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Southwest Transmission
COOPERATIVE, INC

TECHNICAL STUDY REPORT

2011 – 2020

Arizona Corporation Commission
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JANUARY 28, 2010

SOUTHWEST TRANSMISSION COOPERATIVE, INC.

TEN-YEAR PLAN

2011 – 2020

TECHNICAL STUDY REPORT

SUBMITTED TO THE ARIZONA CORPORATION COMMISSION IN FULFILLMENT OF A.R.S. §40-360.02 ¶C.7

TRANSMISSION PLANNING
JANUARY 28, 2011

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SOUTHWEST TRANSMISSION COOPERATIVE, INC.
TEN-YEAR PLAN
2011 – 2020
TECHNICAL STUDY REPORT

INTRODUCTION

This technical report is submitted to the Arizona Corporation Commission ("Commission") pursuant to the Arizona Revised Statutes ("ARS") §40-360.02 ¶C.7, and Decision No. 63876, dated July 25, 2001, regarding the Biennial Transmission Assessment prepared by Commission Utilities Division Staff.

Power flow analyses used for this report were performed in accordance with the NERC criteria for Planning Standards TPL-001-0 through TPL-004-0, such that the reliability of the SWTC transmission system was analyzed within the near-term planning horizon (2011-2014) and the long-term planning horizon (2015-2020). This provided an excellent snapshot of how the system would perform with the most recent forecasted loads used in this Ten-Year Plan Filing. The analyses showed that under a variety of outage conditions, the system performed well with minimal violations of the NERC criteria. Mitigation Plans, however, are in place to resolve these minor violations in each of the study years, as noted below.

Post-transient Stability Analyses were recently performed on the summer of 2010 and 2014 and the results can be found in Appendix D of this report, which starts on page 188.

At this time, there are no planned third-party generation interconnections to the SWTC transmission system.

SWTC's current and planned transmission system maps are included in Appendix A, which starts on page 11. A sampling of the 2011-2020 Contingency Lists are included in Appendix B, which starts on page 16. Selective power flow one-line diagrams are included in Appendix C, which starts on page 26. The power flow diagrams show the entire SWTC system under N-0 conditions for the years 2011, 2015, and 2020 of the Ten-Year Plan. Selective Extra-High Voltage (EHV) and High Voltage (HV) N-1 and N-2 outage simulations for the years 2011, 2015, and 2020 are also shown. A few N-n outage simulations for each year are also included; however, these are extreme transmission contingency events and it would be necessary for SWTC to drop load to its member cooperatives in the event any of these extreme contingencies occurred. N-1 simulations for radial transmission lines have been excluded from this listing.

POWER FLOW ANALYSES

Power flow studies were performed using General Electric's Positive Sequence Load Flow ("PSLF") program. The power flow base cases were created for the 2011-2020 study period, using the latest base cases from the Western Electricity Coordinating Council ("WECC"), Southeast Arizona Transmission Study ("SATS"), and the Southwest Area Transmission ("SWAT") Planning Group, as listed below:

- SATS 2011HS Case (Originally created from WECC 2012HS2S case and SATS 2012HS case) – Load Flow
- SATS 2015HS Case (Originally created from WECC 2015HS2A1 case and AZ 2015 seed case) – Load Flow
- SWAT 2020HS Case (Originally created from WECC 19HS1A case, WestConnect 2020 data for areas 10-14, and SWAT 2020HS seed case) – Load Flow

These base cases were updated with the latest (2009) load projections of SWTC, using the medium economic forecast. Base case and single contingency conditions were evaluated using PSLF to determine system impacts and timing of transmission facilities needed to mitigate those system impacts.

Numerous outage simulations were performed for the years 2011, 2015 and 2020. The analyses looked at the impact of the most recent projected member system load growth to the interconnected transmission system. The analyses determined where facilities would be placed to most economically serve this projected member system load.

FULFILLMENT OF BTA REQUIREMENT

The Commission's Sixth Biennial Transmission Assessment for 2010-2019 ("BTA") contained a conclusion stating: "The Southeast Arizona Transmission System ("SATS") report and the Southwest Transmission Cooperative ("SWTC") ten-year plan have both identified overload issues on the Apache-Butterfield 230 kV line beginning in 2012. Therefore, interim measures will be needed by 2012 in order to maintain system reliability. Furthermore, the study has identified numerous 230 kV and 115 kV bus voltage deviations that may be unacceptable, and states that further analysis is needed to address these issues. This analysis will be completed in 2011."

It was ordered in the 6th BTA that "APS, SWTC, and TEP shall conduct additional analyses of potential 230 kV and 138 kV voltage deviations in Southeastern Arizona as noted in the 2009 SATS report and file an update based on the 2020 SATS [Report] by February 28, 2011, and shall finalize mitigation plans if needed for this voltage concern in ten-year plan filing(s) for the 7th BTA by January 31, 2012."

There are two issues noted here, the first being the overload of the Apache to Butterfield 230 kV line, and the second being voltage deviations seen on various 230 kV and 115 kV buses. The second of these issues will be addressed, in part, in this report.

The overload of the Apache to Butterfield 230 kV line has been addressed in a separate report, "Engineering Re-rating Study of Apache to Butterfield 230 kV Line," which has been filed in conjunction with this document to the ACC as part of this ten-year plan filing that addresses the following order from the Sixth BTA: "SWTC shall determine if an engineering "re-rating" of the Apache-Butterfield 230 kV line as proposed in the Sixth BTA filings would be an acceptable measure until the line is upgraded in 2016, and to file the results of this assessment by January 31, 2011."

NEAR TERM ASSESSMENT (2011-2014)

2011 Category A (N-0) Analysis:

Under all lines in service (ALIS) conditions there are no voltage violations or thermal overloads.

2011 Category B (N-1) Analysis:

The N-1 analysis for 2011 yields some low voltages on the SWTC 115 kV system in its Western Area for loss of the Western 115 kV lines at Marana Tap or for loss of the Marana Tap to Marana 115 kV line. These are seen at the Avra Valley, Marana, Marana Tap, and Sandario 115 kV buses.

The N-1 analysis also yields some voltage deviations on the SWTC 115 kV and 230 kV systems in its Western Area. For the 230 kV system, upon the loss of the Apache to Butterfield 230 kV line, these are seen at the Butterfield, Pantano and San Rafael 230 kV buses. For the 115 kV system, upon loss of the Western 115 kV lines at Marana Tap or for loss of the Marana Tap to Marana 115 kV line, and upon a loss of the Avra to Sandario 115 kV line, these are seen at the Avra Valley, Kartchner, Marana, Marana Tap, Pantano, Sandario, Three Points, and Valencia 115 kV buses.

The Marana to Avra 115 kV line overloads for N-1 outages of the Apache to Butterfield and Butterfield to Pantano 230 kV lines, and for the loss of the Pinal West to South, Springerville to Greenlee, and Springerville to Vail2 345 kV lines. Prior to the mitigation measures discussed below, SWTC would initiate operator action to open the 115 kV loop while maintaining member system loads.

2011 Category C (N-2) Analysis:

No voltage violations are seen.

The Marana to Avra 115 kV line overloads for the following N-2 outages: Apache to Butterfield & Apache to Redtail 230 kV lines, Apache to Butterfield & Apache to Winchester 230 kV Lines, Apache to Butterfield & Greenlee 345/230 kV transformer, Apache to Redtail & Greenlee 345/230 kV transformer, Greenlee to Winchester & Greenlee to Copper Verde 345 kV lines, Springerville to Greenlee & Pinal West to South 345 kV lines, and the Springerville to Greenlee & Winchester to 345 kV lines. Prior to the mitigation measures discussed below, SWTC would initiate operator action to open the 115 kV loop while maintaining member system loads.

The Marana to Avra and the Avra to Sandario 115 kV lines overload for the following N-2 outages: Apache to Butterfield & Apache to Winchester 230 kV lines and Springerville to Greenlee & Pinal West to South. Prior to the mitigation measures discussed below, SWTC would initiate operator action to open the 115 kV loop while maintaining member system loads.

The Greenlee 345/230 kV transformer overloads for loss of the N-2 outage of Greenlee to Winchester and Greenlee to Copper Verde 345 kV lines. Prior to the mitigation measures

discussed below, and as noted in previous Technical Study Reports, through operator instructions that have been in place for many years on the SWTC transmission system, a large mine will be alerted to drop load to protect this transformer, if it begins to overload.

2011 Mitigation Plans:

The upgrade of the Marana Tap to Marana 115 kV line in 2011, and the upgrade of the Marana to Avra and Avra to Sandario Tap 115 kV lines in 2012, resolve the low voltage and overload issues noted above. Placement of capacitor banks at Avra Valley, Hackberry, and New Tucson in 2013 resolve the delta-voltage violations. As noted in this Ten Year Plan filing, a second 345/230 kV transformer is scheduled to be placed at Greenlee in 2015, which resolves the overload of the existing Greenlee 345/230 kV transformer for the foreseeable future.

LONG TERM ASSESSMENT (2015-2020)

2015 Category A (N-0) Analysis:

Under all lines in service (ALIS) conditions there are no voltage violations or thermal overloads.

2015 Category B (N-1) Analysis:

No voltage violations are seen.

The Apache to Butterfield 230 kV line overloads for the loss of the Winchester to Vail 345 kV line. Prior to the mitigation measures discussed below, this overload can be resolved by generation re-dispatch at Apache Station.

2015 Category C (N-2) Analysis:

No voltage violations are seen.

The Apache to Butterfield 230 kV line overloads for the loss of the Springerville to Greenlee and Winchester to Vail 345 kV lines, and for the loss of the GreenleeSW to Greenlee and Winchester to Vail 345 kV lines. Prior to the mitigation measures discussed below, this overload can be resolved by generation re-dispatch at Apache Station.

2015 Mitigation Plans:

The overload of the Apache to Butterfield 230 kV line is resolved in the long-term by re-rating the line as discussed in the "Engineering Re-rating Study of the Apache to Butterfield 230 kV Line," which has been filed with the Commission along with this ten-year plan filing. The study discusses that this effort resolves an overload of the Apache to Butterfield 230 kV line as a result of EHV outages that cause the overload, well beyond the ten-year plan horizon.

2020 Category A (N-0) Analysis:

Under all lines in service (ALIS) conditions there are no voltage violations or thermal overloads.

2020 Category B (N-1) Analysis:

Two delta-voltage violations are seen in this time frame, at the Redtail 230 kV bus for an outage of the Apache to Redtail 230 kV line and at the San Rafael 230 kV bus for an outage of the Apache to Butterfield 230 kV line.

There are no thermal overloads.

2020 Category C (N-2) Analysis:

No voltage violations or thermal overloads seen.

2020 Mitigation Plans:

The installation of capacitor banks at Redtail and San Rafael in 2020 resolve the delta-V issues.

As noted earlier, a sampling of the list of contingencies used for the 2011-2020 study period are found in Appendix B and the selective power flow diagrams are found in Appendix C.

STABILITY ANALYSIS

SWTC transient stability analyses for its interconnected transmission system were performed for 2010 and 2014 summer conditions. The stability base cases created for use in this report are as follows:

- SATS 2010HS Case (Originally created from WECC 2009HS3A approved operating case)
- WECC 2014HS3-SA approved case

The outages selected for analysis in both 2010 and 2014 are as follows:

- Apache to Butterfield 230 kV Line
- Apache to Redtail 230 kV Line
- Bicknell to Vail 345 kV Line
- Marana Tap to Marana 115 kV Line

The analyses do not show any issues needing mitigation. The previous stability study for SWTC was done for the 2009-2018 Ten Year Plan. It noted a problem with the damping of the Apache CT1 unit. The study noted that General Electric, the maker of the turbine, and SWTC considered this result to be a modeling issue. This most recent study, with a new PSLF database, confirms this sentiment, as it shows the Apache CT1 unit damping under all disturbances. In addition,

AEPCO began the process of replacing the controls on Apache CT1 (and CT3) in 2010, because replacement parts are not readily available. The existing Woodward control system was replaced by an Allen Bradley control system in late December of 2010.

As no new generation is planned for the foreseeable future on the SWTC system, these results are considered adequate for the ten-year planning horizon of this Report. Future ten year plan filings will include stability analyses for generation that may be planned for location on the SWTC transmission system, as they become known.

Additional generation that is planned for the area, such as the proposed Bowie Project or variable generation that may become associated with the SunZia Southwest and Southline Transmission Projects, will be studied in detail by the entities that have expressed interest in those projects and will be reported on in future ten year plan filings. The stability plots are found in Appendix D.

SOUTHWEST TRANSMISSION COOPERATIVE, INC.

TEN-YEAR PLAN

2011 – 2020

TECHNICAL STUDY REPORT

APPENDICES

APPENDIX A

CURRENT AND PLANNED TRANSMISSION SYSTEM MAPS

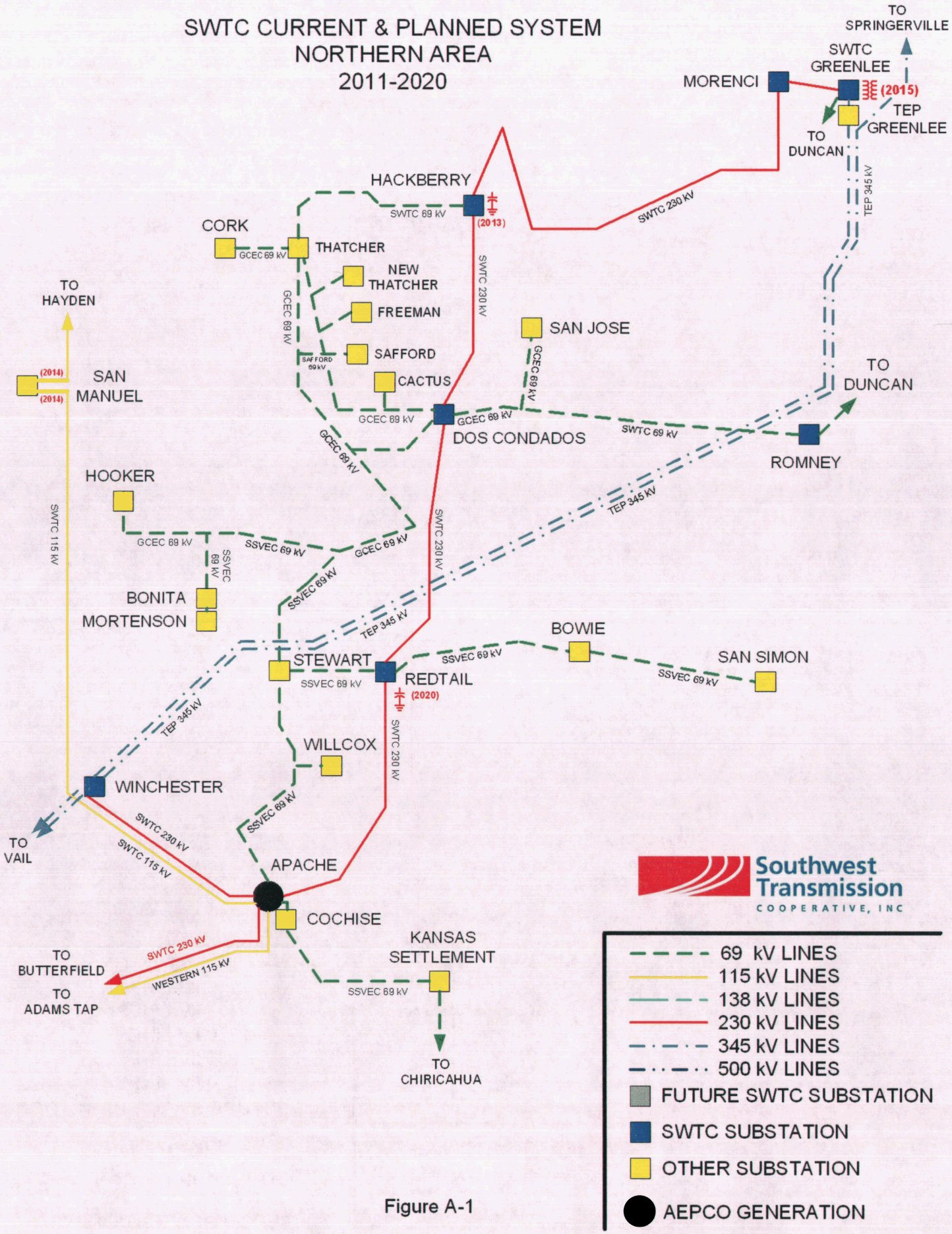

SWTC CURRENT & PLANNED SYSTEM
NORTHERN AREA
2011-2020
TO SPRINGERVILLE
SWTC GREENLEE
(2015)
MORENCI
TEP GREENLEE
TO DUNCAN
TEP 345 kV
SWTC 230 kV
HACKBERRY
SWTC 69 kV
(2013)
CORK
GCEC 69 kV
THATCHER
NEW THATCHER
FREEMAN
SAFFORD
SAFFORD 69kV
CACTUS
GCEC 69 kV
SAN JOSE
DOS CONDADOS
ROMNEY
TO DUNCAN
TO HAYDEN
(2014)
(2014)
SAN MANUEL
SWTC 115 kV
HOOKER
SSVEC 69 kV
BONITA
MORTENSON
STEWART
REDTAIL
(2020)
BOWIE
SAN SIMON
WILLCOX
WINCHESTER
TO VAIL
APACHE
COCHISE
KANSAS SETTLEMENT
TO BUTTERFIELD
TO ADAMS TAP
WESTERN 115 kV
TO CHIRICAHUA
Southwest Transmission COOPERATIVE, INC
69 kV LINES
115 kV LINES
138 kV LINES
230 kV LINES
345 kV LINES
500 kV LINES
FUTURE SWTC SUBSTATION
SWTC SUBSTATION
OTHER SUBSTATION
AEPCO GENERATION

Figure A-1

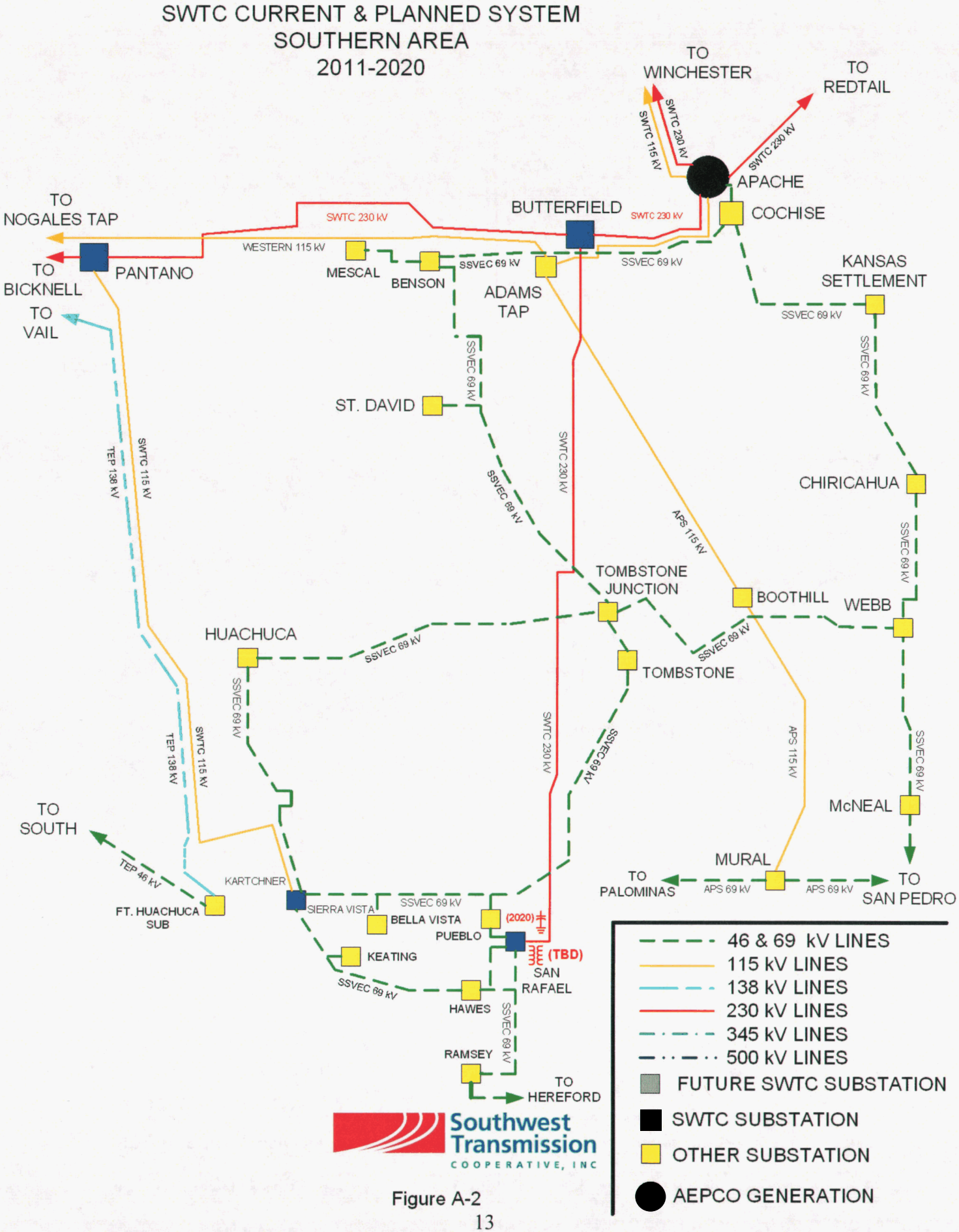

SWTC CURRENT & PLANNED SYSTEM
SOUTHERN AREA
2011-2020
TO WINCHESTER
TO REDTAIL
SWTC 115 kV
SWTC 230 kV
SWTC 230 kV
APACHE
COCHISE
TO NOGALES TAP
SWTC 230 kV
BUTTERFIELD
SWTC 230 kV
WESTERN 115 kV
MESCAL
BENSON
SSVEC 69 kV
SSVEC 69 kV
ADAMS TAP
KANSAS SETTLEMENT
SSVEC 69 kV
PANTANO
TO BICKNELL
TO VAIL
SSVEC 69 kV
SSVEC 69 kV
ST. DAVID
TEP 138 kV
SWTC 115 kV
SWTC 230 kV
SSVEC 69 kV
CHIRICAHUA
APS 115 kV
SSVEC 69 kV
TOMBSTONE JUNCTION
BOOTHILL
WEBB
HUACHUCA
SSVEC 69 kV
SSVEC 69 kV
TOMBSTONE
SSVEC 69 kV
SSVEC 69 kV
TEP 138 kV
SWTC 115 kV
SWTC 230 kV
SSVEC 69 kV
APS 115 kV
SSVEC 69 kV
TO SOUTH
McNEAL
MURAL
TEP 46 kV
KARTCHNER
TO PALOMINAS
APS 69 kV
APS 69 kV
TO SAN PEDRO
FT. HUACHUCA SUB
SIERRA VISTA
SSVEC 69 kV
BELLA VISTA
(2020)
PUEBLO
(TBD)
SAN RAFAEL
KEATING
SSVEC 69 kV
HAWES
SSVEC 69 kV
RAMSEY
TO HEREFORD
Southwest Transmission
COOPERATIVE, INC
46 & 69 kV LINES
115 kV LINES
138 kV LINES
230 kV LINES
345 kV LINES
500 kV LINES
FUTURE SWTC SUBSTATION
SWTC SUBSTATION
OTHER SUBSTATION
AEPCO GENERATION

Figure A-2

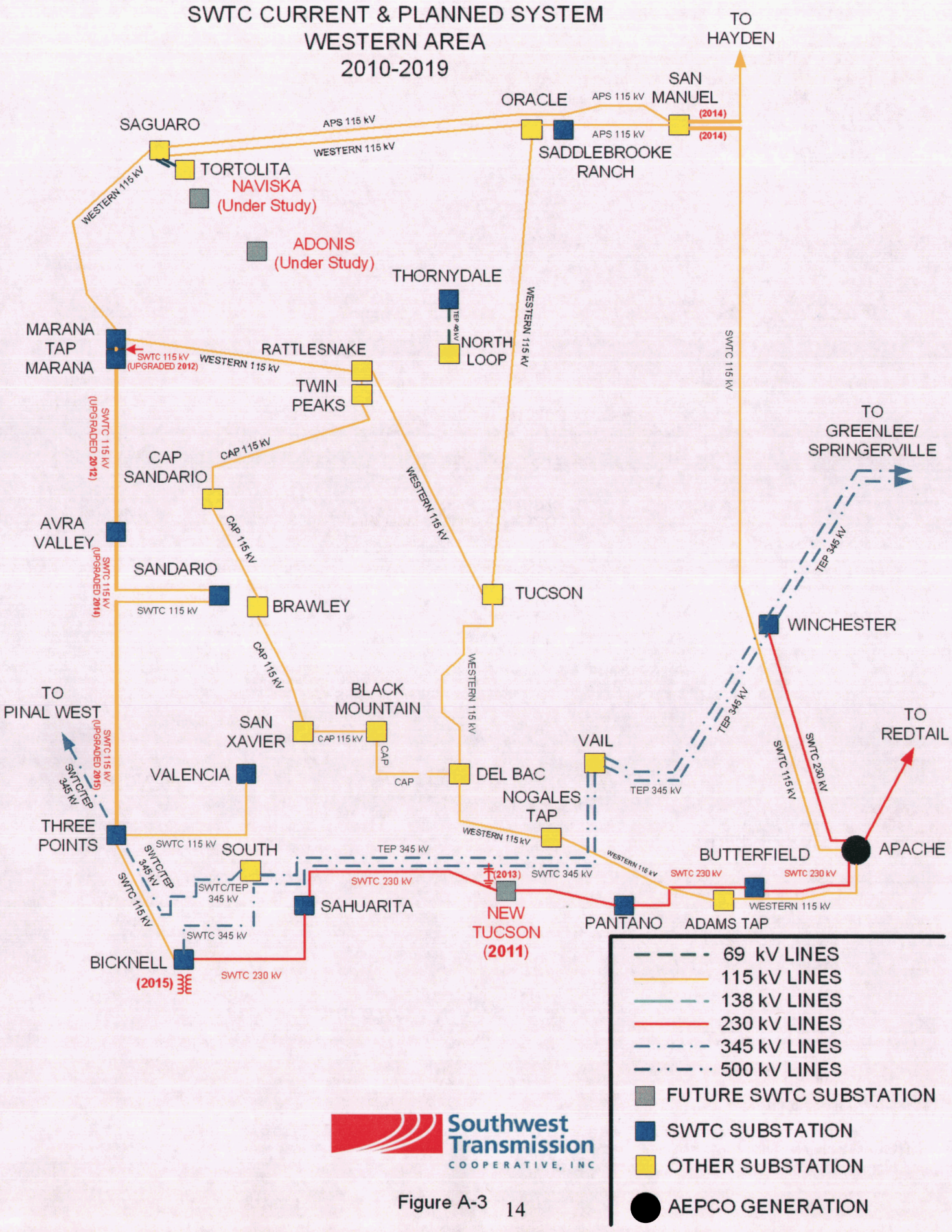

SWTC CURRENT & PLANNED SYSTEM
WESTERN AREA
2010-2019
TO HAYDEN
SAN MANUEL
(2014)
(2014)
ORACLE
APS 115 kV
APS 115 kV
SAGUARO
APS 115 kV
WESTERN 115 kV
SADDLEBROOKE RANCH
TORTOLITA
NAVISKA
(Under Study)
WESTERN 115 kV
ADONIS
(Under Study)
THORNYDALE
TEP 46 kV
NORTH LOOP
WESTERN 115 kV
SWTC 115 kV
MARANA TAP MARANA
SWTC 115 kV
(UPGRADED 2012)
WESTERN 115 kV
RATTLESNAKE
TWIN PEAKS
SWTC 115 kV
(UPGRADED 2012)
CAP 115 kV
CAP SANDARIO
TO GREENLEE/ SPRINGERVILLE
TEP 345 kV
AVRA VALLEY
SWTC 115 kV
(UPGRADED 2014)
CAP 115 kV
SANDARIO
SWTC 115 kV
BRAWLEY
WESTERN 115 kV
TUCSON
WINCHESTER
CAP 115 kV
WESTERN 115 kV
TO PINAL WEST
SWTC 115 kV
(UPGRADED 2015)
BLACK MOUNTAIN
SAN XAVIER
CAP 115 kV
CAP
CAP
DEL BAC
VAIL
TEP 345 kV
SWTC 115 kV
SWTC 230 kV
TO REDTAIL
VALENCIA
NOGALES TAP
SWTC/TEP 345 kV
THREE POINTS
SWTC 115 kV
SOUTH
TEP 345 kV
WESTERN 115 kV
WESTERN 115 kV
SWTC 230 kV
SWTC 230 kV
BUTTERFIELD
APACHE
SWTC/TEP 345 kV
SWTC 115 kV
SWTC/TEP 345 kV
SWTC 230 kV
(2013)
SWTC 345 kV
SAHUARITA
NEW TUCSON
(2011)
PANTANO
ADAMS TAP
WESTERN 115 kV
SWTC 345 kV
BICKNELL
(2015)
SWTC 230 kV
69 kV LINES
115 kV LINES
138 kV LINES
230 kV LINES
345 kV LINES
500 kV LINES
FUTURE SWTC SUBSTATION
SWTC SUBSTATION
OTHER SUBSTATION
AEPCO GENERATION
Southwest Transmission
COOPERATIVE, INC

Figure A-3

SWTC CURRENT & PLANNED SYSTEM
PV-SEV PROJECT AREA
2010-2019

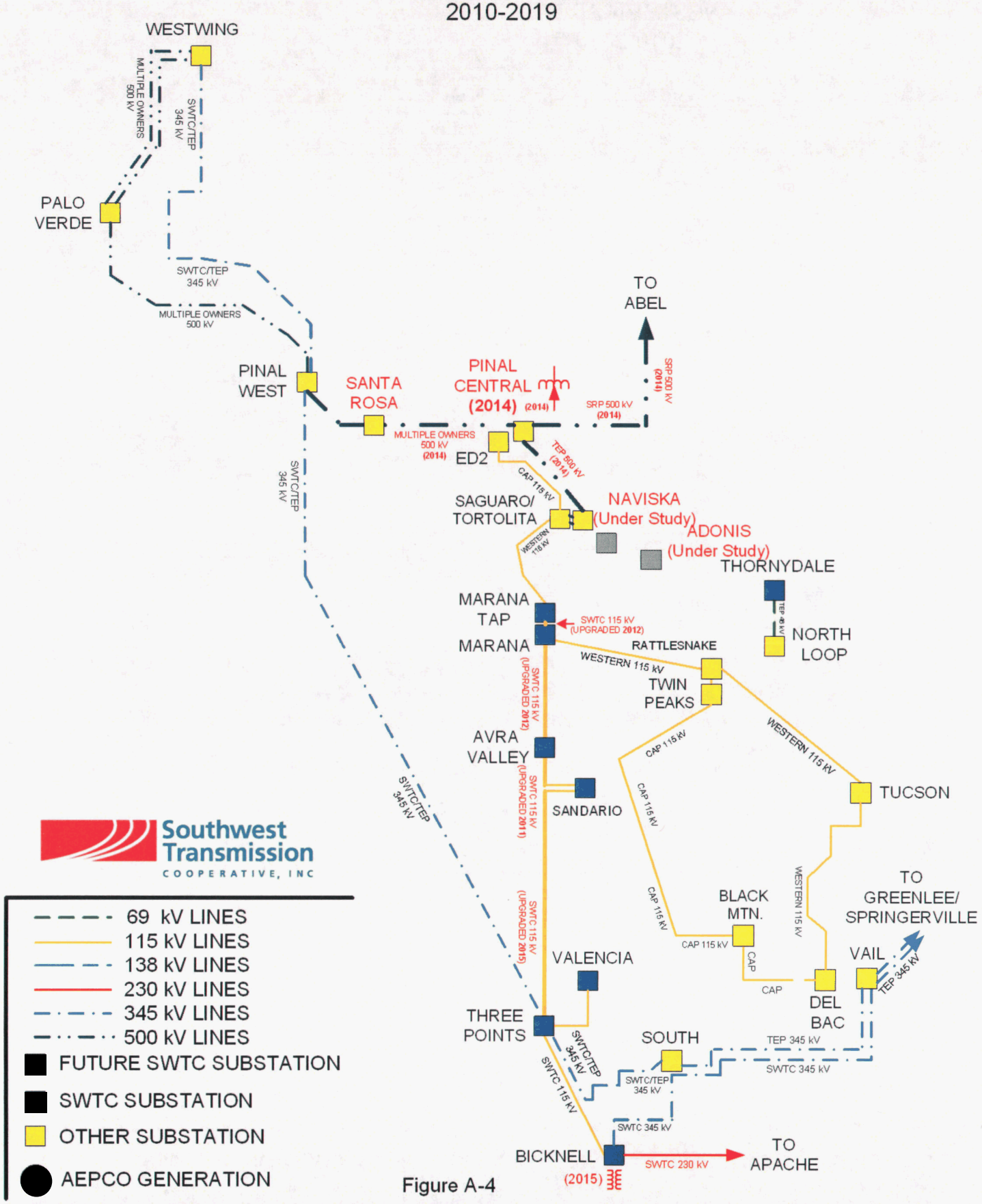


Figure A-4

APPENDIX B

2011-2020 POWER FLOW CONTINGENCY LISTS

2011 CONTINGENCY LIST

line_1	"Line BICKNELL 345.0 to VAIL 345.0 Circuit 1"
line_2	"Line GREEN-SW 345.0 to GREENLEE 345.0 Circuit 1"
line_3	"Line APACHE 230.0 to BUTERFLD 230.0 Circuit 1"
line_4	"Line APACHE 230.0 to RED TAIL 230.0 Circuit 1"
line_5	"Line APACHE 230.0 to WINCHSTR 230.0 Circuit 1"
line_6	"Line BUTERFLD 230.0 to PANTANO 230.0 Circuit 1"
line_7	"Line BUTERFLD 230.0 TO SAN RAF 230.0 Circuit 1"
line_8	"Line DOSCONDO 230.0 to HACKBERY 230.0 Circuit 1"
line_9	"Line HACKBERY 230.0 to MORENCI 230.0 Circuit 1"
line_10	"Line MORENCI 230.0 to GREEN-SW 230.0 Circuit 1"
line_11	"Line MORENCI 230.0 to PD-MORNC 230.0 Circuit 1"
line_12	"Line NEWTUCSN 230.0 to SAHUARIT 230.0 Circuit 1"
line_13	"Line PANTANO 230.0 to NEWTUCSN 230.0 Circuit 1"
line_14	"Line RED TAIL 230.0 to DOSCONDO 230.0 Circuit 1"
line_15	"Line SAHUARIT 230.0 to BICKNELL 230.0 Circuit 1"
line_16	"Line APACHE 115.0 to HAYDENAZ 115.0 Circuit 1"
line_17	"Line AVRA 115.0 to MARANA 115.0 Circuit 1"
line_18	"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1"
line_19	"Line BICKNELL 115.0 to THREEPNT 115.0 Circuit 1"
line_20	"Line MARANATP 115.0 to MARANA 115.0 Circuit 1"
line_21	"Line PANTANO 115.0 to KARTCHNR 115.0 Circuit 1"
line_22	"Line THREEPNT 115.0 to SNDARIO 115.0 Circuit 1"
line_23	"Line THREEPNT 115.0 to VALEN-SW 115.0 Circuit 1"
tran_24	"Tran BICKNELL 345.00 to BICKNELL 230.00 Circuit 1"
tran_25	"Tran GREEN-SW 345.00 to GREEN-SW 230.00 Circuit 1"
tran_26	"Tran WINCHSTR 345.00 to WINCHSTR 230.00 Circuit 1"
tran_27	"Tran APACHE 230.00 to APACHE 115.00 Circuit 1"
tran_28	"Tran APACHE 230.00 to APACHE 115.00 Circuit 2"
tran_29	"Tran BICKNELL 230.00 to BICKNELL 115.00 Circuit 1"
tran_30	"Tran BICKNELL 230.00 to BICKNELL 115.00 Circuit 2"
tran_31	"Tran PANTANO 230.00 to PANTANO 115.00 Circuit 1"
tran_32	"Tran RED TAIL 230.00 to REDTAIL 69.00 Circuit 1"
line_33	"Line SAGUARO 500.0 to TORTOLIT 500.0 Circuit 1"
line_34	"Line SAGUARO 500.0 to TORTOLIT 500.0 Circuit 2"
line_35	"Line GREENLEE 345.0 to COPPERVR 345.0 Circuit 1"
line_36	"Line GREENLEE 345.0 to WINCHSTR 345.0 Circuit 1"
line_37	"Line HIDALGO 345.0 to GREENLEE 345.0 Circuit 1"
line_38	"Line MCKINLEY 345.0 to SPRINGR 345.0 Circuit 1"
line_39	"Line MCKINLEY 345.0 to SPRINGR 345.0 Circuit 2"

line_40 "Line PINALWES 345.0 to SOUTH 345.0 Circuit 1"
line_41 "Line SAN JUAN 345.0 to MCKINLEY 345.0 Circuit 1"
line_42 "Line SAN JUAN 345.0 to MCKINLEY 345.0 Circuit 2"
line_43 "Line SPRINGR 345 .0 to CORONADO 345.0 Circuit 1"
line_44 "Line SPRINGR 345.0 to GREENLEE 345.0 Circuit 1"
line_45 "Line SPRINGR 345 .0 to LUNA 345.0 Circuit 1"
line_46 "Line SPRINGR 345.0 to VAIL2 345.0 Circuit 1"
line_47 "Line VAIL 345.0 to SOUTH 345.0 Circuit 1"
line_48 "Line WESTWING 345 to PINALWES 345.0 Circuit 1"
line_49 "Line WINCHSTR 345.0 to VAIL 345.0 Circuit 1"
line_50 "Line COPPERVR 230.0 to FRISCO 230.0 Circuit 1"
line_51 "Line PD-MORNC 230.0 to FRISCO 230.0 Circuit 1"
tran_52 "Tran CORONADO 500.00 to CORONADO 345.00 Circuit 1"
tran_53 "Tran CORONADO 500.00 to CORONADO 345.00 Circuit 2"
tran_54 "Tran PINAL_W 500.00 to PINALWES 345.00 Circuit 1"
tran_55 "Tran TORTOLIT 500.00 to TORTOLIT 345.00 Circuit 1"
tran_56 "Tran WESTWING 500.00 to WESTWING 345.00 Circuit 1"
tran_57 "Tran COPPERVR 345.00 to COPPERVR 230.00 Circuit 1"
tran_58 "Tran COPPERVR 345.00 to COPPERVR 230. 00 Circuit 2"
line_59 "Line ADAMS 115.0 to ADAMSTAP 115.0 Circuit 1"
line_60 "Line ADAMSTAP 115.0 to APACHE 115.0 Circuit 1"
line_61 "Line ADAMSTAP 115.0 to NOGALES 115.0 Circuit 1"
line_62 "Line BLACKMTN 115.0 to SNYDHILL 115.0 Circuit 1"
line_63 "Line BRAWLEY 115.0 to SANXAVER 115.0 Circuit 1"
line_64 "Line DEL BAC 115.0 to NOGALES 115.0 Circuit 1"
line_65 "Line MARANATP 115.0 to RATTLSNK 115.0 Circuit 1"
line_66 "Line RATTLSNK 115.0 to TUCSON 115.0 Circuit 1"
line_67 "Line RATTLSNK 115.0 to TWINPEAK 115.0 Circuit 1"
line_68 "Line SAG.EAST 115.0 to MARANATP 115.0 Circuit 1"
line_69 "Line SAG.EAST 115.0 to ORACLE 115.0 Circuit 1"
line_70 "Line SANDARIO 115.0 to BRAWLEY 115.0 Circuit 1"
line_71 "Line SANXAVER 115.0 to SNYDHILL 115.0 Circuit 1"
line_72 "Line TUCSON 115.0 to DEL BAC 115.0 Circuit 1"
line_73 "Line TUCSON 115.0 to ORACLE 115.0 Circuit 1"
line_74 "Line TWINPEAK 115.0 to SANDARIO 115.0 Circuit 1"
line_75 "Line CHOLLA 500.0 to SAGUARO 500.0 Circuit 1"
line_76 "Line HASSYAMP 500.0 to JOJOBA 500.0 Circuit 1"
line_77 "Line JOJOBA 500.0 to GILARIVR 500.00 Circuit 1"
line_78 "Line JOJOBA 500.0 to GILARIVR 500.00 Circuit 2"
line_79 "Line SAGUARO 230.0 to CASGRAPS 230.0 Circuit 1"
line_80 "Line SAGUARO 230.0 to TATMOMLI 230.0 Circuit 1"
line_81 "Line BOOTHILL 115.0 to ADAMS 115.0 Circuit 1"
line_82 "Line BOOTHILL 115.0 to MURAL 115.0 Circuit 1"
line_83 "Line ORACLE 115.0 to S.BRKRCH 115.0 Circuit1"
line_84 "Line RED ROCK 115.0 to SAG.EAST 115.0 Circuit 1"
line_85 "Line S.BRKRCH 115.0 to SNMANUEL 115.0 Circuit 1"

line_86 "Line SAG.EAST 115.0 to SAG.WEST 115.0 Circuit 1"
line_87 "Line SAG.WEST 115.0 to ED-5 115.0 Circuit 1"
line_88 "Line SAG.WEST 115.0 to ED-5B 115.0 Circuit 1"
line_89 "Line SAG.WEST 115.0 to SNMANUEL 115.0 Circuit 1"
tran_90 "Tran SAGUARO 500.00 to SAG.EAST 115.00 Circuit 1"
tran_91 "Tran SAGUARO 500.00 to SAG.WEST 115.00 Circuit 1"
tran_92 "Tran SAGUARO 230.00 to SAG.EAST 115.00 Circuit 1"
tran_93 "Tran SAGUARO 230.00 to SAG.WEST 115.0 Circuit 1"
tran_94 "Tran TORTOLIT 138.00 to SAG.EAST 115.0 Circuit 1"
tran_95 "Tran TORTOLIT 138.00 to SAG.WEST 115.0 Circuit 1"
line_96 "Line BROWNING 500.0 to KYRENE 500.0 Circuit 1"
line_97 "Line HASSYAMP 500.0 to PINAL_W 500.0 Circuit 1"
line_98 "Line JOJOBA 500.0 to KYRENE 500.0 Circuit 1"
line_99 "Line PALOVRDE 500.0 to RUDD 500.0 Circuit 1"
line_100 "N-2:Line APA-BUTT 230.0 & APA-RED TAIL 230.0"
line_101 "N-2:Line APA-BUTT 230.0 & APA-WIN 230.0"
line_102 "N-2:Line APA-BUTT 230.0 & BICK-VAIL 345.0"
line_103 "N-2:Line APA-BUTT 230.0 & GREEN-SW 345/230 XFMR"
line_104 "N-2:Line APA-REDTAIL 230.0 & BICK-VAIL 345.0"
line_105 "N-2:Line APA-REDTAIL 230.0 & GREEN-SW 345/230 XFMR"
line_106 "N-2:Line APACHE-WIN 230.0 & APA-REDTAIL 230.0"
line_107 "N-2:Line APACHE-WIN 230.0 & BICK-VAIL 345.0"
line_108 "N-2:Line APACHE-WIN 230.0 & GREEN-SW-GRNL 345.0"
line_109 "N-2:Line GRNL-COPPVR 345.0 & HACK-MORENCI 230.0"
line_110 "N-2:Line GRNL-COPPVR 345.0 & GREEN-SW-GRNL 345.0"
line_111 "N-2:Line GRNL-WIN 345.0 & GRNL-COPPVR 345.0"
line_112 "N-2:Line GREEN-SW-GRNL 345.0 & WIN-VAIL 345.0"
line_113 "N-2:Line GREEN-SW-GRNL 345.0 & BICK-VAIL 345.0"
line_114 "N-2:Line SPRINGR-GRNL 345.0 & PINALWES-SOUTH 345.0"
line_115 "N-2:Line SPRINGR-GRNL 345.0 & WIN-VAIL 345kV"
line_116 "N-2:Line SPRINGR-VAIL2 345.0 & PINALWES-SOUTH 345.0"
line_117 "N-2:Line SPRINGR-VAIL2 345.0 & WIN-VAIL 345.0"
line_118 "N-2:Line WIN-VAIL 345.0 & PINALWES-SOUTH 345.0"
line_119 "N-n:Line APA-BUTT/RED TAIL230.0 & APA-WIN 230.0"
line_120 "N-n:Line APA-BUTT/RED TAIL 230.0 & AVRA-MARANA 115.0"
line_121 "N-n:Line: APA-BUTT 230.0, AVRA-MARANA 115.0, & BICK-VAIL 345.0"
line_122 "N-n:COMMON CORRIDOR LINES OUT OF APACHE"
line_123 "N-n:ENTIRE APACHE STATION OUT OF SERVICE"
line_124 "N-n:ENTIRE BICKNELL SUBSTATION OUT OF SERVICE"

