages are logged as violations if post-contingency voltage is outside the range of 90% to 110% (R5, WR1.1.2). Additionally, any load bus experiencing a change in bus voltage greater than 8% for P1 events is logged as a violation (R5, WR1.2).

4.1.2 System Stability

4.1.2.1 Cascading or Uncontrolled Islanding

Any scenario resulting in post-contingency line or transformer loading greater than 125% of the highest seasonal facility rating will be further analyzed for potential to become a cascading scenario or result in uncontrolled islanding (WR4).

4.1.2.2 Voltage Stability

Load Area QV analysis is used to validate voltage stability performance, and violations are noted if positive reactive margin is not maintained when load is 105% of forecasted peak for P0-P1 events, or 102.5% of forecasted peak for P2-P7 events (WR5.3 and WR5.4). District load is scaled to 110% before analysis, and the load area buses analyzed are: White Trail 115 kV Tap, Warden 115 kV Tap, Mountain View 230 kV, North Quincy 230 kV and Silicon 230 kV.

4.1.3 Performance Based Contingency Analysis

4.1.3.1 Generator Low Voltage Ride-thru

Any generator low-side bus having a post-contingency voltage less than 0.90 PU of nominal for more than 3.0 seconds will be assumed to have tripped during the event. Violating events will be duplicated and redefined with those tripping generators being de-energized as part of the scenario, and the scenario will be run again to check for performance violations (R3.3.1.1).

4.1.3.2 Relay Loadability

District relay loadability settings will trip a transmission element if loading exceeds 150% of the facility thermal rating. Any transmission elements with a post-contingency loading greater than 150% will be deemed as tripped during the event, and the original event definition will be duplicated to add the tripped element and run again to check for performance violations (R3.3.1.2).

4.2 Transient Stability Criteria

4.2.1 Transient Voltage Performance

Several limit monitor settings in each case track voltages and log violations to assess for post-fault voltage recovery (R5, WR1.4, WR1.5) and voltage stability (R6, WR1.3). The limit monitoring settings are taken directly from WECC Criterion TPL-001-WECC-CRT-3.1.

4.2.2 Generation Out of Synchronism and Power Oscillations

A limit monitor in each case monitors generator rotor angle during P0 – P7 events, and the monitor records a violation if any generator rotor angle deviates by more than 180 degrees from its initial value (R4.1.1). Additionally, power system oscillations are checked for acceptable damping by manually inspecting plots of generator power flow for all transient stability scenarios run in this analysis (R4.1.3).

4.2.3 Relay Misoperation for Power Swings

Generic zone distance relays (DISTRELAY) are installed on all District transmission lines, and all relays are set to log instances when the relay would have tripped. Event logs for each transient stability scenario are checked for correct operation of each instance of DISTRELAY, and any misoperation is logged as a violation (R4.1.2).

4.2.4 Unrestrained Successive Load or Generation Loss

Each transient stability event log is checked for load and generation losses not directly related to the event definition (WR4), and any noted loss is treated as a performance violation.

4.3 Short Circuit Criteria

Fault current recorded during short circuit analysis is compared against the District's equipment ratings for each circuit breaker to determine adequate performance.

5 Steady State Study Results

5.1 Thermal and Voltage Studies

Steady state analysis of all cases used in this study finds the District system maintains adequate performance for all contingencies studied; no performance violations were found.

For a fault on the Columbia-West Quincy 230kV line section, the post-contingency voltage of 0.9297 pu in the Quincy area (Table 7) is approaching the low voltage limit of 0.90 pu. This has been flagged in past GCPD studies, and it is recommended to install a total of 40 MVAR of capacitors at Mountain View substation to bring the post-contingency voltage in the Quincy area to greater than 0.95 pu.

Table 7: Steady State Contingency Analysis Results

P4.2_BF: Columbia 230 Flt Larson-Rocky Ford 230 + Closing Rocky Ford	2025HS Sensitivity
Bus Low Volts	
MNT VIEW (46289)	0.9297
WQUINCYT (46298)	0.9305

5.2 System Stability in the Steady State

5.2.1 Cascading and/or Uncontrolled Islanding

The WECC criterion for detecting the potential for system instability in the steady state focusses on outages resulting in excessing thermal loading or unrestrained loss of load and generation. For this assessment, the WECC stability criteria are met given no transmission line loading greater than 125% is noted for any outage studied in this assessment and no unintentional islands are created (WR4).

5.2.2 Reactive Margin

The WECC criterion for voltage stability in the steady state focusses on the amount of reactive power margin remaining at load buses once an outage occurs. When reactive power margin is low at load buses, fault conditions can cause local voltage collapse at those buses. For this assessment, voltage stability criteria are met given positive reactive margin (a negative MVar value) is maintained for all load busses analyzed with District loads scaled to 110% in the 2022 Heavy Summer and Heavy Summer scenarios (WR5.3 and 5.4). QV curves for each monitored bus are presented in **Appendix A: QV Analysis Results**.

5.3 Performance Based Contingency Analysis

NERC TPL-001-4 requires a rewrite and rerun of any contingency showing generators would have tripped for bus voltage going below the minimum ride through requirement or transmission facilities would have tripped for relay loadability levels being exceeded/

For this assessment, no generator bus voltages fell below the 0.90 PU during technical studies (R3.3.1.1), and no transmission line loading exceeded the 150% of rated capacity; therefore, no scenarios had to be re-written and analyzed for this assessment (R3.3.1.2).

5.4 Conclusion for Steady State Technical Studies

This assessment finds the District transmission system has adequate steady state performance through the long-term planning horizon and no steady state system stability issues are present.

6 Transient Stability Study Results

6.1 Transient Voltage and Generation Stability Performance

Transient stability analysis shows adequate District transmission system performance for all cases studied; no Limit Monitoring criteria violations were found in this study (R5, WR1.4, WR1.5, R6, and WR1.3). Plots of system performance for representative contingencies are provided in **Appendix B: Transient Stability Plots**.

6.2 Dynamic Stability

6.2.1 Transient Power Oscillation Damping

Post-transient generator power swings are required to show positive damping within 30 seconds of clearing a fault. For this assessment, plots of generator power over time were created and analyzed for damping, and all cases show positive damping within the required 30 seconds (R4.1.3, WR1.6).

6.2.2 Relay Misoperation for Power Swings

Special transmission line models (DISTRELAY) are installed on each end of every line owned by the District. These relay models act as Zone Distance relays, and while the models are capable of tripping lines during contingency analysis for faults within the relay zones, they are set to log any trips in each contingencies' trip event log. Each log was checked for instances of a relay tripping for a fault not within the relay's zone (misoperation), and no relay misoperation events were found for any cases studied in this assessment (R4.1.2).

6.2.3 Unrestrained Successive Load or Generation Loss

Event logs for each outage were analyzed for instances of generation or load loss that were not directly attributed to the fault defined and protection system actions expected. No cascading load or generation loss was found for any cases studied in this assessment (WR4).

6.3 Conclusion for Transient Stability Technical Studies

This assessment finds the District transmission system has adequate transient stability performance through the long-term planning horizon. No corrective action plans or system adjustments are necessary.

7 Short Circuit Analysis Results

Technical studies of the near-term system model show no exceedance of circuit breaker interrupting duty; therefore, no corrective actions plans are required.

8 Conclusion

Grant County PUD (District) completed the 2020 Annual Planning Assessment of its portion of the Bulk Electric System (BES) in compliance with the North American Electric Reliability Cooperation (NERC) Standard TPL-001-4 (R2). Assessment of the District transmission system based on technical studies shows the system exhibits adequate performance over all scenarios simulated in compliance with NERC Standard TPL-001-4. No corrective action plans are required.

Steady state studies subjected the system to over 17,000 power flow contingencies for seasonal cases out to the year 2030, and no performance violations were identified in this study.

Transient stability studies validate adequate system performance for all required fault types studied in this report.

Short circuit studies of the near-term system model show no circuit breakers exceeding their equipment ratings for fault current performance. No corrective actions plans are required.