2015 CONTINGENCY LIST

line_1 "Line BICKNELL 345.0 to VAIL 345.0 Circuit 1"
line_2 "Line GREEN-SW 345.0 to GREENLEE 345.0 Circuit 1"
line_3 "Line APACHE 230.0 to BUTERFLD 230.0 Circuit 1"
line_4 "Line APACHE 230.0 to RED TAIL 230.0 Circuit 1"

line_5 "Line APACHE 230.0 to WINCHSTR 230.0 Circuit 1"
line_6 "Line BUTERFLD 230.0 to PANTANO 230.0 Circuit 1"
line_7 "Line BUTERFLD 230.0 TO SAN RAF 230.0 Circuit 1"
line_8 "Line DOSCONDO 230.0 to HACKBERY 230.0 Circuit 1"
line_9 "Line HACKBERY 230.0 to MORENCI 230.0 Circuit 1"
line_10 "Line MORENCI 230.0 to GREEN-SW 230.0 Circuit 1"
line_11 "Line MORENCI 230.0 to PD-MORNC 230.0 Circuit 1"
line_12 "Line NEWTUCSN 230.0 to SAHUARIT 230.0 Circuit 1"
line_13 "Line PANTANO 230.0 to NEWTUCSN 230.0 Circuit 1"
line_14 "Line RED TAIL 230.0 to DOSCONDO 230.0 Circuit 1"
line_15 "Line SAHUARIT 230.0 to BICKNELL 230.0 Circuit 1"
line_16 "Line APACHE 115.0 to SNM1 115.0 Circuit 1"
line_17 "Line AVRA 115.0 to MARANA 115.0 Circuit 1"
line_18 "Line AVRA 115.0 to SNDARIO 115.0 Circuit 1"
line_19 "Line BICKNELL 115.0 to THREEPNT 115.0 Circuit 1"
line_20 "Line MARANATP 115.0 to MARANA 115.0 Circuit 1"
line_21 "Line PANTANO 115.0 to KARTCHNR 115.0 Circuit 1"
line_22 "Line SNM1 115.0 to SNMANUEL 115.0 Circuit 1"
line_23 "Line SNM1 115.0 to HAYDENAZ 115.0 Circuit 1"
line_24 "Line THREEPNT 115.0 to SNDARIO 115.0 Circuit 1"
line_25 "Line THREEPNT 115.0 to VALEN-SW 115.0 Circuit 1"
tran_26 "Tran BICKNELL 345.00 to BICKNELL 230.00 Circuit 1"
tran_27 "Tran GREEN-SW 345.00 to GREEN-SW 230.00 Circuit 1"
tran_28 "Tran WINCHSTR 345.00 to WINCHSTR 230.00 Circuit 1"
tran_29 "Tran APACHE 230.00 to APACHE 115.00 Circuit 1"
tran_30 "Tran APACHE 230.00 to APACHE 115.00 Circuit 2"
tran_31 "Tran BICKNELL 230.00 to BICKNELL 115.00 Circuit 1"
tran_32 "Tran BICKNELL 230.00 to BICKNELL 115.00 Circuit 2"
tran_33 "Tran PANTANO 230.00 to PANTANO 115.00 Circuit 1"
tran_34 "Tran RED TAIL 230.00 to REDTAIL 69.00 Circuit 1"
line_35 "Line PINAL_C 500.0 to TORTOLIT 500.0 Circuit 1"
line_36 "Line SAGUARO 500.0 to TORTOLIT 500.0 Circuit 1"
line_37 "Line SAGUARO 500.0 to TORTOLIT 500.0 Circuit 2"
line_38 "Line GREENLEE 345.0 to COPPERVR 345.0 Circuit 1"
line_39 "Line GREENLEE 345.0 to WILLOW 345.0 Circuit 1"
line_40 "Line HIDALGO 345.0 to GREENLEE 345.0 Circuit 1"
line_41 "Line MCKINLEY 345.0 to SPRINGR 345.0 Circuit 1"
line_42 "Line MCKINLEY 345.0 to SPRINGR 345.0 Circuit 2"
line_43 "Line PINALWES 345.0 to SOUTH 345.0 Circuit 1"
line_44 "Line SAN JUAN 345.0 to MCKINLEY 345.0 Circuit 1"
line_45 "Line SAN JUAN 345.0 to MCKINLEY 345.0 Circuit 2"
line_46 "Line SPRINGR 345 .0 to CORONADO 345.0 Circuit 1"
line_47 "Line SPRINGR 345.0 to GREENLEE 345.0 Circuit 1"
line_48 "Line SPRINGR 345 .0 to LUNA 345.0 Circuit 1"
line_49 "Line SPRINGR 345.0 to VAIL2 345.0 Circuit 1"
line_50 "Line VAIL 345.0 to SOUTH 345.0 Circuit 1"

line_51 "Line WESTWING 345 to PINALWES 345.0 Circuit 1"
line_52 "Line WILLOW 345.0 to BOWIE 345.0 Circuit 1"
line_53 "Line WILLOW 345.0 to BOWIE 345.0 Circuit 2"
line_54 "Line WILLOW 345.0 to WINCHSTR 345.0 Circuit 1"
line_55 "Line WINCHSTR 345.0 to VAIL 345.0 Circuit 1"
line_56 "Line COPPERVR 230.0 to FRISCO 230.0 Circuit 1"
line_57 "Line PD-MORNC 230.0 to FRISCO 230.0 Circuit 1"
tran_58 "Tran CORONADO 500.00 to CORONADO 345.00 Circuit 1"
tran_59 "Tran CORONADO 500.00 to CORONADO 345.00 Circuit 2"
tran_60 "Tran PINAL_W 500.00 to PINALWES 345.00 Circuit 1"
tran_61 "Tran TORTOLIT 500.00 to TORTOLIT 345.00 Circuit 1"
tran_62 "Tran WESTWING 500.00 to WESTWING 345.00 Circuit 1"
tran_63 "Tran COPPERVR 345.00 to COPPERVR 230.00 Circuit 1"
tran_64 "Tran COPPERVR 345.00 to COPPERVR 230. 00 Circuit 2"
line_65 "Line ADAMS 115.0 to ADAMSTAP 115.0 Circuit 1"
line_66 "Line ADAMSTAP 115.0 to APACHE 115.0 Circuit 1"
line_67 "Line ADAMSTAP 115.0 to NOGALES 115.0 Circuit 1"
line_68 "Line BLACKMTN 115.0 to SNYDHILL 115.0 Circuit 1"
line_69 "Line BRAWLEY 115.0 to SANXAVER 115.0 Circuit 1"
line_70 "Line DEL BAC 115.0 to NOGALES 115.0 Circuit 1"
line_71 "Line MARANATP 115.0 to RATTLSNK 115.0 Circuit 1"
line_72 "Line RATTLSNK 115.0 to TUCSON 115.0 Circuit 1"
line_73 "Line RATTLSNK 115.0 to TWINPEAK 115.0 Circuit 1"
line_74 "Line SAG.EAST 115.0 to MARANATP 115.0 Circuit 1"
line_75 "Line SAG.EAST 115.0 to ORACLE 115.0 Circuit 1"
line_76 "Line SANDARIO 115.0 to BRAWLEY 115.0 Circuit 1"
line_77 "Line SANXAVER 115.0 to SNYDHILL 115.0 Circuit 1"
line_78 "Line TUCSON 115.0 to DEL BAC 115.0 Circuit 1"
line_79 "Line TUCSON 115.0 to ORACLE 115.0 Circuit 1"
line_80 "Line TWINPEAK 115.0 to SANDARIO 115.0 Circuit 1"
line_81 "Line CHOLLA 500.0 to SAGUARO 500.0 Circuit 1"
line_82 "Line HASSYAMP 500.0 to JOJOBA 500.0 Circuit 1"
line_83 "Line JOJOBA 500.0 to GILARIVR 500.00 Circuit 1"
line_84 "Line JOJOBA 500.0 to GILARIVR 500.00 Circuit 2"
line_85 "Line MILLIGAN 230.0 to CASGRAPS 230.0 Circuit 1"
line_86 "Line SAGUARO 230.0 to MILLIGAN 230.0 Circuit 1"
line_87 "Line SAGUARO 230.0 to TATMOMLI 230.0 Circuit 1"
line_88 "Line BOOTHILL 115.0 to ADAMS 115.0 Circuit 1"
line_89 "Line BOOTHILL 115.0 to MURAL 115.0 Circuit 1"
line_90 "Line ORACLE 115.0 to S.BRKRCH 115.0 Circuit1"
line_91 "Line RED ROCK 115.0 to SAG.EAST 115.0 Circuit 1"
line_92 "Line S.BRKRCH 115.0 to SNMANUEL 115.0 Circuit 1"
line_93 "Line SAG.EAST 115.0 to SAG.WEST 115.0 Circuit 1"
line_94 "Line SAG.WEST 115.0 to ED-5 115.0 Circuit 1"
line_95 "Line SAG.WEST 115.0 to ED-5B 115.0 Circuit 1"
line_96 "Line SAG.WEST 115.0 to SNMANUEL 115.0 Circuit 1"

tran_97 "Tran SAGUARO 500.00 to SAG.EAST 115.00 Circuit 1"
tran_98 "Tran SAGUARO 500.00 to SAG.WEST 115.00 Circuit 1"
tran_99 "Tran SAGUARO 230.00 to SAG.EAST 115.00 Circuit 1"
tran_100 "Tran SAGUARO 230.00 to SAG.WEST 115.0 Circuit 1"
tran_101 "Tran TORTOLIT 138.00 to SAG.EAST 115.0 Circuit 1"
tran_102 "Tran TORTOLIT 138.00 to SAG.WEST 115.0 Circuit 1"
line_103 "Line ABEL 500.0 to BROWNING 500.0 Circuit 1"
line_104 "Line ABEL 500.0 to PINAL_C 500.0 Circuit 1"
line_105 "Line BROWNING 500.0 to KYRENE 500.0 Circuit 1"
line_106 "Line HASSYAMP 500.0 to PINAL_W 500.0 Circuit 1"
line_107 "Line JOJOBA 500.0 to KYRENE 500.0 Circuit 1"
line_108 "Line PINAL_W 500.0 to SNTAROSA 500.0 Circuit 1"
line_109 "Line SNTAROSA 500.0 to PINAL_C 500.0 Circuit 1"
line_110 "N-2:Line APA-BUTT 230.0 & APA-RED TAIL 230.0"
line_111 "N-2:Line APA-BUTT 230.0 & APA-WIN 230.0"
line_112 "N-2:Line APA-BUTT 230.0 & BICK-VAIL 345.0"
line_113 "N-2:Line APA-REDTAIL 230.0 & BICK-VAIL 345.0"
line_114 "N-2:Line APACHE-WIN 230.0 & APA-REDTAIL 230.0"
line_115 "N-2:Line APACHE-WIN 230.0 & BICK-VAIL 345.0"
line_116 "N-2:Line APACHE-WIN 230.0 & GREEN-SW-GRNL 345.0"
line_117 "N-2:Line GRNL-COPPVR 345.0 & HACK-MORENCI 230.0"
line_118 "N-2:Line GRNL-COPPVR 345.0 & GREEN-SW-GRNL 345.0"
line_119 "N-2:Line GRNL-WILLOW 345.0 & GRNL-COPPVR 345.0"
line_120 "N-2:Line GREEN-SW-GRNL 345.0 & WIN-VAIL 345.0"
line_121 "N-2:Line GREEN-SW-GRNL 345.0 & BICK-VAIL 345.0"
line_122 "N-2:Line SPRINGR-GRNL 345.0 & PINALWES-SOUTH 345.0"
line_123 "N-2:Line SPRINGR-GRNL 345.0 & WIN-VAIL 345kV"
line_124 "N-2:Line SPRINGR-VAIL2 345.0 & PINALWES-SOUTH 345.0"
line_125 "N-2:Line SPRINGR-VAIL2 345.0 & WIN-VAIL 345.0"
line_126 "N-2: Both WILLOW TO BOWIE 345 kV LINES"
line_127 "N-2:Line WIN-VAIL 345.0 & PINALWES-SOUTH 345.0"
line_128 "N-n:Line APA-BUTT/RED TAIL230.0 & APA-WIN 230.0"
line_129 "N-n:Line APA-BUTT/RED TAIL 230.0 & AVRA-MARANA 115.0"
line_130 "N-n:Line: APA-BUTT 230.0, AVRA-MARANA 115.0, & BICK-VAIL 345.0"
line_131 "N-n:COMMON CORRIDOR LINES OUT OF APACHE"
line_132 "N-n:ENTIRE APACHE STATION OUT OF SERVICE"
line_133 "N-n:ENTIRE BICKNELL SUBSTATION OUT OF SERVICE"

2020 CONTINGENCY LIST

line_1 "Line BICKNELL 345.0 to VAIL 345.0 Circuit 1"
line_2 "Line GREEN-SW 345.0 to GREENLEE 345.0 Circuit 1"
line_3 "Line APACHE 230.0 to BUTERFLD 230.0 Circuit 1"
line_4 "Line APACHE 230.0 to RED TAIL 230.0 Circuit 1"
line_5 "Line APACHE 230.0 to WINCHSTR 230.0 Circuit 1"
line_6 "Line BUTERFLD 230.0 to PANTANO 230.0 Circuit 1"

line_7 "Line BUTERFLD 230.0 TO SAN RAF 230.0 Circuit 1"
line_8 "Line DOSCONDO 230.0 to HACKBERY 230.0 Circuit 1"
line_9 "Line HACKBERY 230.0 to MORENCI 230.0 Circuit 1"
line_10 "Line MORENCI 230.0 to GREEN-SW 230.0 Circuit 1"
line_11 "Line MORENCI 230.0 to PD-MORNC 230.0 Circuit 1"
line_12 "Line NEWTUCSN 230.0 to SAHUARIT 230.0 Circuit 1"
line_13 "Line PANTANO 230.0 to NEWTUCSN 230.0 Circuit 1"
line_14 "Line RED TAIL 230.0 to DOSCONDO 230.0 Circuit 1"
line_15 "Line SAHUARIT 230.0 to BICKNELL 230.0 Circuit 1"
line_16 "Line APACHE 115.0 to SNM1 115.0 Circuit 1"
line_17 "Line AVRA 115.0 to MARANA 115.0 Circuit 1"
line_18 "Line AVRA 115.0 to SNDARIO 115.0 Circuit 1"
line_19 "Line BICKNELL 115.0 to THREEPNT 115.0 Circuit 1"
line_20 "Line MARANATP 115.0 to MARANA 115.0 Circuit 1"
line_21 "Line PANTANO 115.0 to KARTCHNR 115.0 Circuit 1"
line_22 "Line SNM1 115.0 to SNMANUEL 115.0 Circuit 1"
line_23 "Line SNM1 115.0 to HAYDENAZ 115.0 Circuit 1"
line_24 "Line THREEPNT 115.0 to SNDARIO 115.0 Circuit 1"
line_25 "Line THREEPNT 115.0 to VALEN-SW 115.0 Circuit 1"
tran_26 "Tran BICKNELL 345.00 to BICKNELL 230.00 Circuit 1"
tran_27 "Tran GREEN-SW 345.00 to GREEN-SW 230.00 Circuit 1"
tran_28 "Tran WINCHSTR 345.00 to WINCHSTR 230.00 Circuit 1"
tran_29 "Tran APACHE 230.00 to APACHE 115.00 Circuit 1"
tran_30 "Tran APACHE 230.00 to APACHE 115.00 Circuit 2"
tran_31 "Tran BICKNELL 230.00 to BICKNELL 115.00 Circuit 1"
tran_32 "Tran BICKNELL 230.00 to BICKNELL 115.00 Circuit 2"
tran_33 "Tran PANTANO 230.00 to PANTANO 115.00 Circuit 1"
tran_34 "Tran RED TAIL 230.00 to REDTAIL 69.00 Circuit 1"
line_35 "Line PINAL_C 500.0 to TORTOLIT 500.0 Circuit 1"
line_36 "Line SAGUARO 500.0 to TORTOLIT 500.0 Circuit 1"
line_37 "Line SAGUARO 500.0 to TORTOLIT 500.0 Circuit 2"
line_38 "Line GREENLEE 345.0 to COPPERVR 345.0 Circuit 1"
line_39 "Line GREENLEE 345.0 to WILLOW 345.0 Circuit 1"
line_40 "Line HIDALGO 345.0 to GREENLEE 345.0 Circuit 1"
line_41 "Line MCKINLEY 345.0 to SPRINGR 345.0 Circuit 1"
line_42 "Line MCKINLEY 345.0 to SPRINGR 345.0 Circuit 2"
line_43 "Line PINALWES 345.0 to SOUTH 345.0 Circuit 1"
line_44 "Line SAN JUAN 345.0 to MCKINLEY 345.0 Circuit 1"
line_45 "Line SAN JUAN 345.0 to MCKINLEY 345.0 Circuit 2"
line_46 "Line SPRINGR 345 .0 to CORONADO 345.0 Circuit 1"
line_47 "Line SPRINGR 345.0 to GREENLEE 345.0 Circuit 1"
line_48 "Line SPRINGR 345 .0 to LUNA 345.0 Circuit 1"
line_49 "Line SPRINGR 345.0 to VAIL2 345.0 Circuit 1"
line_50 "Line VAIL 345.0 to SOUTH 345.0 Circuit 1"
line_51 "Line WESTWING 345 to PINALWES 345.0 Circuit 1"
line_52 "Line WILLOW 345.0 to BOWIE 345.0 Circuit 1"

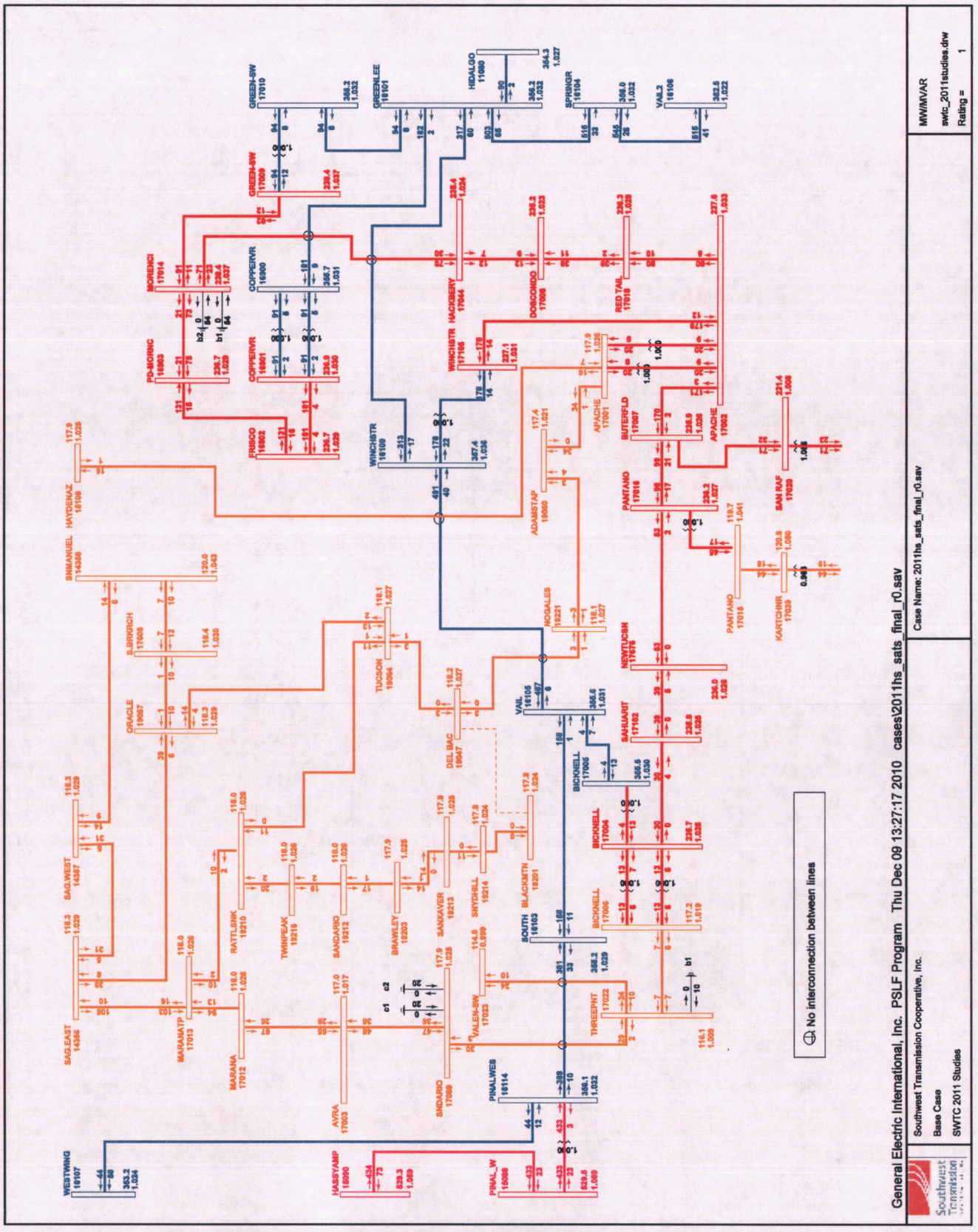
line_53 "Line WILLOW 345.0 to BOWIE 345.0 Circuit 2"
line_54 "Line WILLOW 345.0 to WINCHSTR 345.0 Circuit 1"
line_55 "Line WINCHSTR 345.0 to VAIL 345.0 Circuit 1"
line_56 "Line COPPERVR 230.0 to FRISCO 230.0 Circuit 1"
line_57 "Line PD-MORNC 230.0 to FRISCO 230.0 Circuit 1"
tran_58 "Tran CORONADO 500.00 to CORONADO 345.00 Circuit 1"
tran_59 "Tran CORONADO 500.00 to CORONADO 345.00 Circuit 2"
tran_60 "Tran PINAL_W 500.00 to PINALWES 345.00 Circuit 1"
tran_61 "Tran TORTOLIT 500.00 to TORTOLIT 345.00 Circuit 1"
tran_62 "Tran WESTWING 500.00 to WESTWING 345.00 Circuit 1"
tran_63 "Tran COPPERVR 345.00 to COPPERVR 230.00 Circuit 1"
tran_64 "Tran COPPERVR 345.00 to COPPERVR 230. 00 Circuit 2"
line_65 "Line ADAMS 115.0 to ADAMS TP 115.0 Circuit 1"
line_66 "Line ADAMS TP 115.0 to APACHE 115.0 Circuit 1"
line_67 "Line ADAMS TP 115.0 to NOGALES 115.0 Circuit 1"
line_68 "Line BLACKMTN 115.0 to SNYDHILL 115.0 Circuit 1"
line_69 "Line BRAWLEY 115.0 to SANXAVER 115.0 Circuit 1"
line_70 "Line DEL BAC 115.0 to NOGALES 115.0 Circuit 1"
line_71 "Line MARANATP 115.0 to RATTLSNK 115.0 Circuit 1"
line_72 "Line RATTLSNK 115.0 to TUCSON 115.0 Circuit 1"
line_73 "Line RATTLSNK 115.0 to TWINPEAK 115.0 Circuit 1"
line_74 "Line SAG.EAST 115.0 to MARANATP 115.0 Circuit 1"
line_75 "Line SAG.EAST 115.0 to ORACLE 115.0 Circuit 1"
line_76 "Line SANDARIO 115.0 to BRAWLEY 115.0 Circuit 1"
line_77 "Line SANXAVER 115.0 to SNYDHILL 115.0 Circuit 1"
line_78 "Line TUCSON 115.0 to DEL BAC 115.0 Circuit 1"
line_79 "Line TUCSON 115.0 to ORACLE 115.0 Circuit 1"
line_80 "Line TWINPEAK 115.0 to SANDARIO 115.0 Circuit 1"
line_81 "Line CHOLLA 500.0 to SAGUARO 500.0 Circuit 1"
line_82 "Line HASSYAMP 500.0 to JOJOBA 500.0 Circuit 1"
line_83 "Line JOJOBA 500.0 to GILARIVR 500.00 Circuit 1"
line_84 "Line JOJOBA 500.0 to GILARIVR 500.00 Circuit 2"
line_85 "Line MILLIGAN 230.0 to CASGRAPS 230.0 Circuit 1"
line_86 "Line SAGUARO 230.0 to MILLIGAN 230.0 Circuit 1"
line_87 "Line SAGUARO 230.0 to TATMOMLI 230.0 Circuit 1"
line_88 "Line BOOTHILL 115.0 to ADAMS 115.0 Circuit 1"
line_89 "Line BOOTHILL 115.0 to MURAL 115.0 Circuit 1"
line_90 "Line ORACLE 115.0 to S.BRKRCH 115.0 Circuit1"
line_91 "Line RED ROCK 115.0 to SAG.EAST 115.0 Circuit 1"
line_92 "Line S.BRKRCH 115.0 to SNMANUEL 115.0 Circuit 1"
line_93 "Line SAG.EAST 115.0 to SAG.WEST 115.0 Circuit 1"
line_94 "Line SAG.WEST 115.0 to ED-5 115.0 Circuit 1"
line_95 "Line SAG.WEST 115.0 to ED-5B 115.0 Circuit 1"
line_96 "Line SAG.WEST 115.0 to SNMANUEL 115.0 Circuit 1"
tran_97 "Tran SAGUARO 500.00 to SAG.EAST 115.00 Circuit 1"
tran_98 "Tran SAGUARO 500.00 to SAG.WEST 115.00 Circuit 1"

tran_99	"Tran SAGUARO 230.00 to SAG.EAST 115.00 Circuit 1"
tran_100	"Tran SAGUARO 230.00 to SAG.WEST 115.0 Circuit 1"
tran_101	"Tran TORTOLIT 138.00 to SAG.EAST 115.0 Circuit 1"
tran_102	"Tran TORTOLIT 138.00 to SAG.WEST 115.0 Circuit 1"
line_103	"Line ABEL 500.0 to BROWNING 500.0 Circuit 1"
line_104	"Line ABEL 500.0 to PINAL_C 500.0 Circuit 1"
line_105	"Line BROWNING 500.0 to KYRENE 500.0 Circuit 1"
line_106	"Line HASSYAMP 500.0 to PINAL_W 500.0 Circuit 1"
line_107	"Line JOJOBA 500.0 to KYRENE 500.0 Circuit 1"
line_108	"Line PINAL_W 500.0 to SNTAROSA 500.0 Circuit 1"
line_109	"Line SNTAROSA 500.0 to PINAL_C 500.0 Circuit 1"
line_110	"N-2:Line APA-BUTT 230.0 & APA-RED TAIL 230.0"
line_111	"N-2:Line APA-BUTT 230.0 & APA-WIN 230.0"
line_112	"N-2:Line APA-BUTT 230.0 & BICK-VAIL 345.0"
line_113	"N-2:Line APA-REDTAIL 230.0 & BICK-VAIL 345.0"
line_114	"N-2:Line APACHE-WIN 230.0 & APA-REDTAIL 230.0"
line_115	"N-2:Line APACHE-WIN 230.0 & BICK-VAIL 345.0"
line_116	"N-2:Line APACHE-WIN 230.0 & GREEN-SW-GRNL 345.0"
line_117	"N-2:Line GRNL-COPPVR 345.0 & HACK-MORENCI 230.0"
line_118	"N-2:Line GRNL-COPPVR 345.0 & GREEN-SW-GRNL 345.0"
line_119	"N-2:Line GRNL-WLLOW 345.0 & GRNL-COPPVR 345.0"
line_120	"N-2:Line GREEN-SW-GRNL 345.0 & WIN-VAIL 345.0"
line_121	"N-2:Line GREEN-SW-GRNL 345.0 & BICK-VAIL 345.0"
line_122	"N-2:Line SPRINGR-GRNL 345.0 & PINALWES-SOUTH 345.0"
line_123	"N-2:Line SPRINGR-GRNL 345.0 & WIN-VAIL 345kV"
line_124	"N-2:Line SPRINGR-VAIL2 345.0 & PINALWES-SOUTH 345.0"
line_125	"N-2:Line SPRINGR-VAIL2 345.0 & WIN-VAIL 345.0"
line_126	"N-2: Both WILLOW TO BOWIE 345 kV LINES"
line_127	"N-2:Line WIN-VAIL 345.0 & PINALWES-SOUTH 345.0"
line_128	"N-n:Line APA-BUTT/RED TAIL 230.0 & AVRA-MARANA 115.0"
line_129	"N-n:Line: APA-BUTT 230.0, AVRA-MARANA 115.0, & BICK-VAIL 345.0"
line_130	"N-n:Line APA-BUTT/RED TAIL230.0 & APA-WIN 230.0"
line_131	"N-n:COMMON CORRIDOR LINES OUT OF APACHE"
line_132	"N-n:ENTIRE APACHE STATION OUT OF SERVICE"
line_133	"N-n:ENTIRE BICKNELL SUBSTATION OUT OF SERVICE"

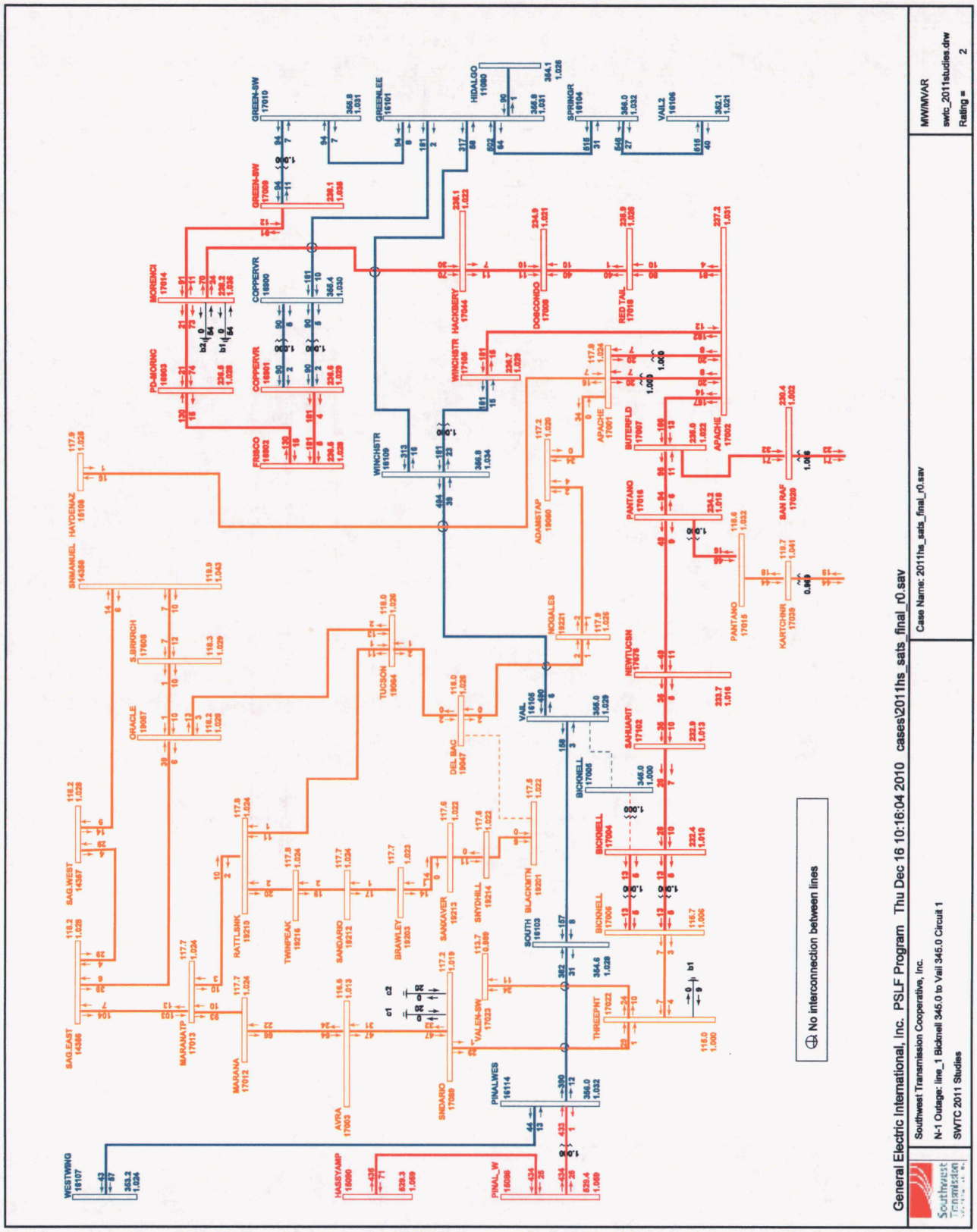
APPENDIX C

POWER FLOW ONE LINE DIAGRAMS

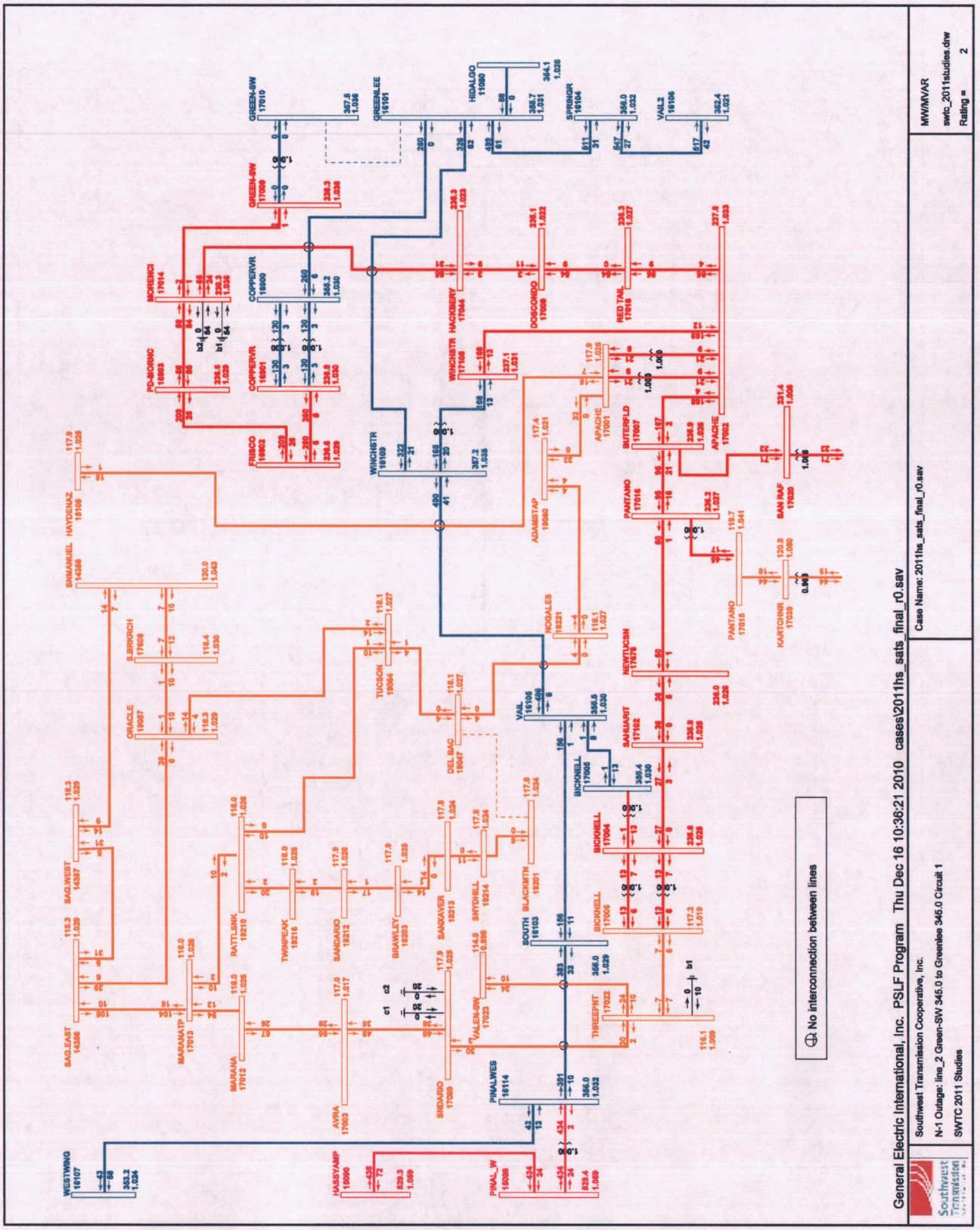
2011HS Southwest Transmission Cooperative Base System



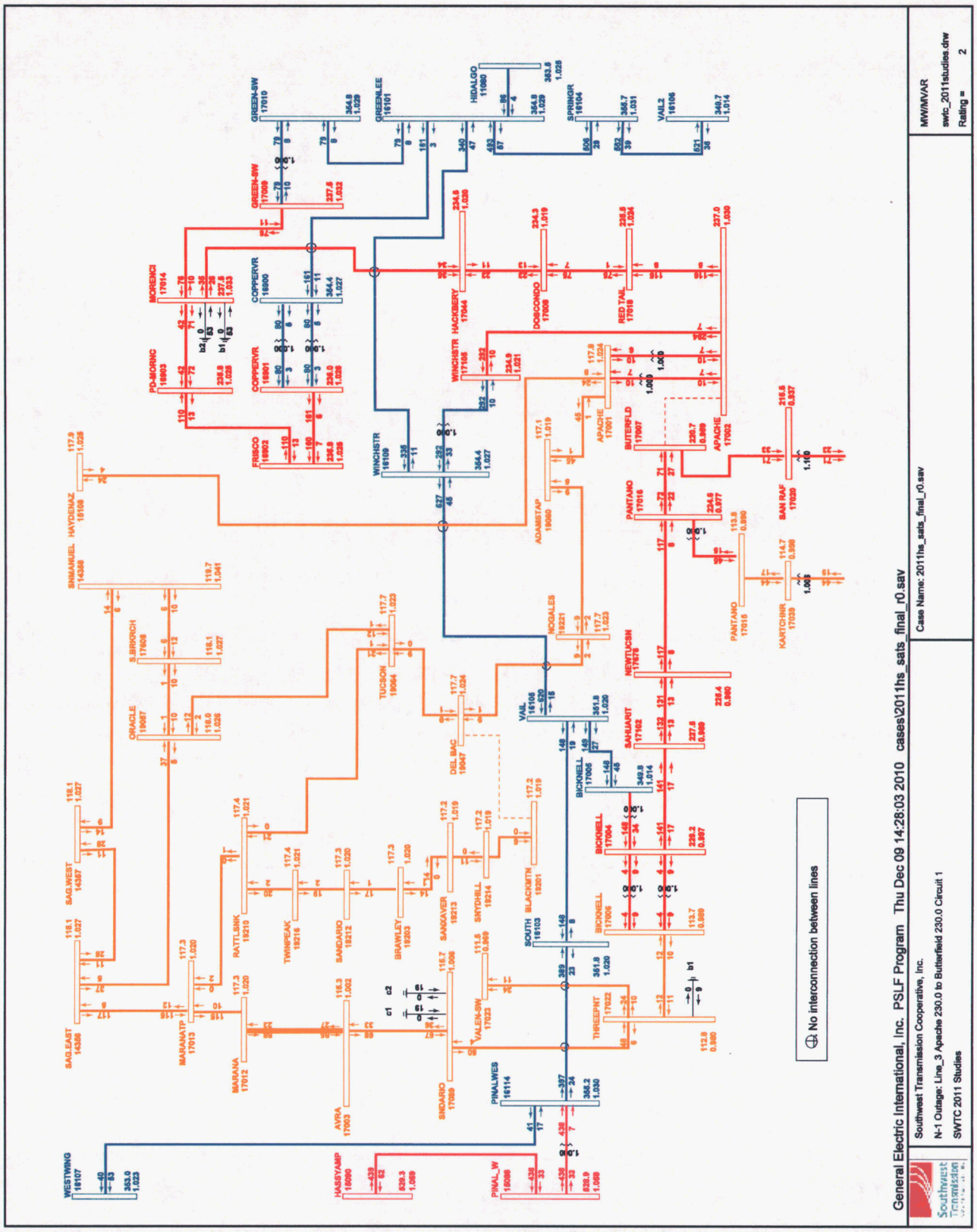
2011HS Southwest Transmission Cooperative Base System with Bicknell to Vail 345 kV Line out of service



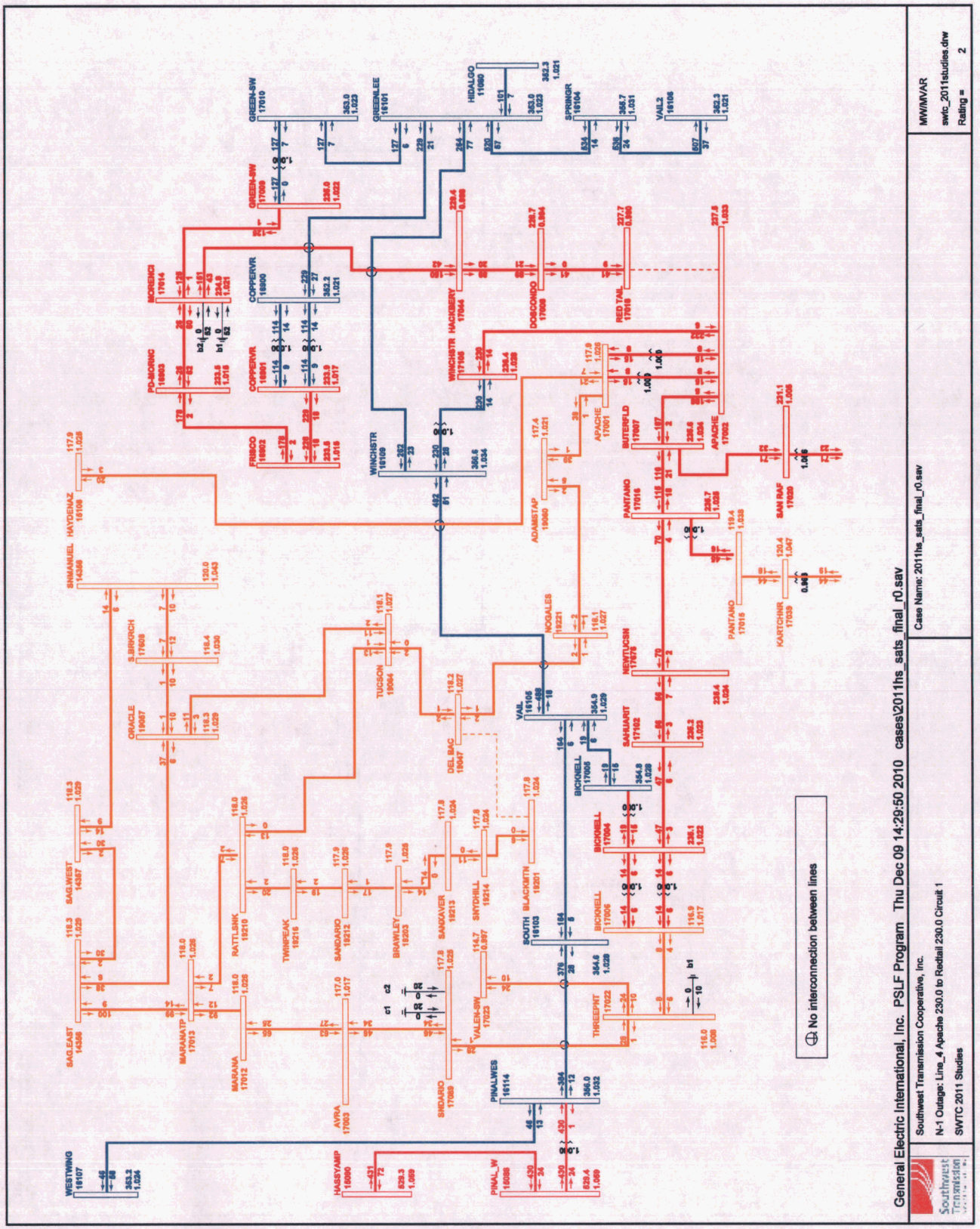
2011HS Southwest Transmission Cooperative Base System with Greenlee to Greenlee 345 kV Line out of service