9 Appendix A: QV Analysis Results

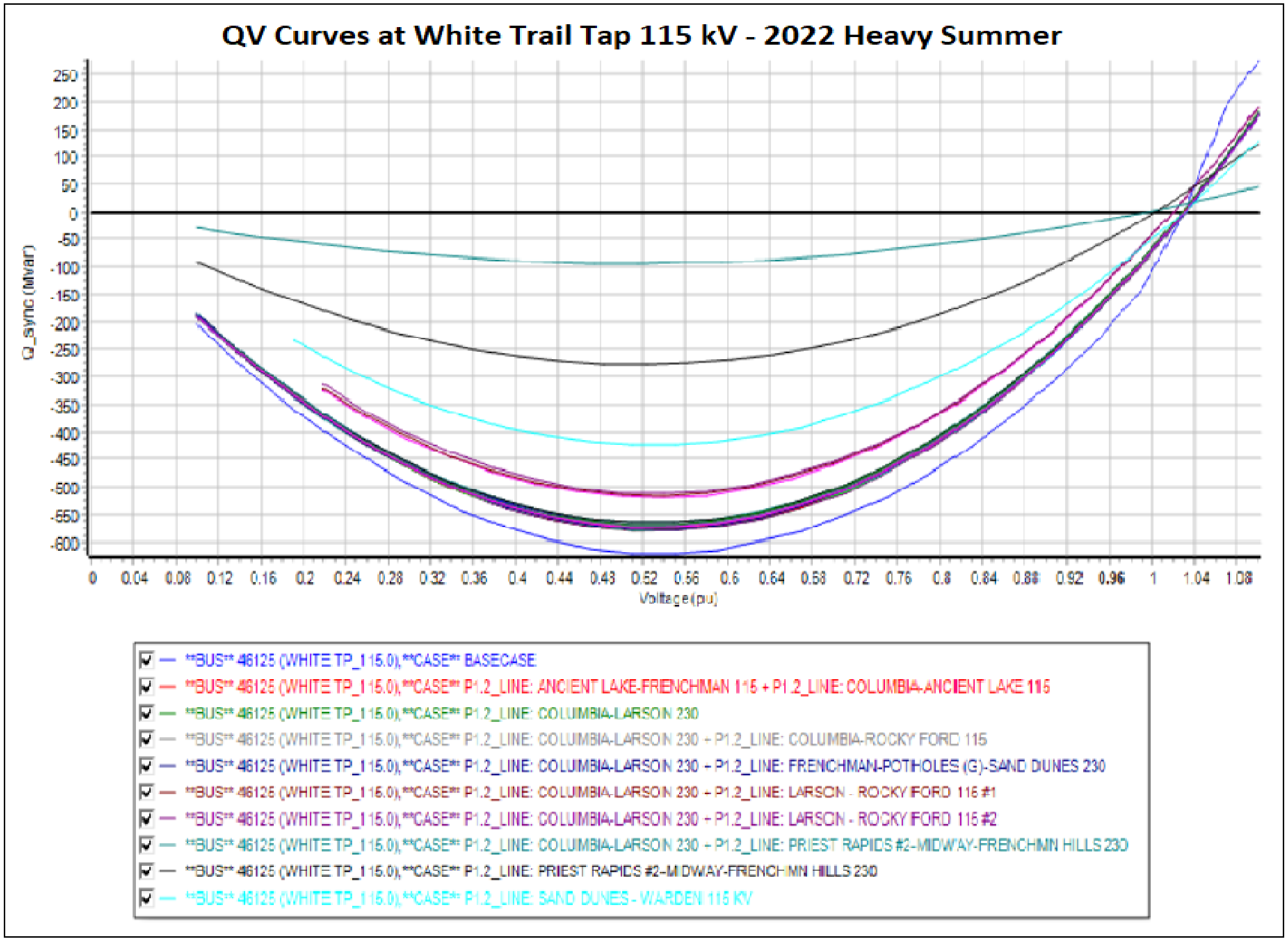

Figure 1: QV Curve at White Trail Tap 115 kV – 2022 Heavy Summer

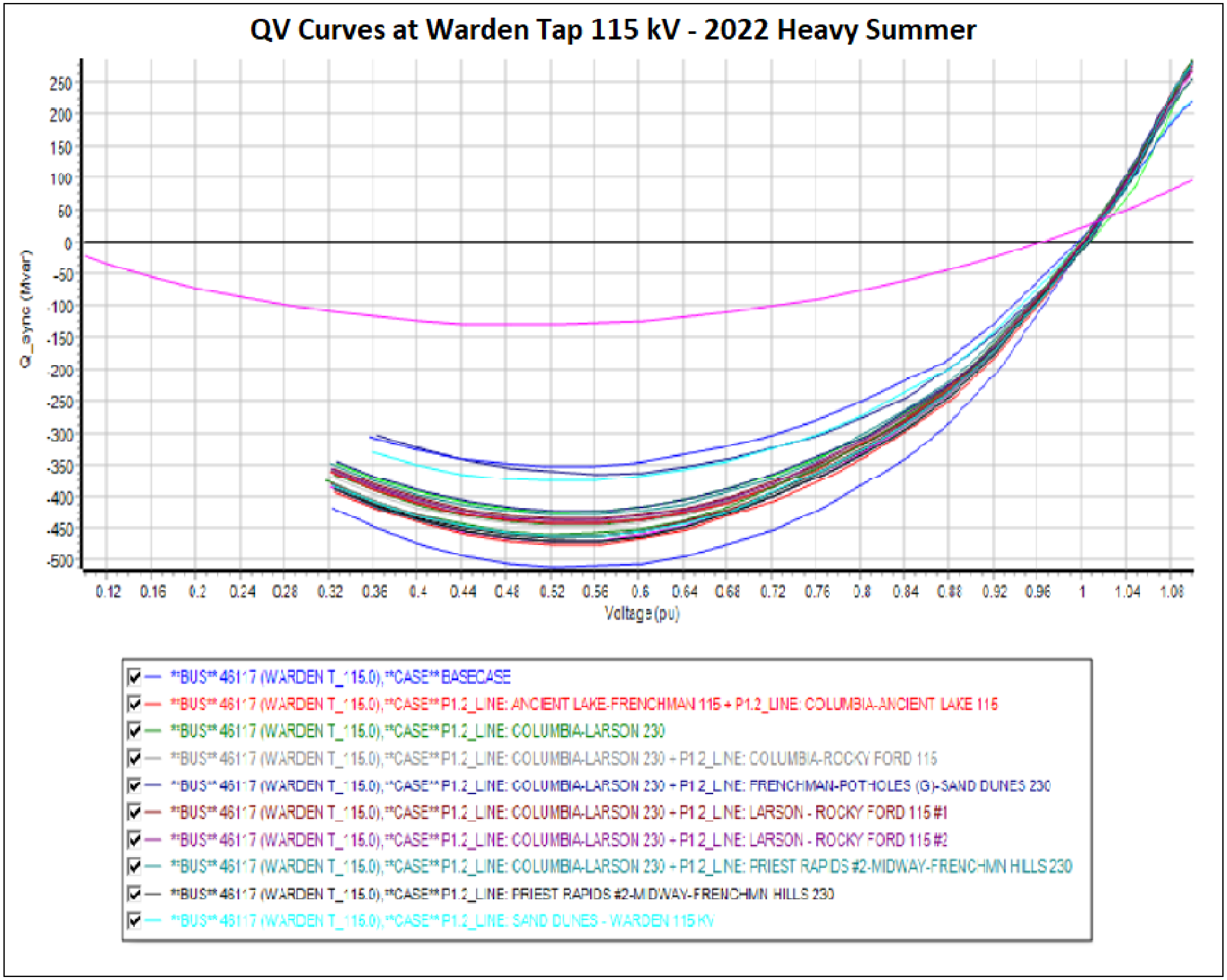

Figure 2: QV Curve at Warden Tap 115 kV – 2022 Heavy Summer

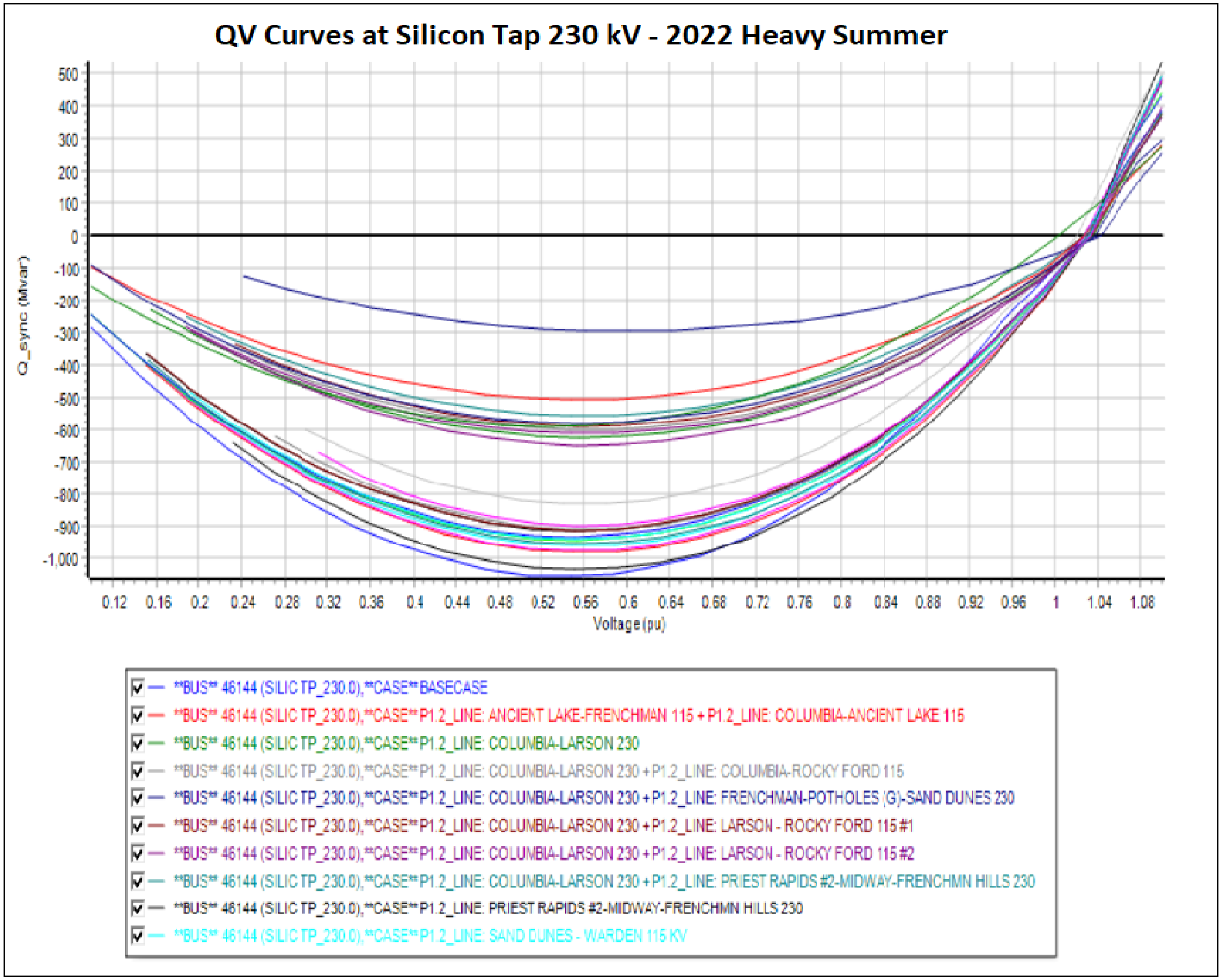