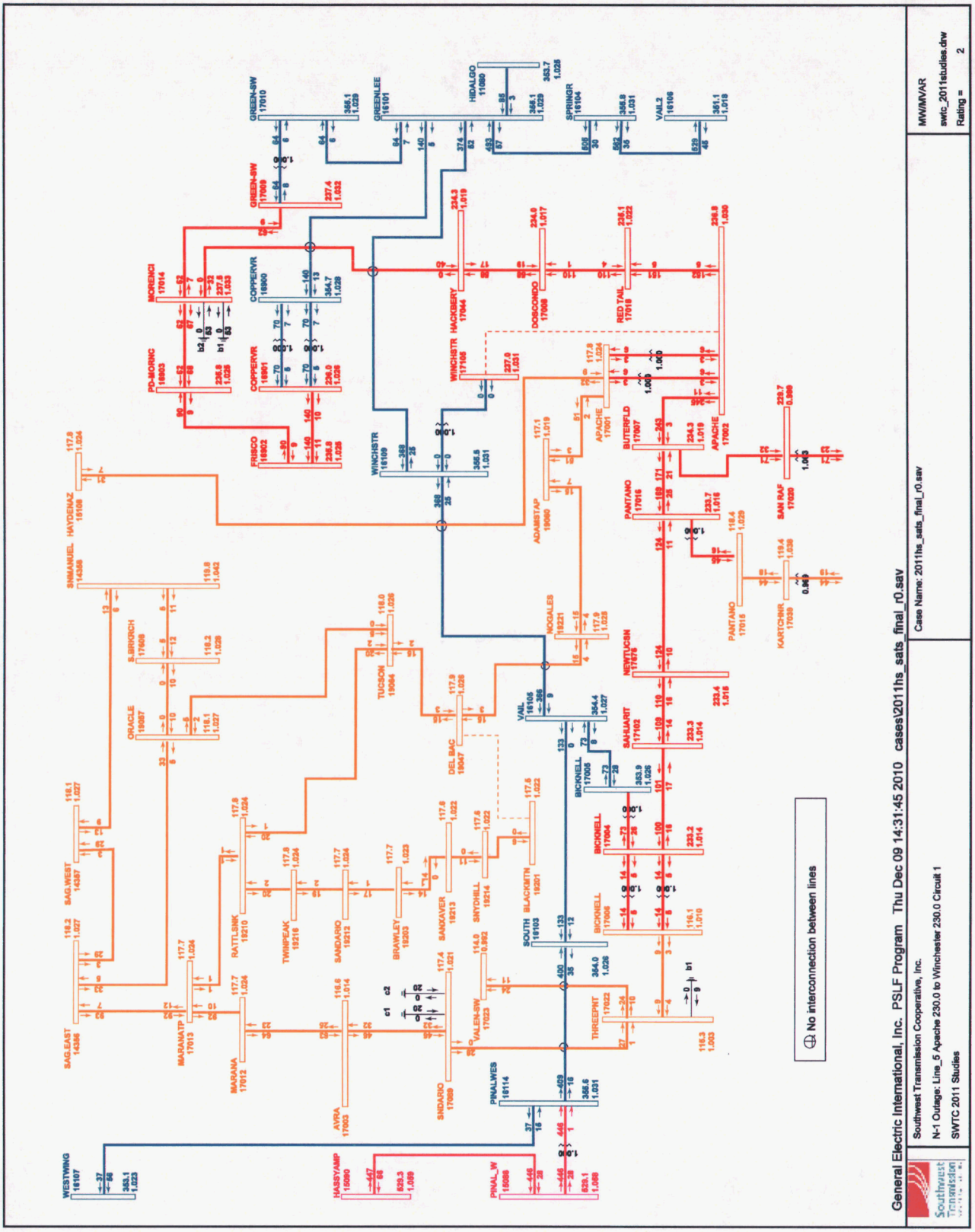
2011HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230 kV Line out of service



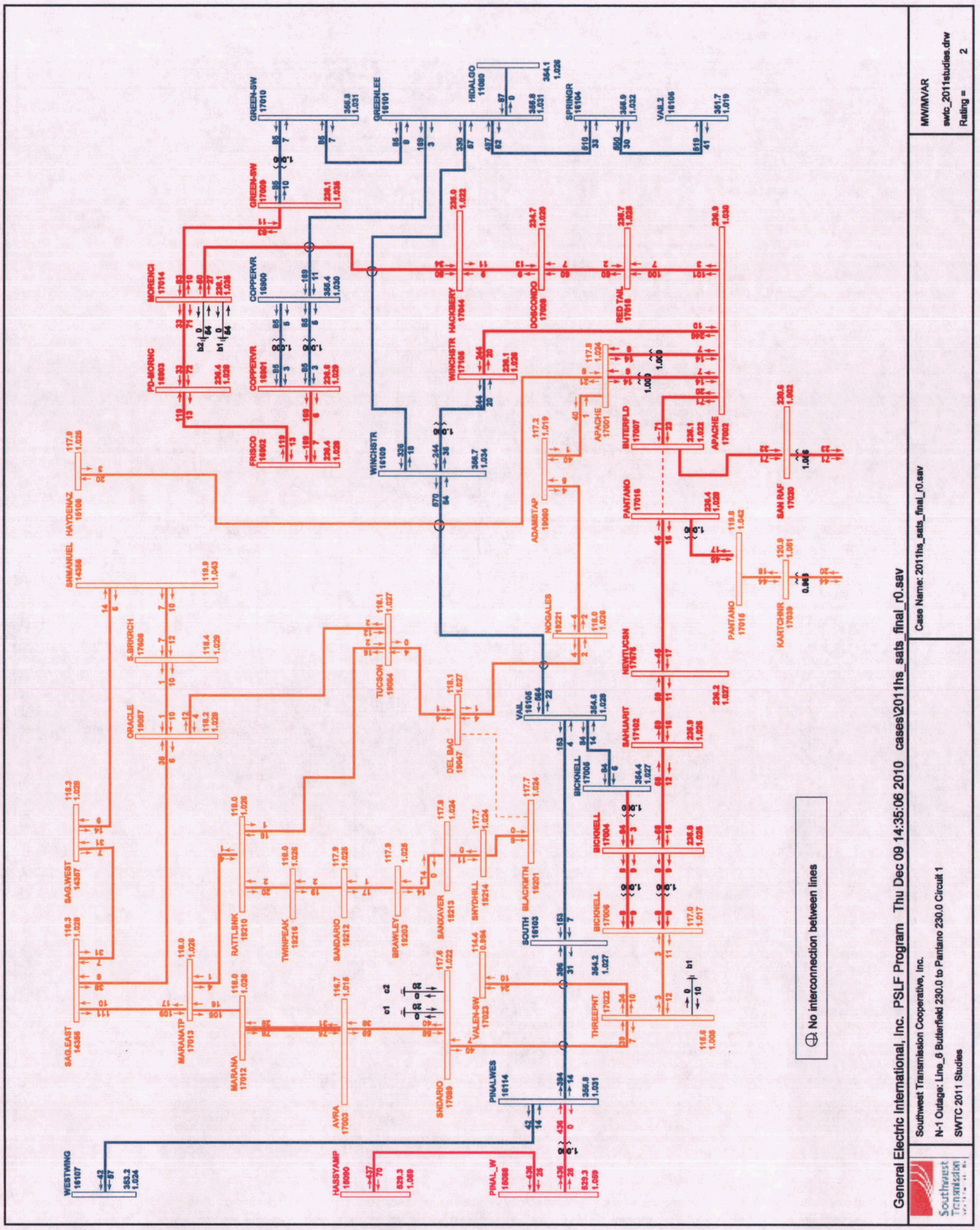
2011HS Southwest Transmission Cooperative Base System with Apache to Redtail 230 kV Line out of service



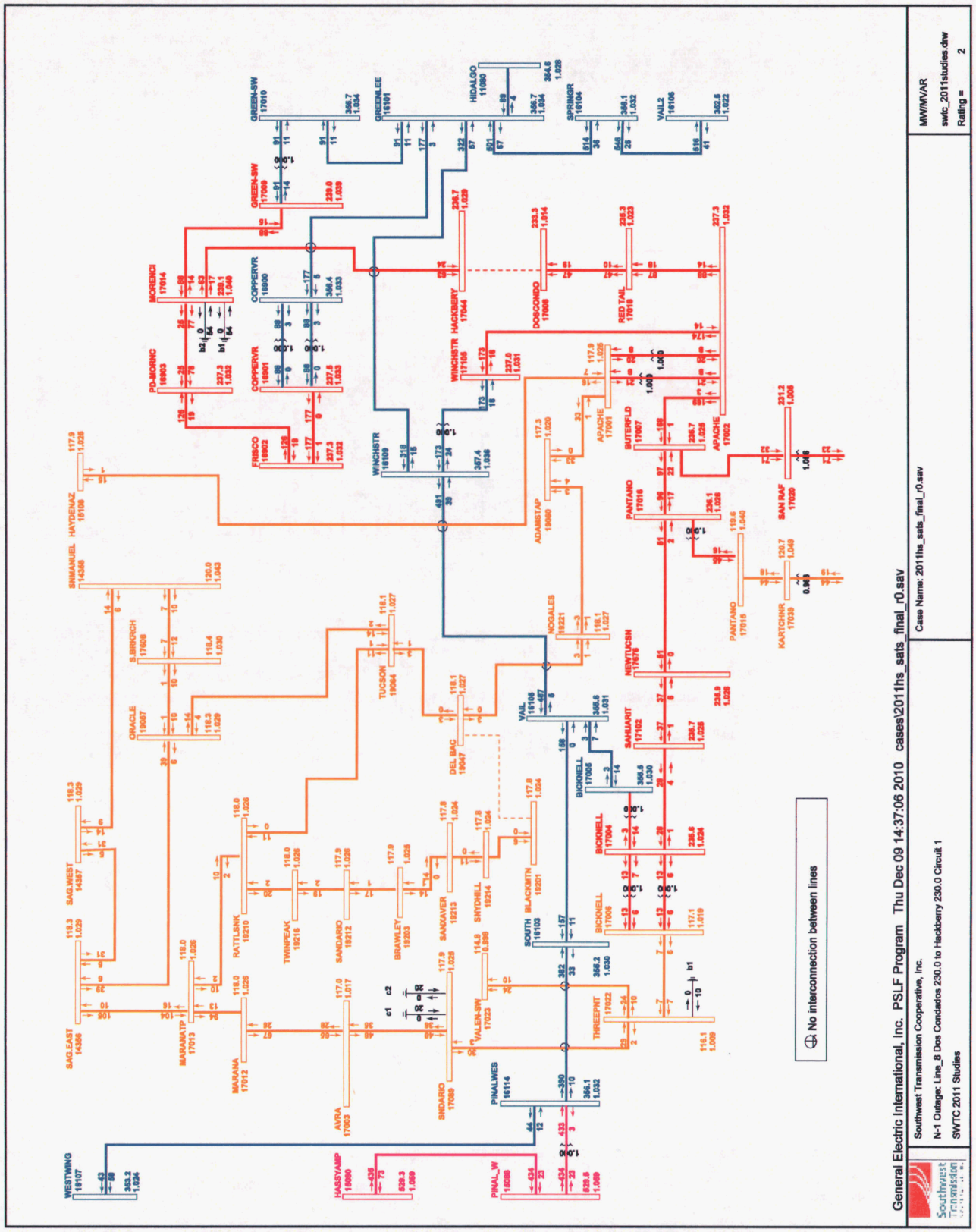
2011HS Southwest Transmission Cooperative Base System with Apache to Winchester 230 kV Line out of service



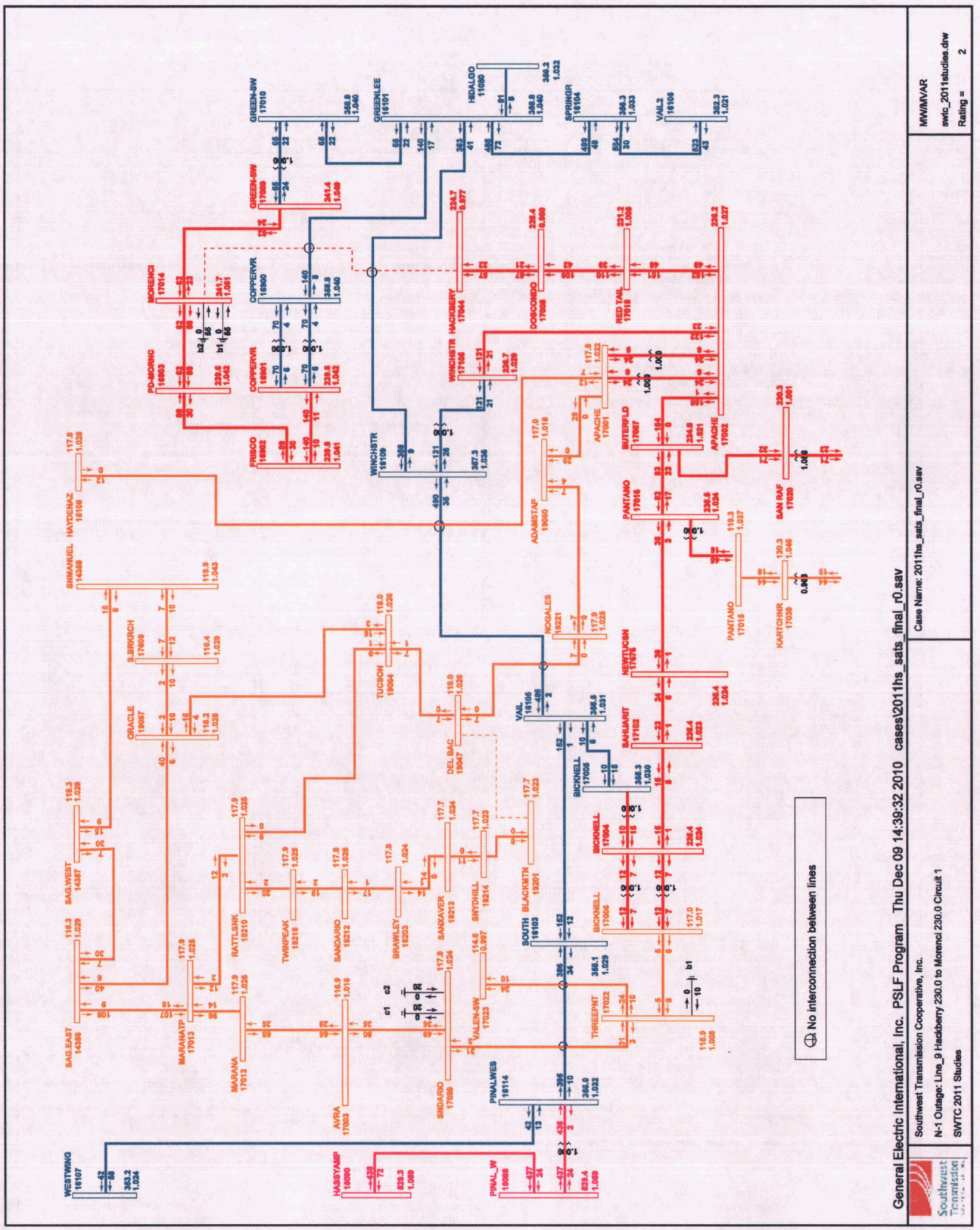
2011HS Southwest Transmission Cooperative Base System with Butterfield to Pantano 230 kV Line out of service



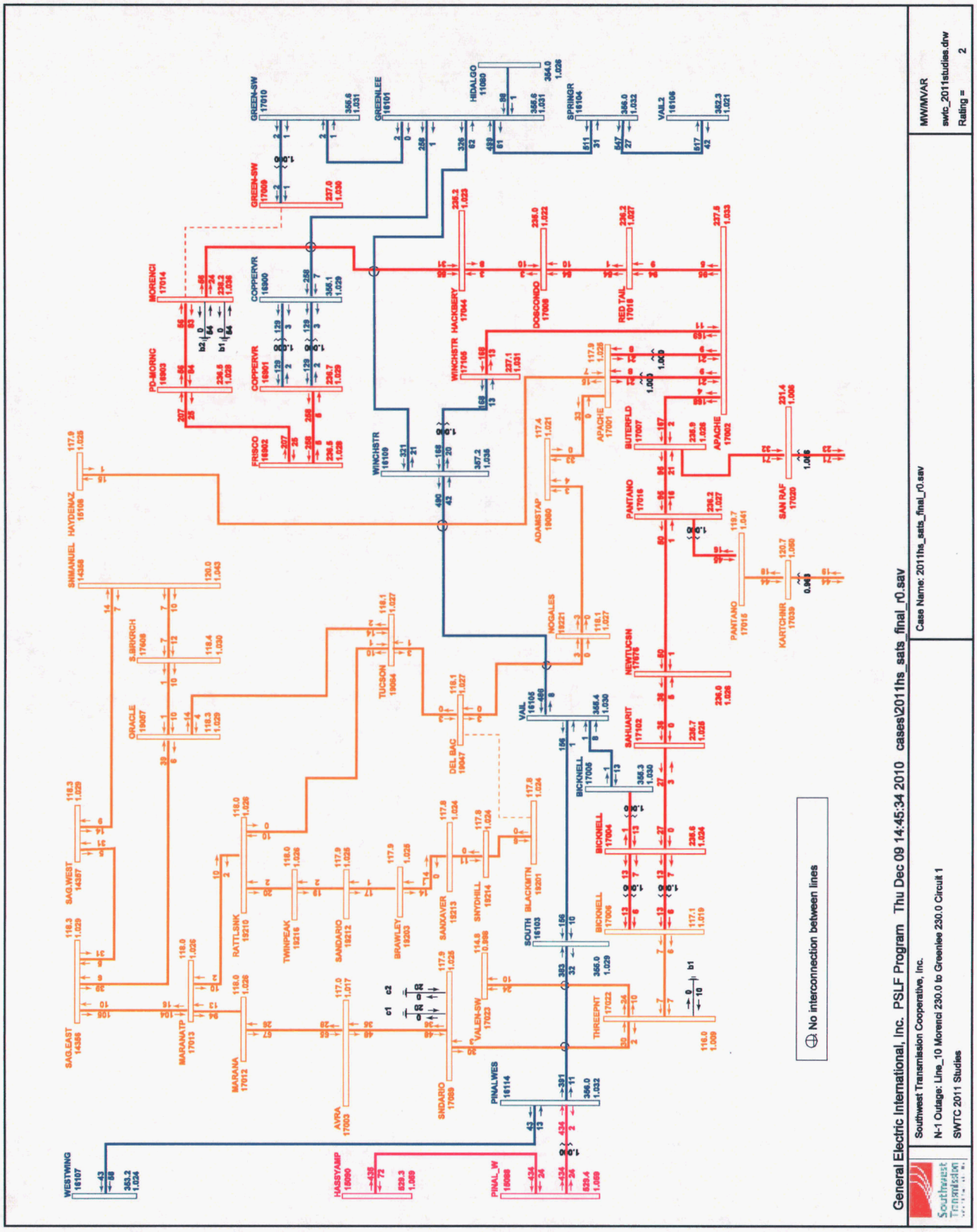
2011HS Southwest Transmission Cooperative Base System with Dos Condados to Hackberry 230 kV Line out of service



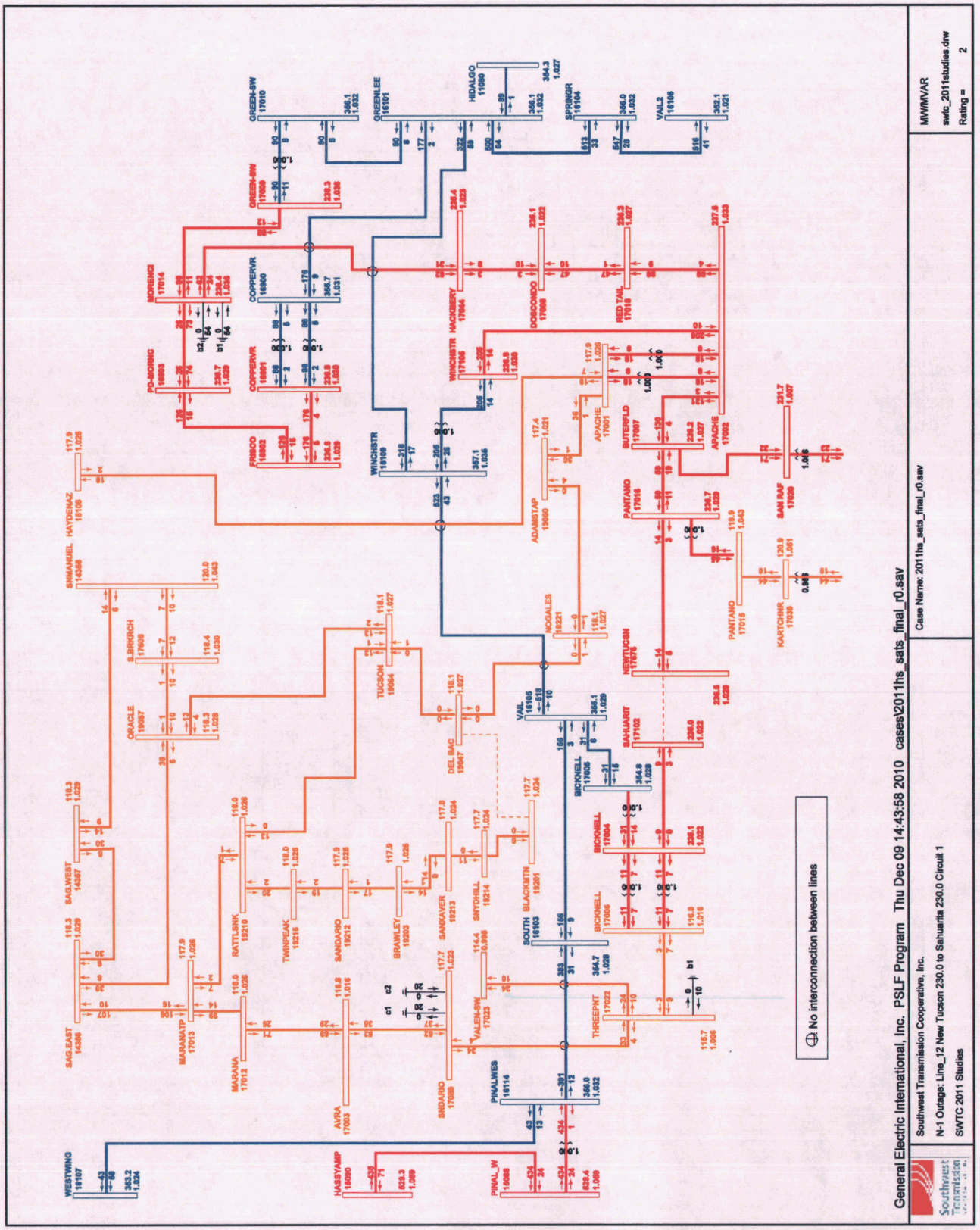
2011HS Southwest Transmission Cooperative Base System with Hackberry to Morenci 230 kV Line out of service



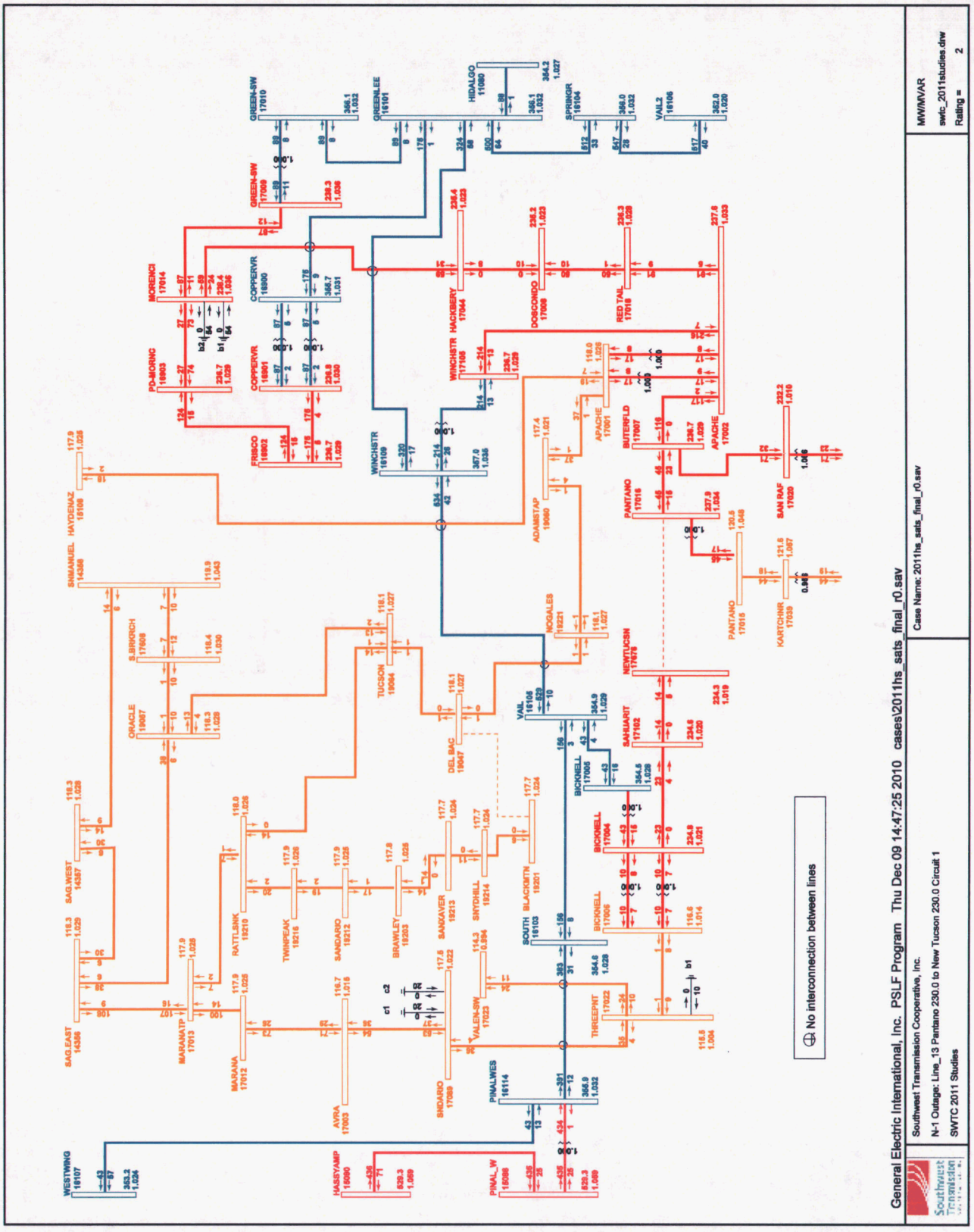
2011HS Southwest Transmission Cooperative Base System with Morenci to Greenlee 230 kV Line out of service



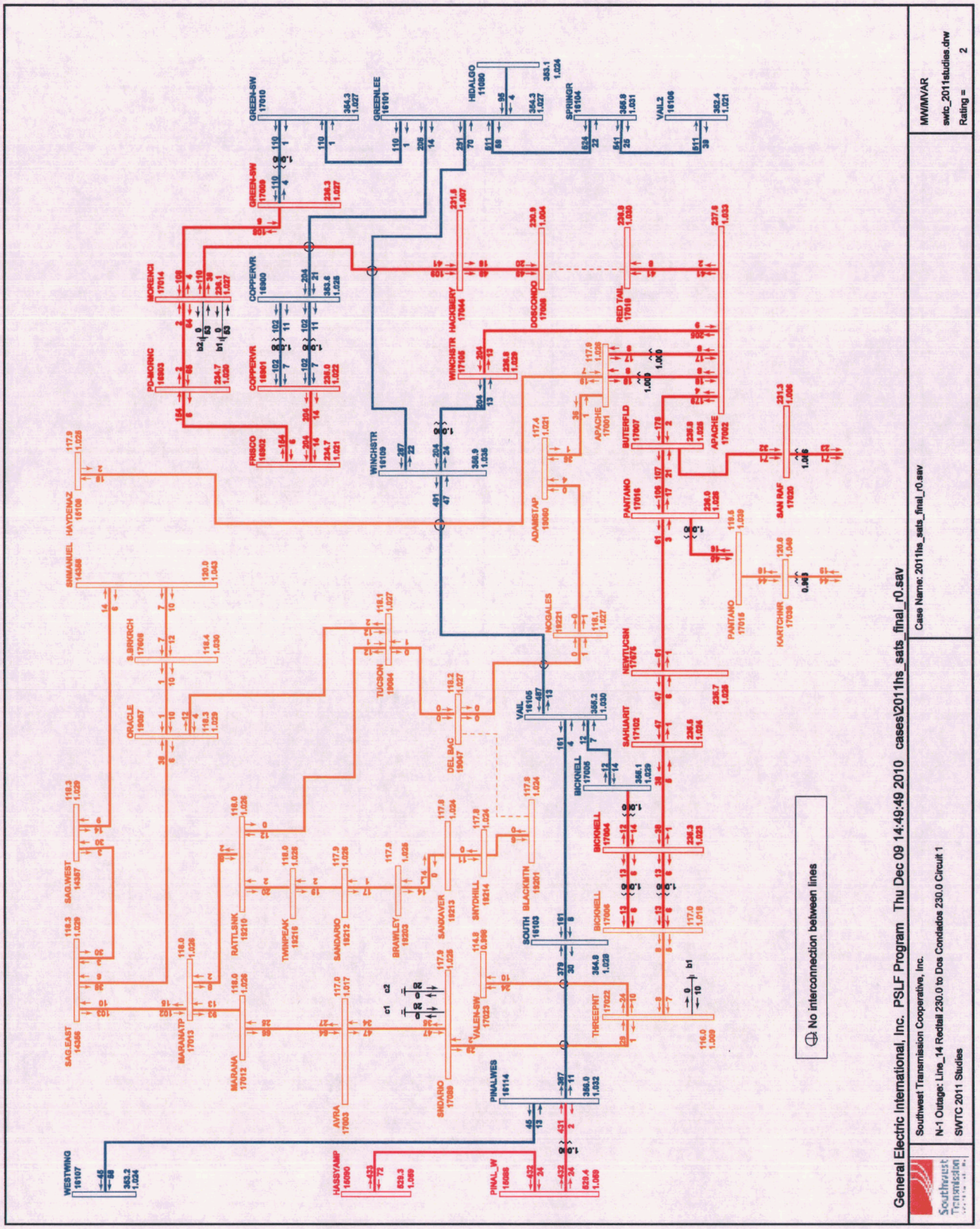
2011HS Southwest Transmission Cooperative Base System with New Tucson to Sahuarita 230 kV Line out of service



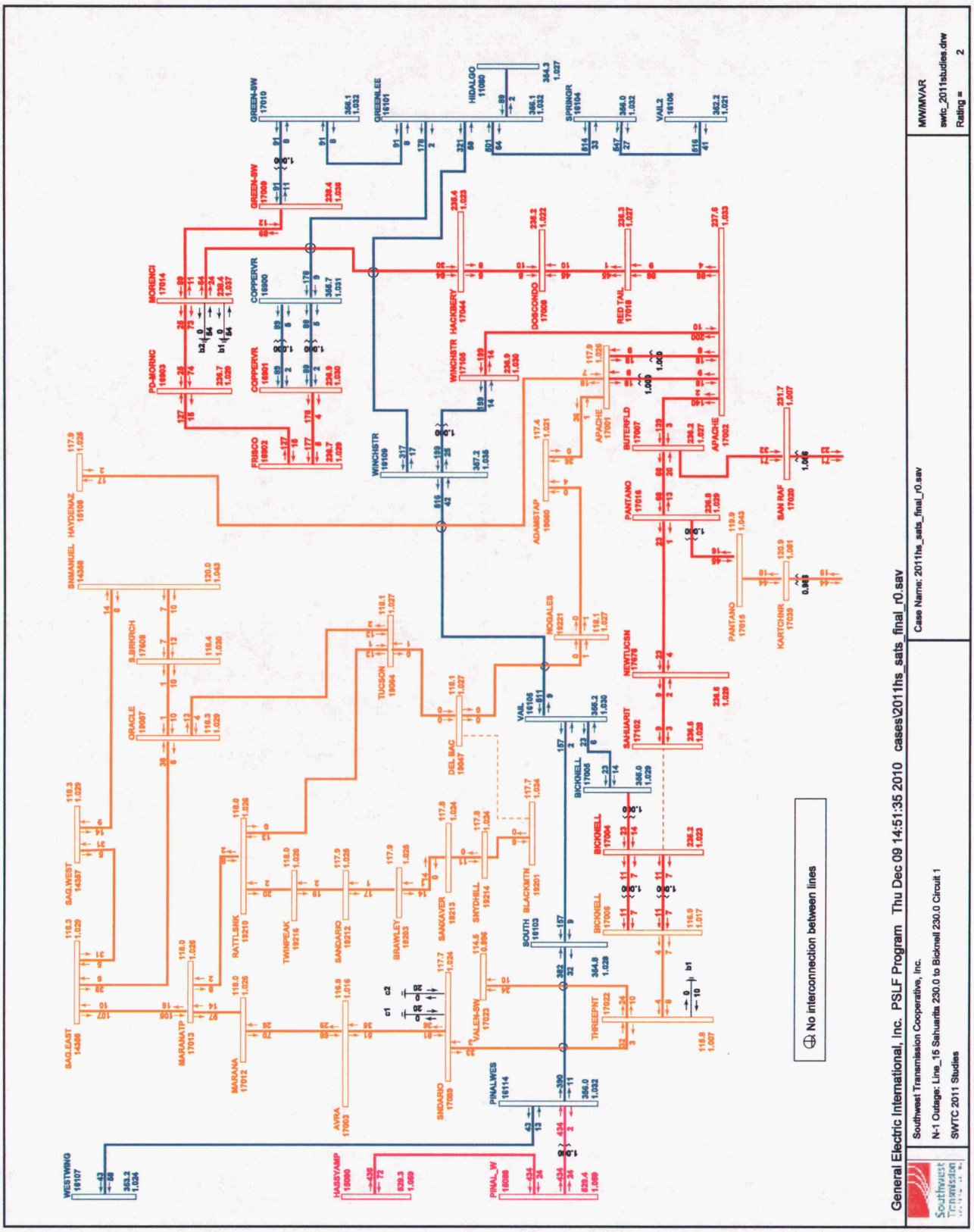
2011HS Southwest Transmission Cooperative Base System with Pantano to New Tucson 230 kV Line out of service



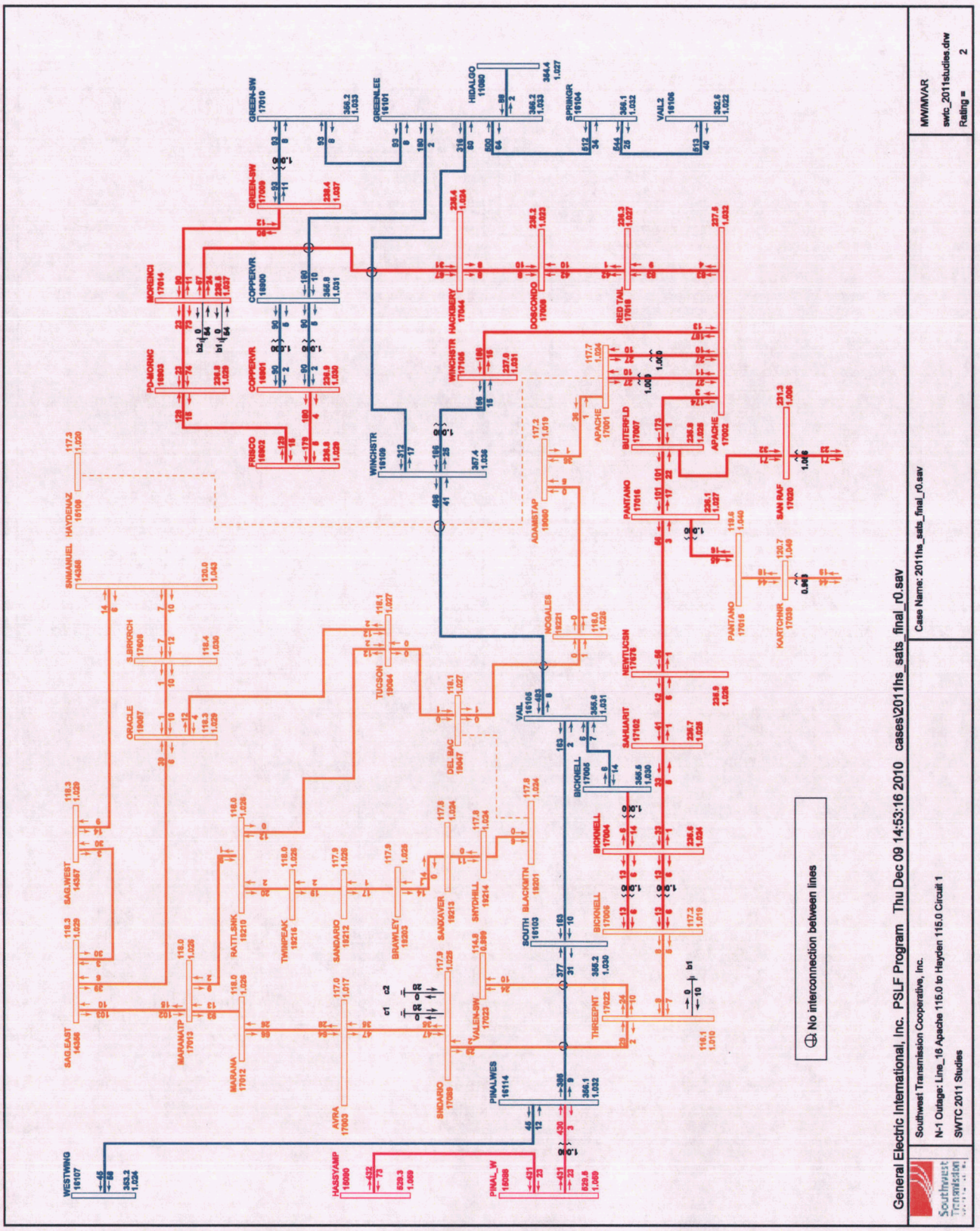
2011HS Southwest Transmission Cooperative Base System with Redtail to Dos Condados 230 kV Line out of service



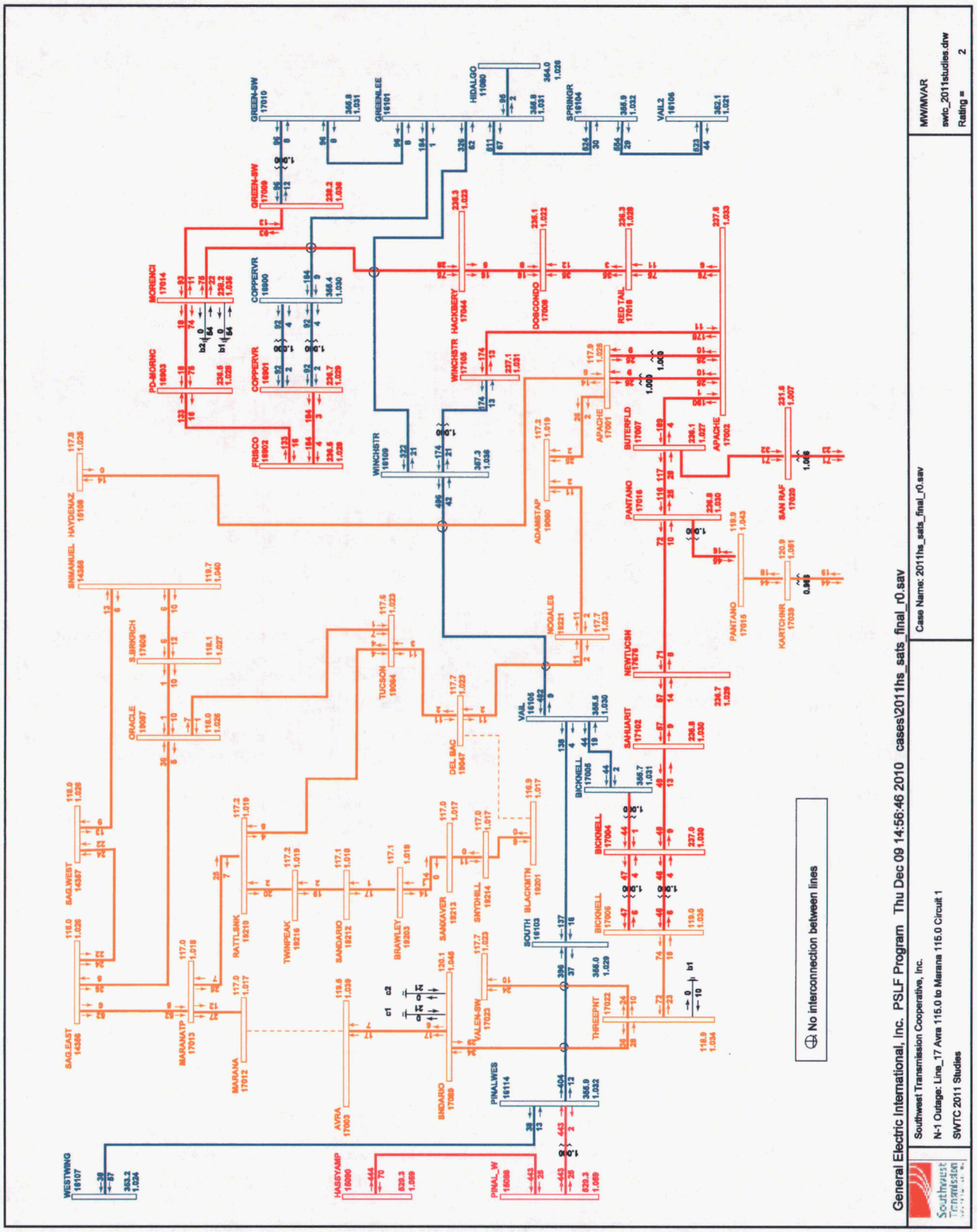
2011HS Southwest Transmission Cooperative Base System with Sahuarita to Bicknell 230 kV Line out of service