Figure 3: QV Curve at Silicon Tap 230 kV – 2022 Heavy Summer

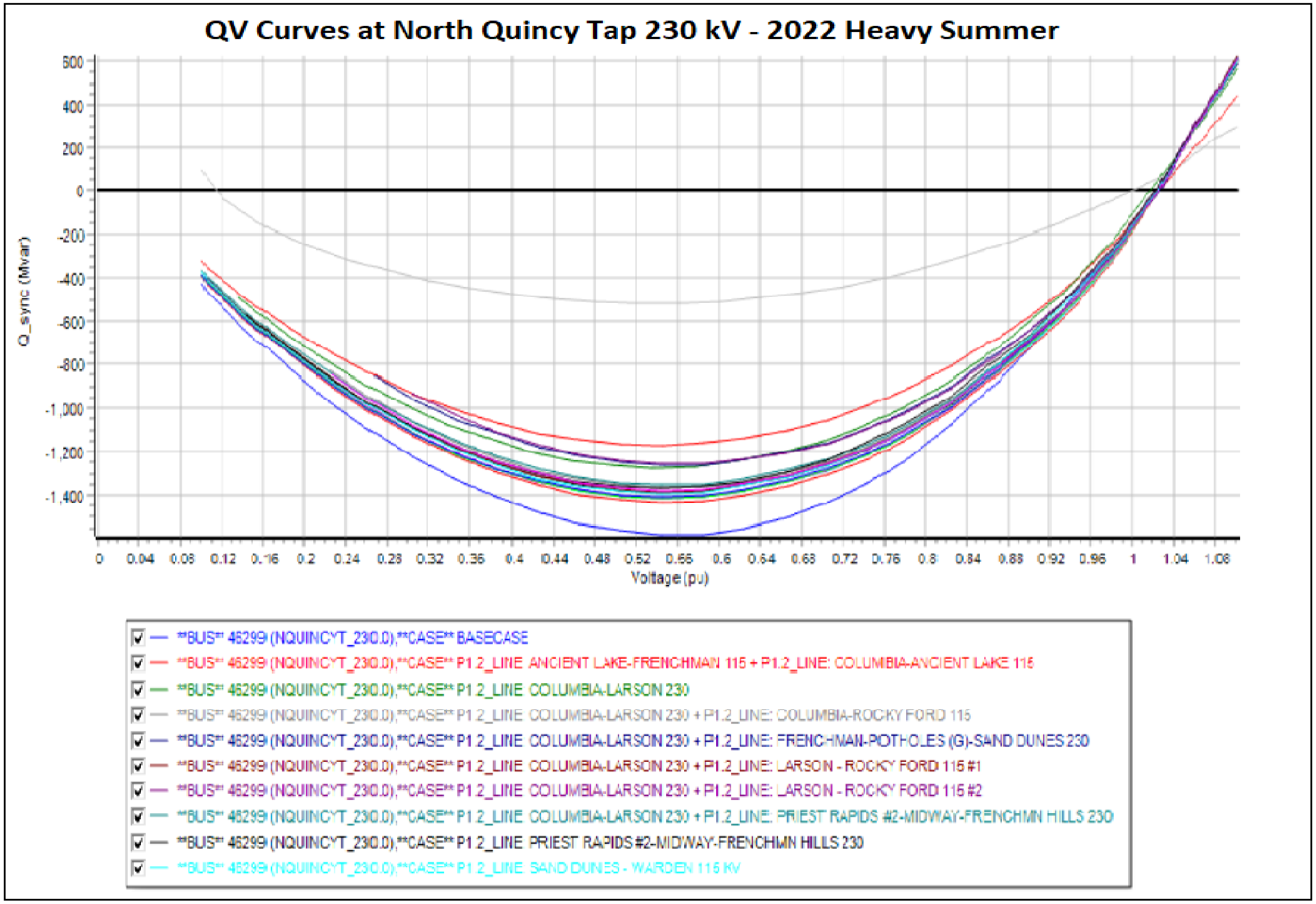

Figure 4: QV Curve at North Quincy Tap 230 kV – 2022 Heavy Summer

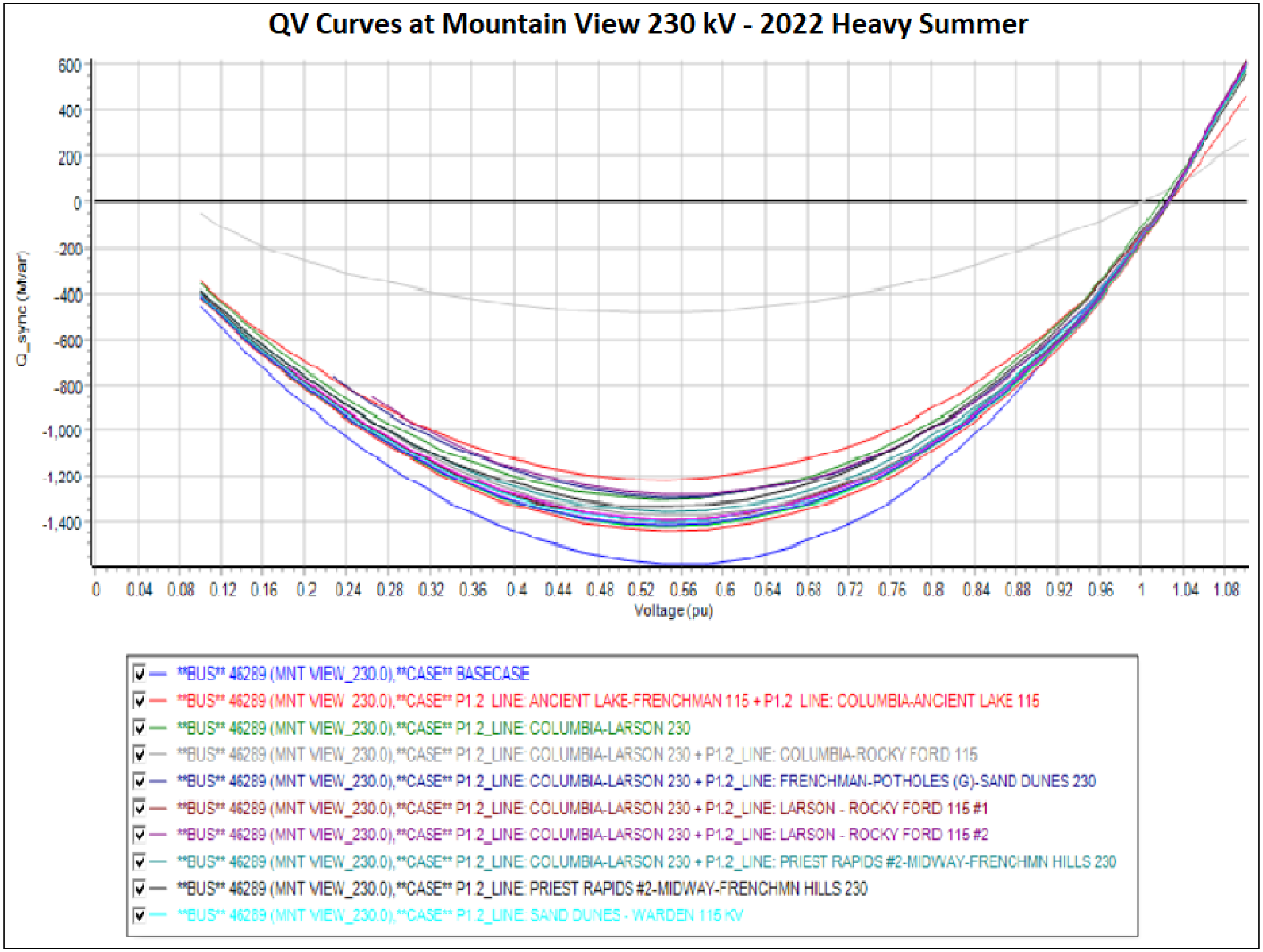

Figure 5: Mountain View 230 kV QV Curve – 2022 Heavy Summer

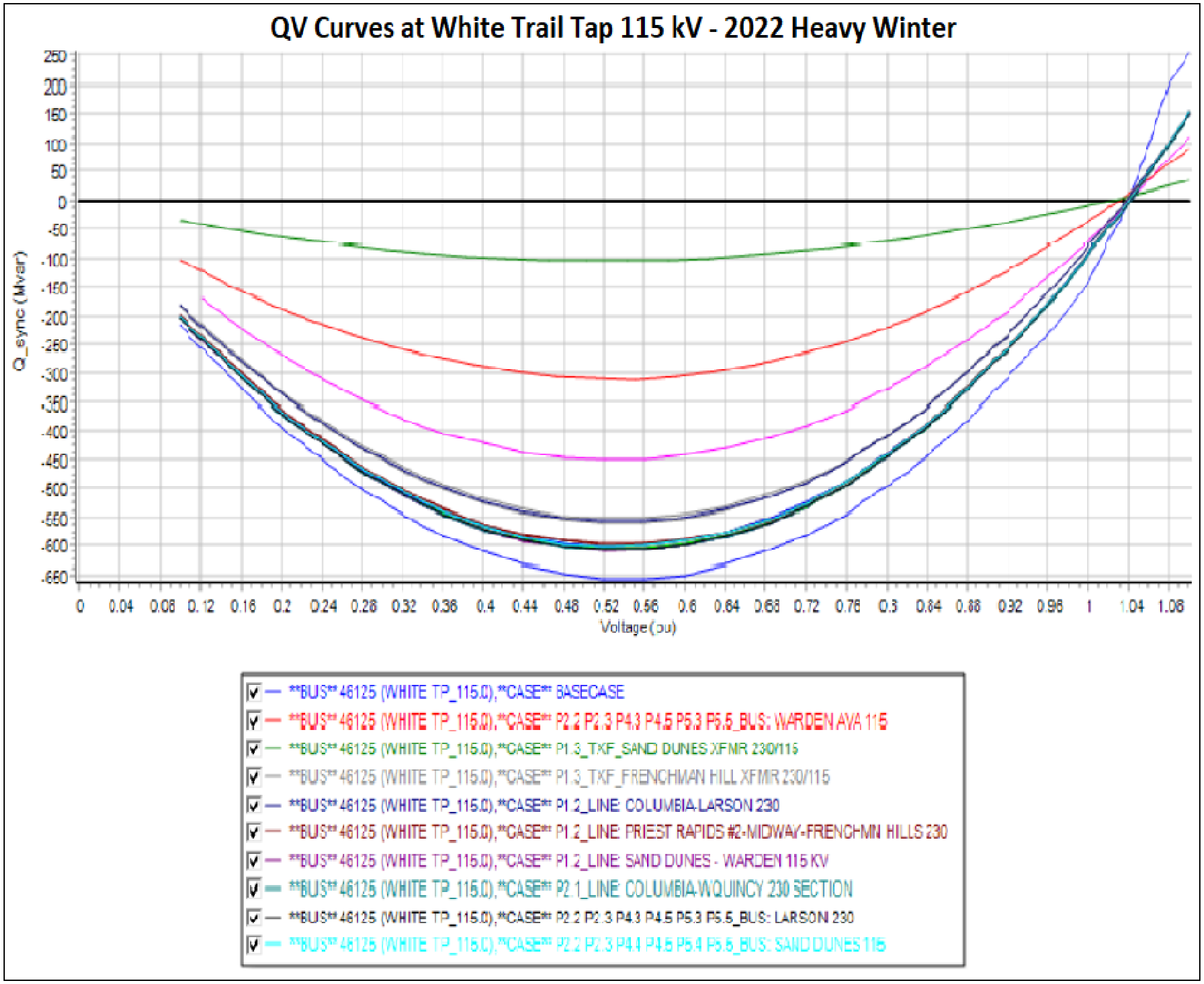