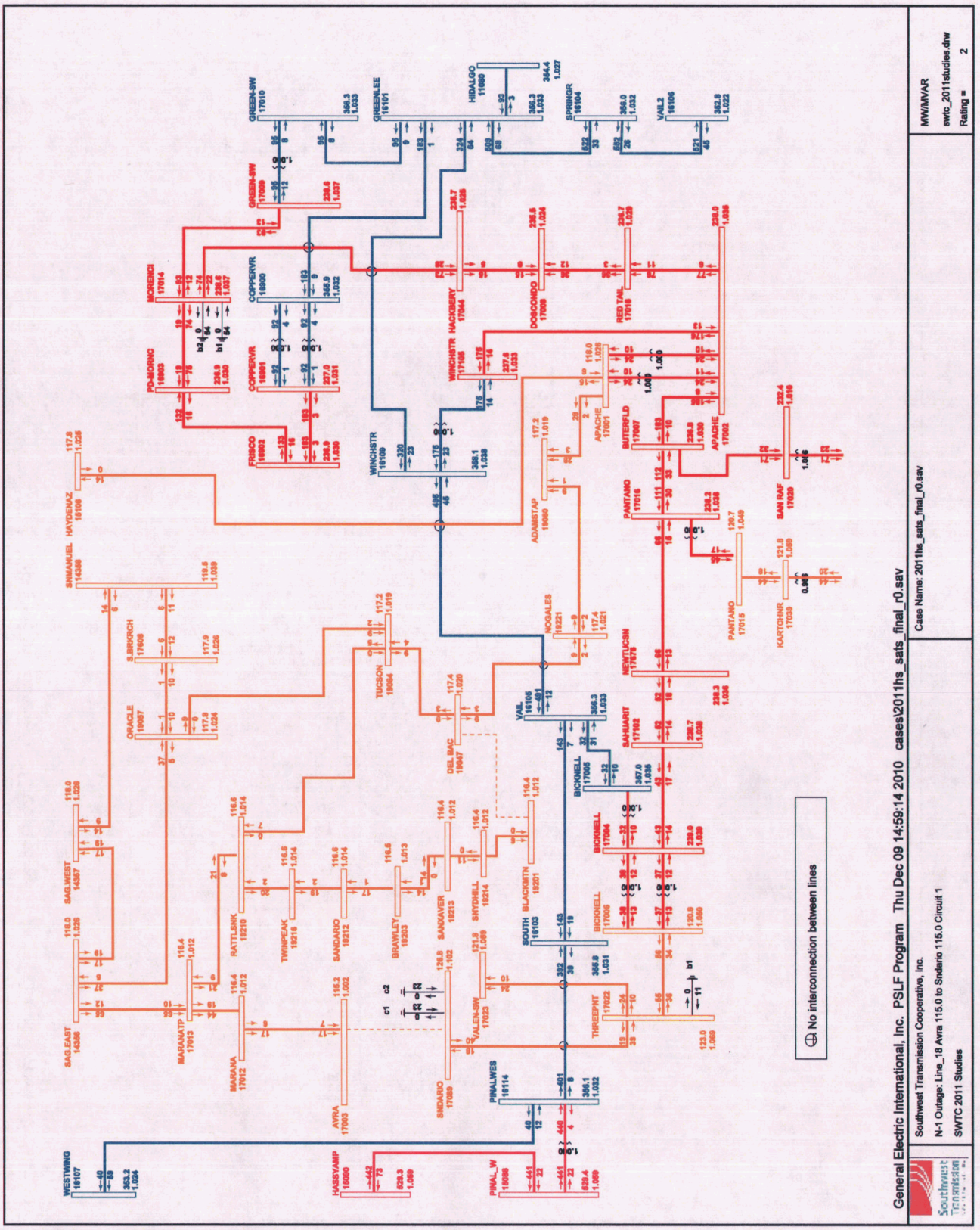
2011HS Southwest Transmission Cooperative Base System with Apache to Hayden 115 kV Line out of service



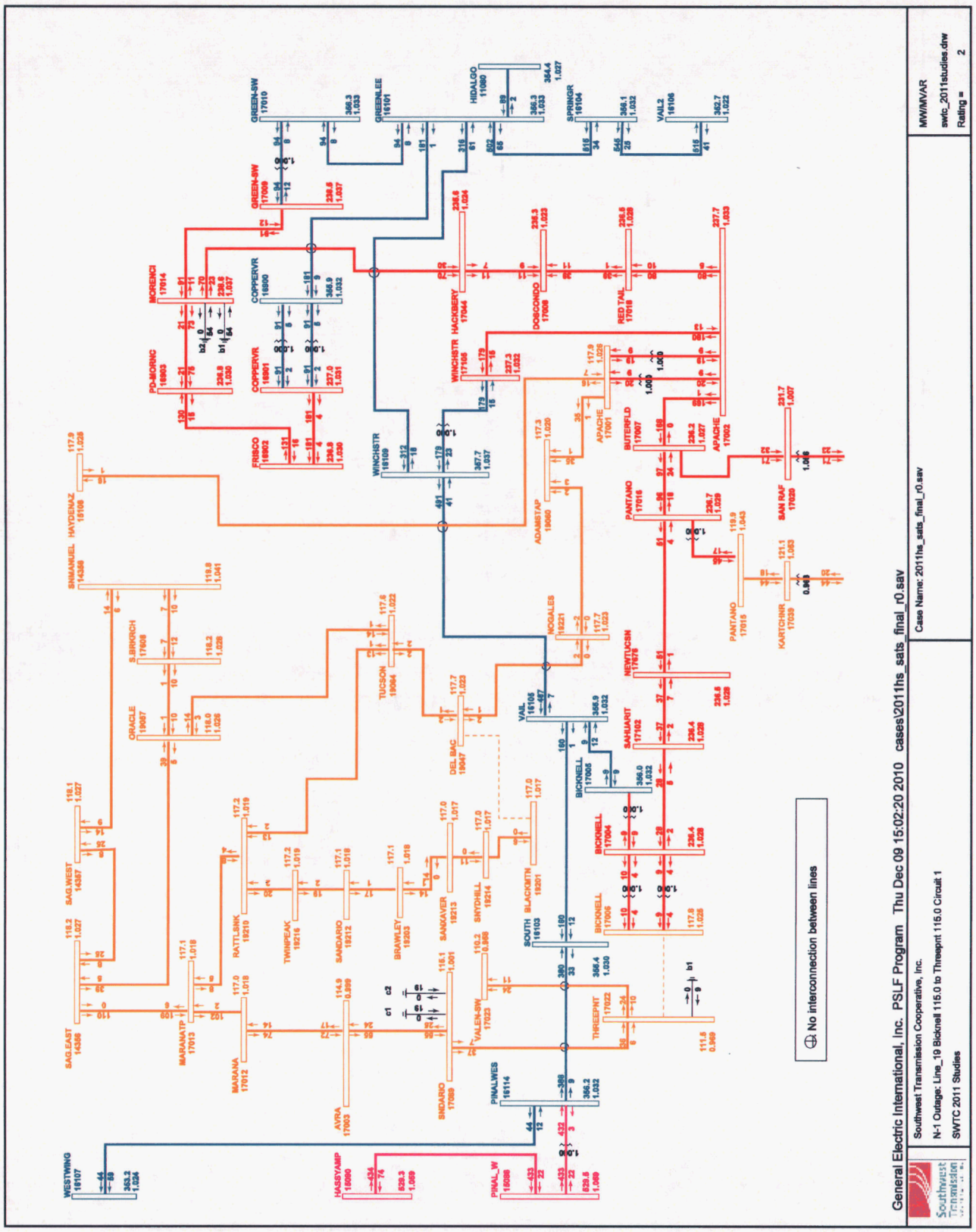
2011HS Southwest Transmission Cooperative Base System with Avra to Marana 115 kV Line out of service



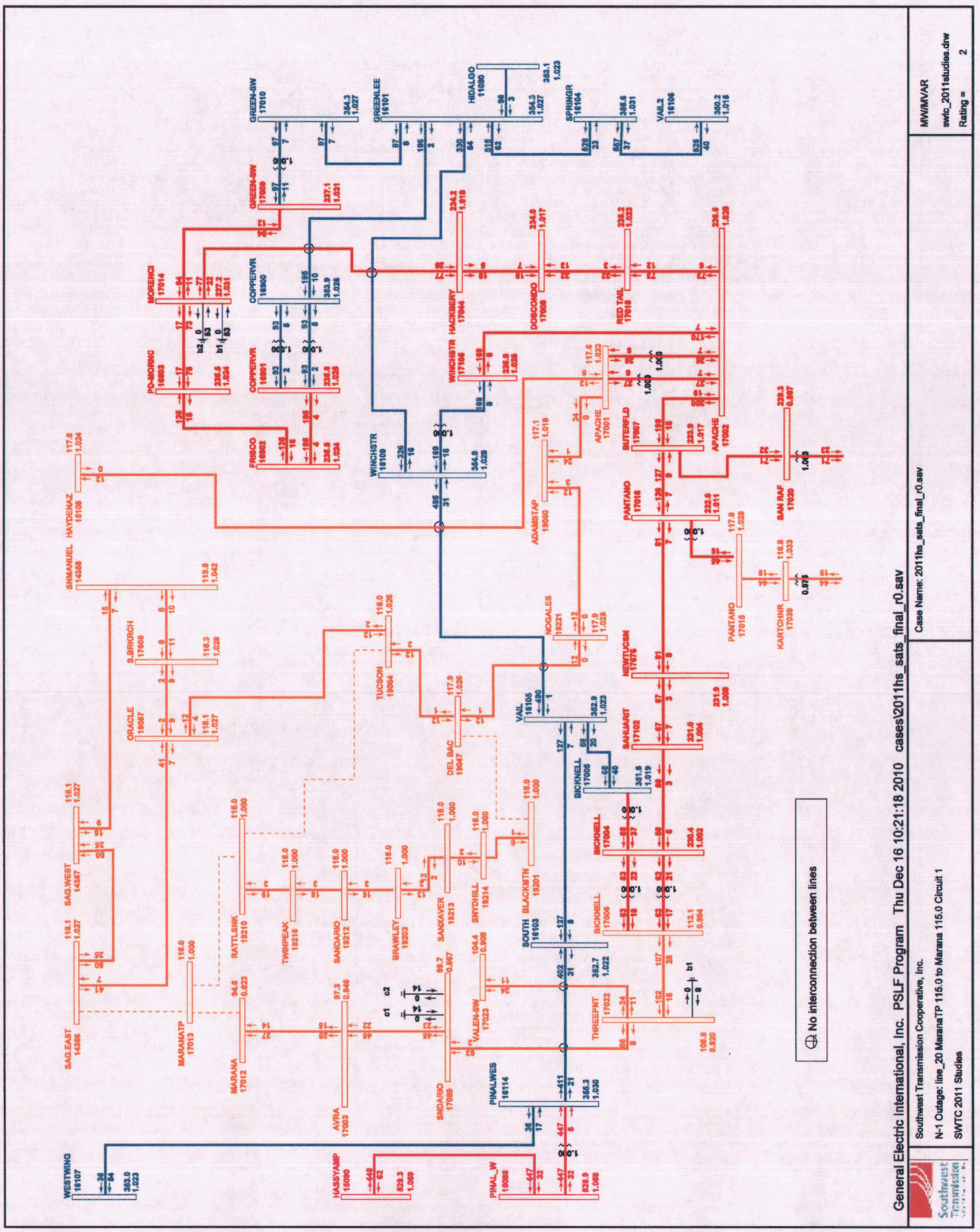
2011HS Southwest Transmission Cooperative Base System with Avra to Sandario 115 kV Line out of service



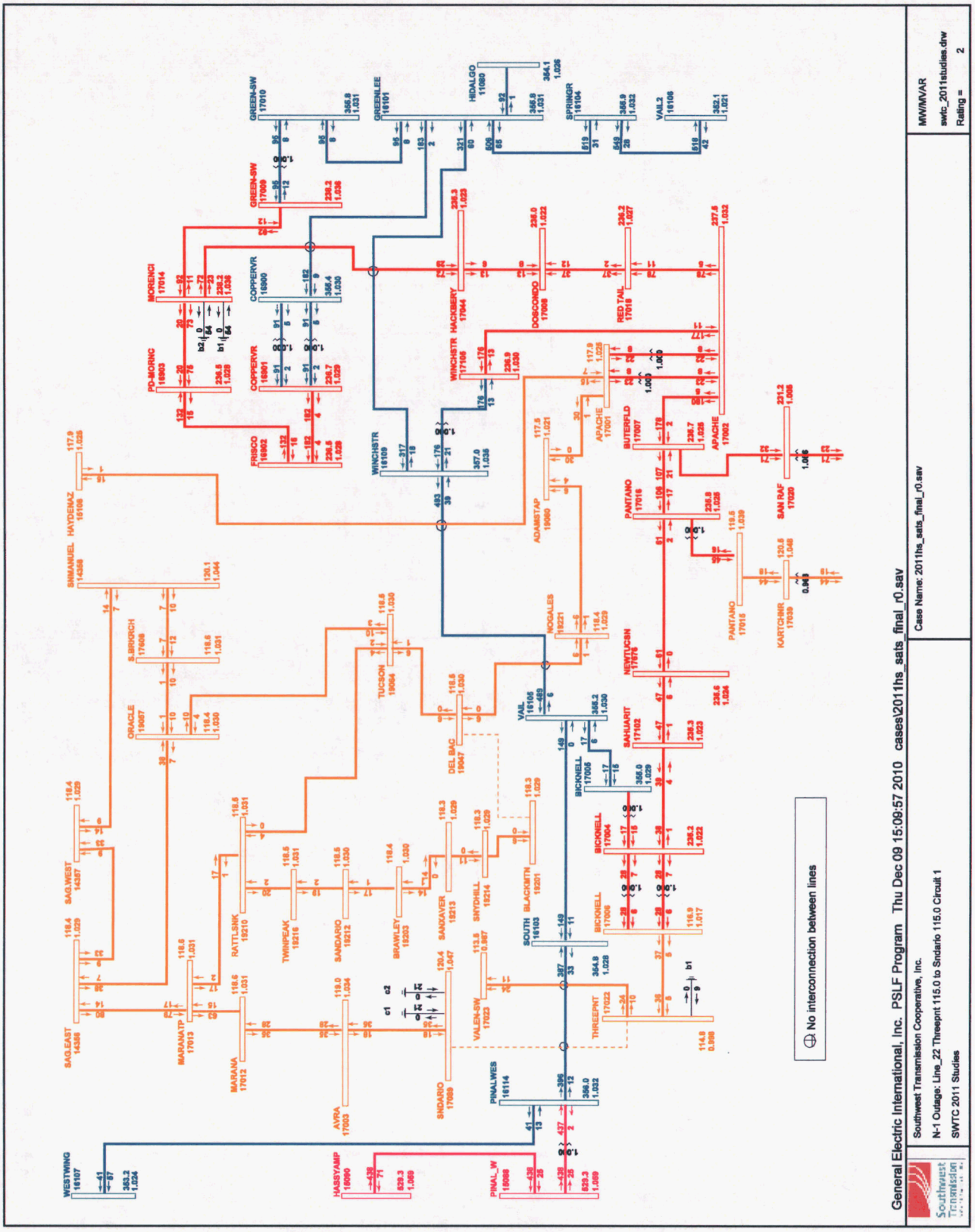
2011HS Southwest Transmission Cooperative Base System with Bicknell to Three Points 115 kV Line out of service



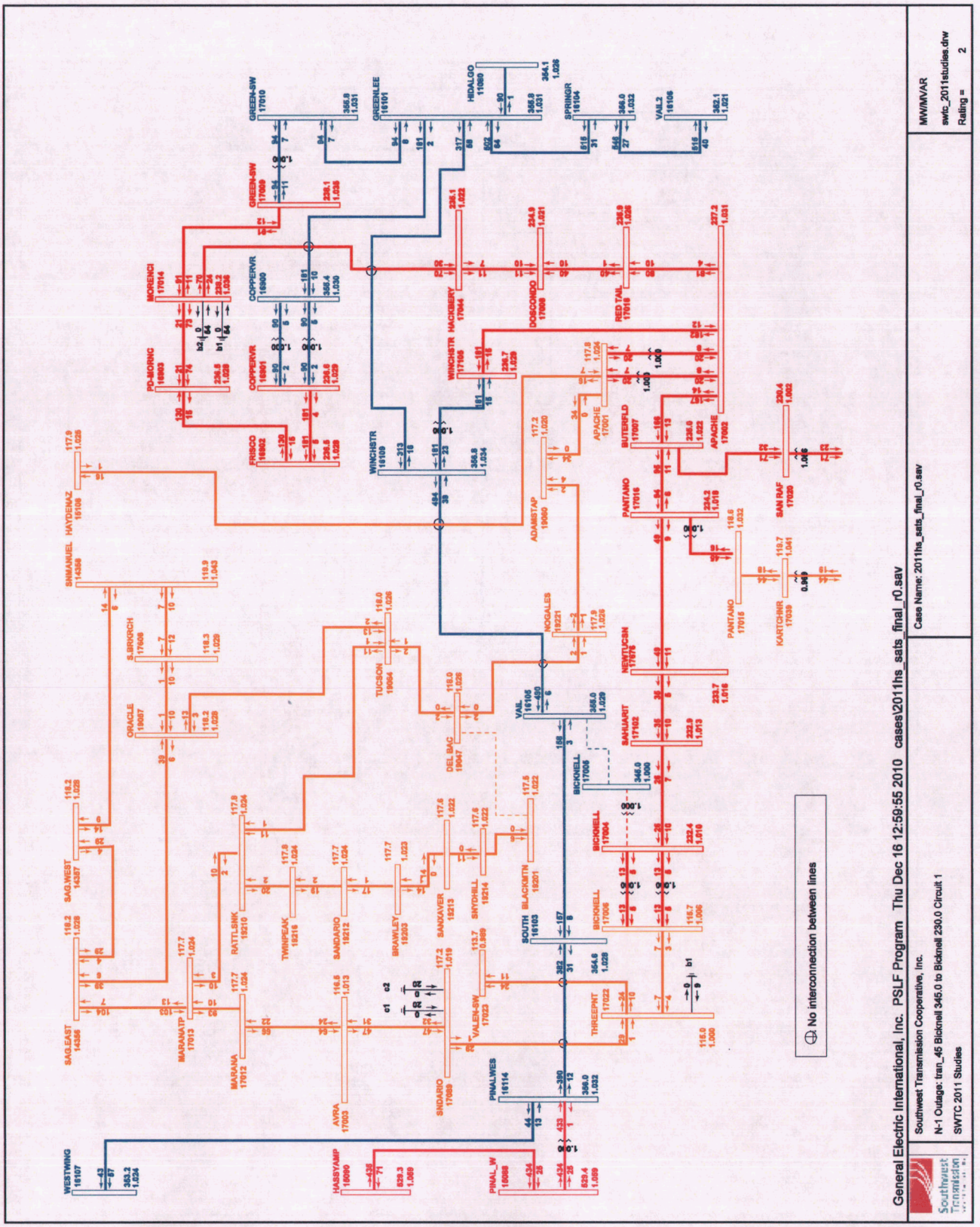
2011HS Southwest Transmission Cooperative Base System with Marana Tap to Marana 115 kV Line out of service



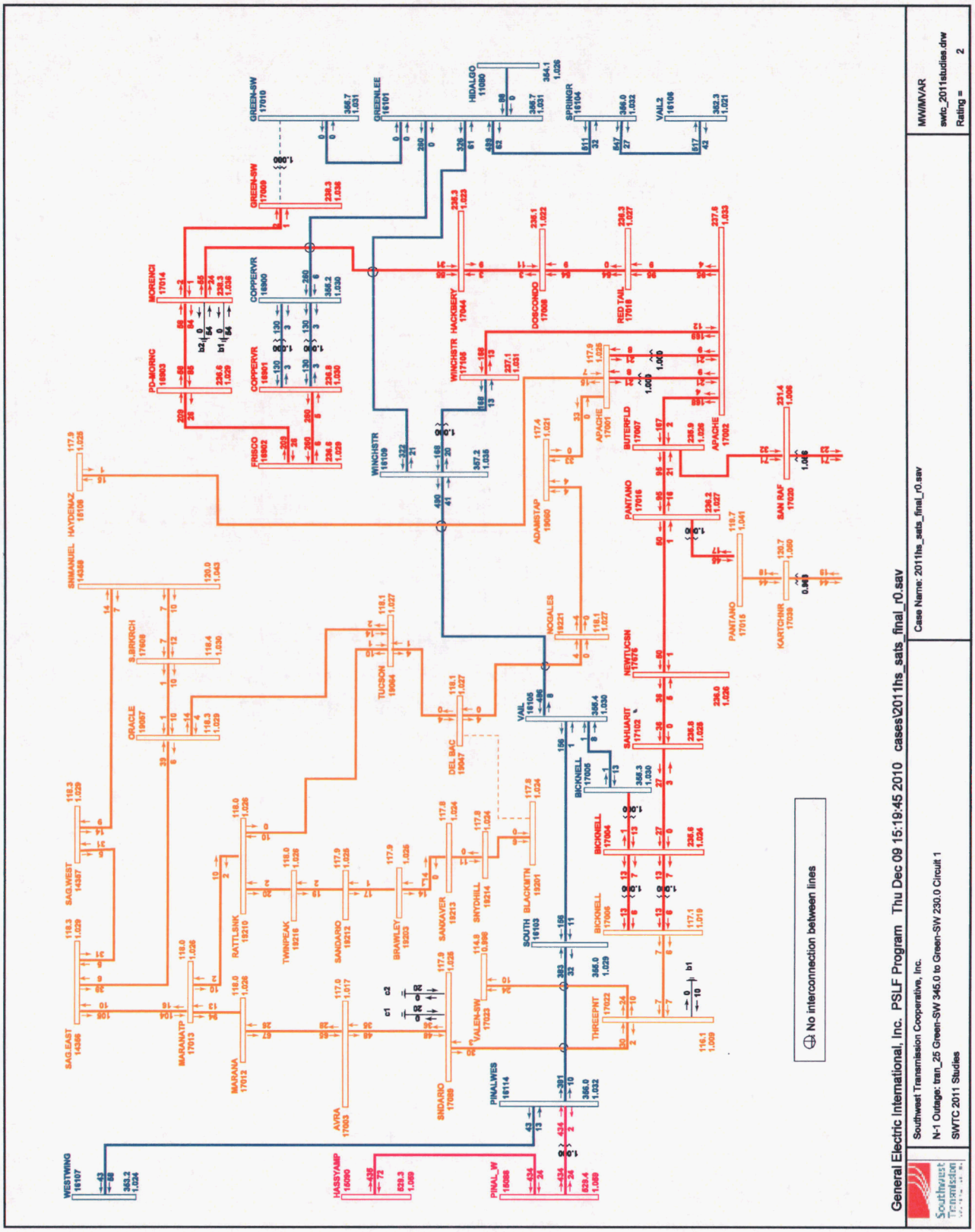
2011HS Southwest Transmission Cooperative Base System with Three Points to Sandario 115 kV Line out of service



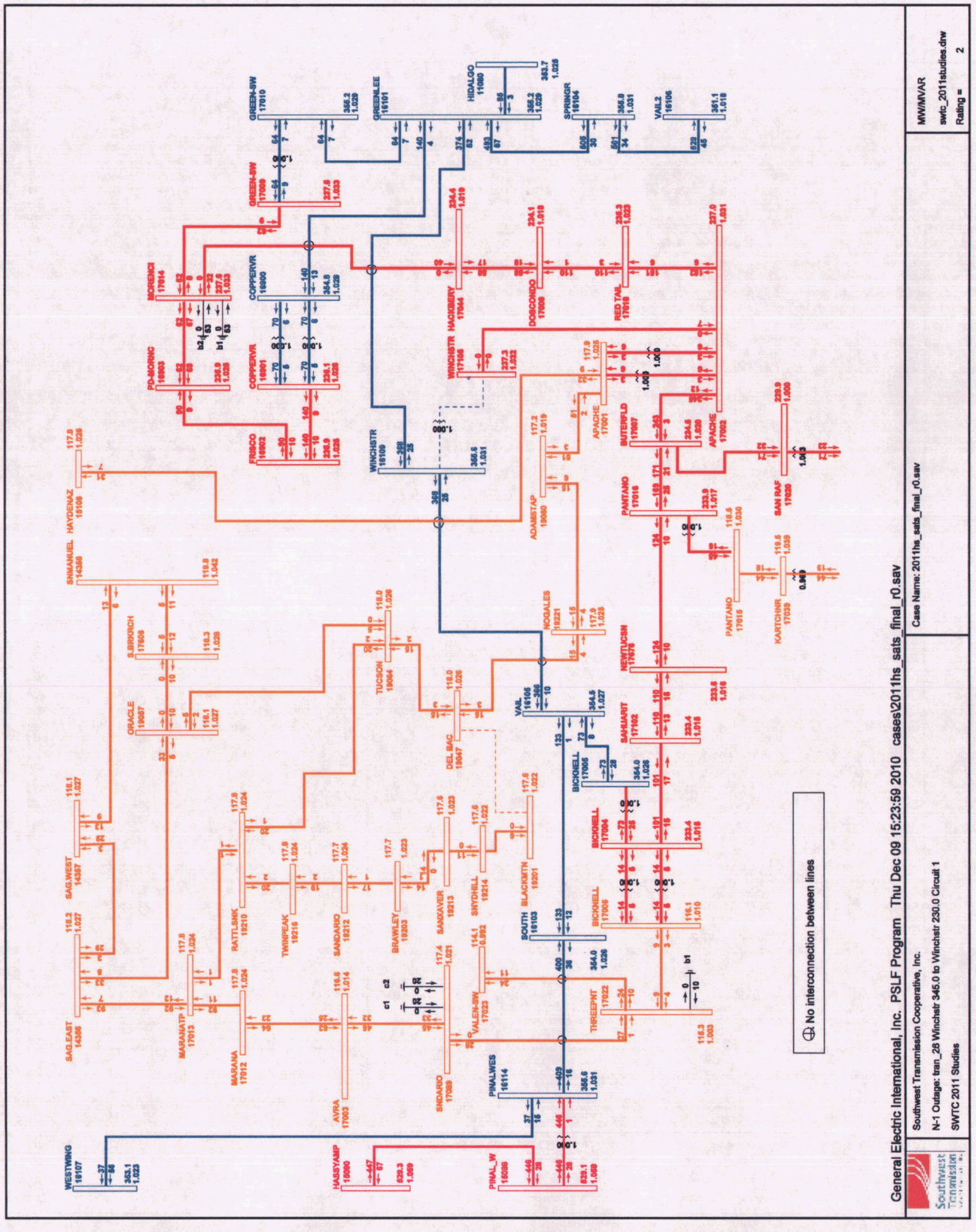
2011HS Southwest Transmission Cooperative Base System with Bicknell 345/230 kV Transformer out of service



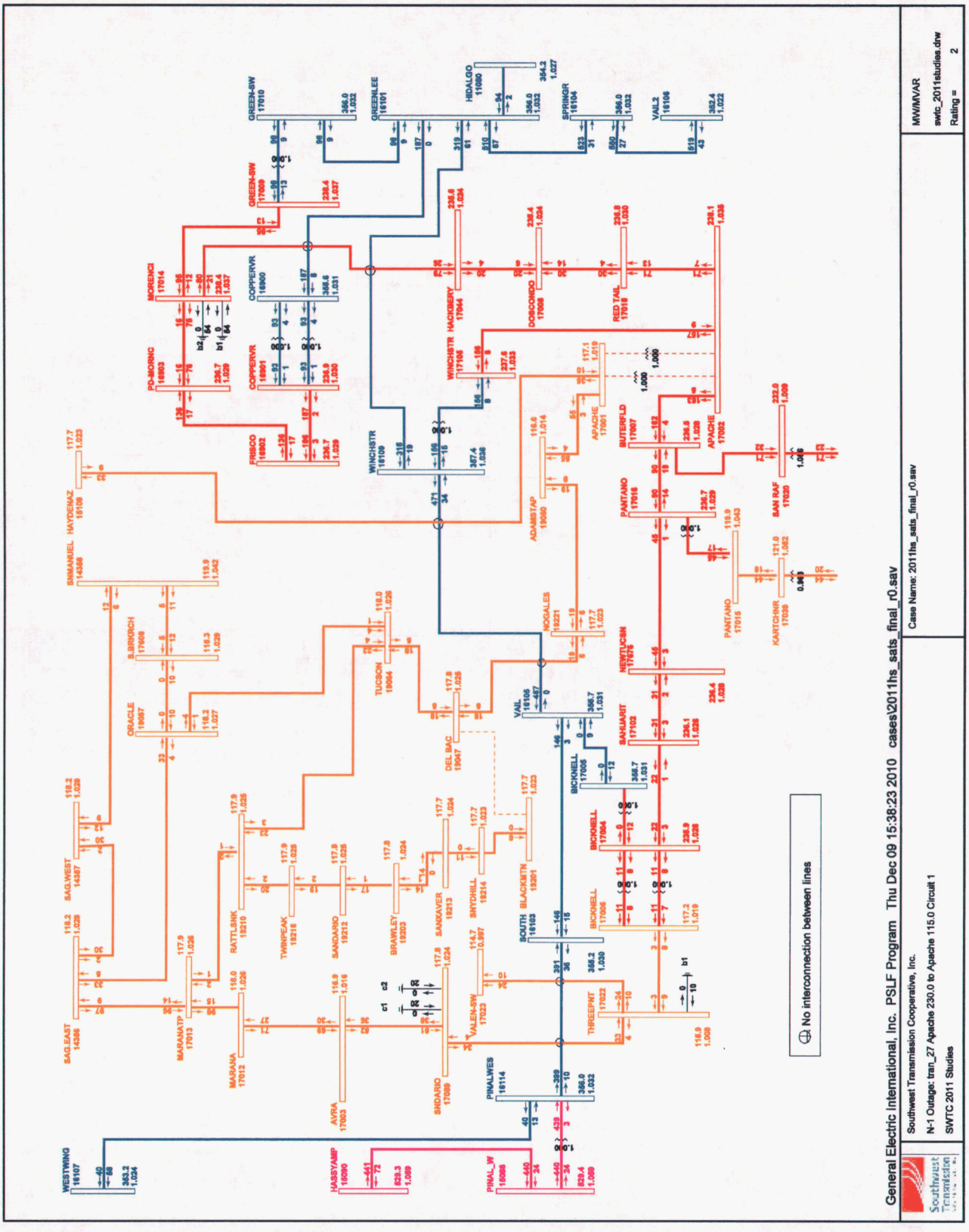
2011HS Southwest Transmission Cooperative Base System with Greenlee 345/230 kV Transformer out of service



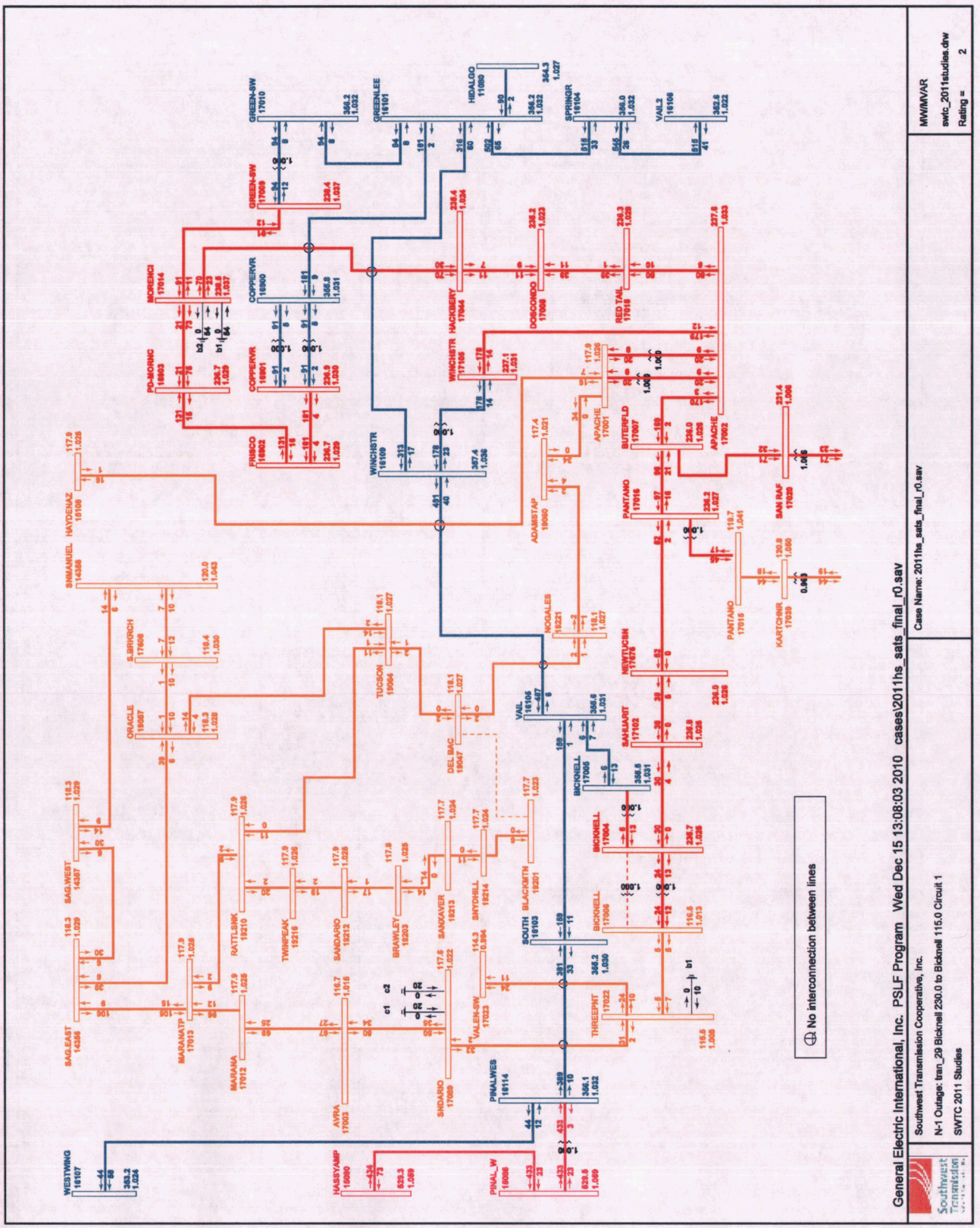
2011HS Southwest Transmission Cooperative Base System with Winchester 345/230 kV Transformer out of service



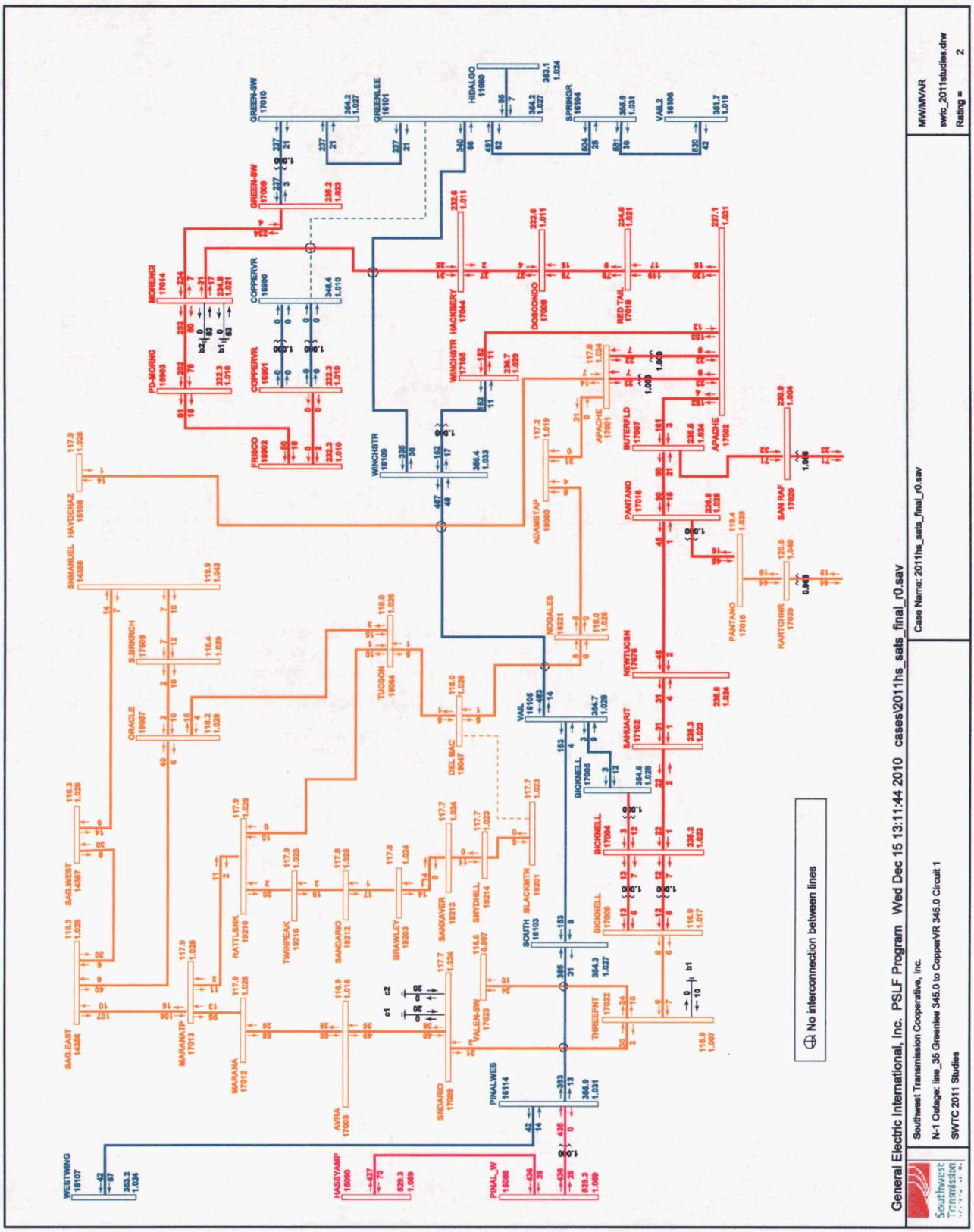
2011HS Southwest Transmission Cooperative Base System with one Apache 230/115 kV Transformer out of service



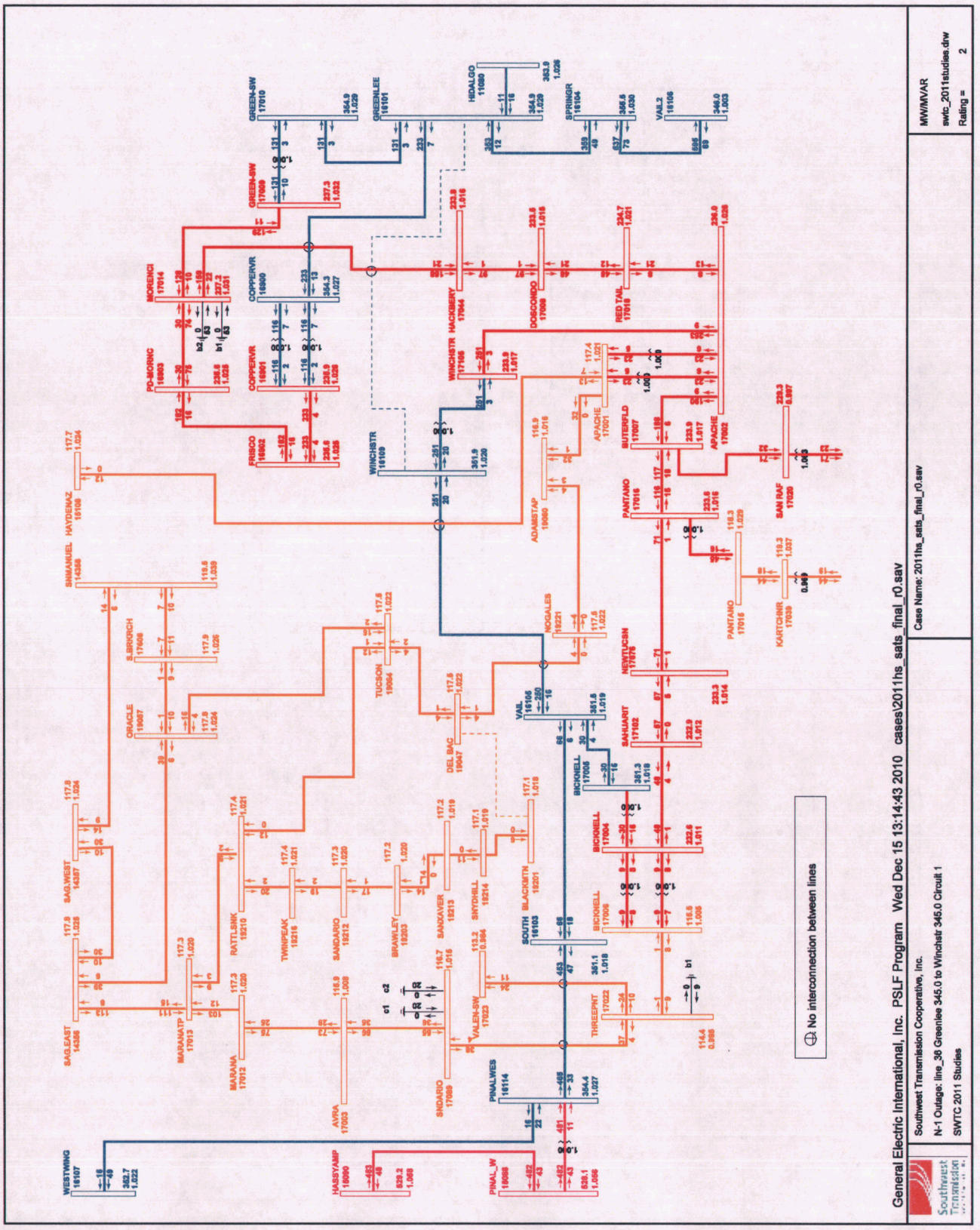
2011HS Southwest Transmission Cooperative Base System with one Bicknell 230/115 kV Transformer out of service



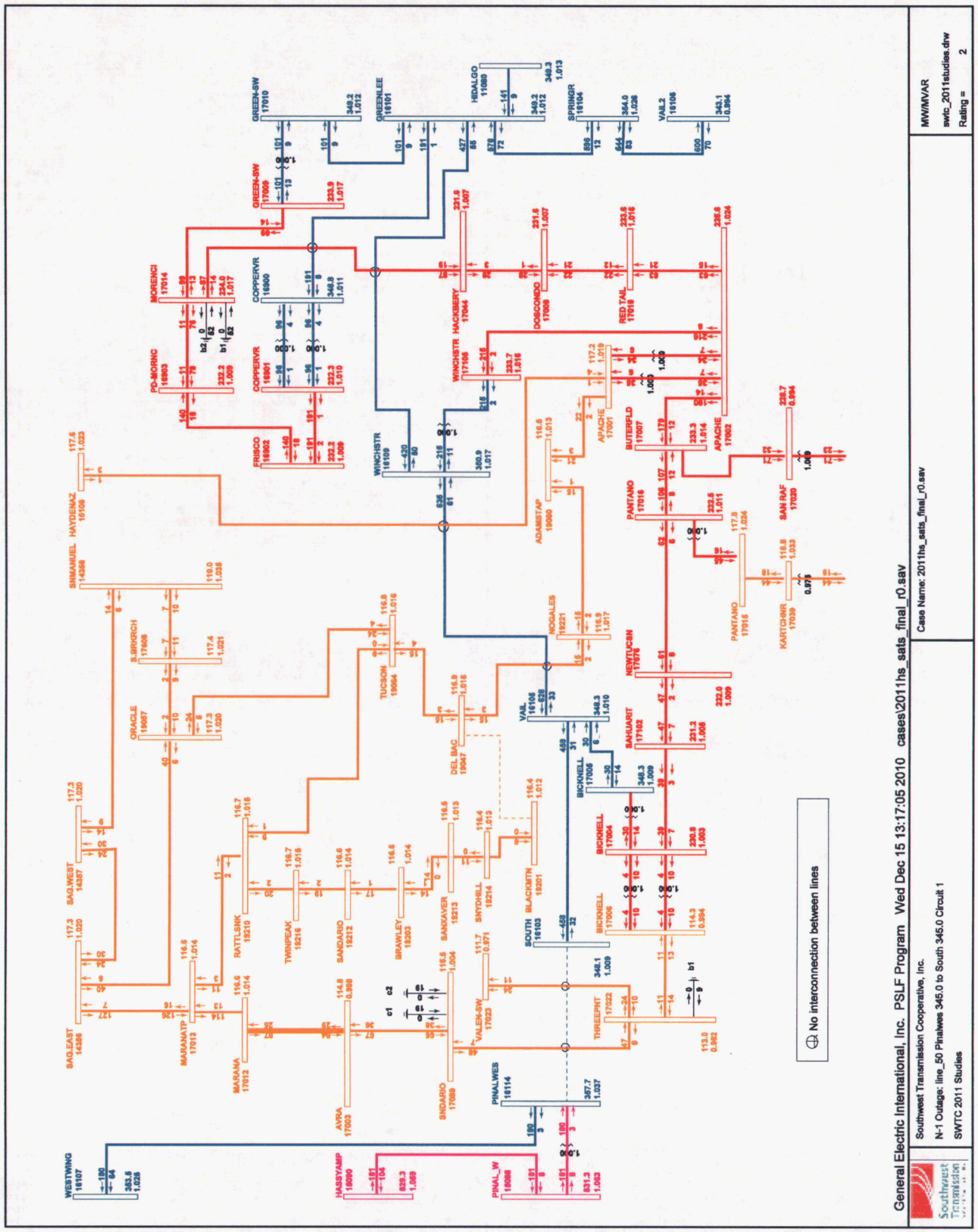
2011HS Southwest Transmission Cooperative Base System with Greenlee to Copper Verde 345 kV Line out of service



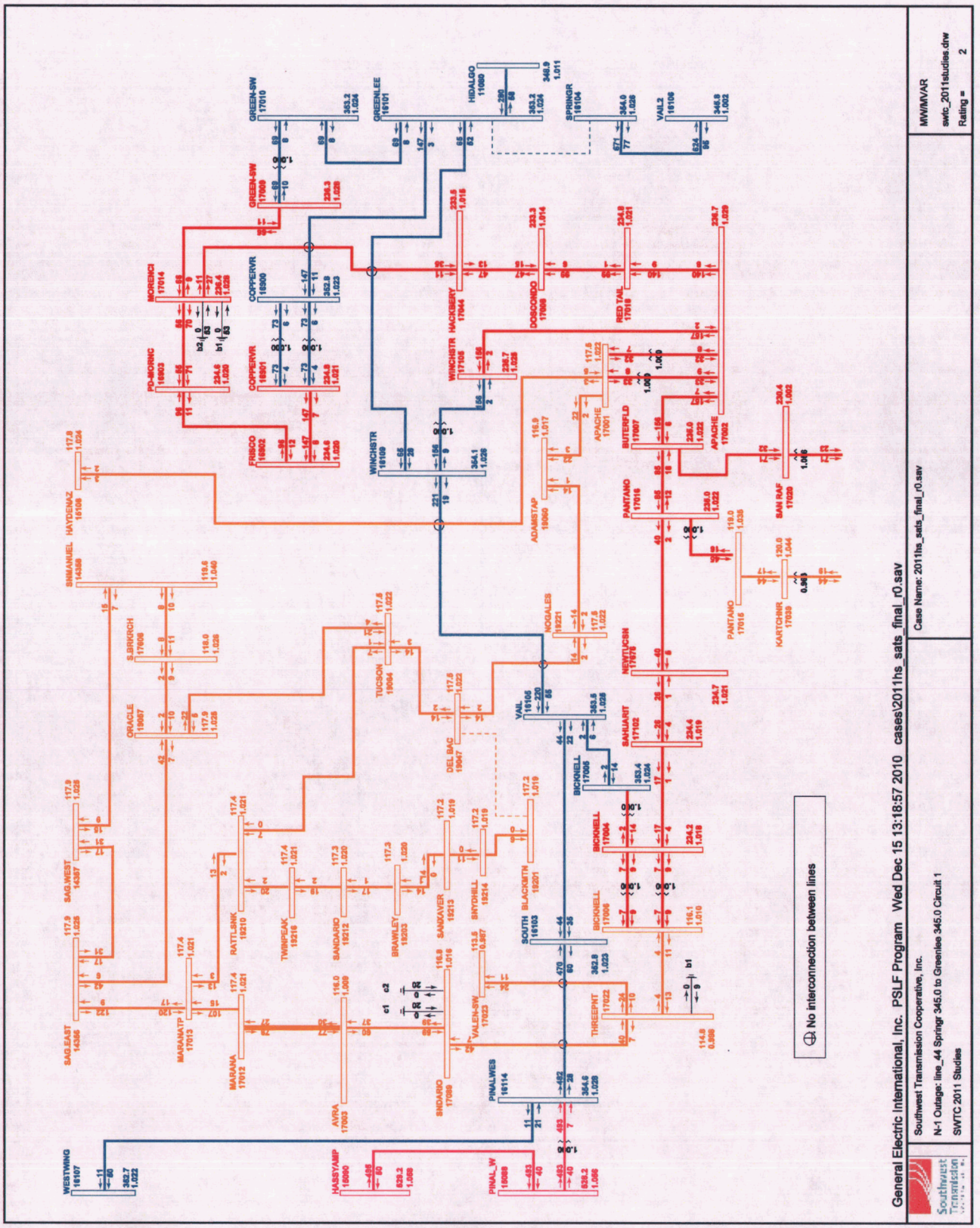
2011HS Southwest Transmission Cooperative Base System with Greenlee to Winchester 345 kV Line out of service



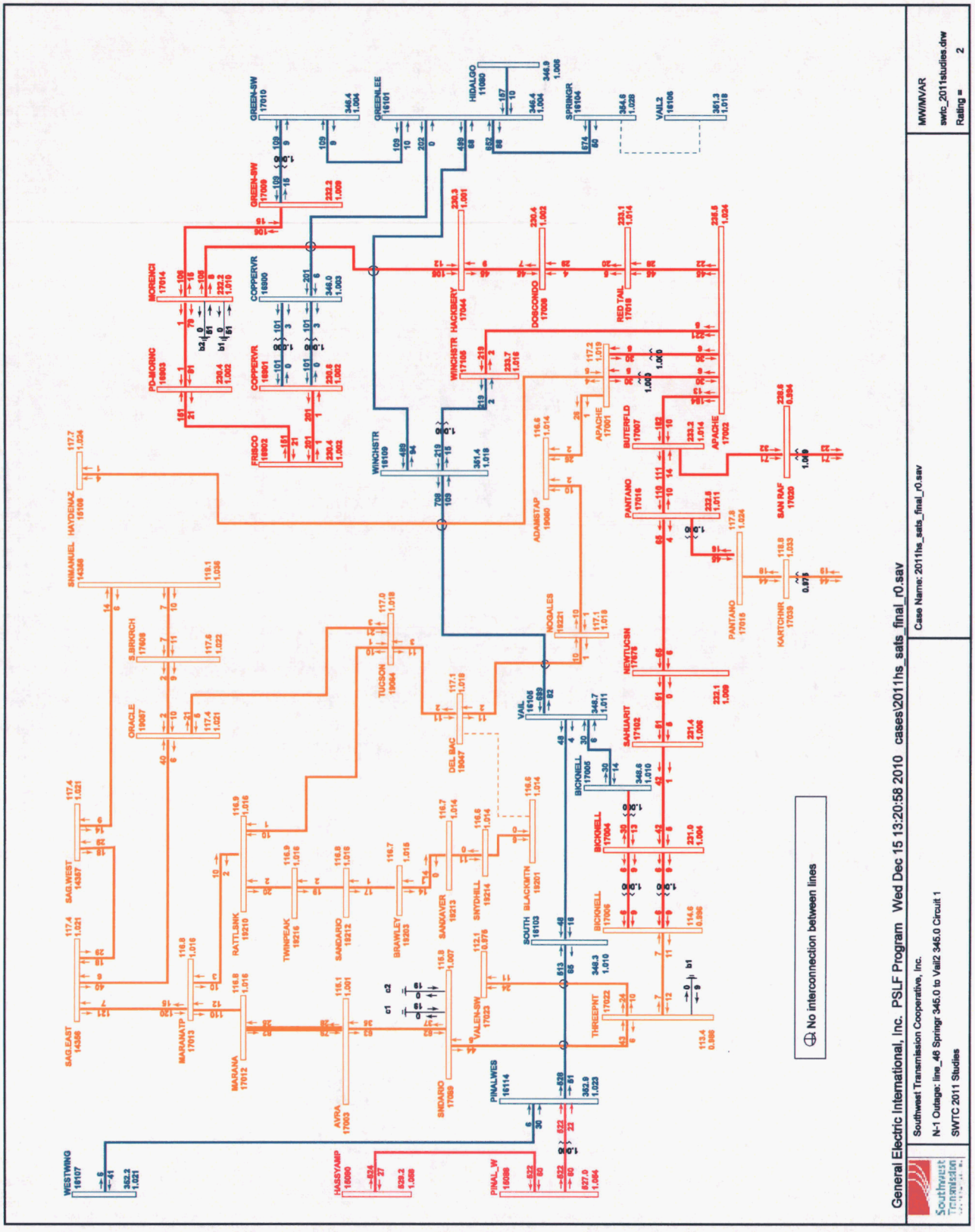
2011HS Southwest Transmission Cooperative Base System with Pinal West to South 345 kV Line out of service



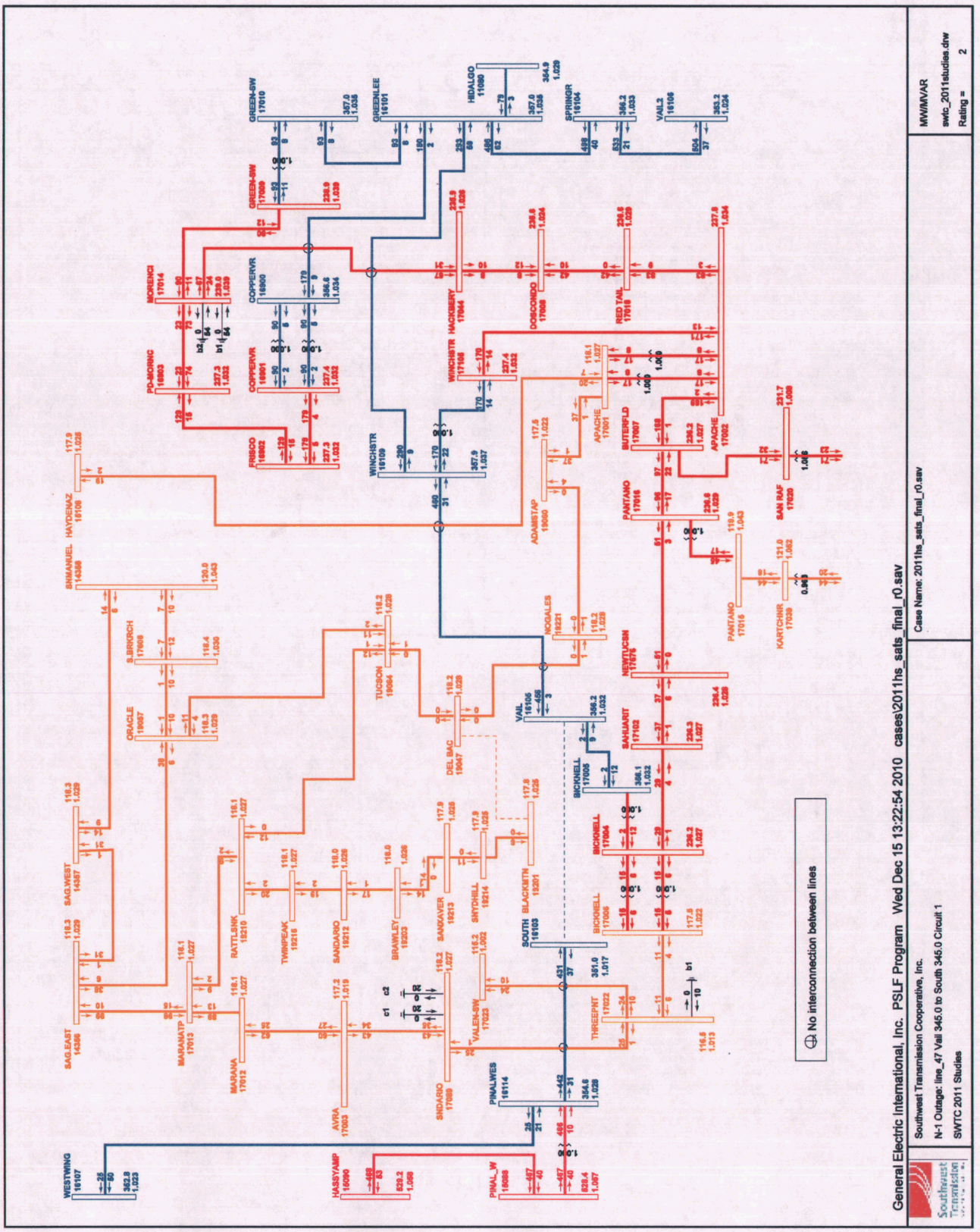
2011HS Southwest Transmission Cooperative Base System with Springerville to Greenlee 345 kV Line out of service



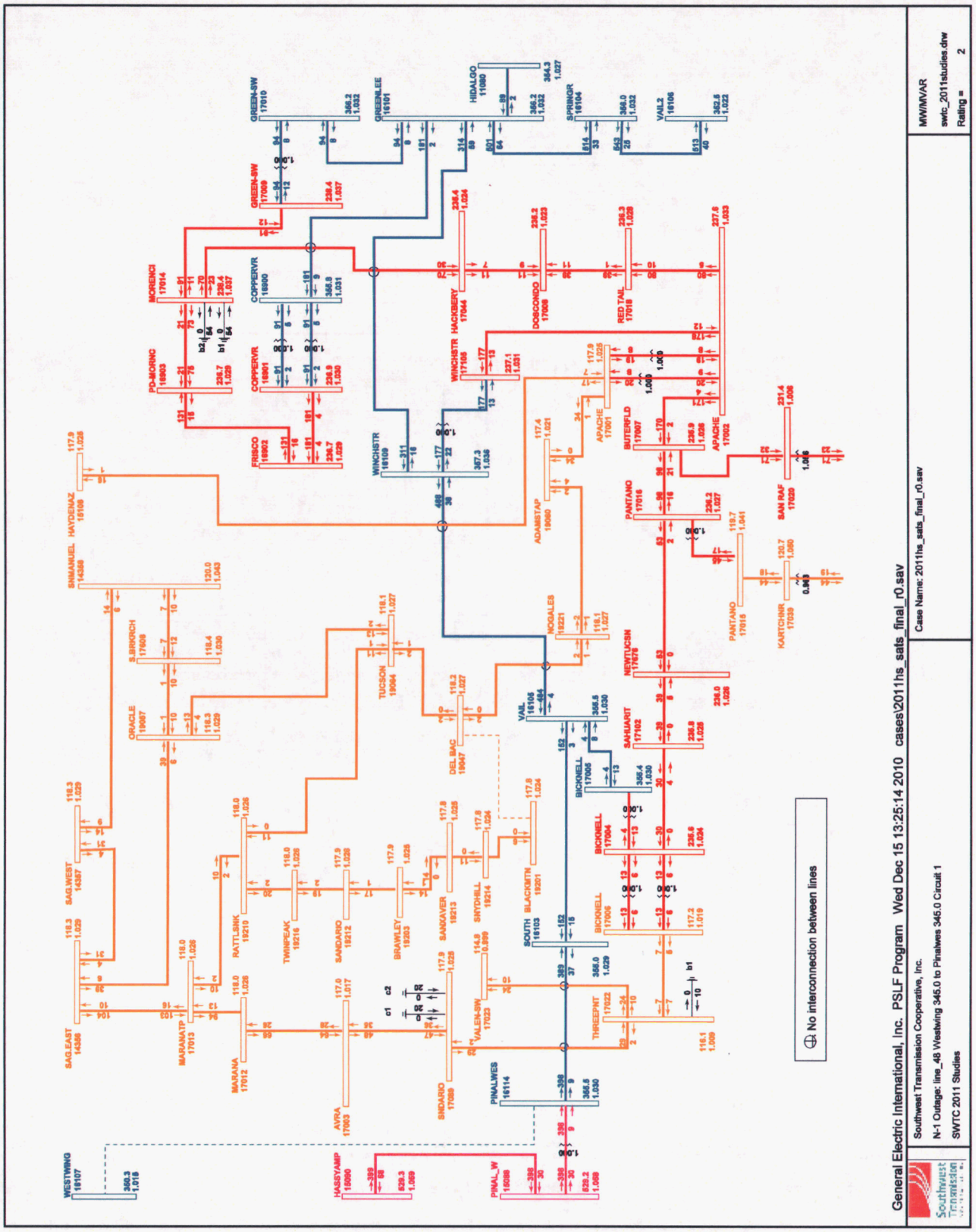
2011HS Southwest Transmission Cooperative Base System with Springerville to Vail2 345 kV Line out of service



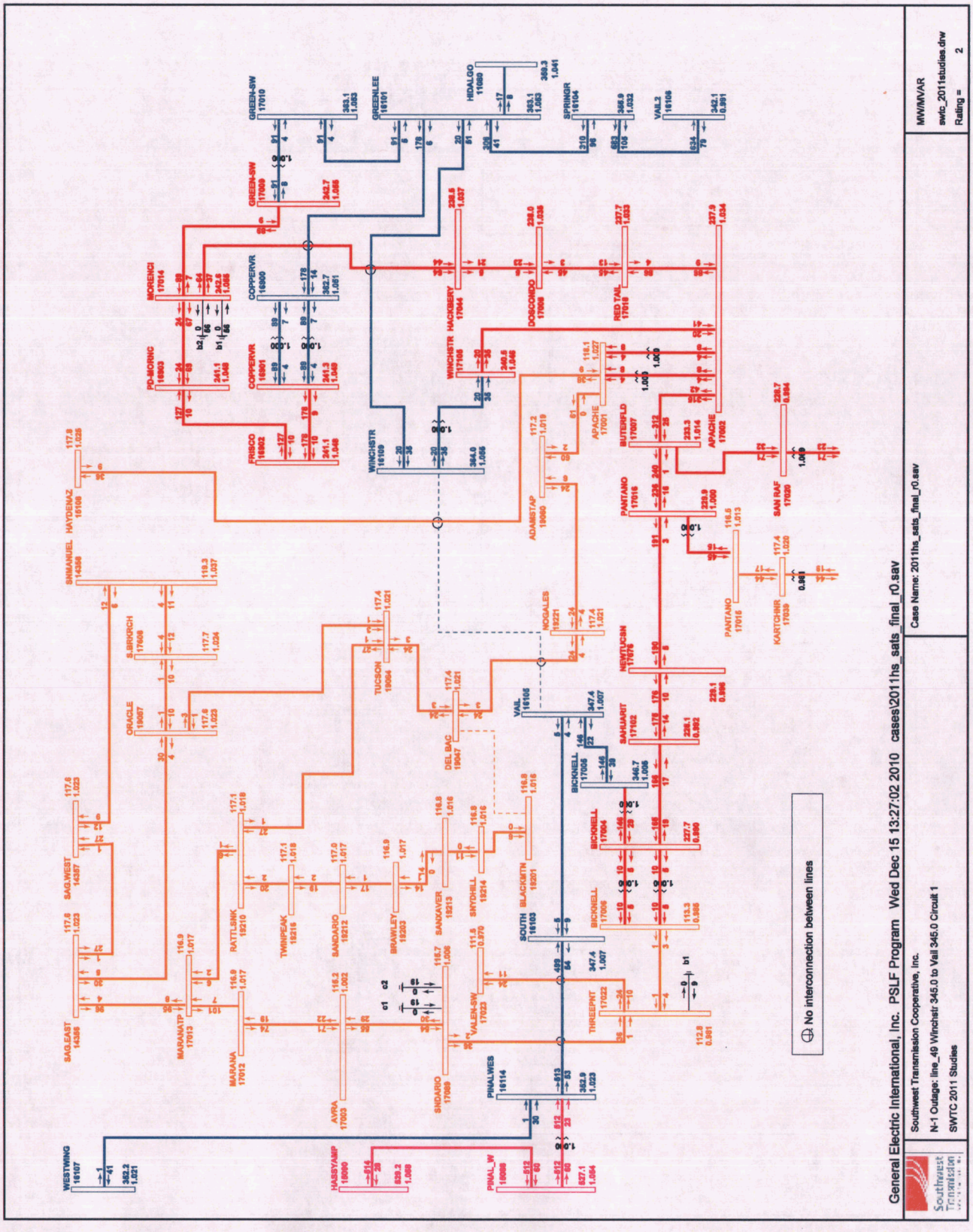
2011HS Southwest Transmission Cooperative Base System with Vail to South 345 kV Line out of service



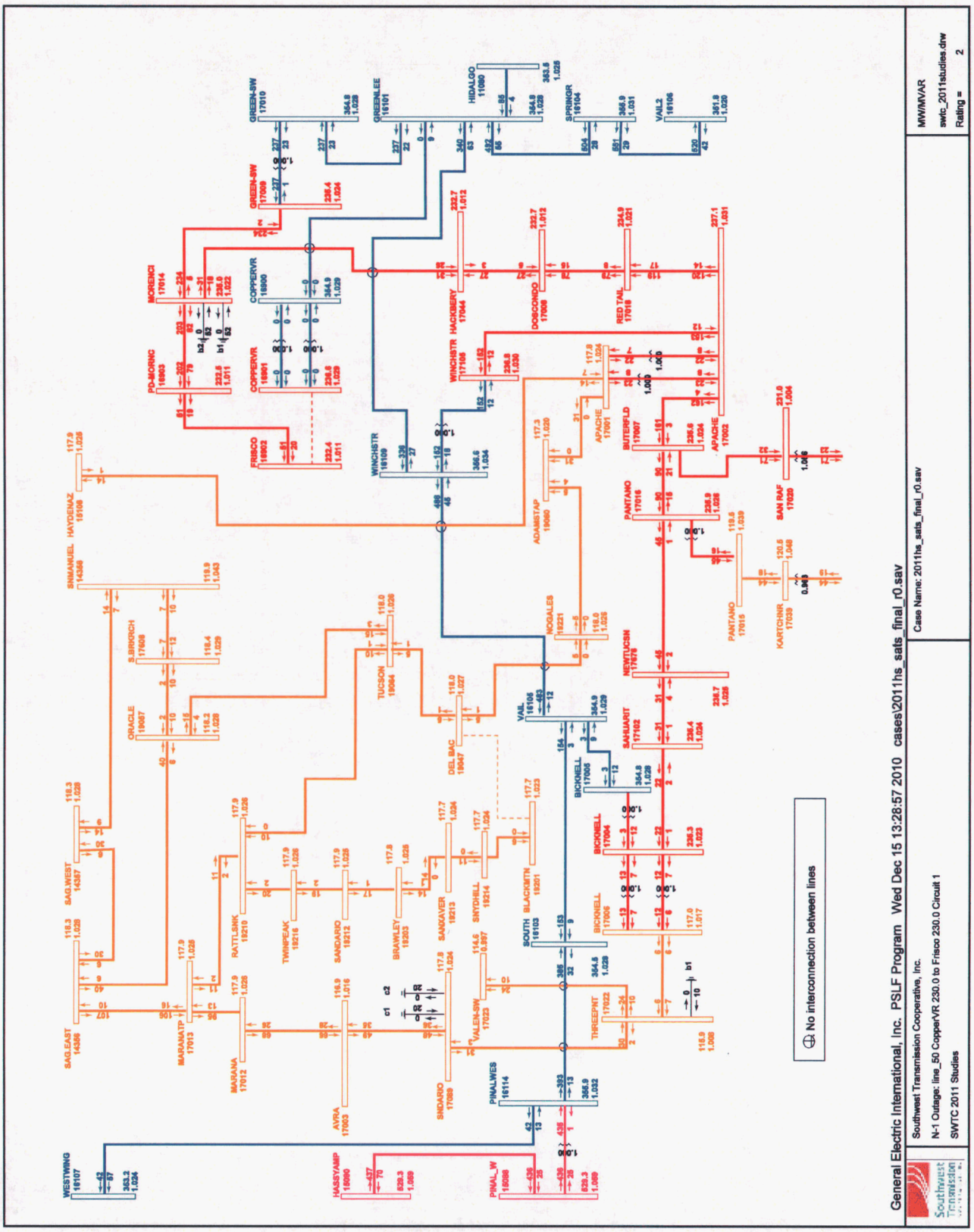
2011HS Southwest Transmission Cooperative Base System with Westwing to Pinal West 345 kV Line out of service



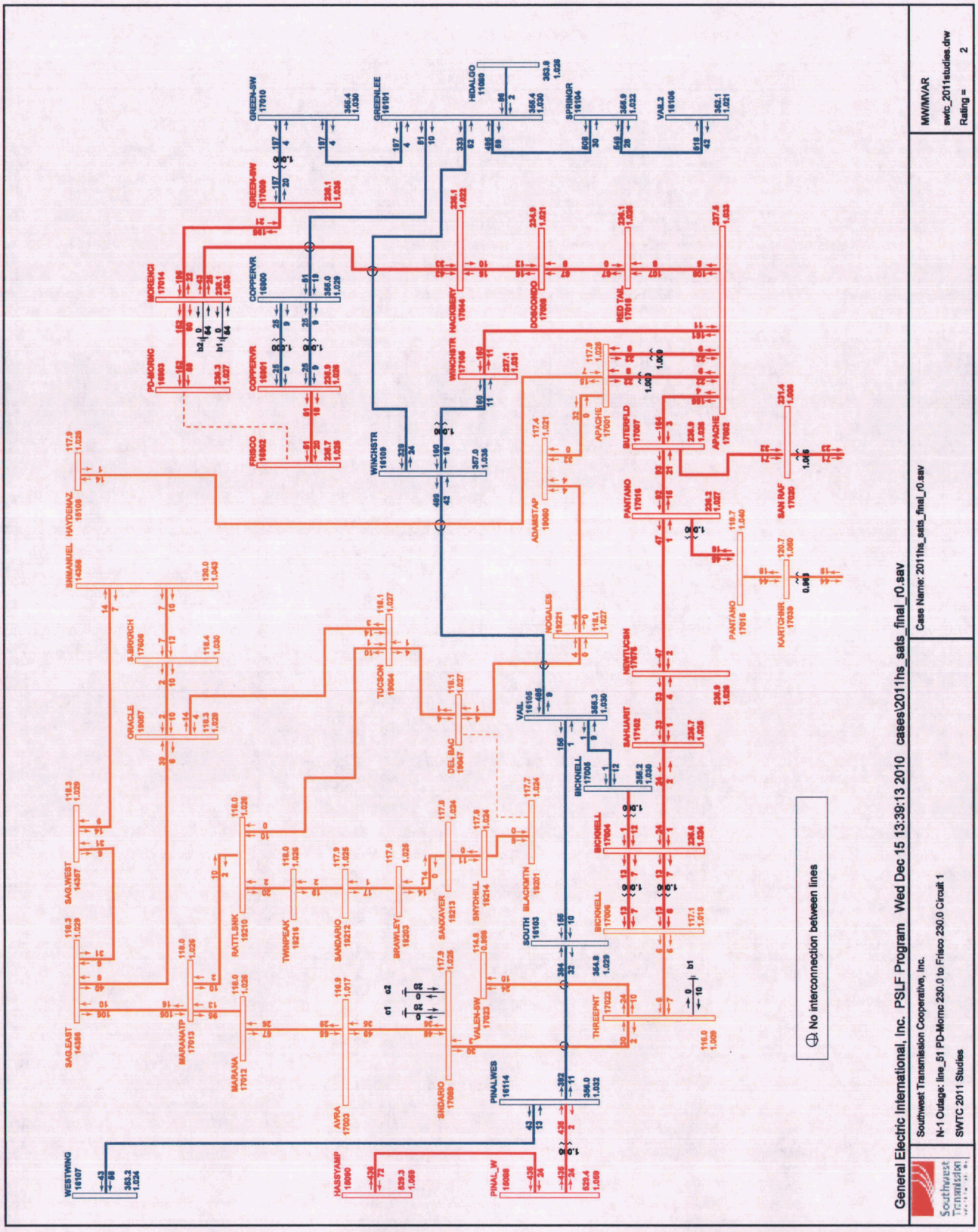
2011HS Southwest Transmission Cooperative Base System with Winchester to Vail 345 kV Line out of service



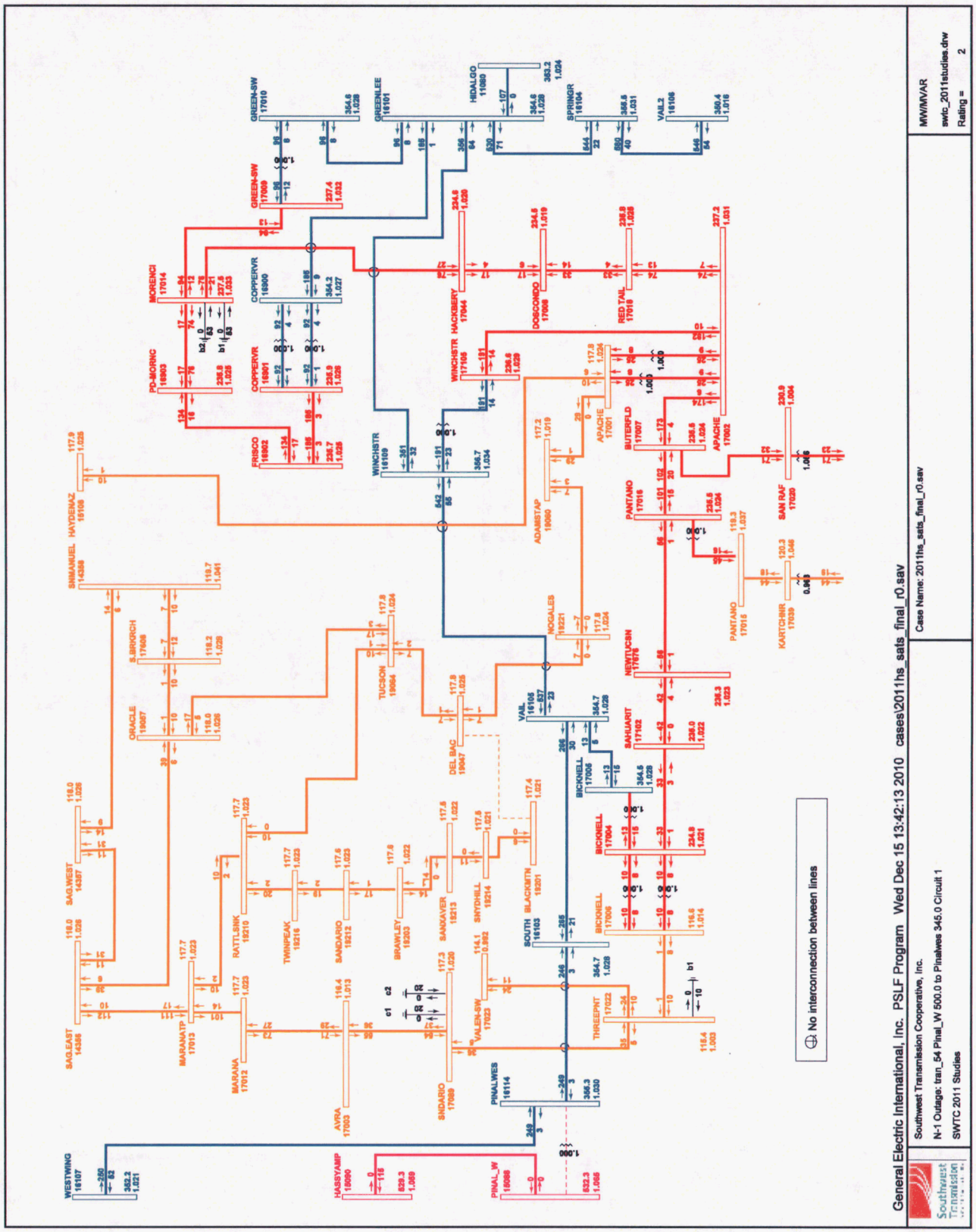
2011HS Southwest Transmission Cooperative Base System with Copper Verde to Frisco 230 kV Line out of service



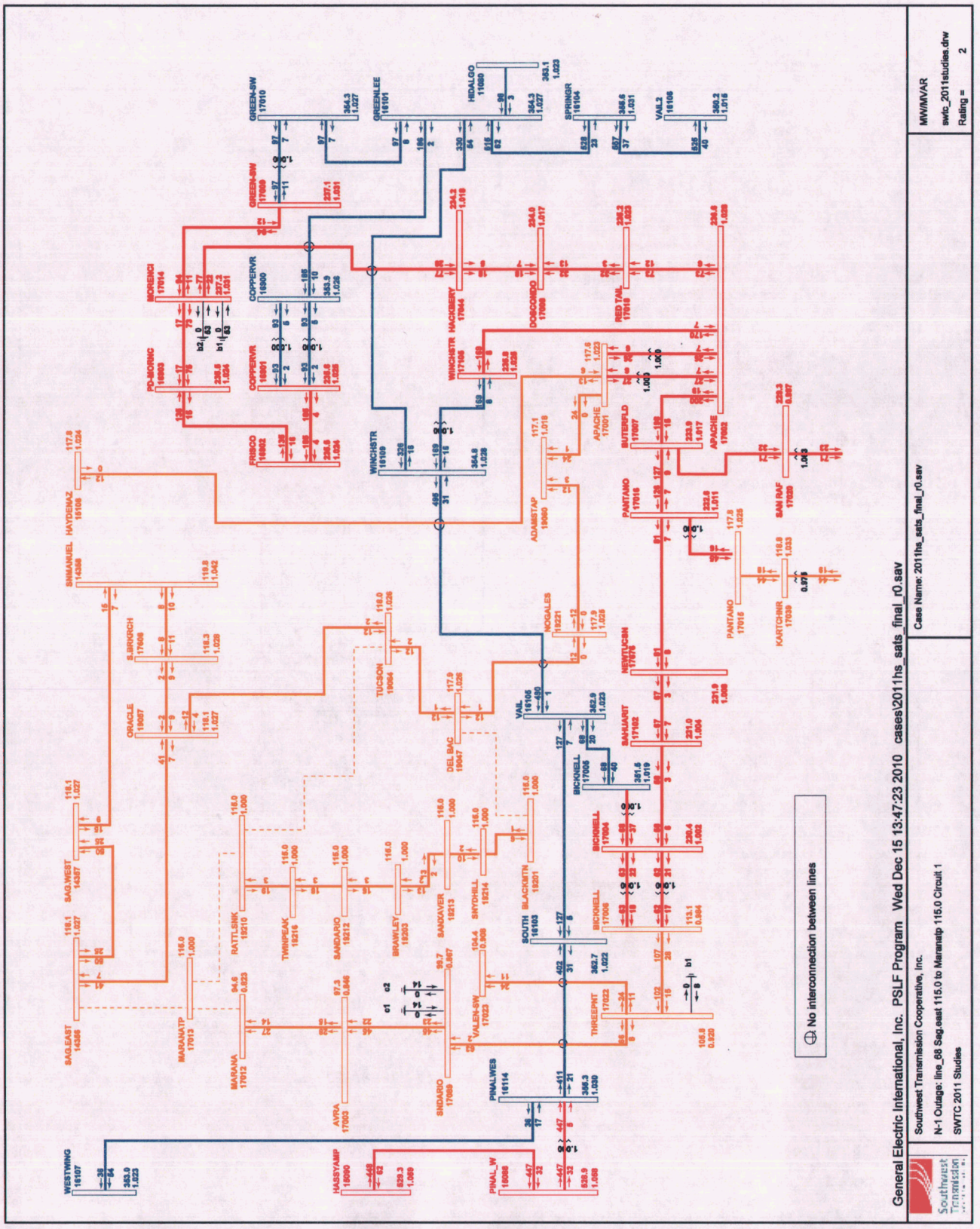
2011HS Southwest Transmission Cooperative Base System with PD Morenci to Frisco 230 kV Line out of service



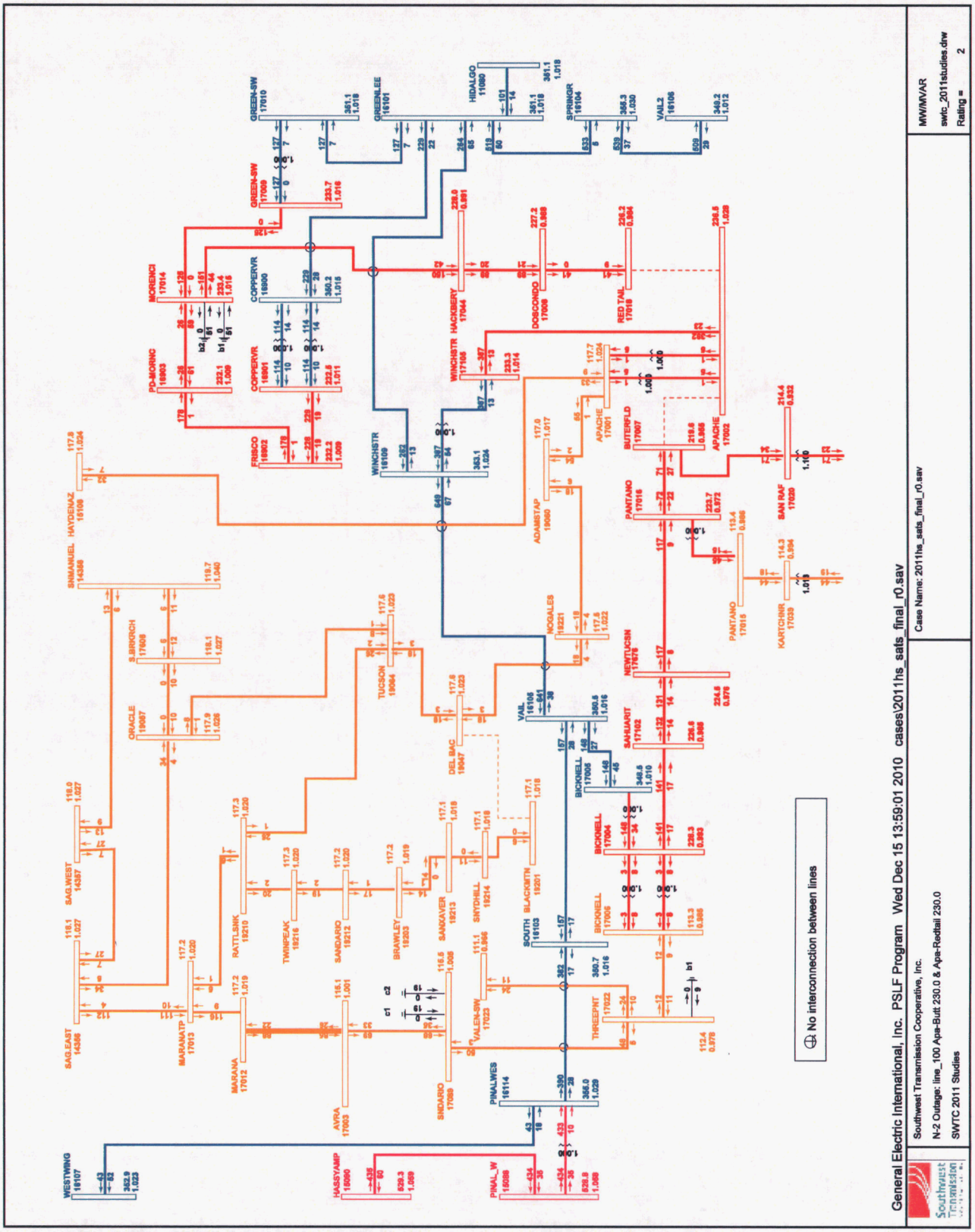
2011HS Southwest Transmission Cooperative Base System with Pinal West 500/345 kV Transformer out of service



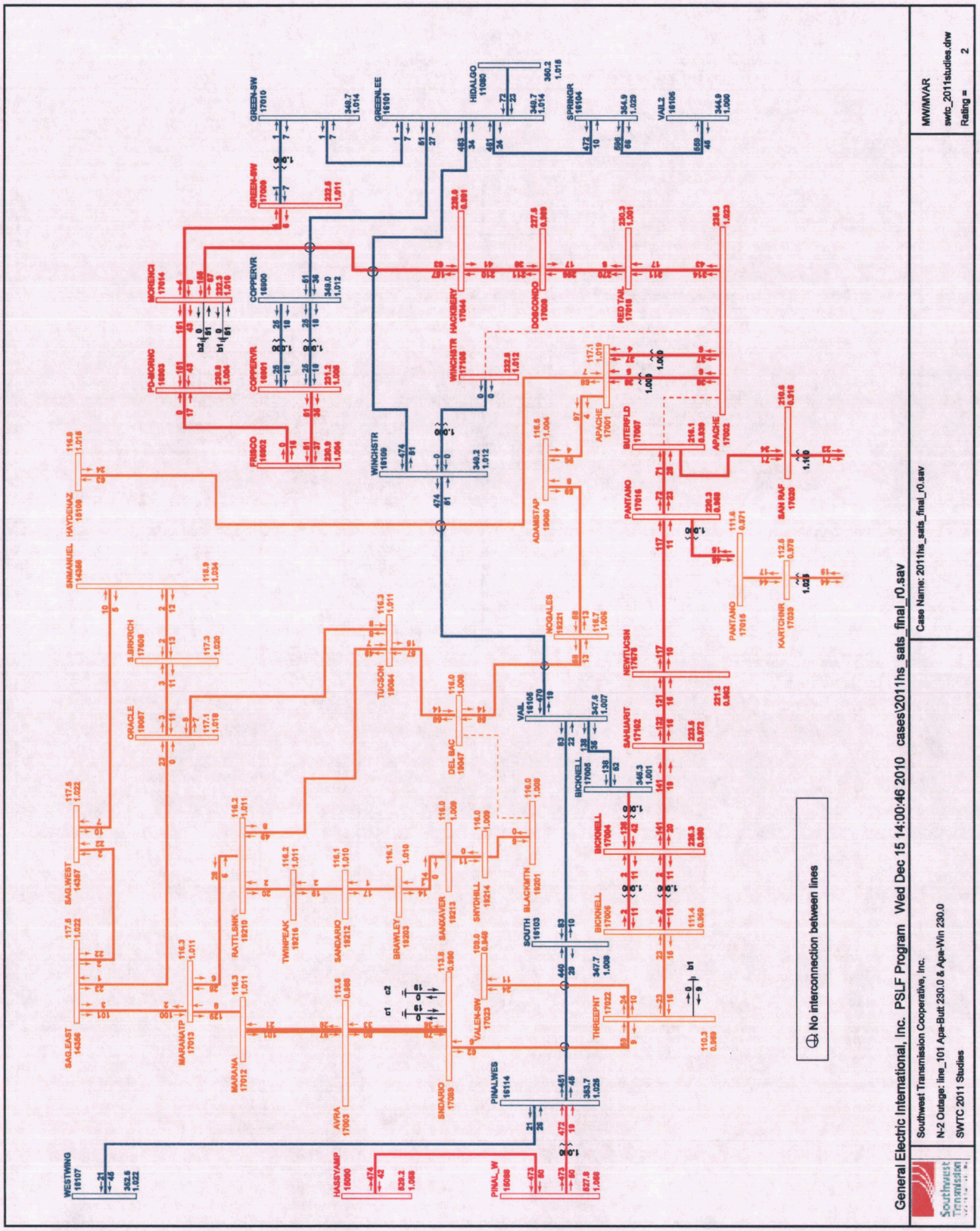
2011HS Southwest Transmission Cooperative Base System with Saguaro East to Marana Tap 115 kV Line out of service