Figure 6: QV Curve at White Trail Tap 115 kV – 2022 Heavy Winter

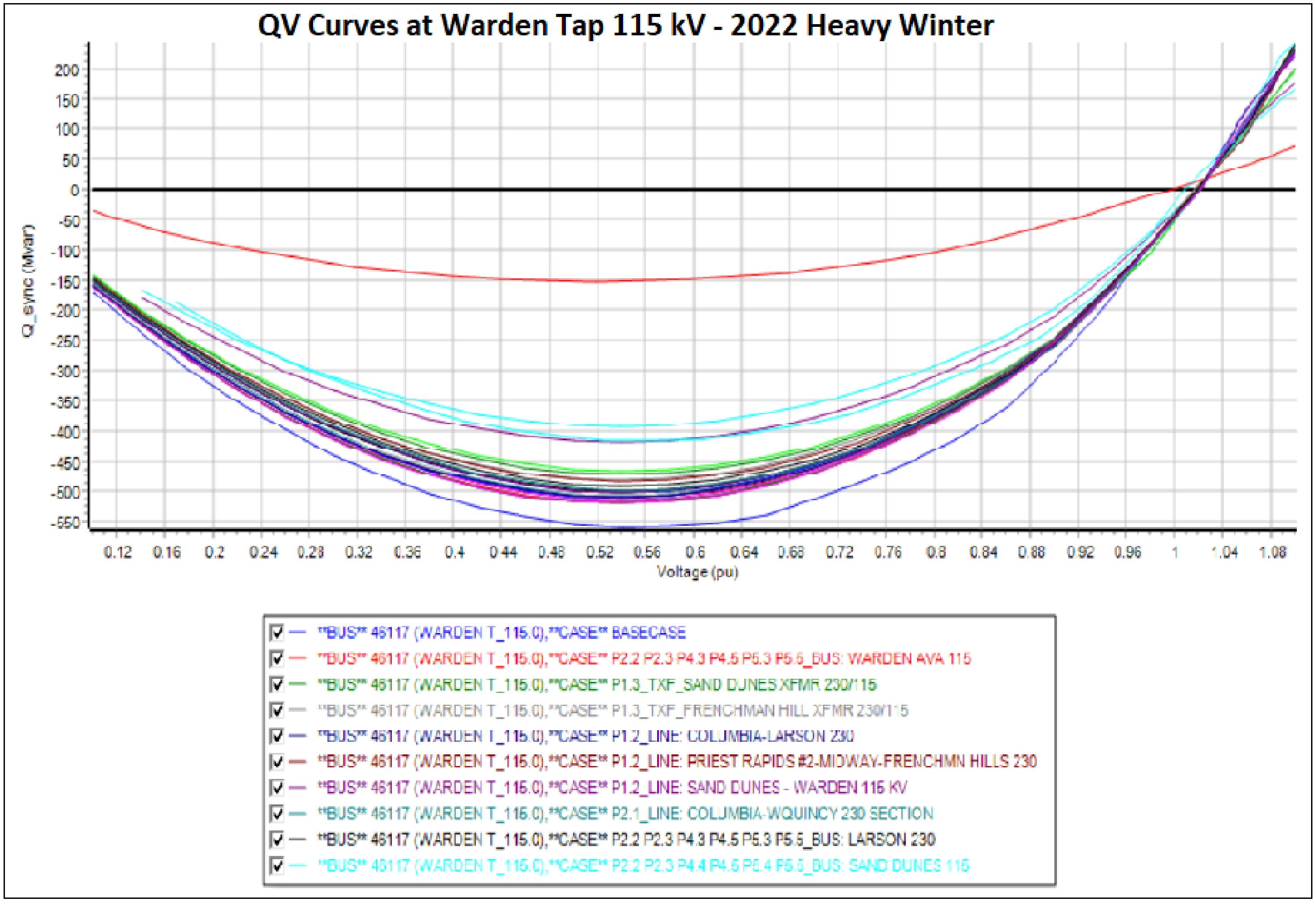

Figure 7: QV Curve at Warden Tap 115 kV – 2022 Heavy Winter

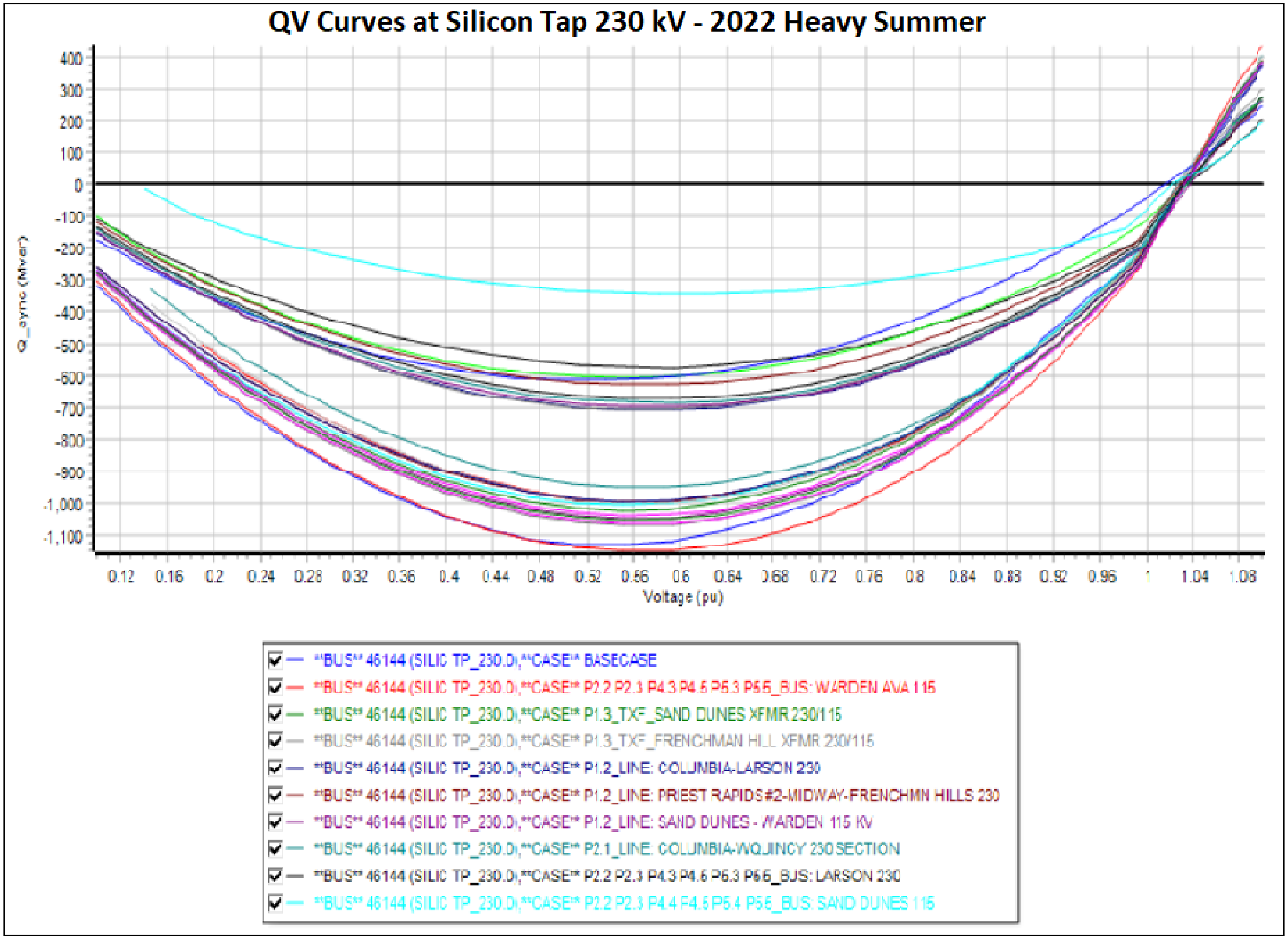

Figure 8: QV Curve at Silicon Tap 230 kV – 2022 Heavy Winter

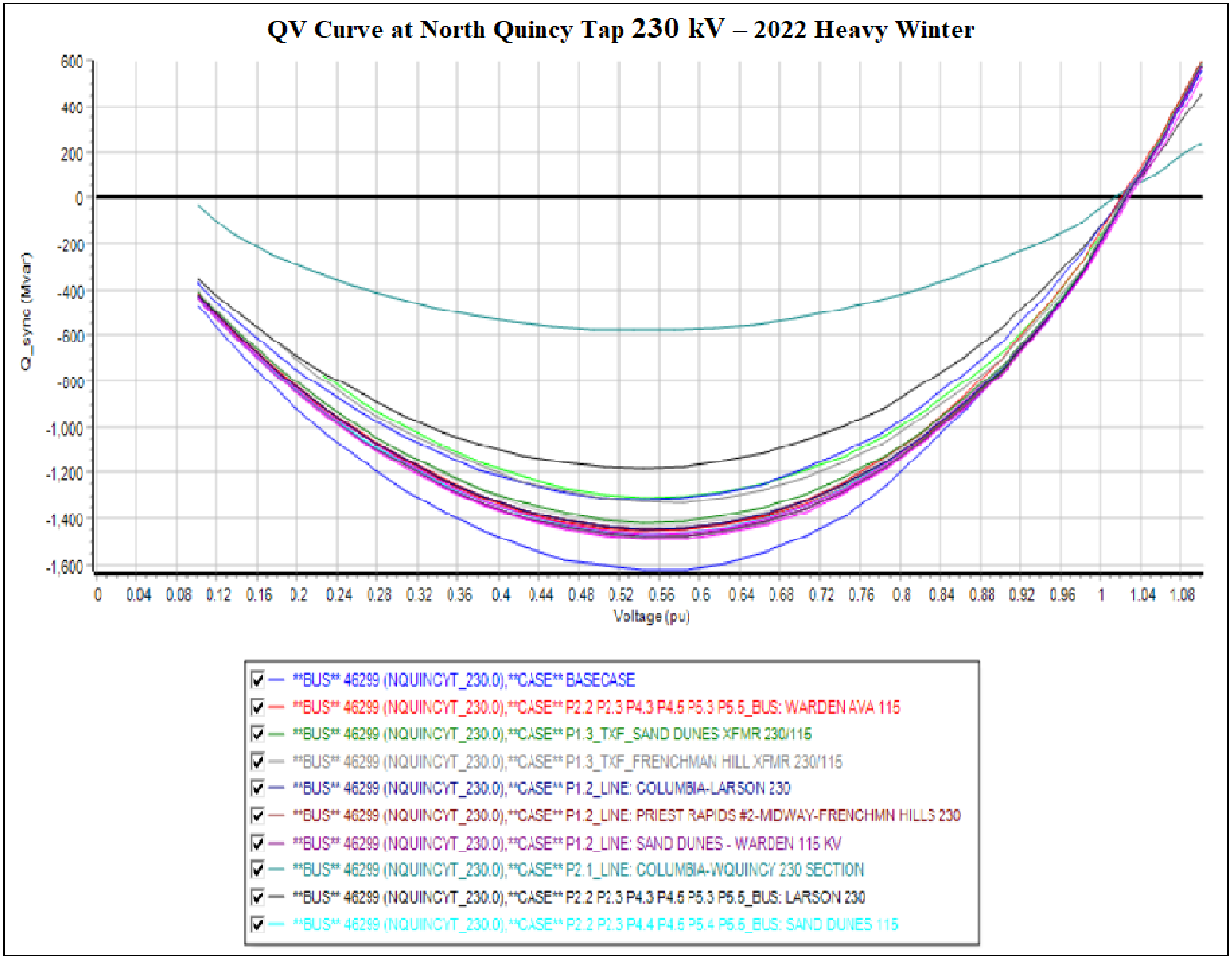

Figure 9: QV Curve at North Quincy Tap 230 kV – 2022 Heavy Winter

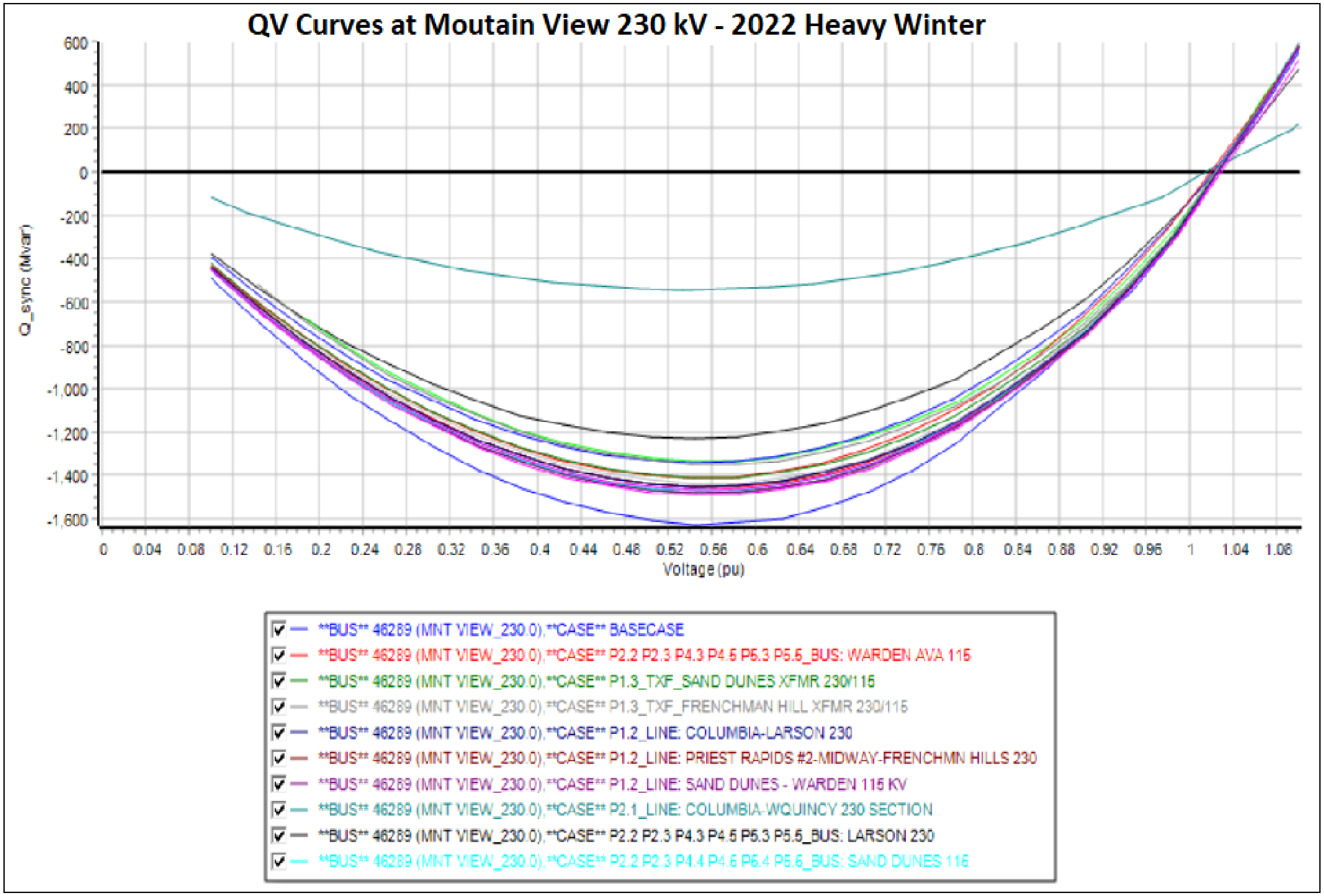

Figure 10: Mountain View 230 kV QV Curve – 2022 Heavy Winter

10 Appendix B: Transient Stability Plots

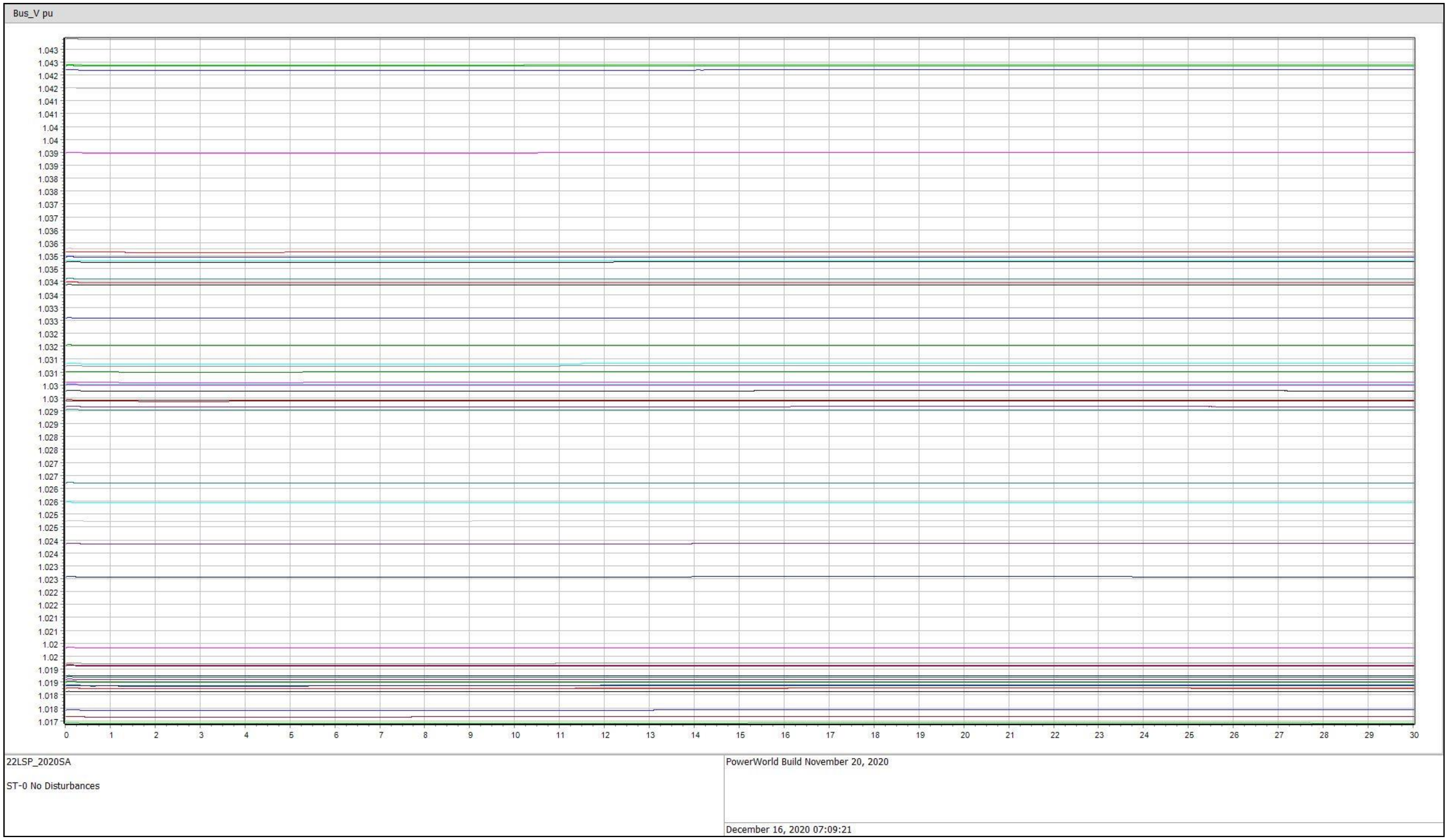

Figure 11: No Disturbance; Bus Voltage, 2022 Light Spring