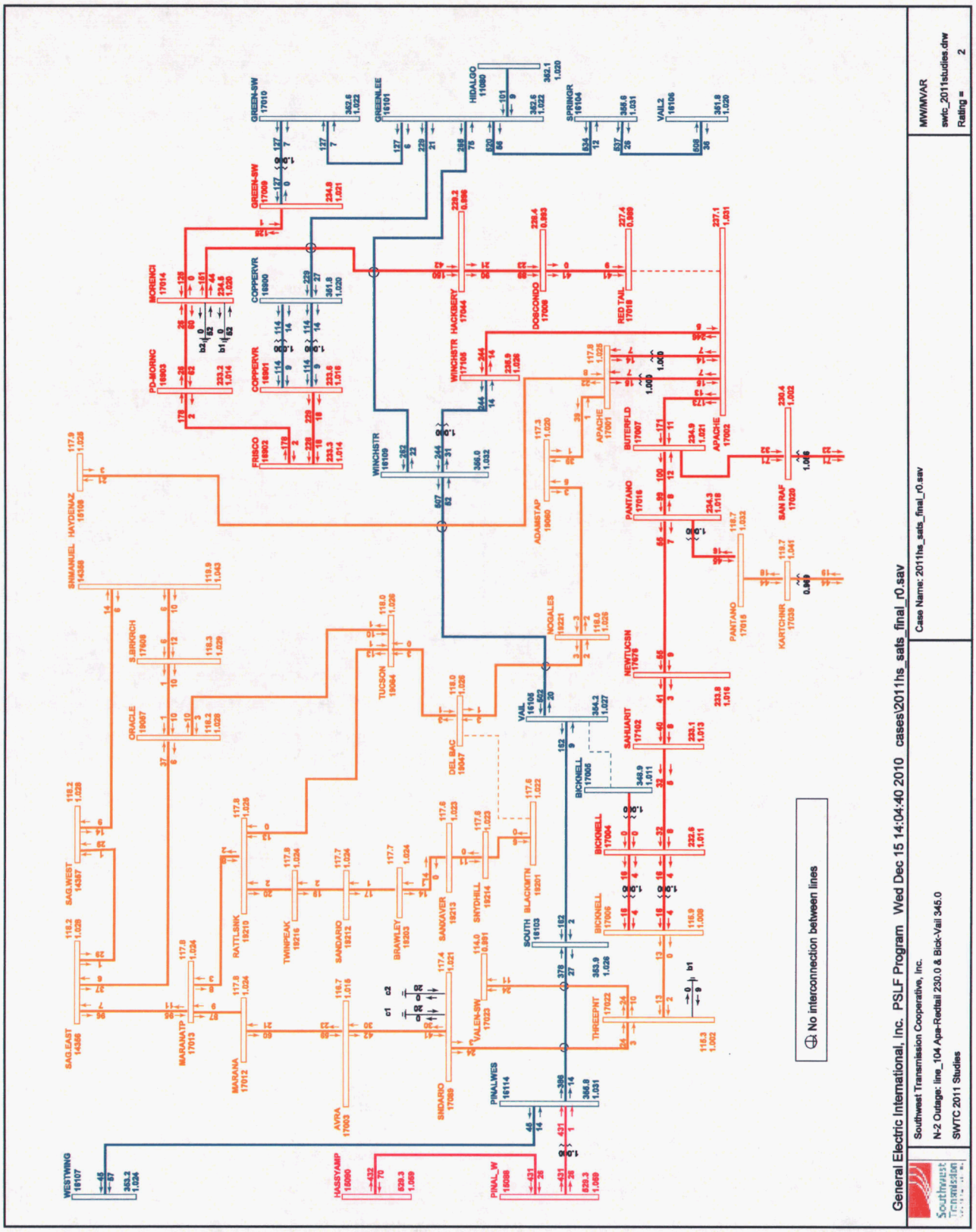
2011HS Southwest Transmission Cooperative Base System with Apache to Butterfield & Apache to Redtail 230 kV Lines out of service



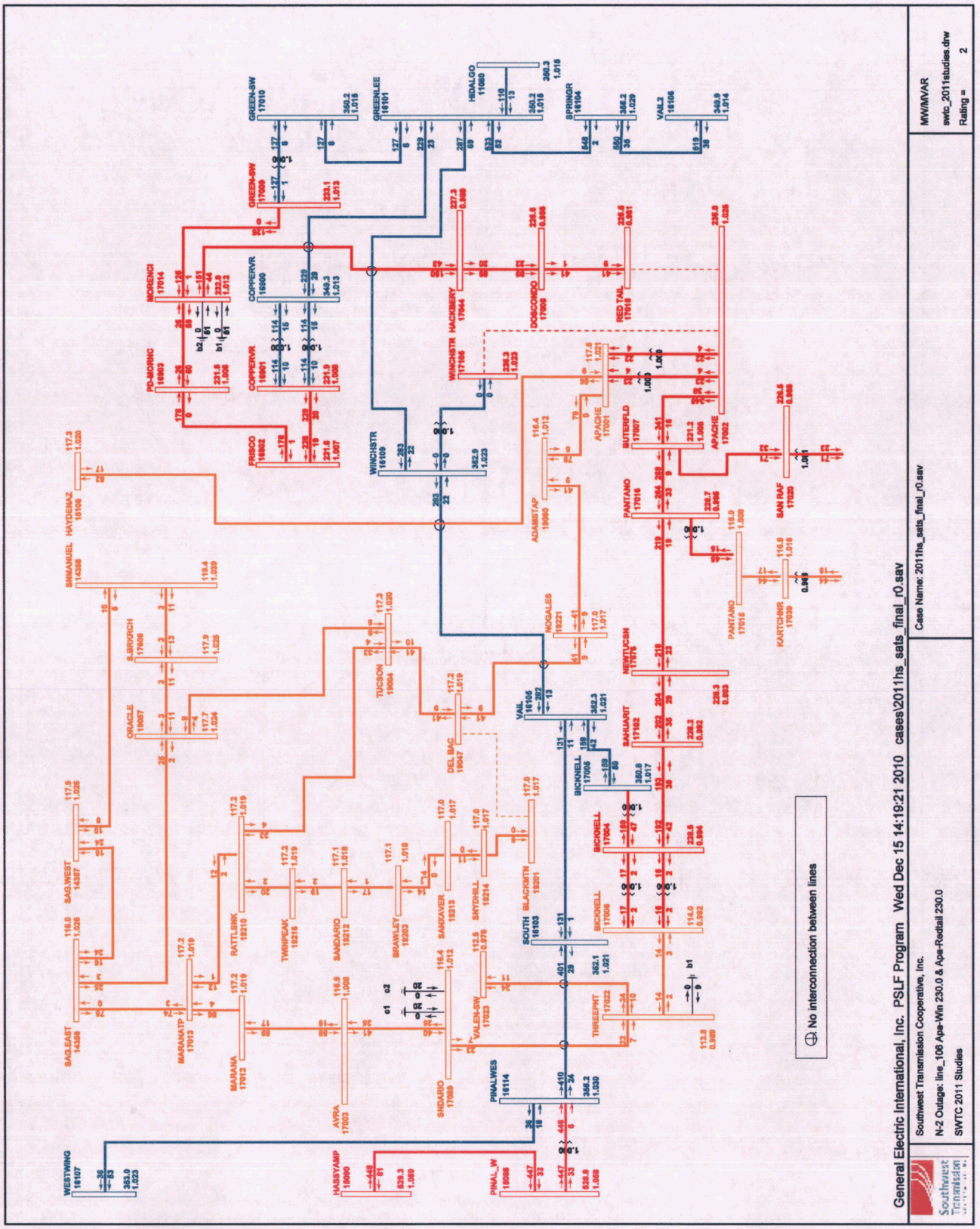
2011HS Southwest Transmission Cooperative Base System with Apache to Butterfield & Apache to Winchester 230 kV Lines out of service



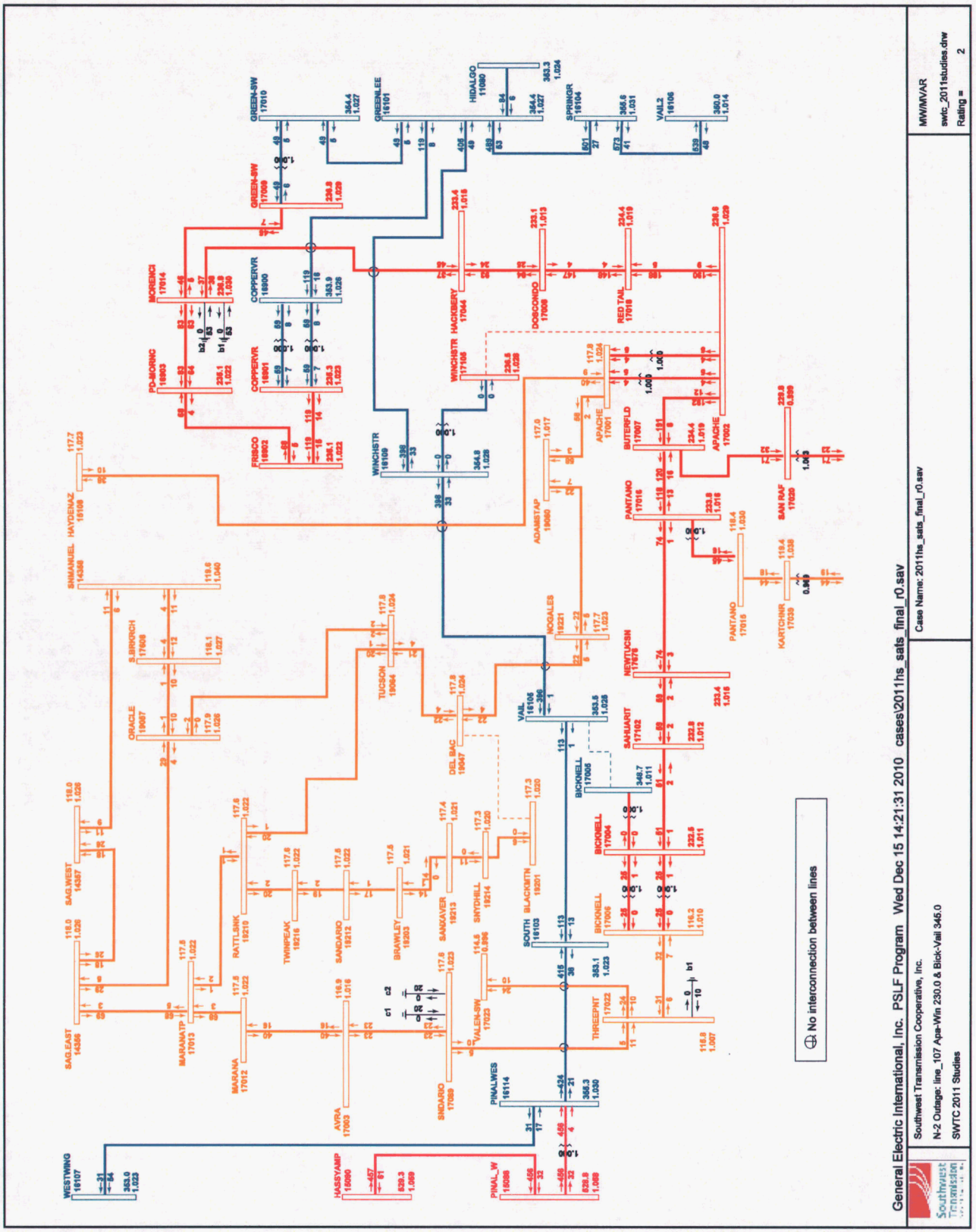
2011HS Southwest Transmission Cooperative Base System with Apache to Redtail 230 kV & Bicknell to Vail 345 kV Lines out of service



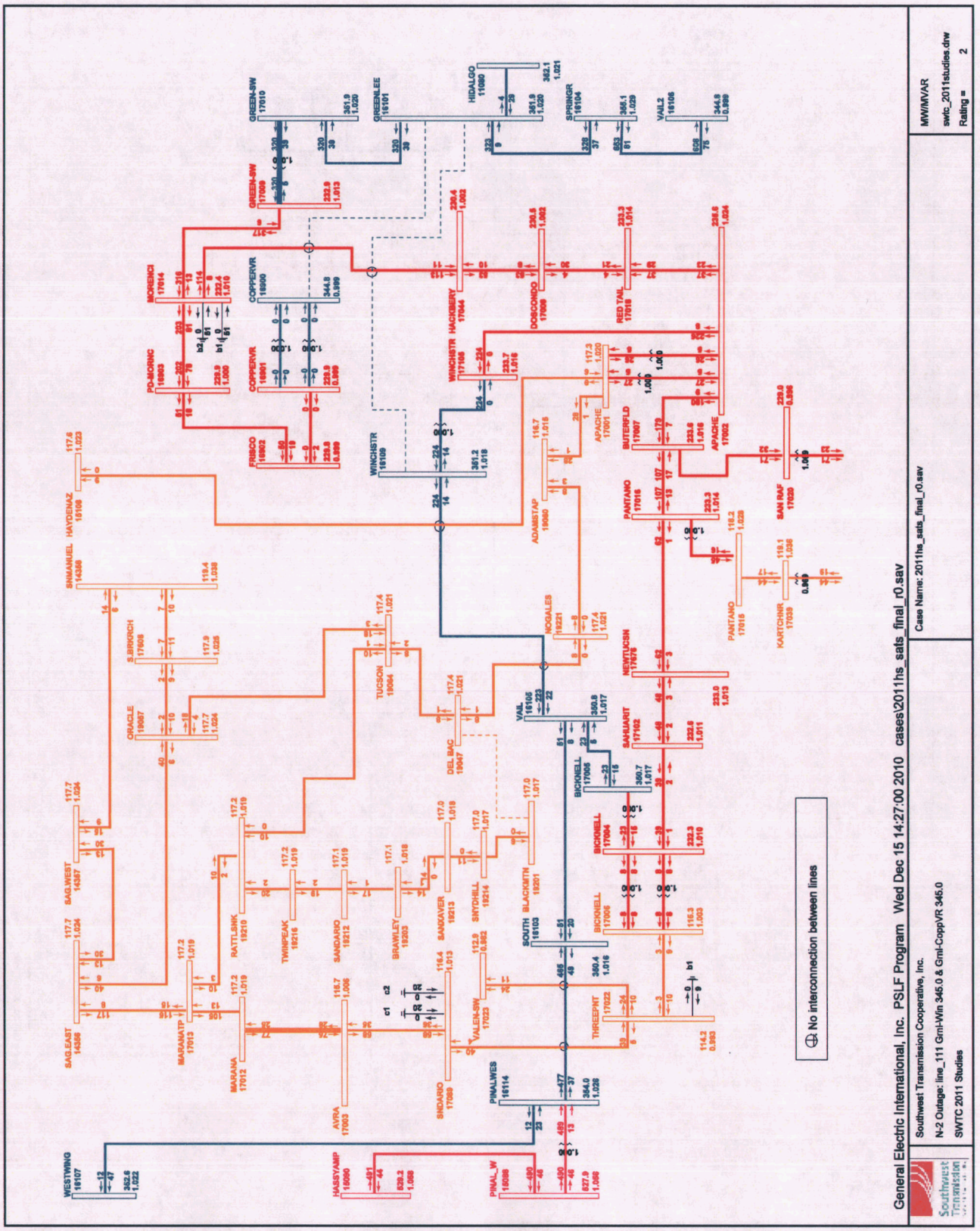
2011HS Southwest Transmission Cooperative Base System with Apache to Winchester 230 kV & Apache to Redtail 230 kV Lines out of service



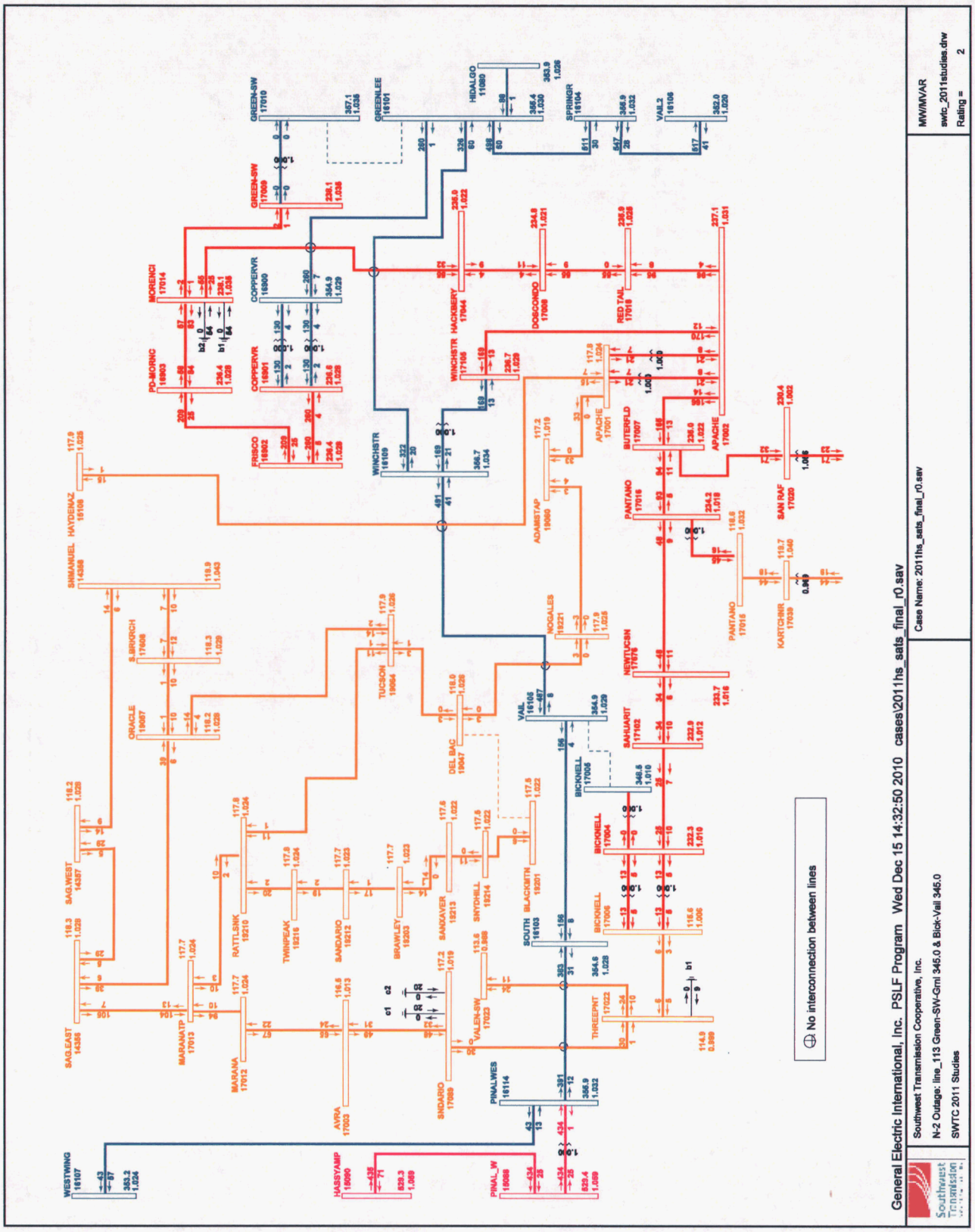
2011HS Southwest Transmission Cooperative Base System with Apache to Winchester 230 kV & Bicknell to Vail 345 kV Lines out of service



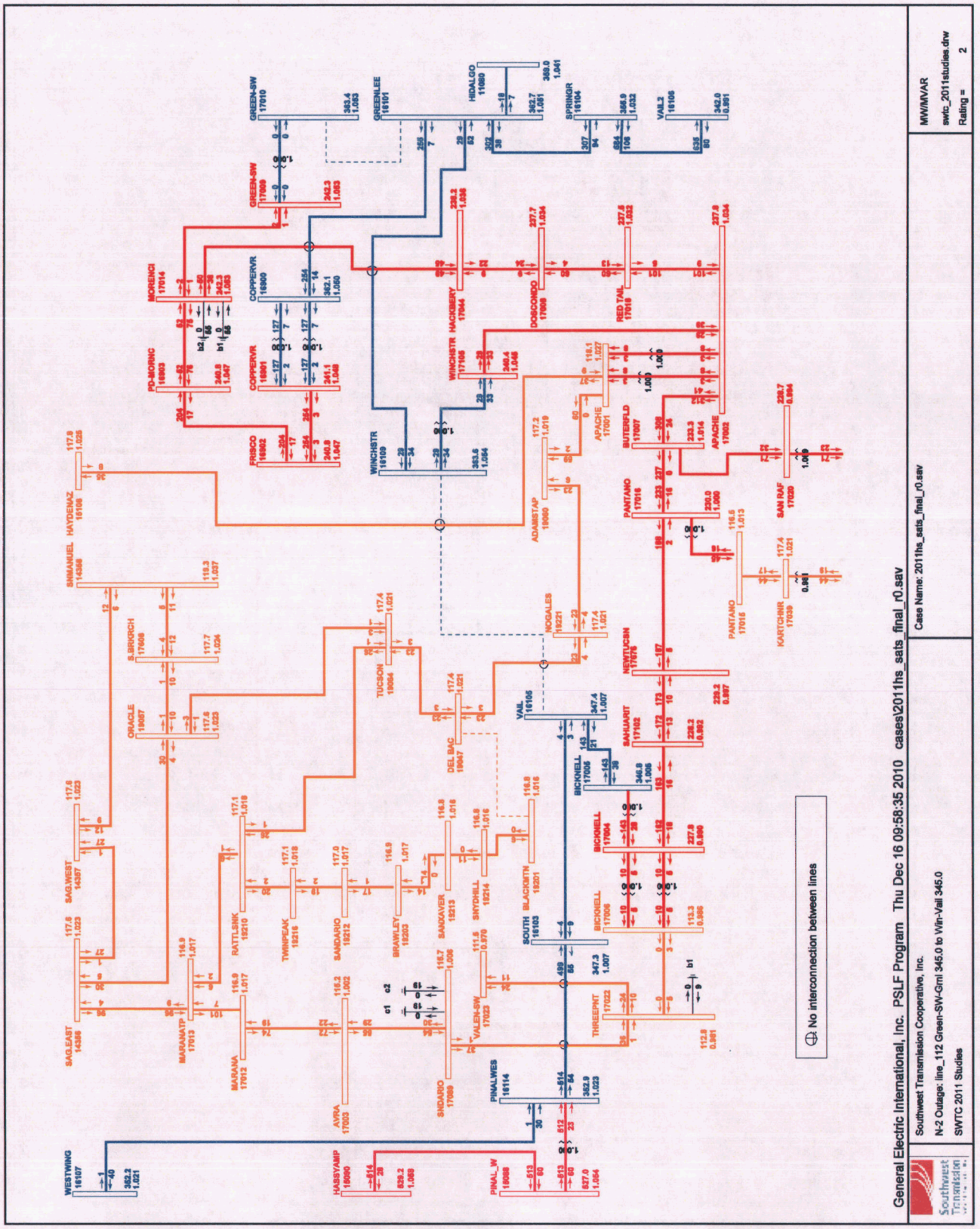
2011HS Southwest Transmission Cooperative Base System with Greenlee to Winchester & Greenlee to Copper Verde 345 kV Lines out of service



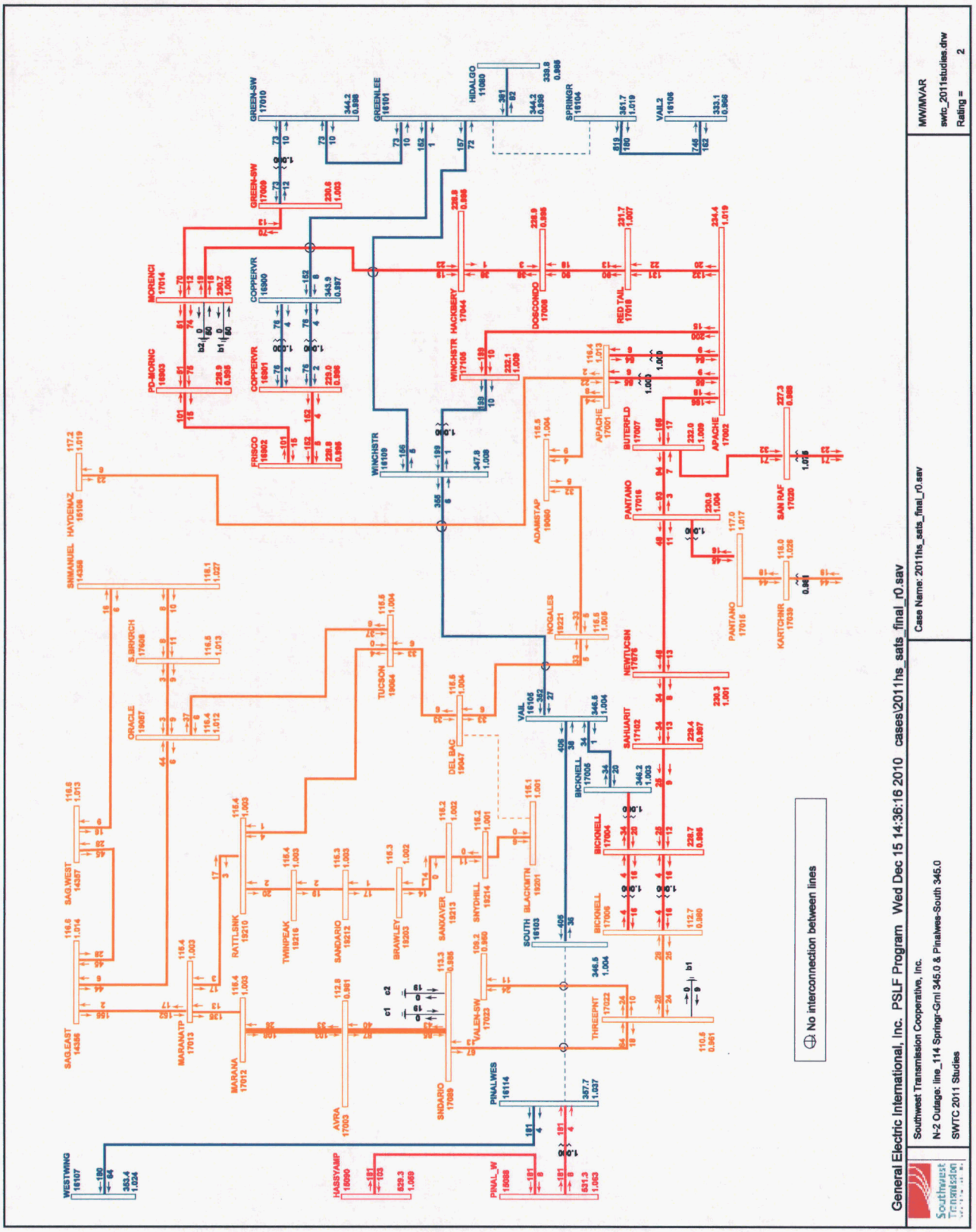
2011HS Southwest Transmission Cooperative Base System with Greenlee-SW to Greenlee & Bicknell to Vail 345 kV Lines out of service



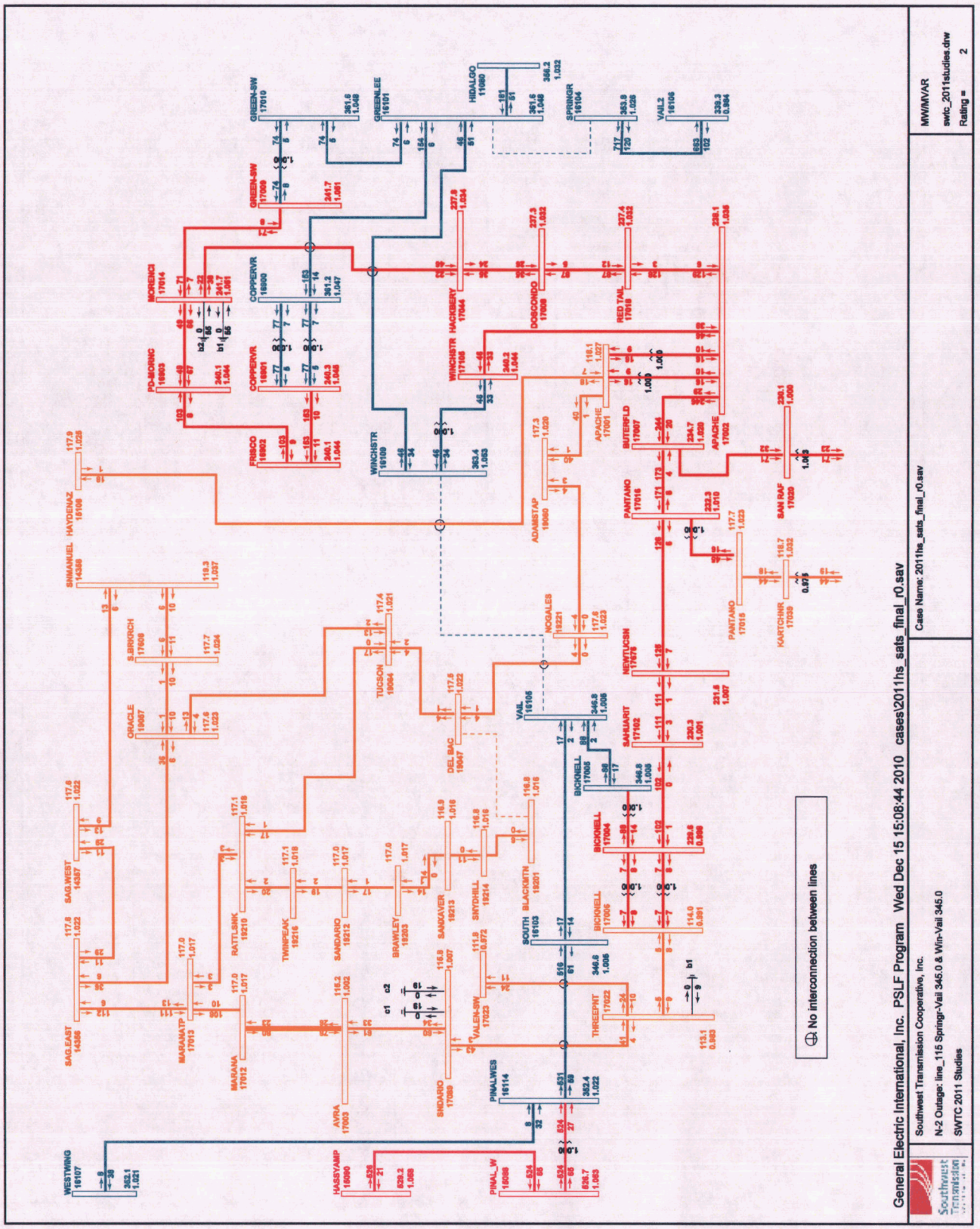
2011HS Southwest Transmission Cooperative Base System with Greenlee-SW to Greenlee & Winchester to Vail 345 kV Lines out service



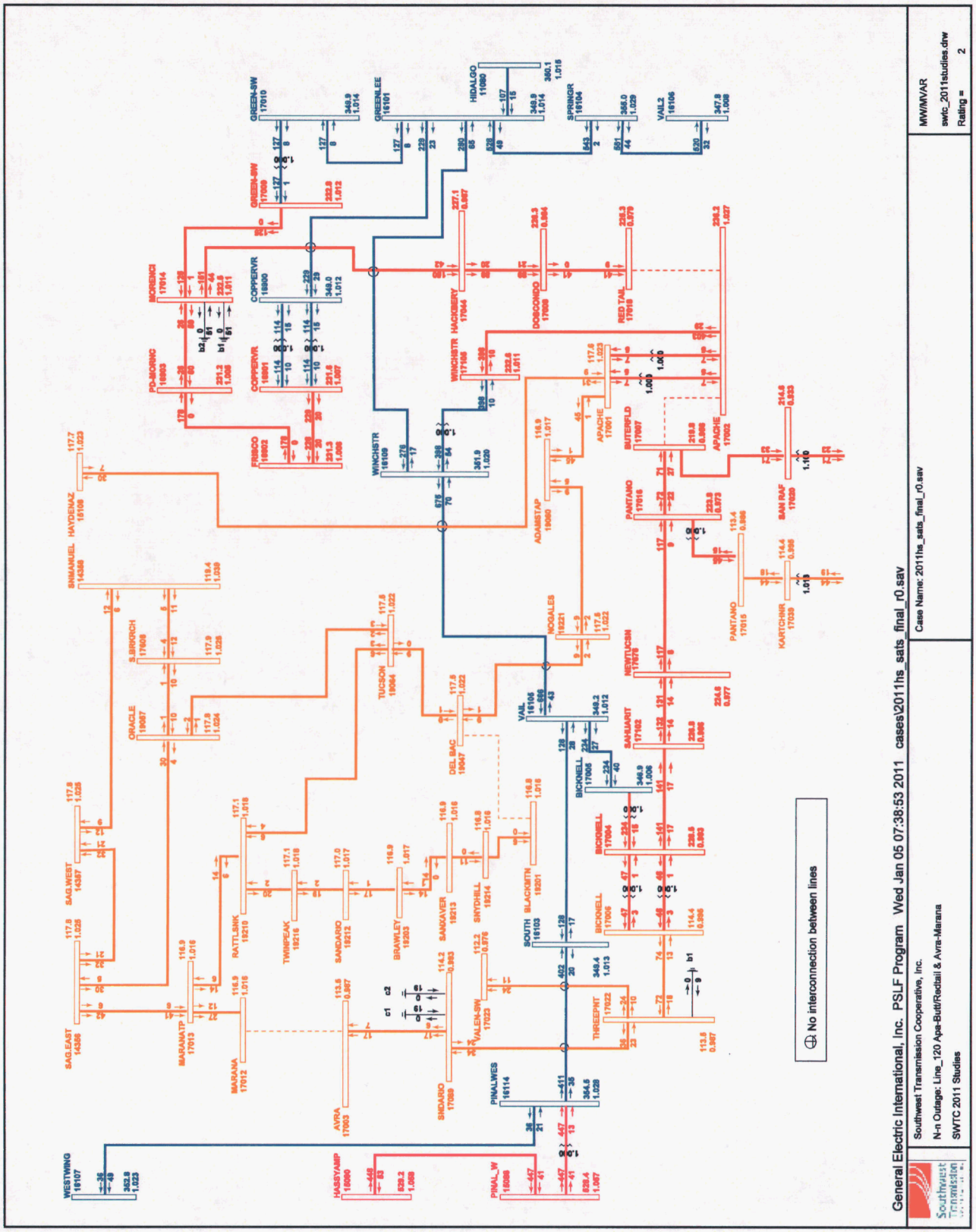
2011HS Southwest Transmission Cooperative Base System with Springerville to Greenlee & Pinal West to South 345 kV Lines out of service



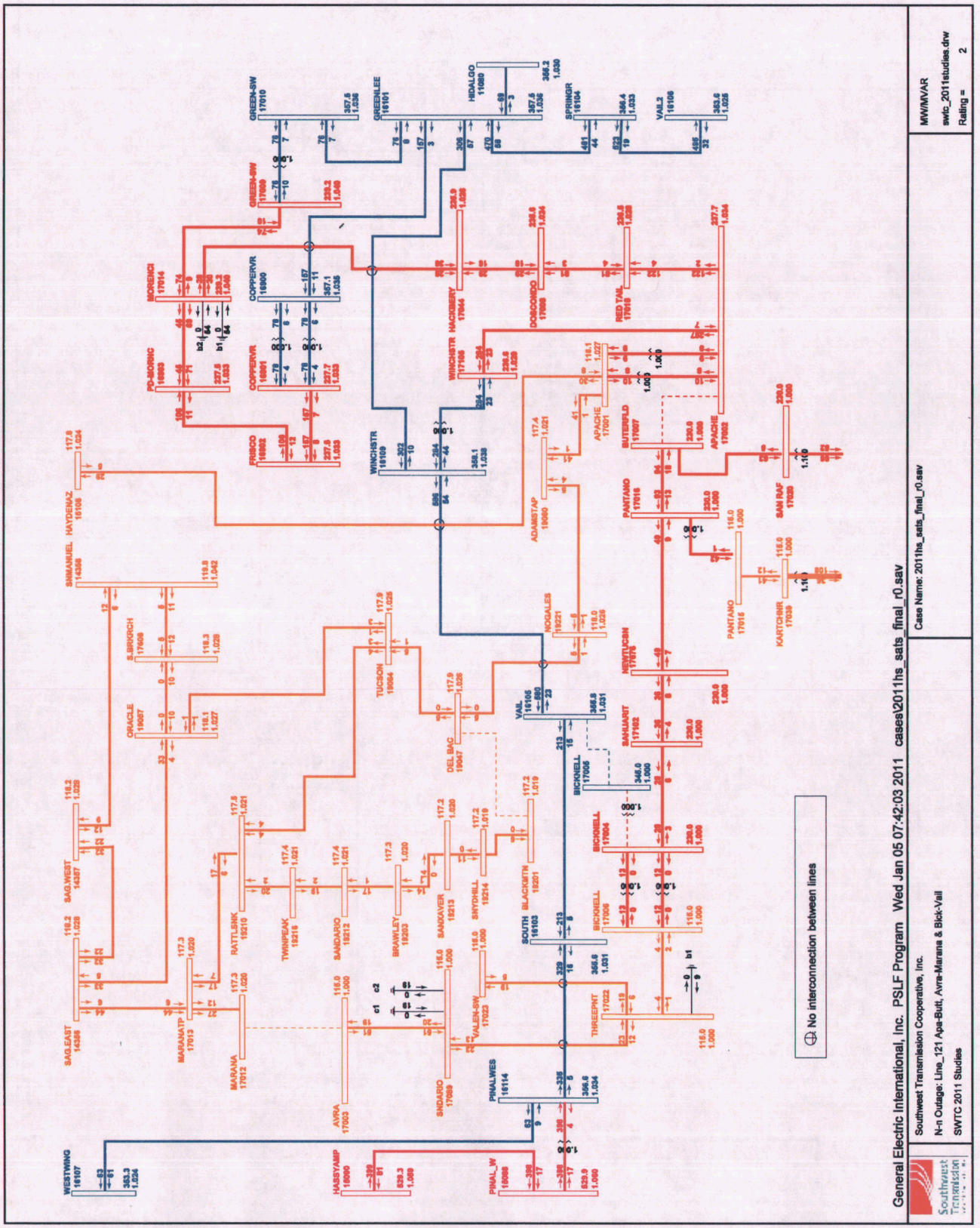
2011HS Southwest Transmission Cooperative Base System with Springerville to Greenlee & Winchester to Vail 345 kV Lines out of service



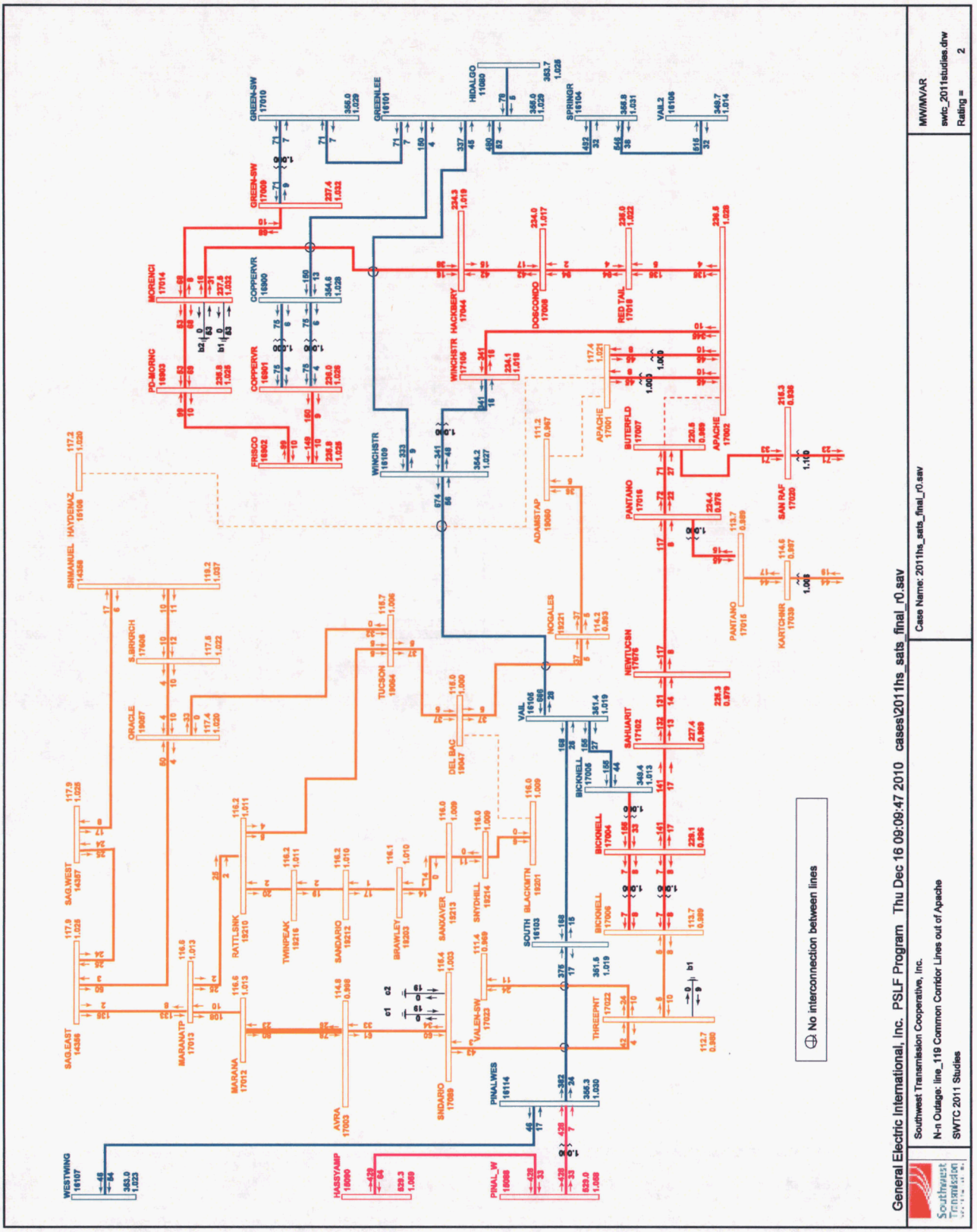
2011HS Southwest Transmission Cooperative Base System with Apache to Butterfield, Apache to Redtail 230 kV & Avra to Marana 115 kV Lines out of service



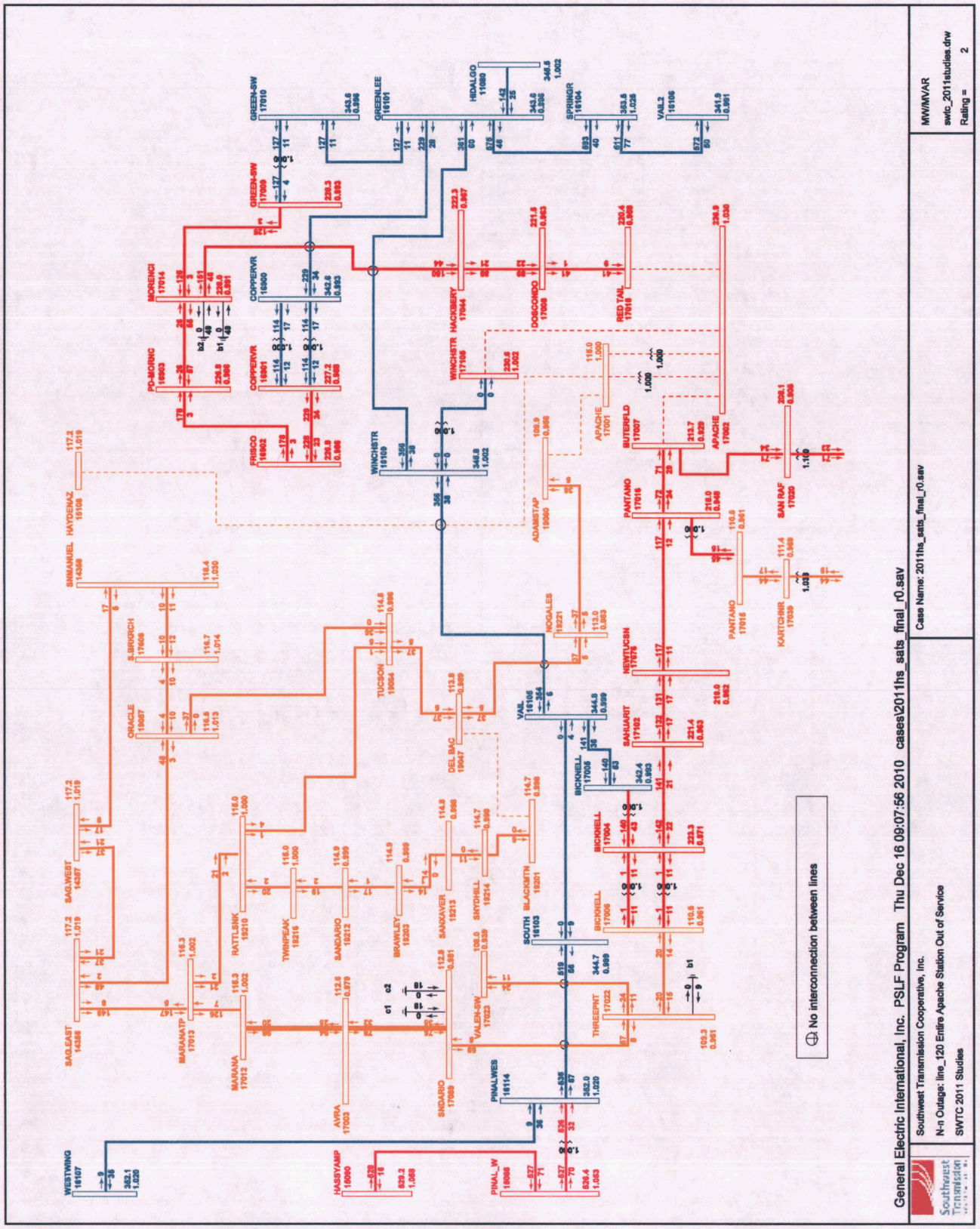
2011HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230 kV, Avra to Marana 115 kV & Bicknell to Vail 345 kV Lines out of service