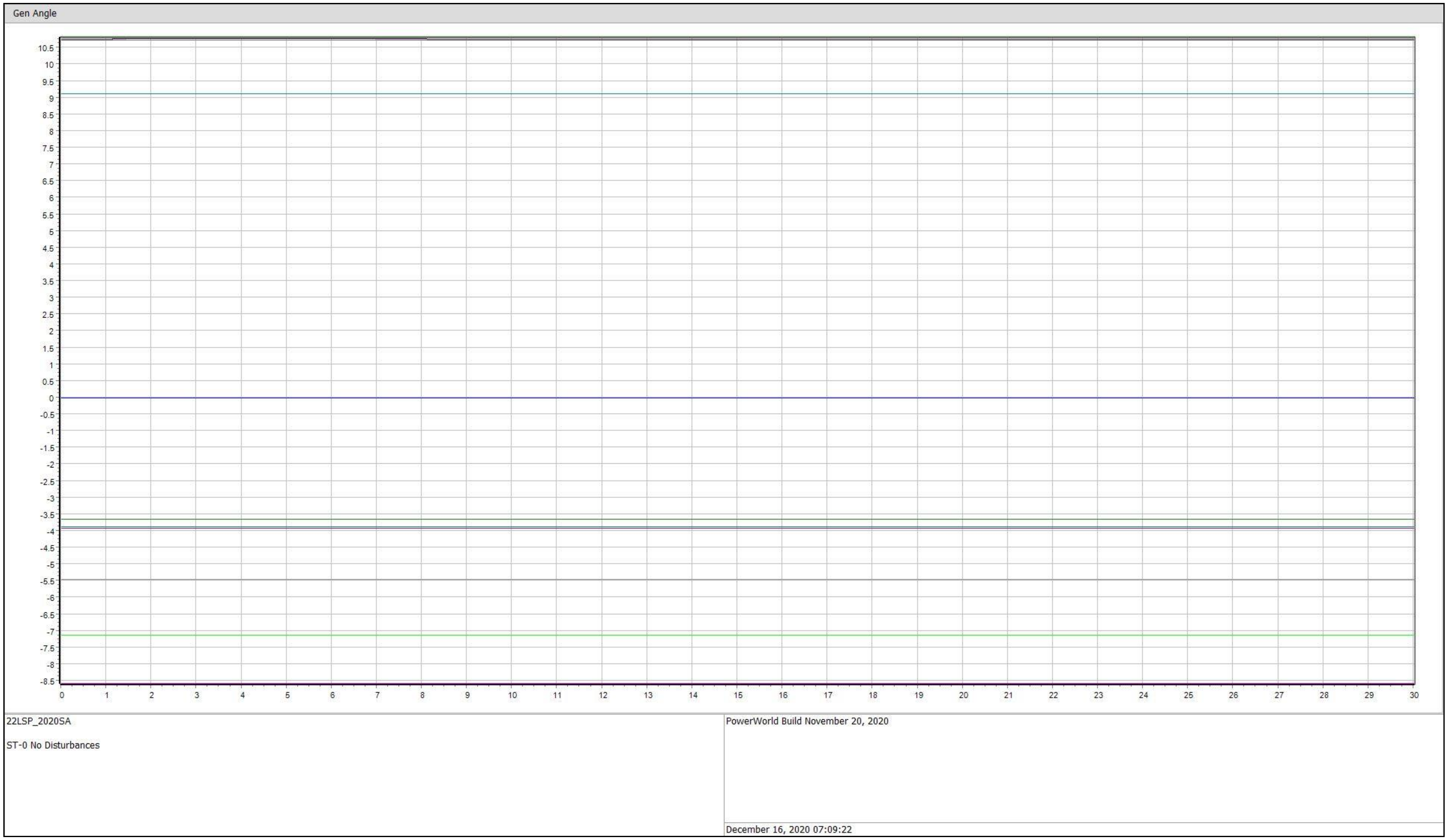

Figure 12: No Disturbance; Generator Angle; 2022 Light Spring

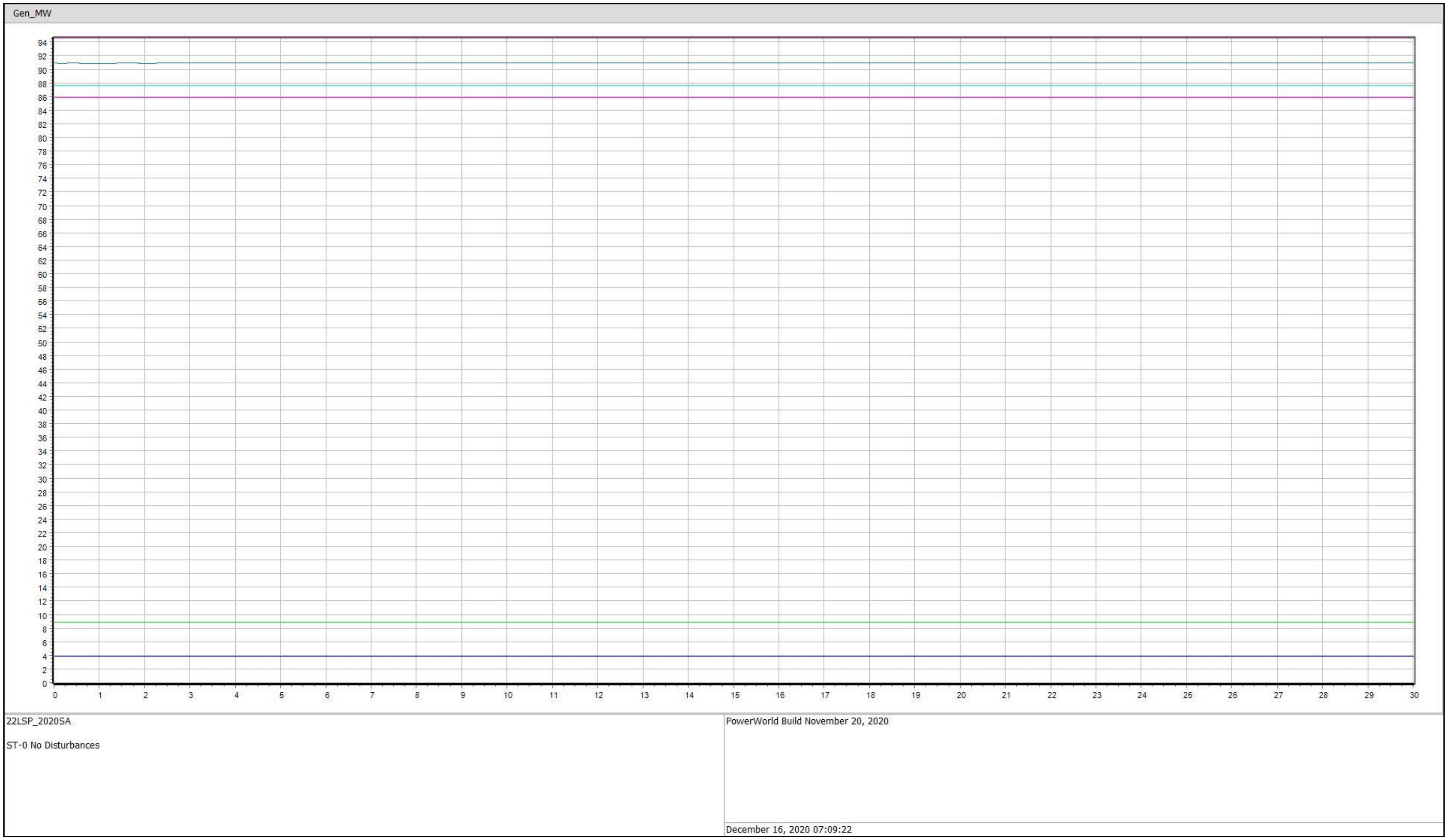

Figure 13: No Disturbance; Generator Power; 2022 Light Spring

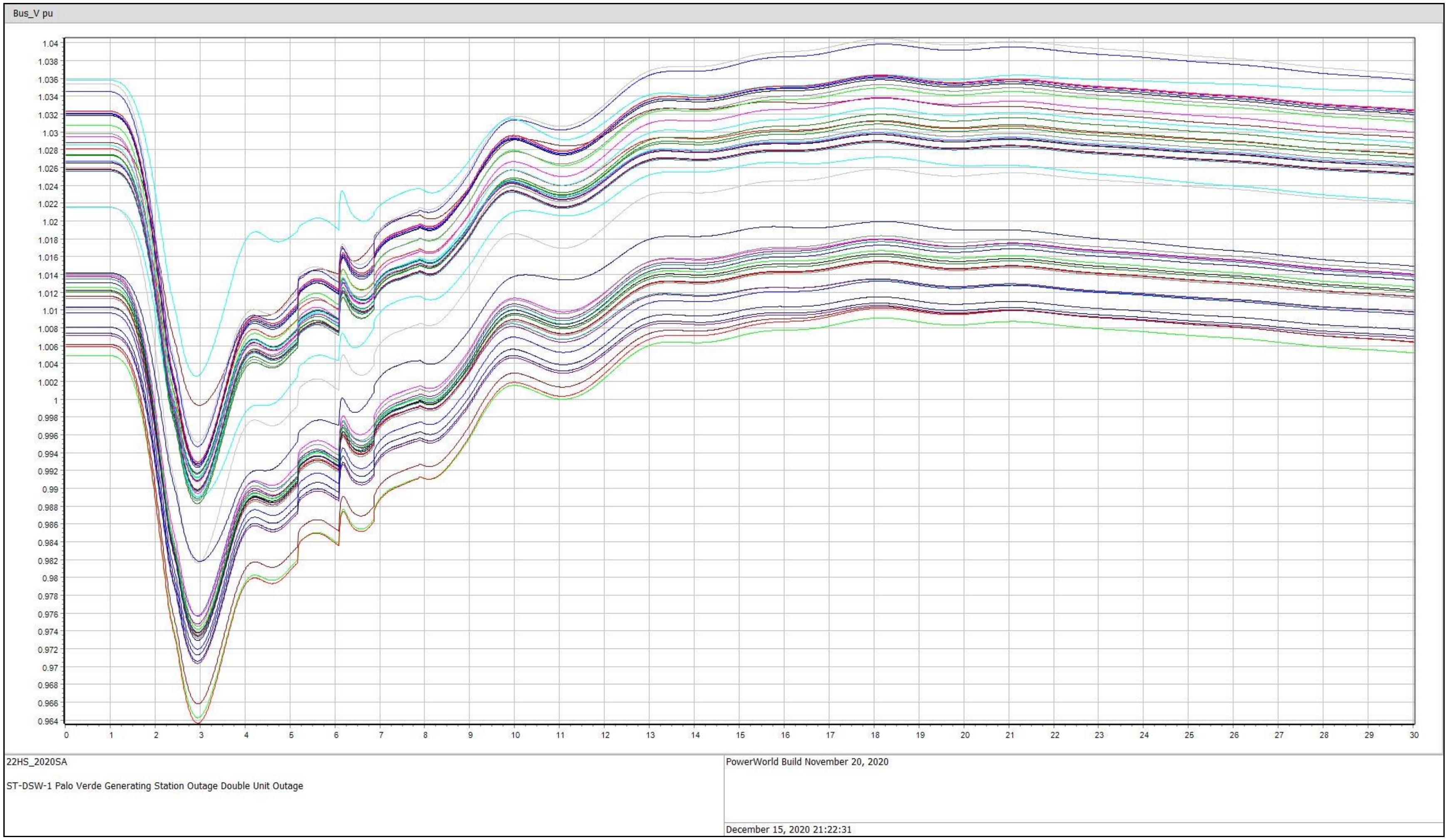

Figure 14: Double Palo Verde; Bus Voltage; 2022 Heavy Summer

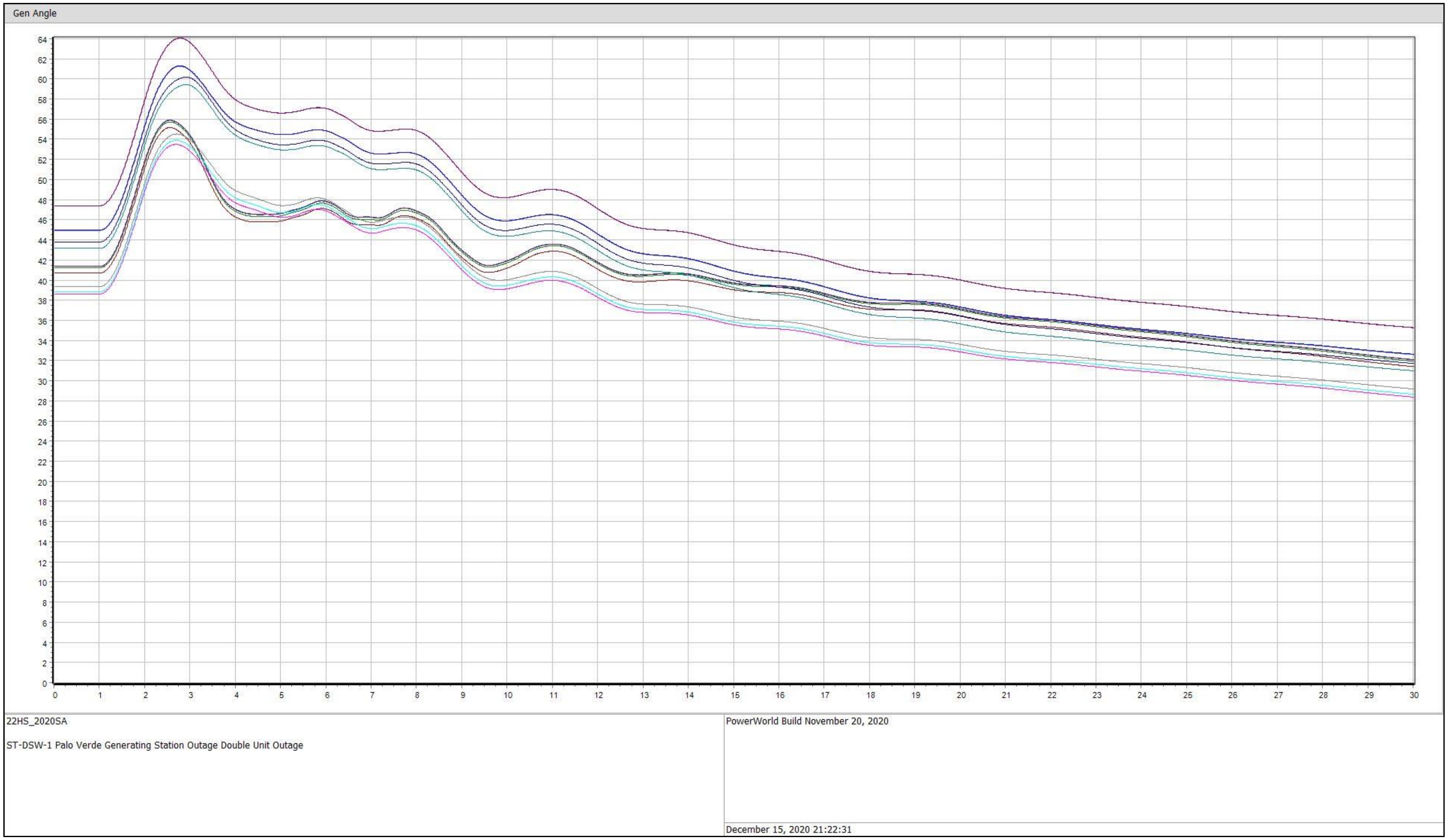

Figure 15: Double Palo Verde; Generator Angle; 2022 Heavy Summer

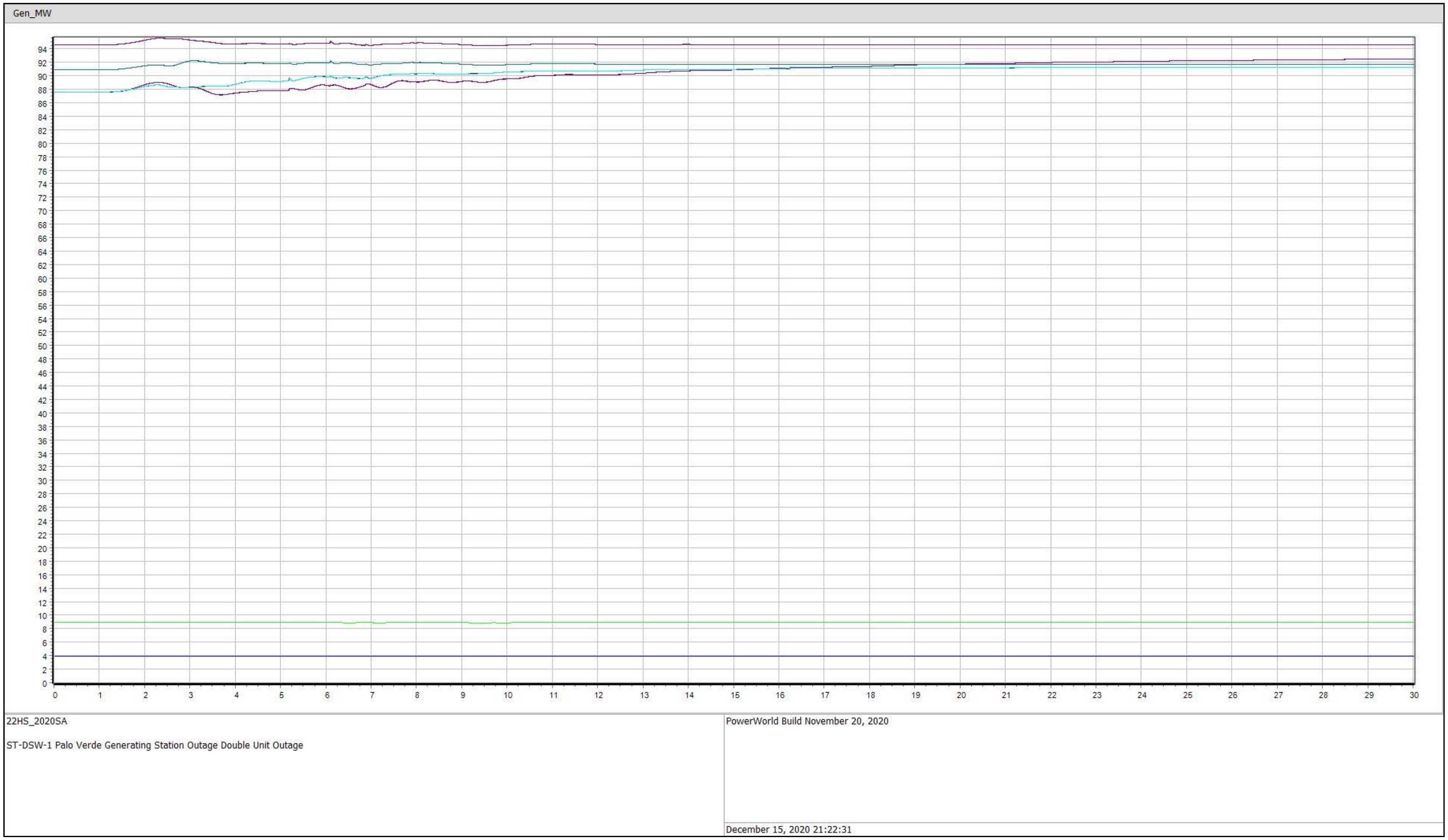

Figure 16: Double Palo Verde; Generator Power; 2022 Heavy Summer

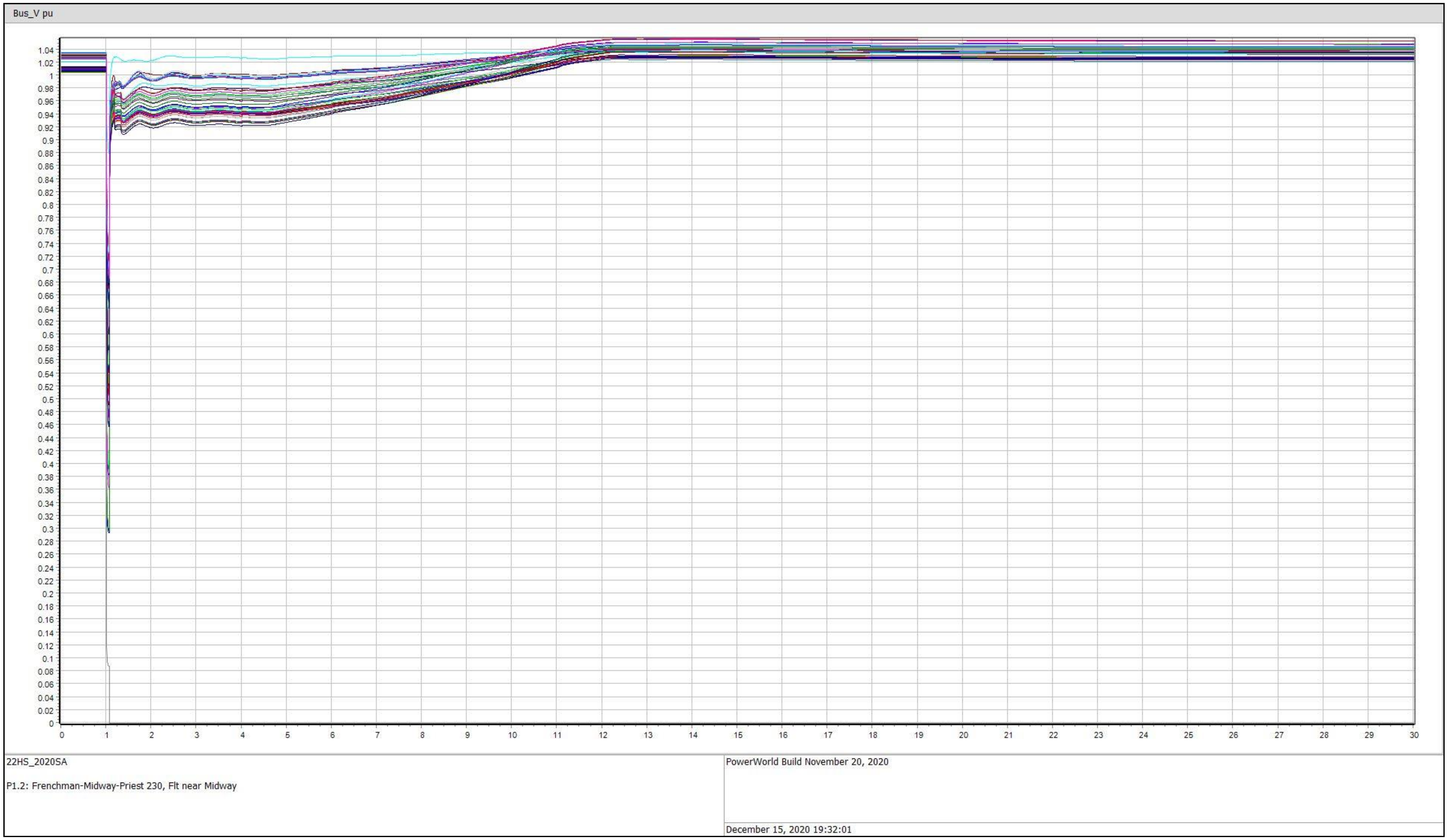