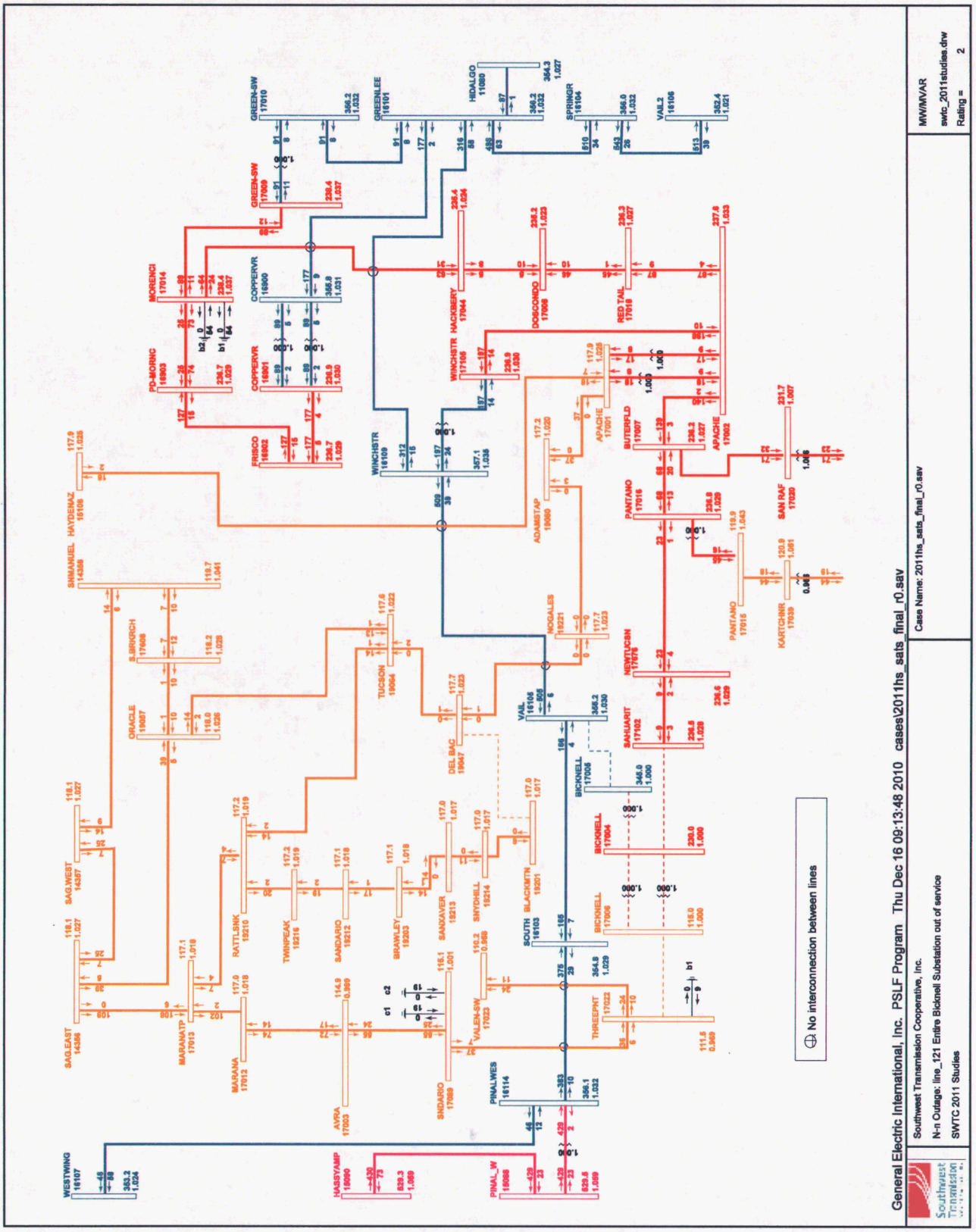
2011HS Southwest Transmission Cooperative Base System with Common Corridor Lines out of Apache Station out of service



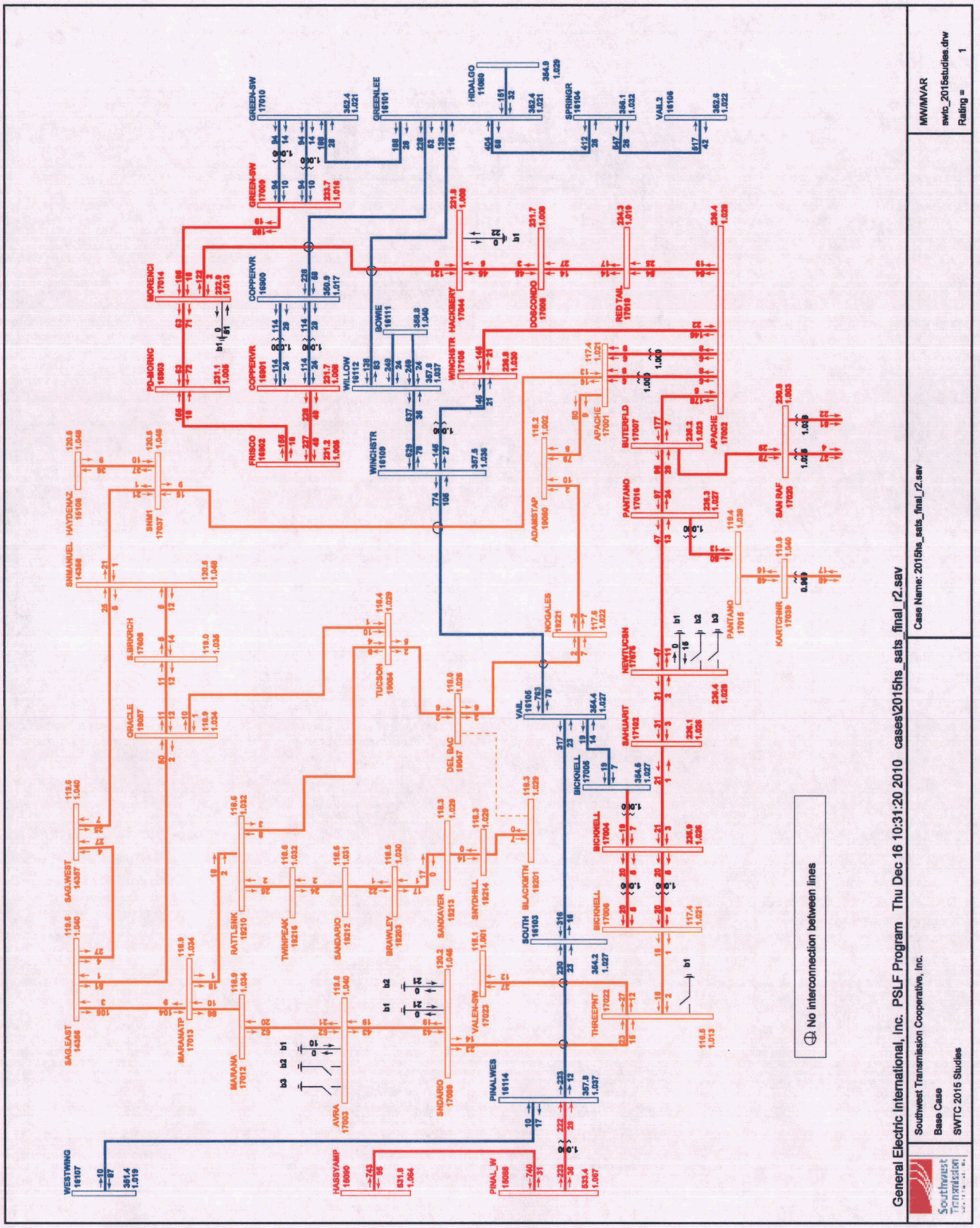
2011HS Southwest Transmission Cooperative Base System with entire Apache Station out of service



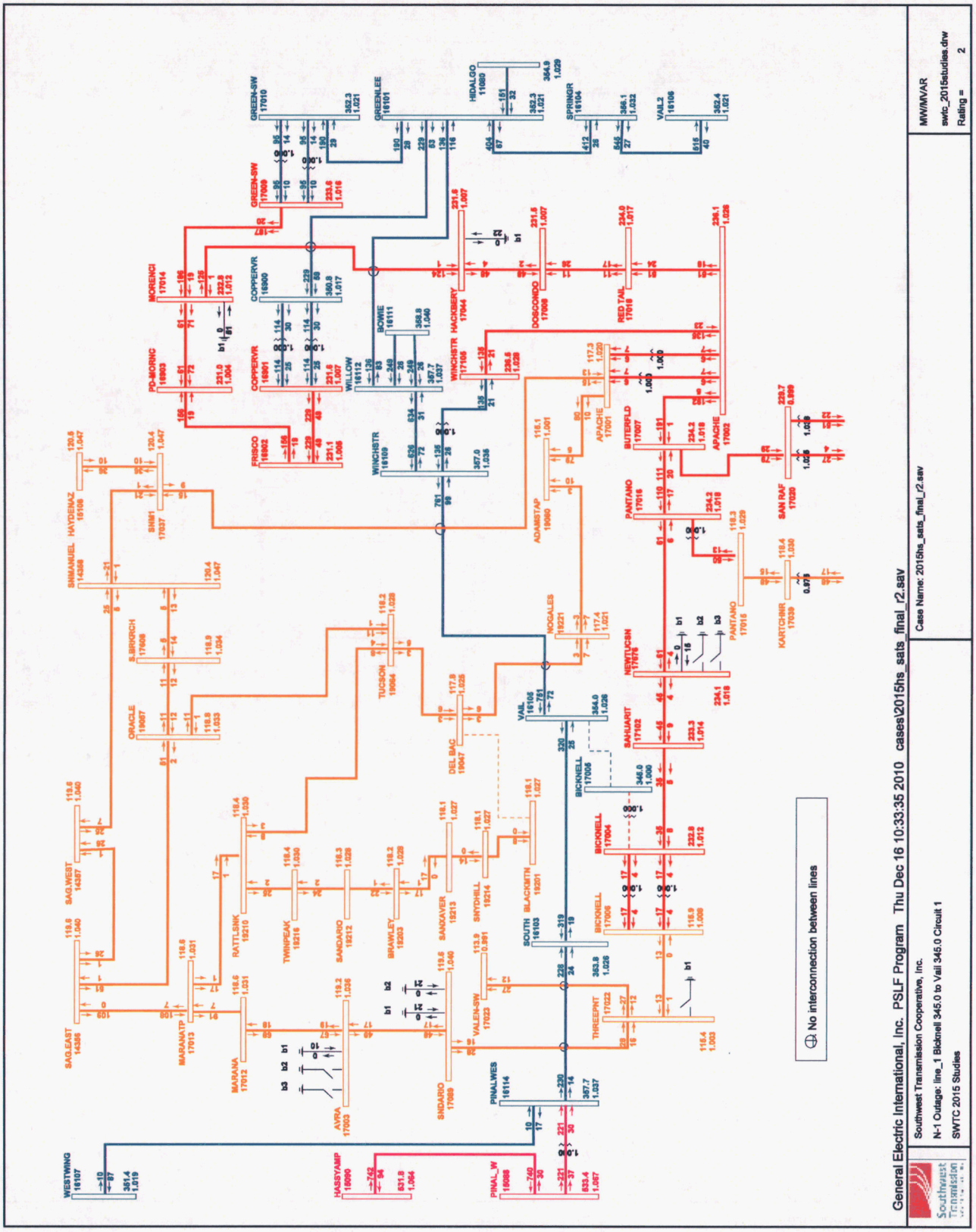
2011HS Southwest Transmission Cooperative Base System with entire Bicknell Substation out of service



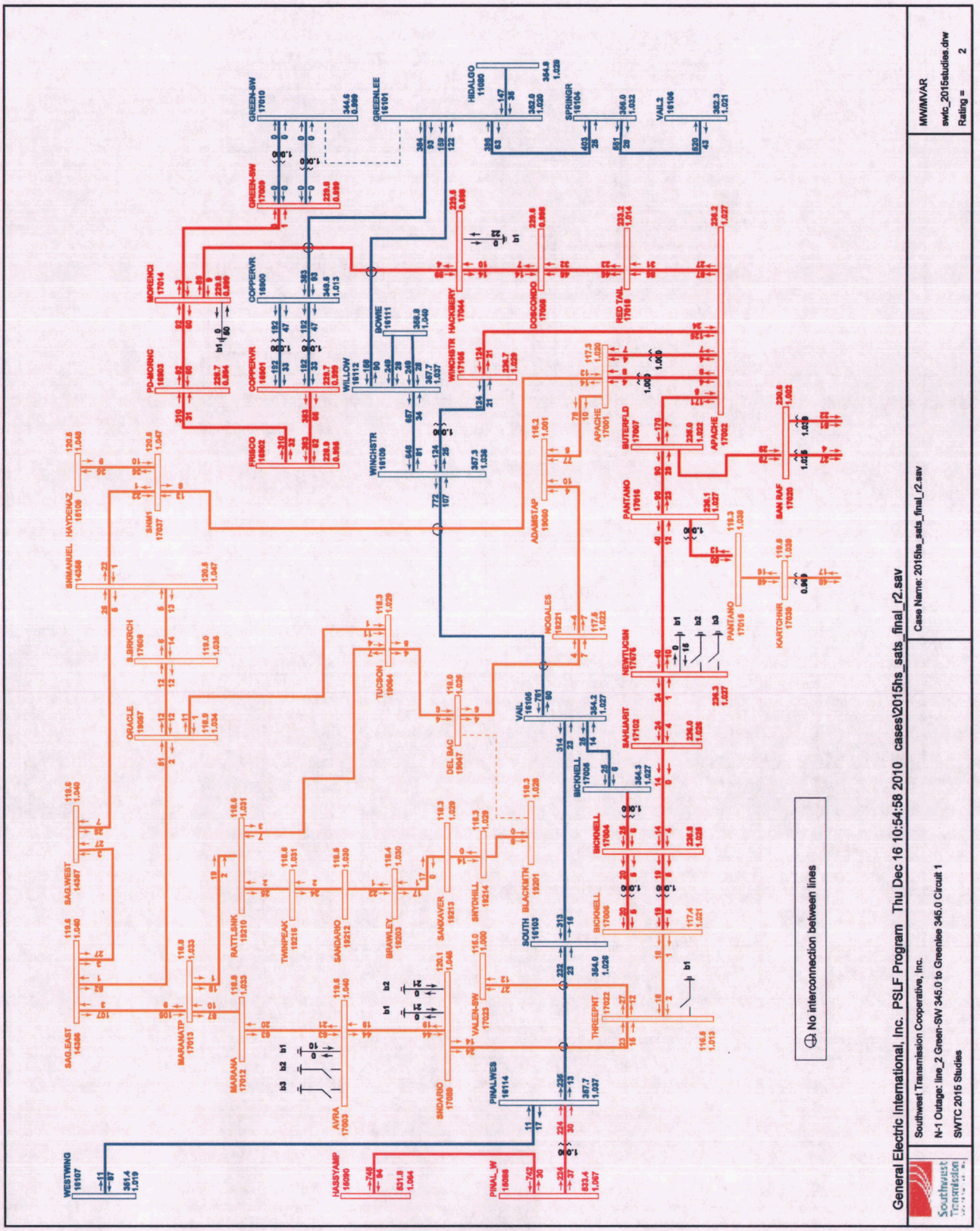
2015HS Southwest Transmission Cooperative Base System



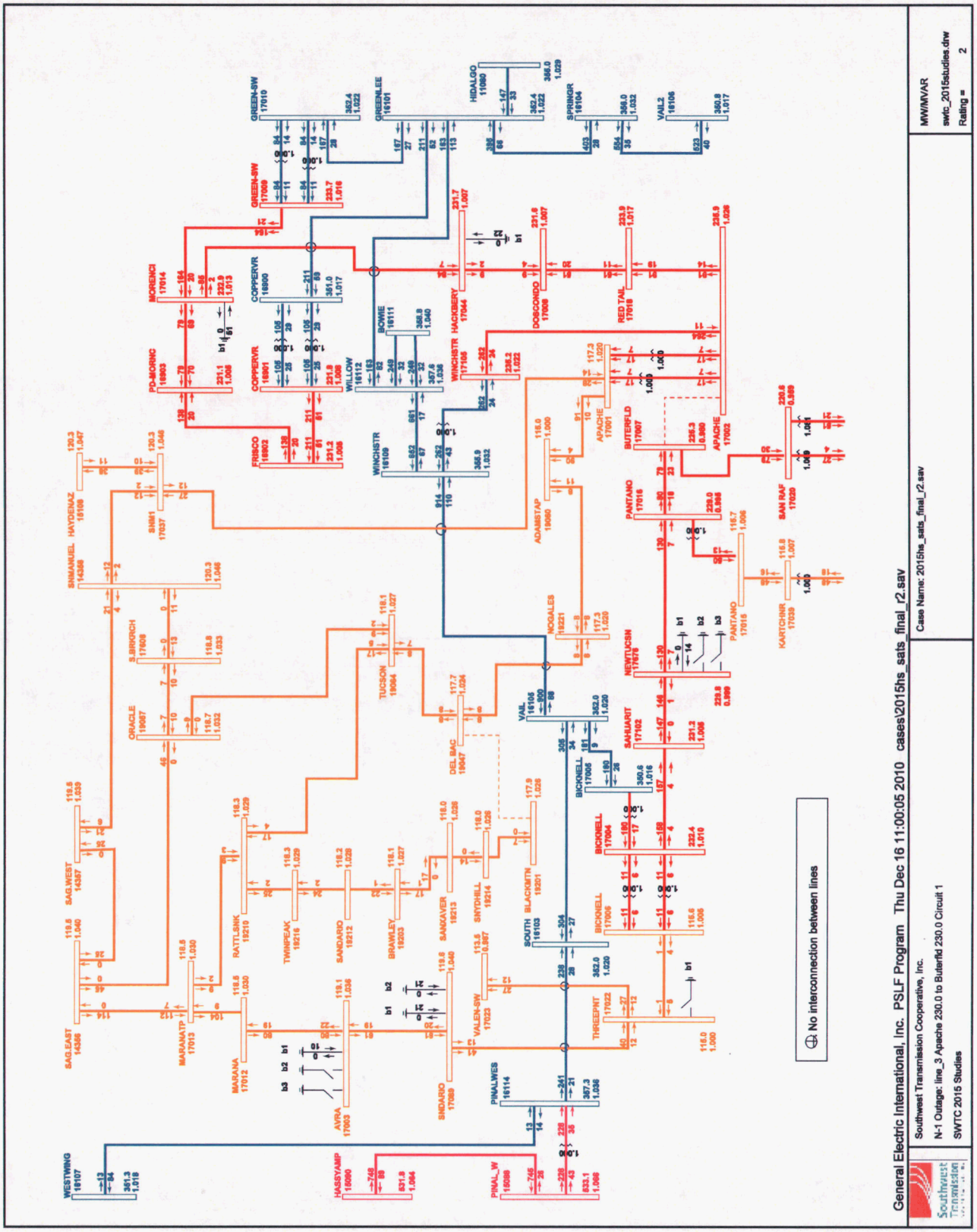
2015HS Southwest Transmission Cooperative Base System with Bicknell to Vail 345 kV Line out of service



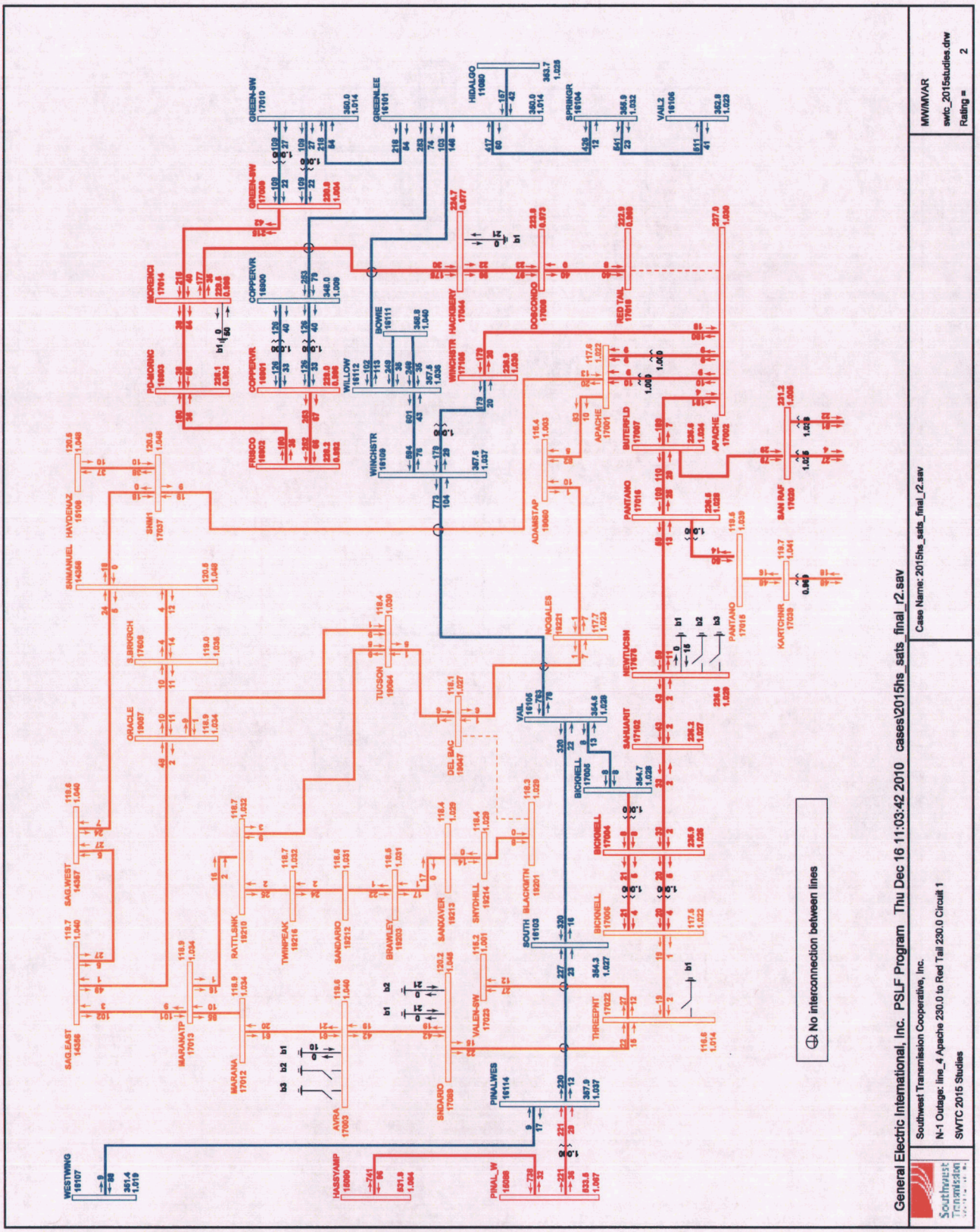
2015HS Southwest Transmission Cooperative Base System with Greenlee to Greenlee 345 kV Line out of service



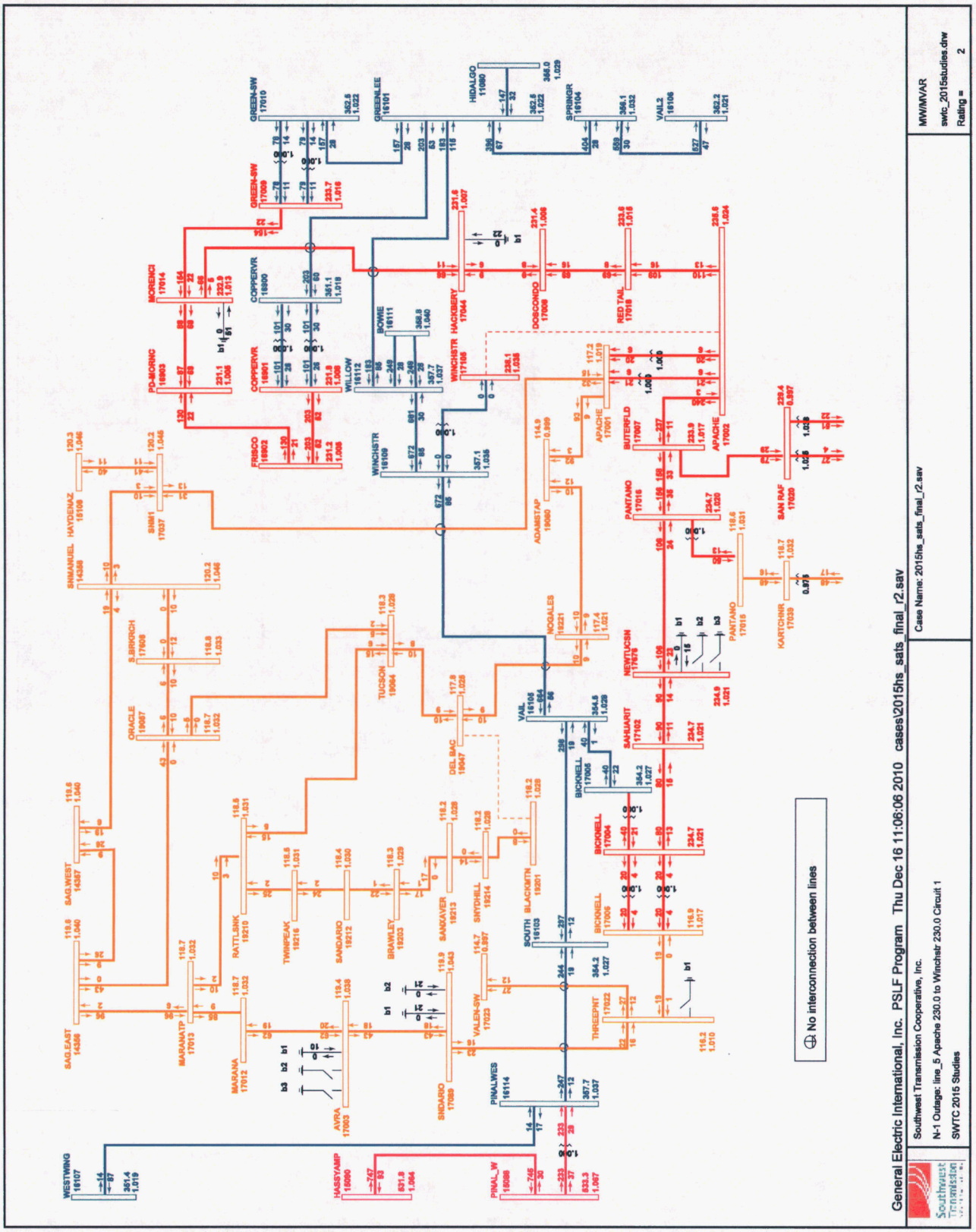
2015HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230 kV Line out of service



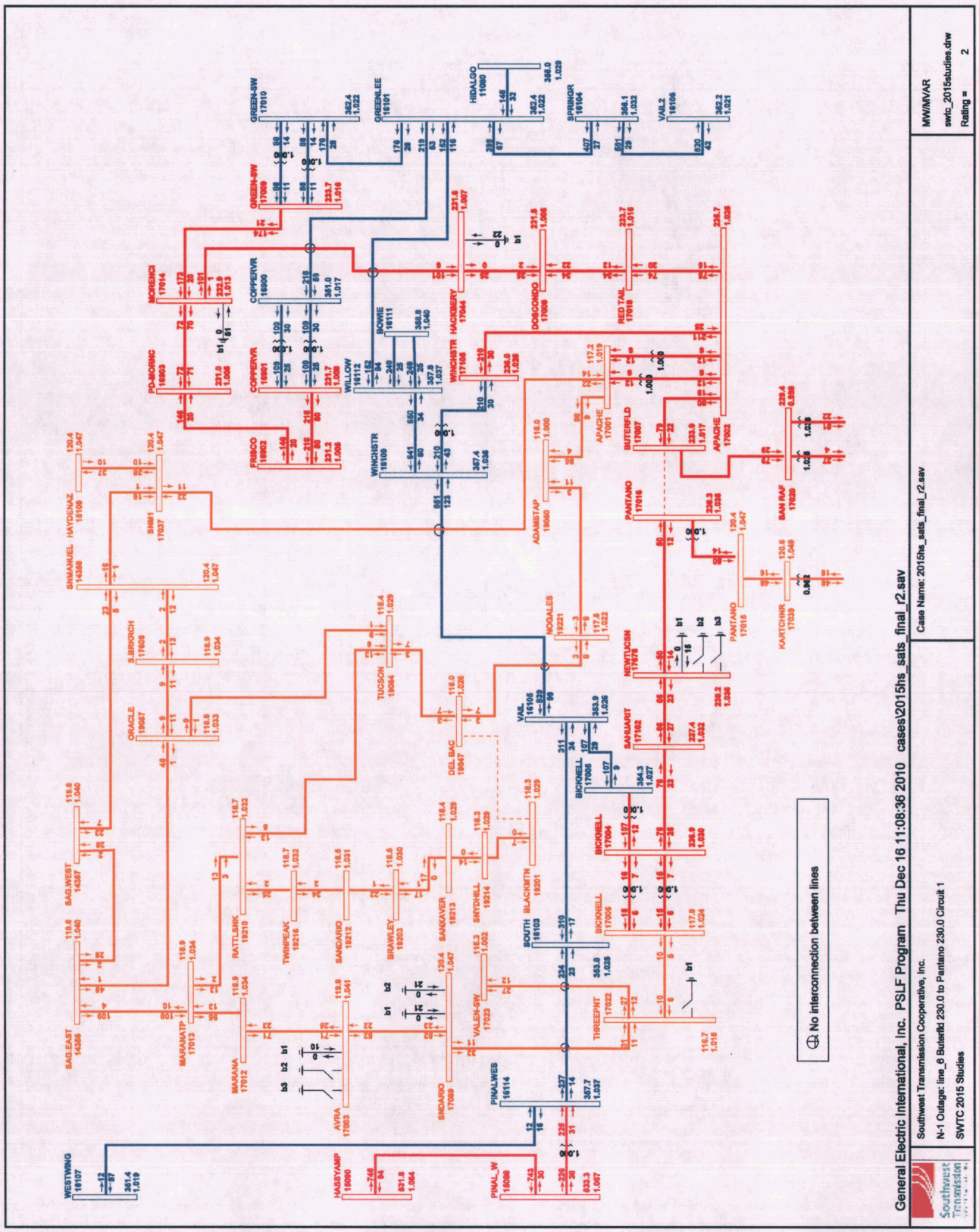
2015HS Southwest Transmission Cooperative Base System with Apache to Redtail 230 kV Line out of service



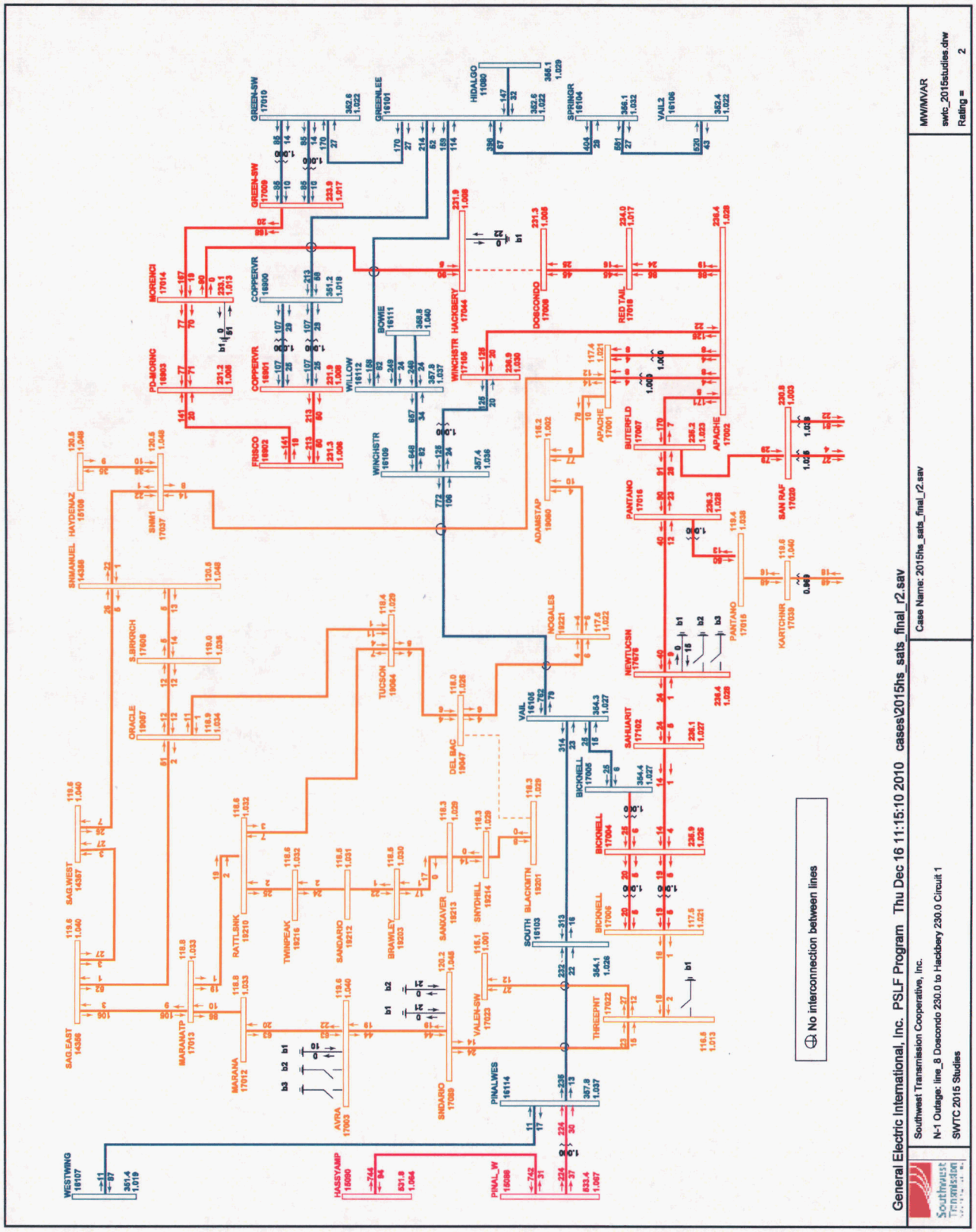
2015HS Southwest Transmission Cooperative Base System with Apache to Winchester 230 kV Line out of service



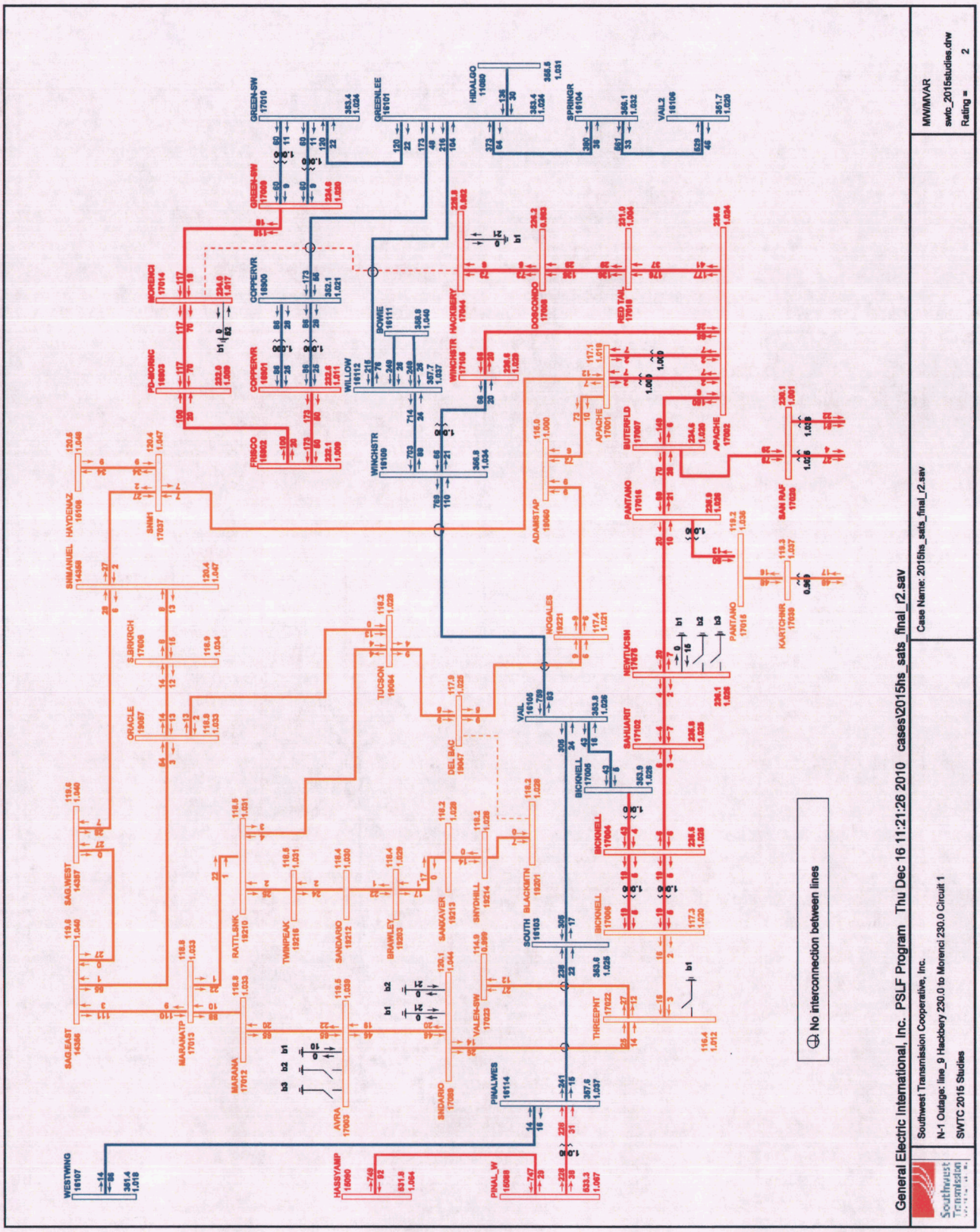
2015HS Southwest Transmission Cooperative Base System with Butterfield to Pantano 230 kV Line out of service



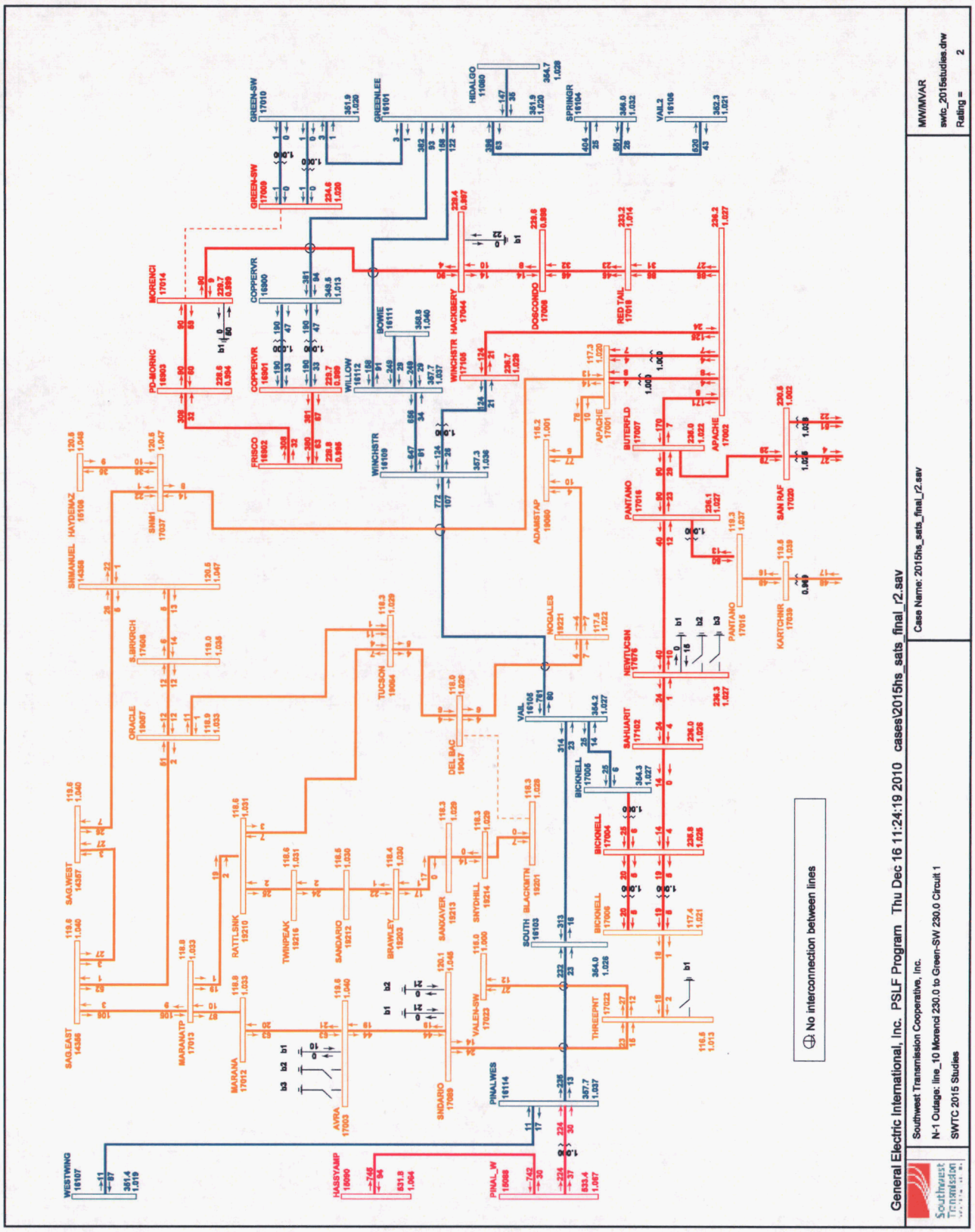
2015HS Southwest Transmission Cooperative Base System with Dos Condados to Hackberry 230 kV Line out of service