Figure 17: Frenchman-Midway-Priest 230 kV; Bus Voltage; 2022 Heavy Summer

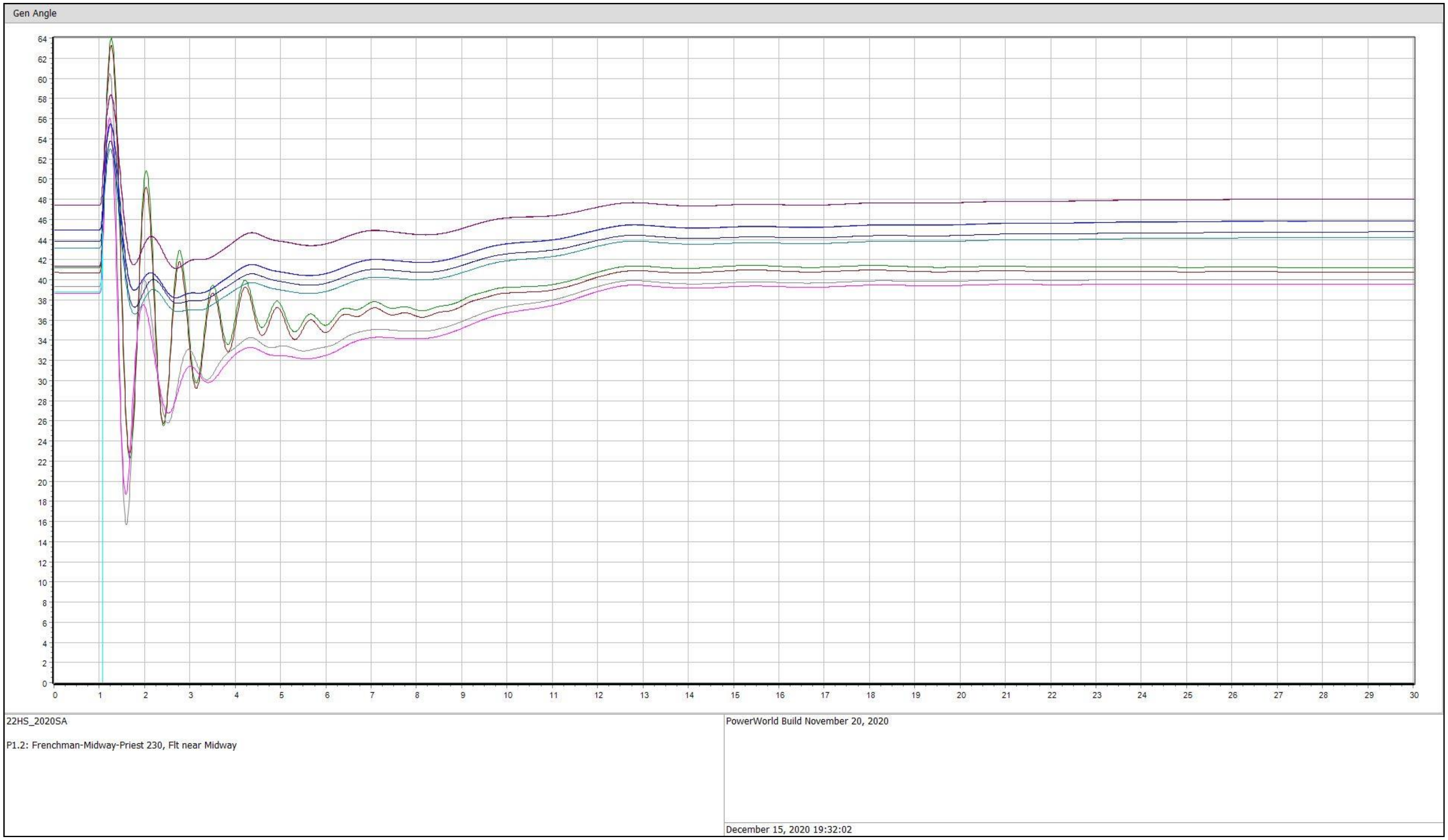

Figure 18: Frenchman-Midway-Priest 230 kV; Generation Angle; 2022 Heavy Summer

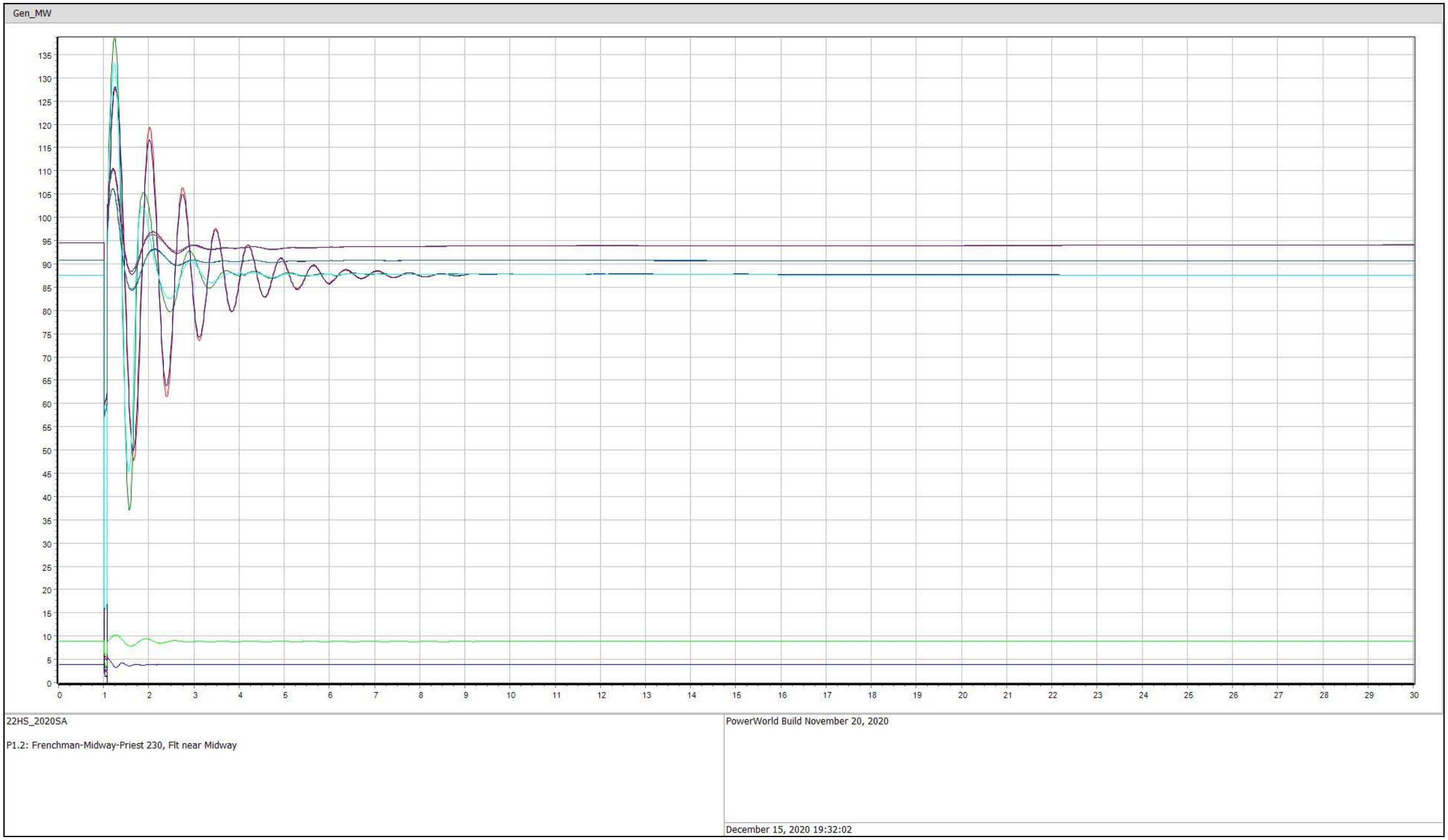

Figure 19: Frenchman-Midway-Priest 230 kV; Generation Power; 2022 Heavy Summer