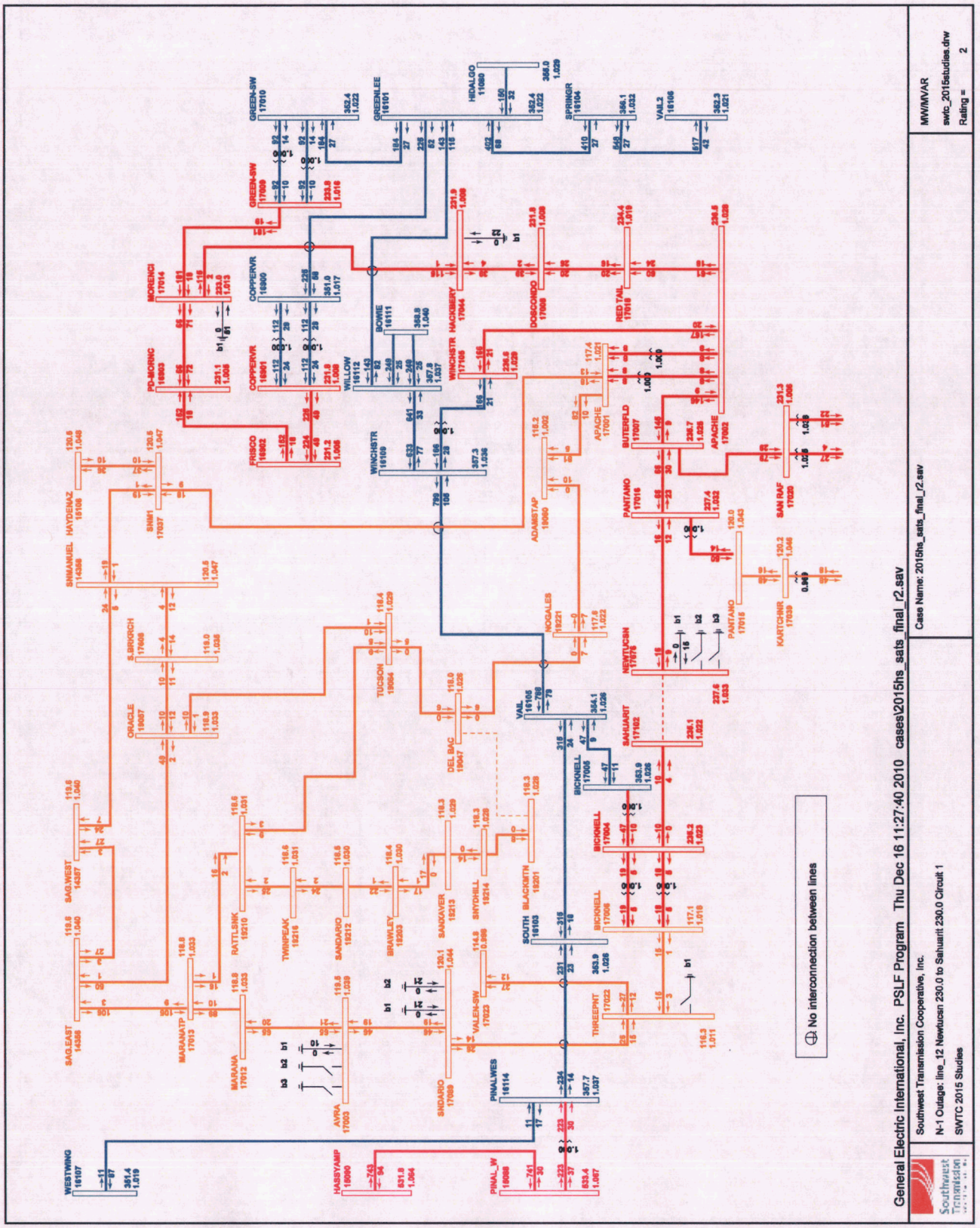
2015HS Southwest Transmission Cooperative Base System with Hackberry to Morenci 230 kV Line out of service



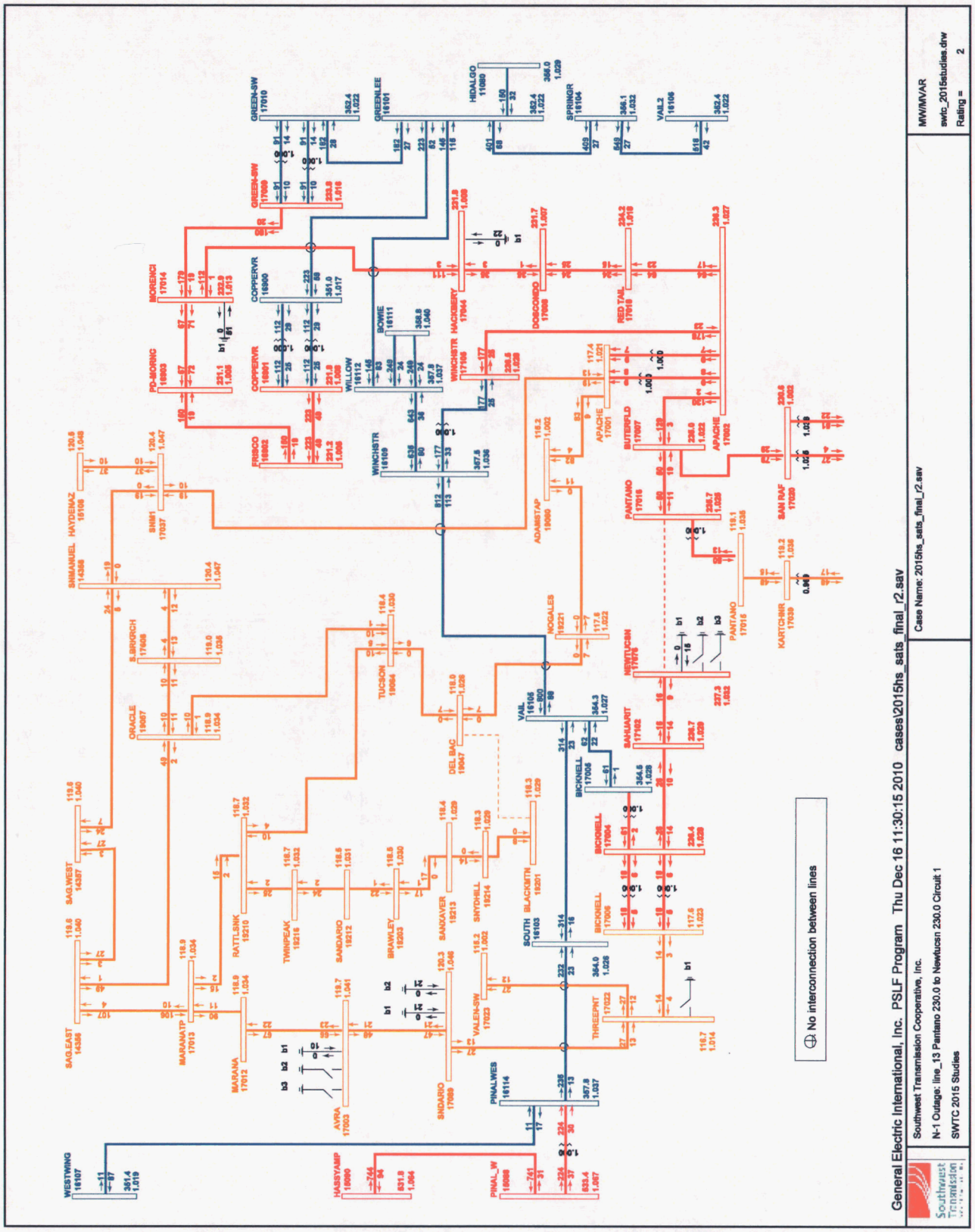
2015HS Southwest Transmission Cooperative Base System with Morenci to Greenlee 230 kV Line out of service



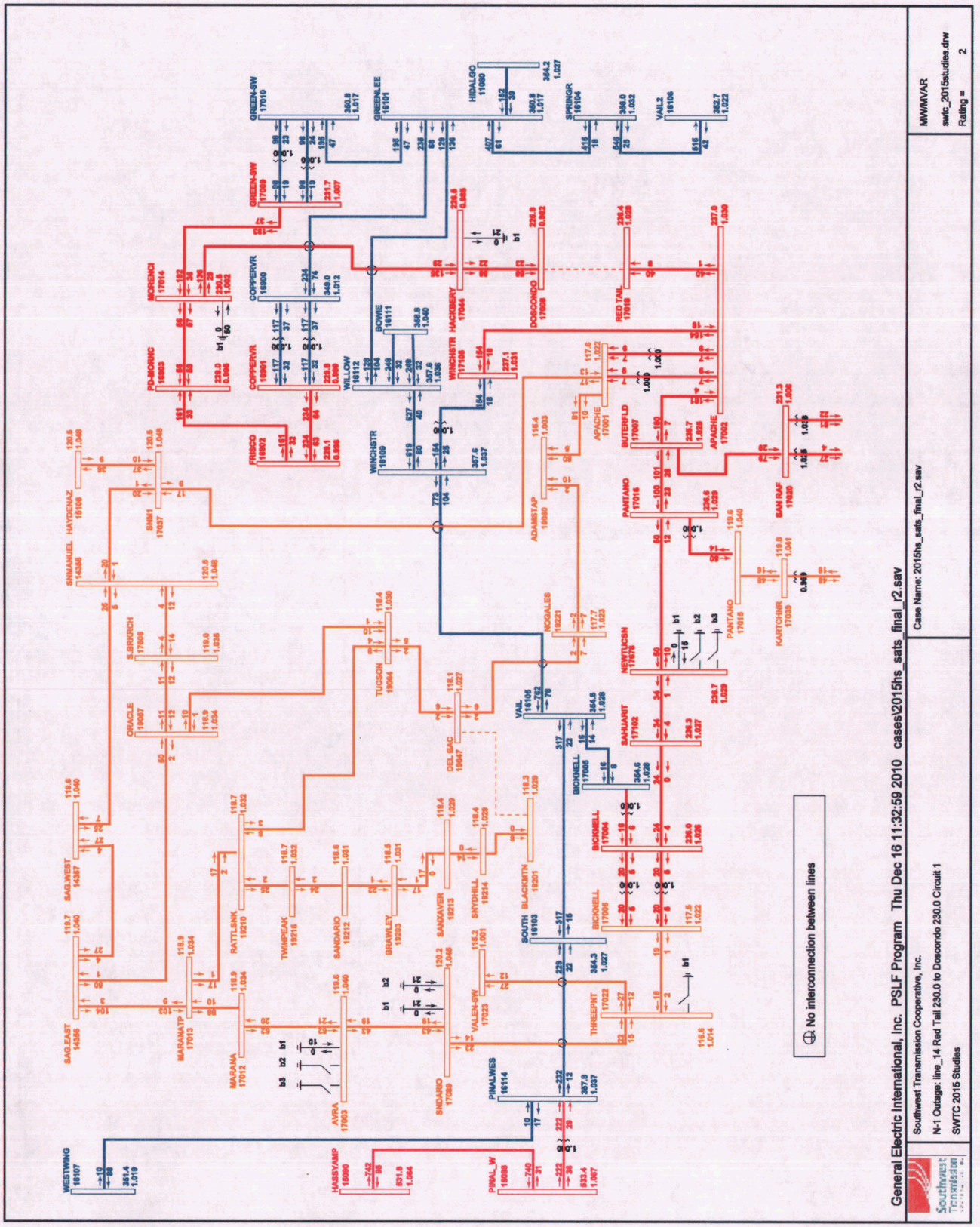
2015HS Southwest Transmission Cooperative Base System with New Tucson to Sahuarita 230 kV Line out of service



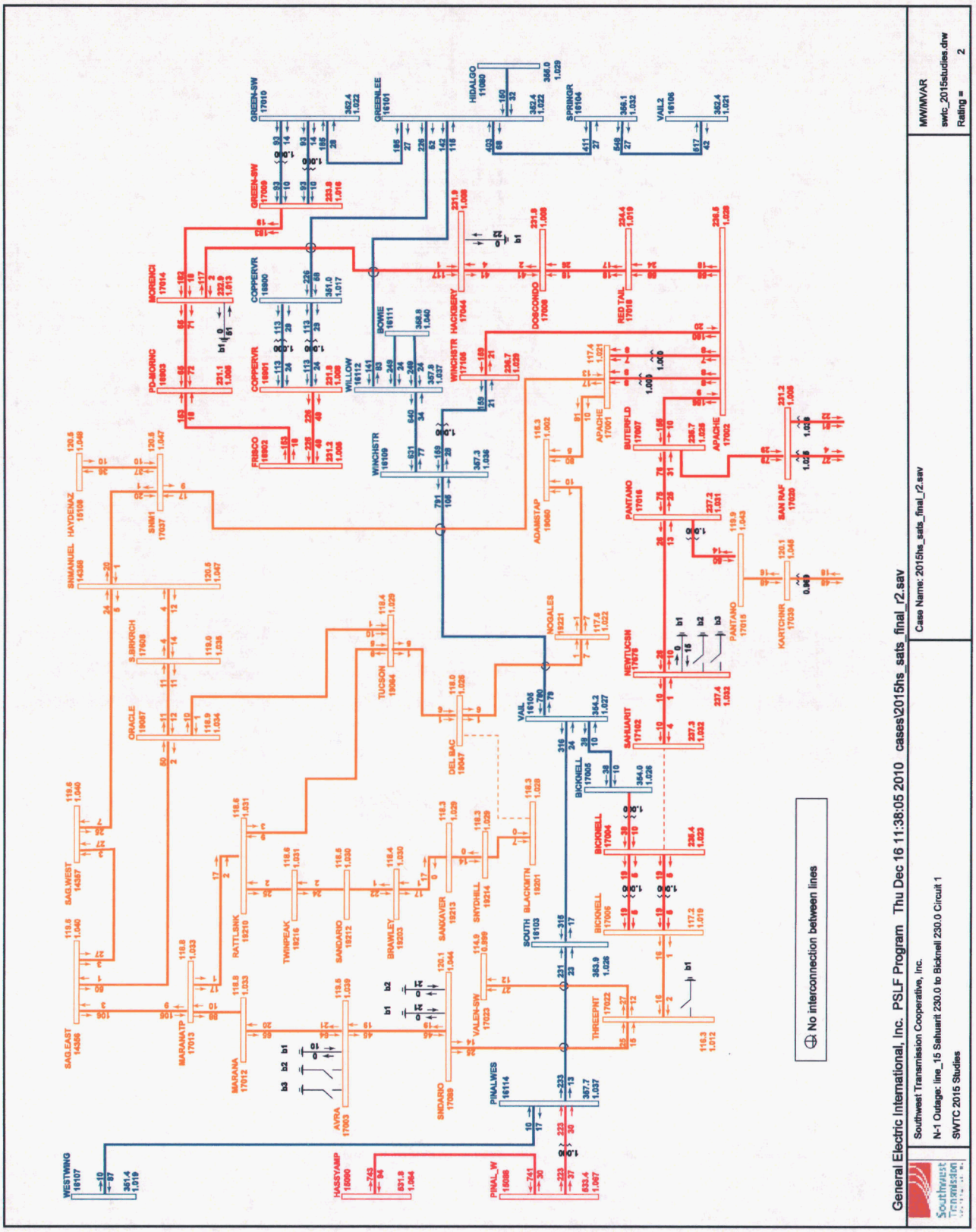
2015HS Southwest Transmission Cooperative Base System with Pantano to New Tucson 230 kV Line out of service



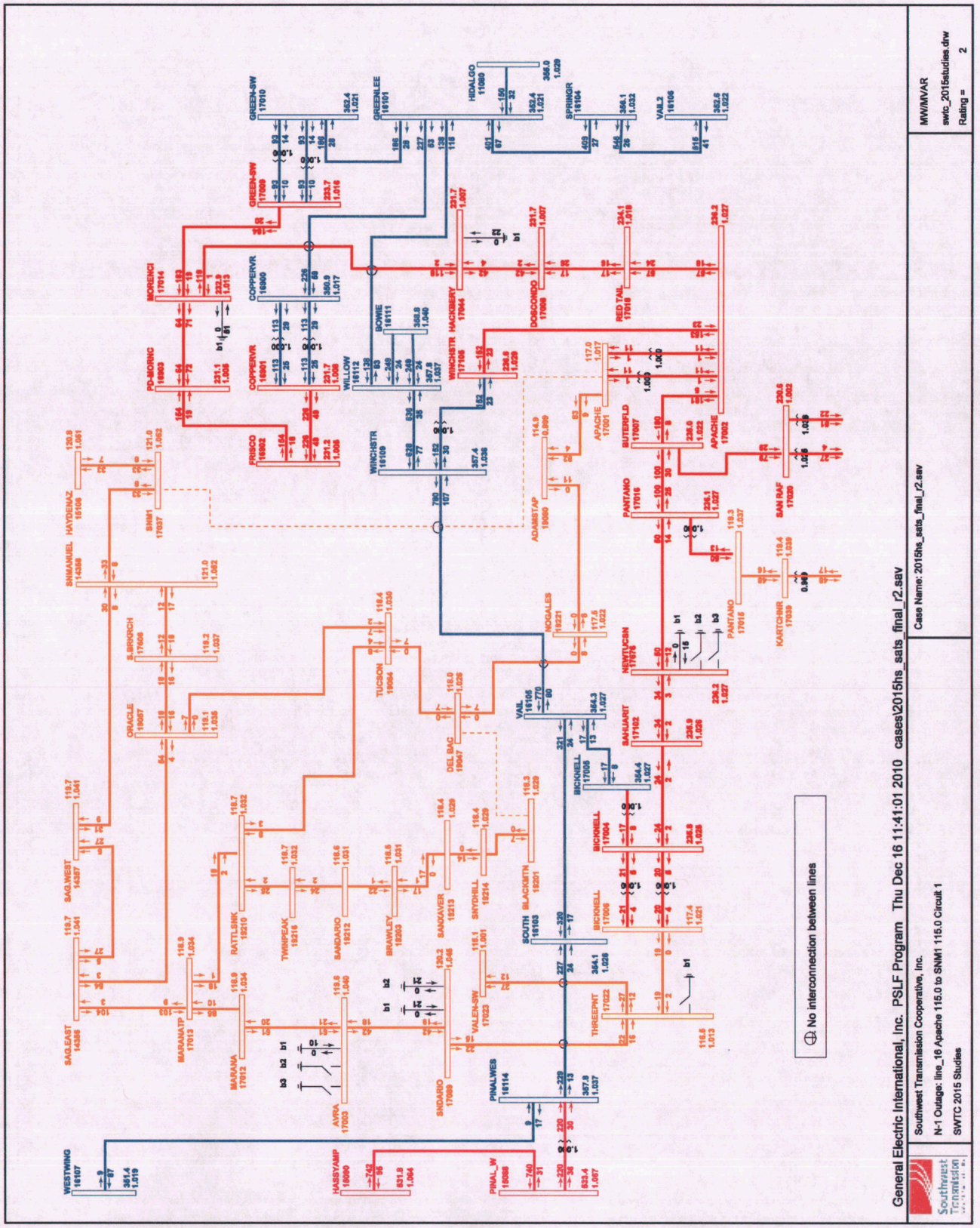
2015HS Southwest Transmission Cooperative Base System with Redtail to Dos Condados 230 kV Line out of service



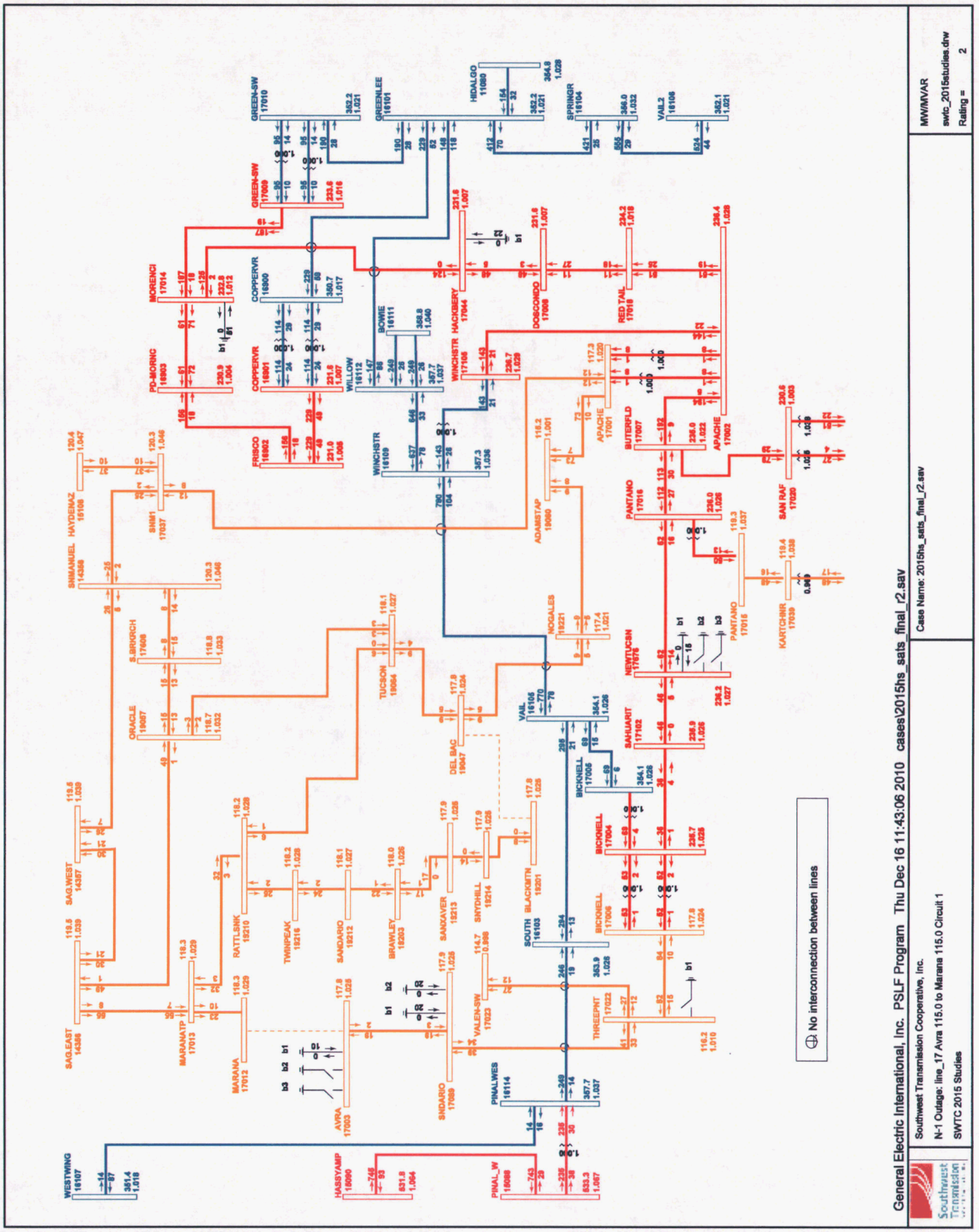
2015HS Southwest Transmission Cooperative Base System with Sahuarita to Bicknell 230 kV Line out of service



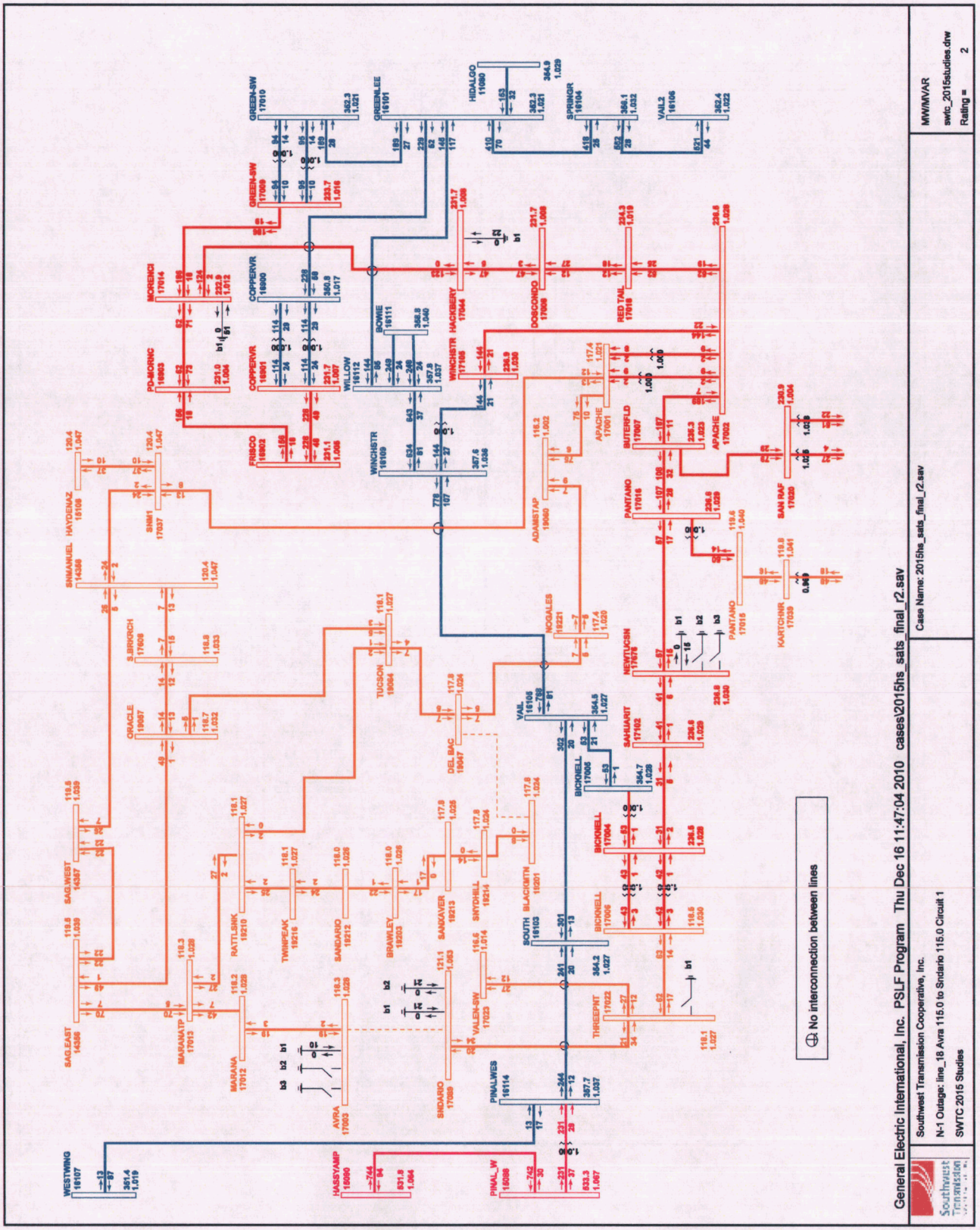
2015HS Southwest Transmission Cooperative Base System with Apache to SNM1 115 kV Line out of service



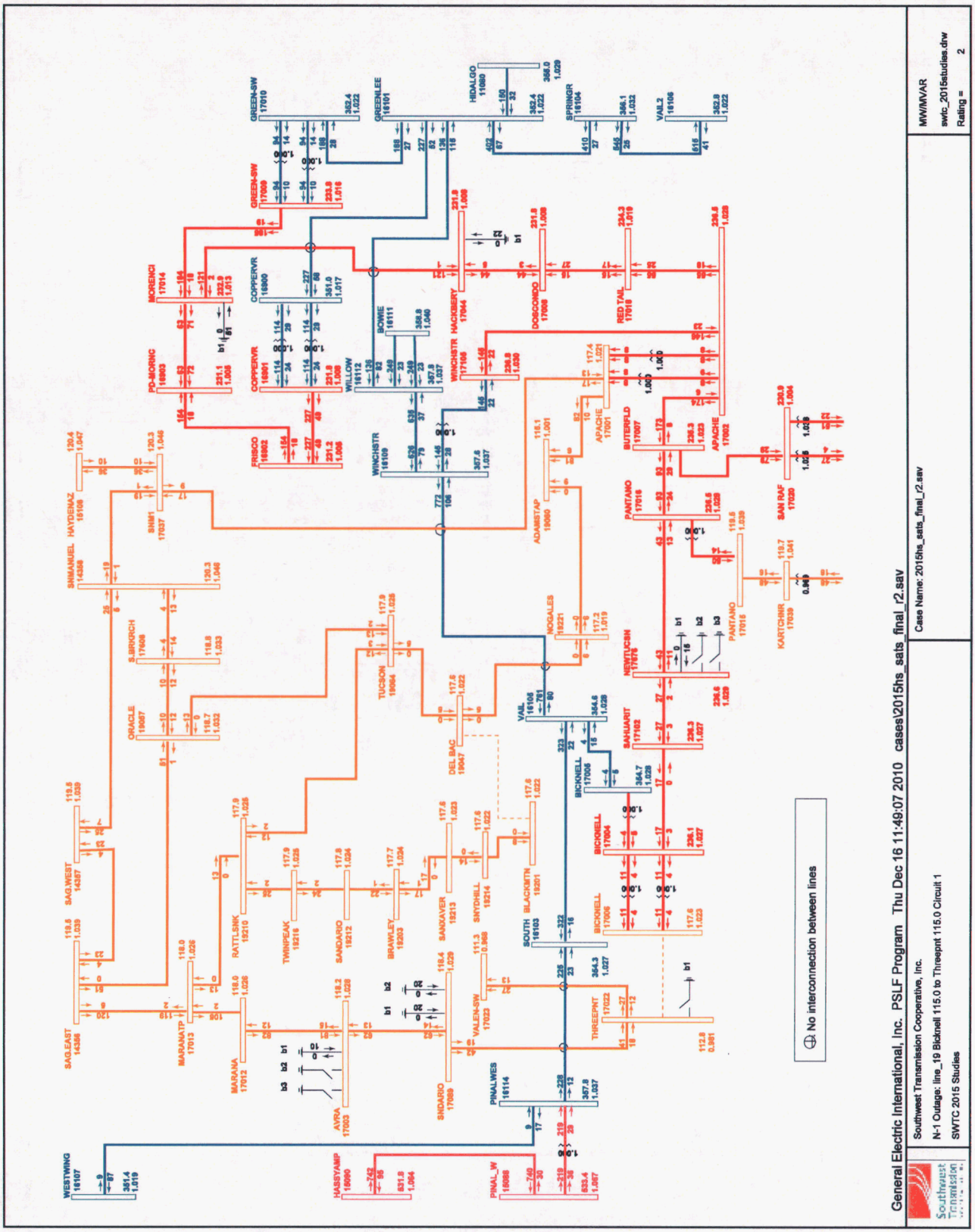
2015HS Southwest Transmission Cooperative Base System with Avra Valley to Marana 115 kV Line out of service



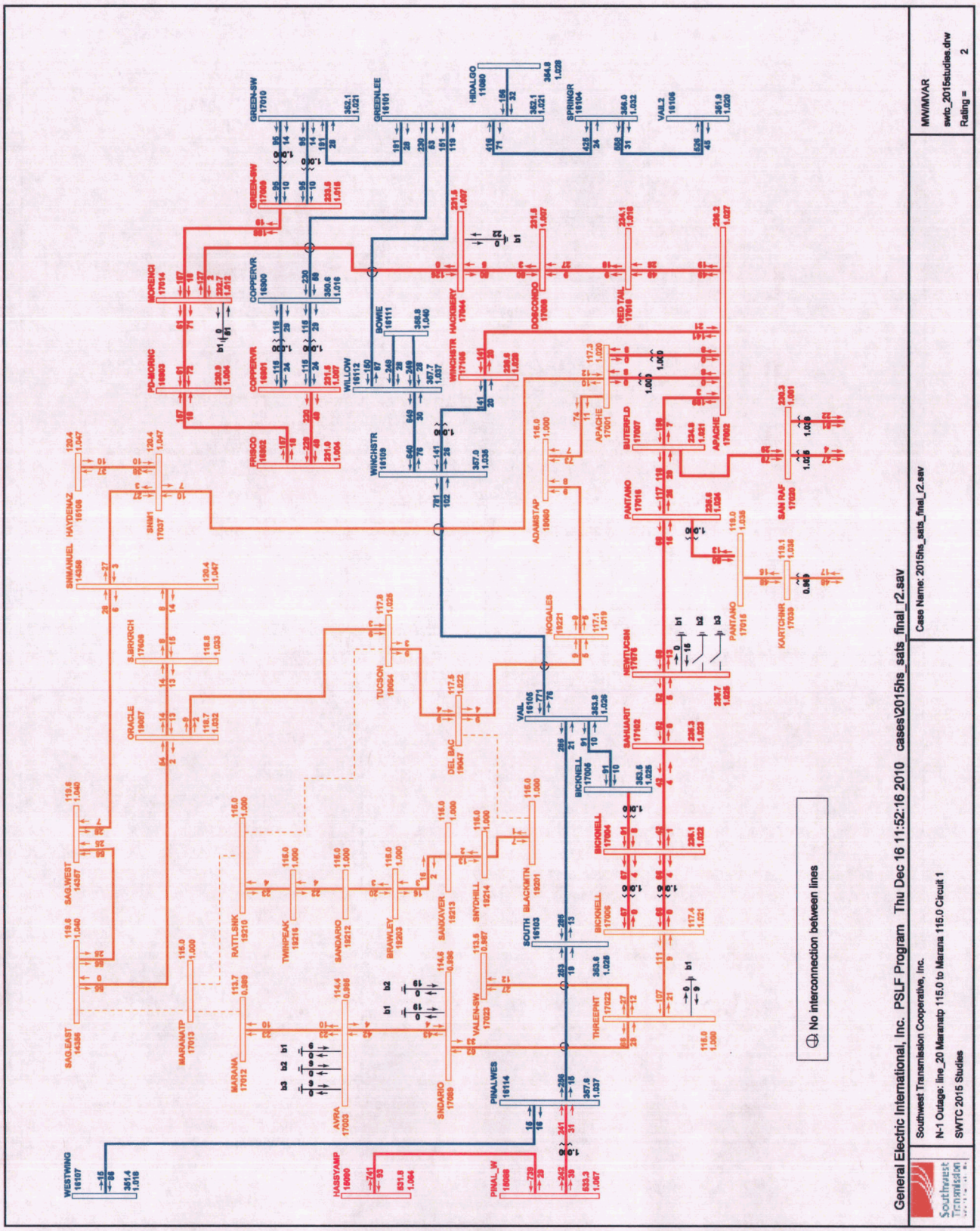
2015HS Southwest Transmission Cooperative Base System with Avra to Sandario 115 kV Line out of service



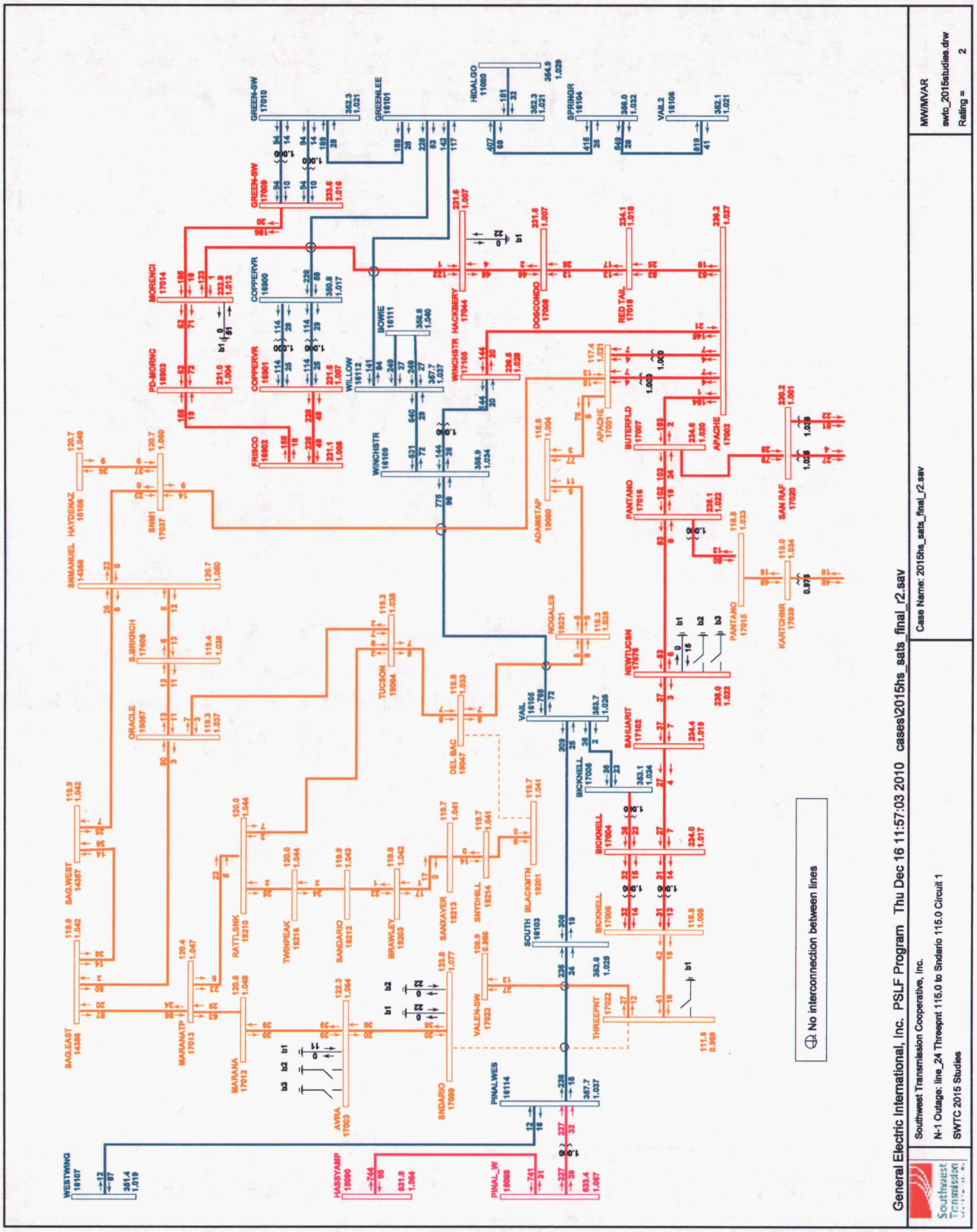
2015HS Southwest Transmission Cooperative Base System with Bicknell to Three Points 115 kV Line out of service



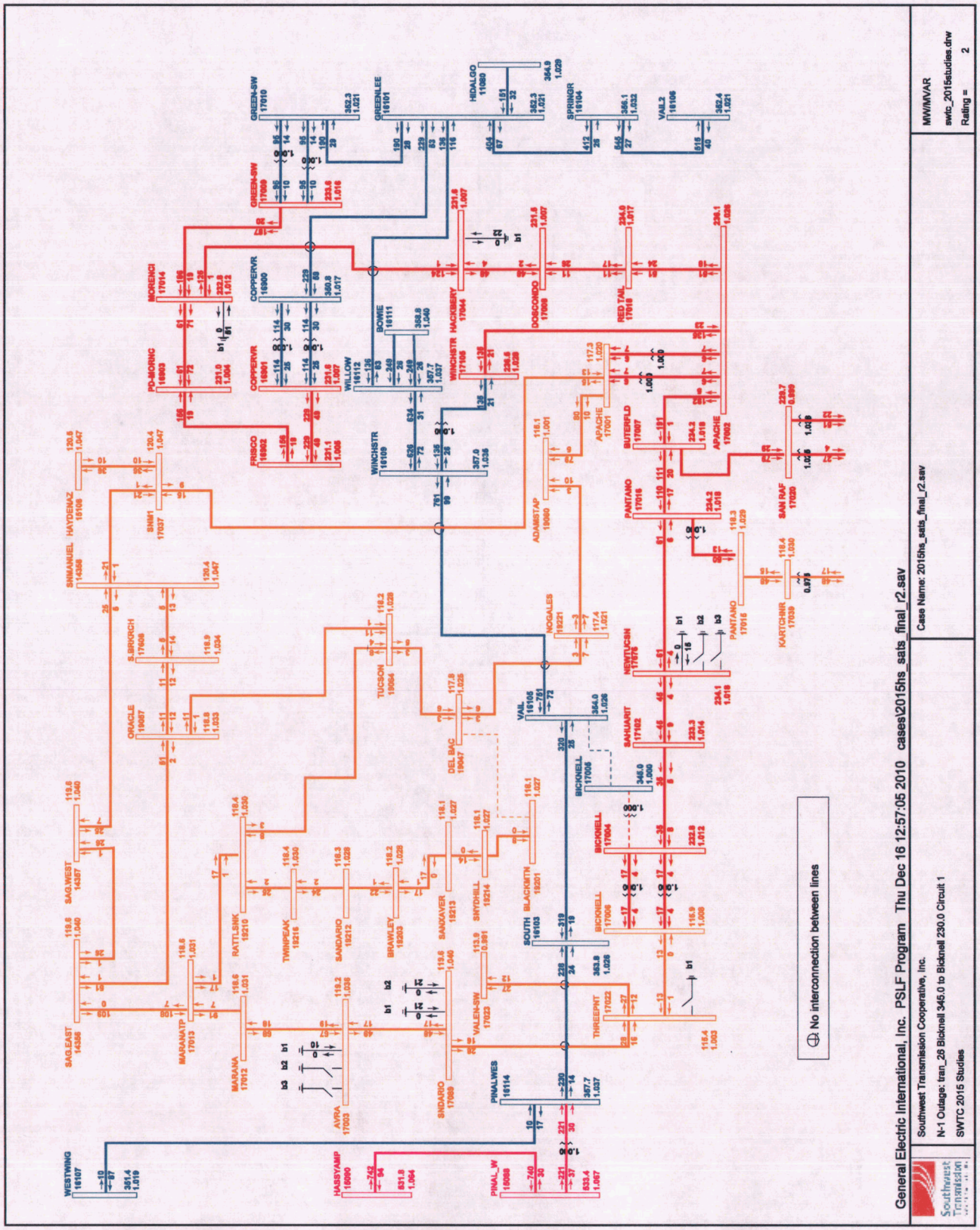
2015HS Southwest Transmission Cooperative Base System with Marana Tap to Marana 115 kV Line out of service



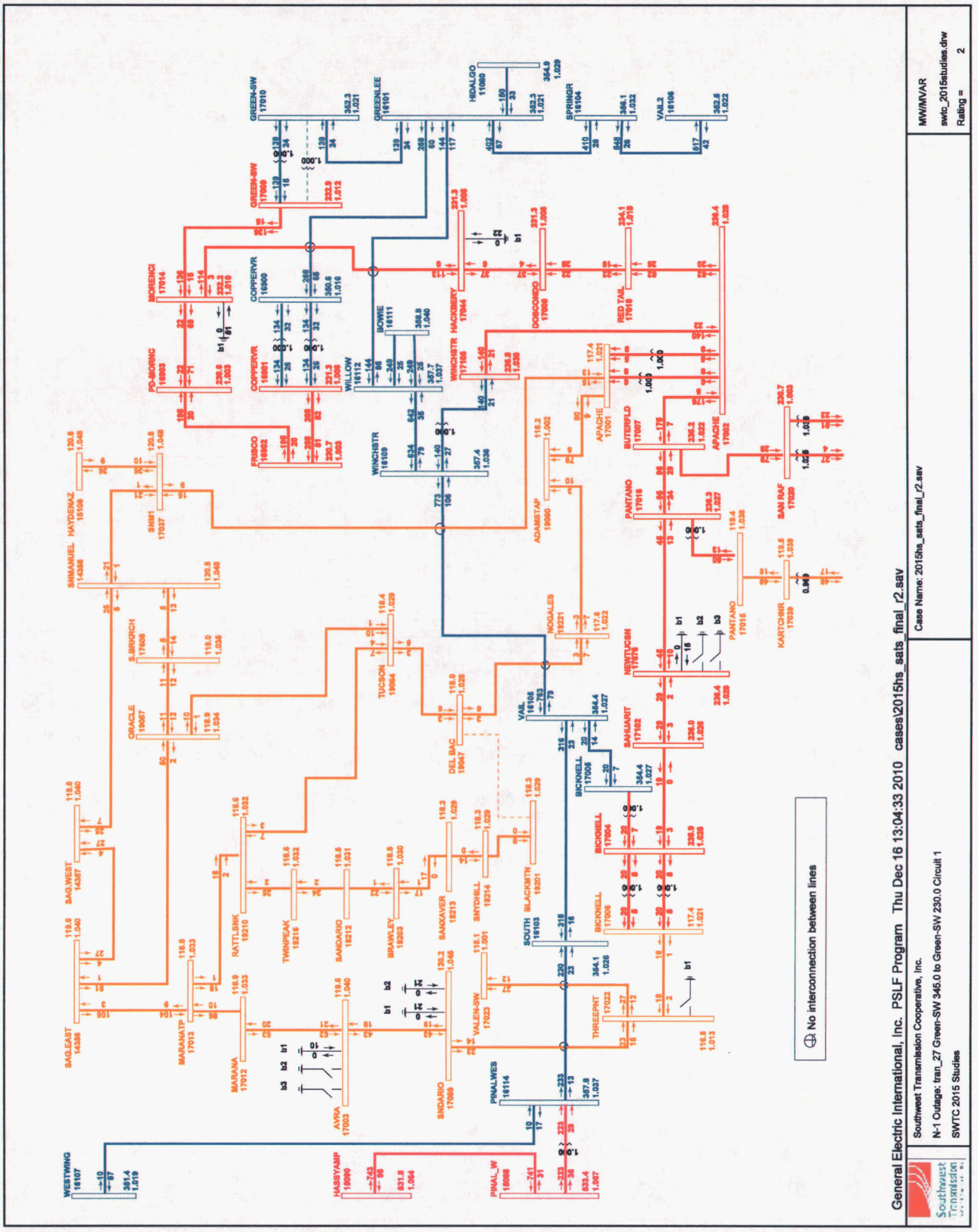
2015HS Southwest Transmission Cooperative Base System with Three Points to Sandario 115 kV Line out of service



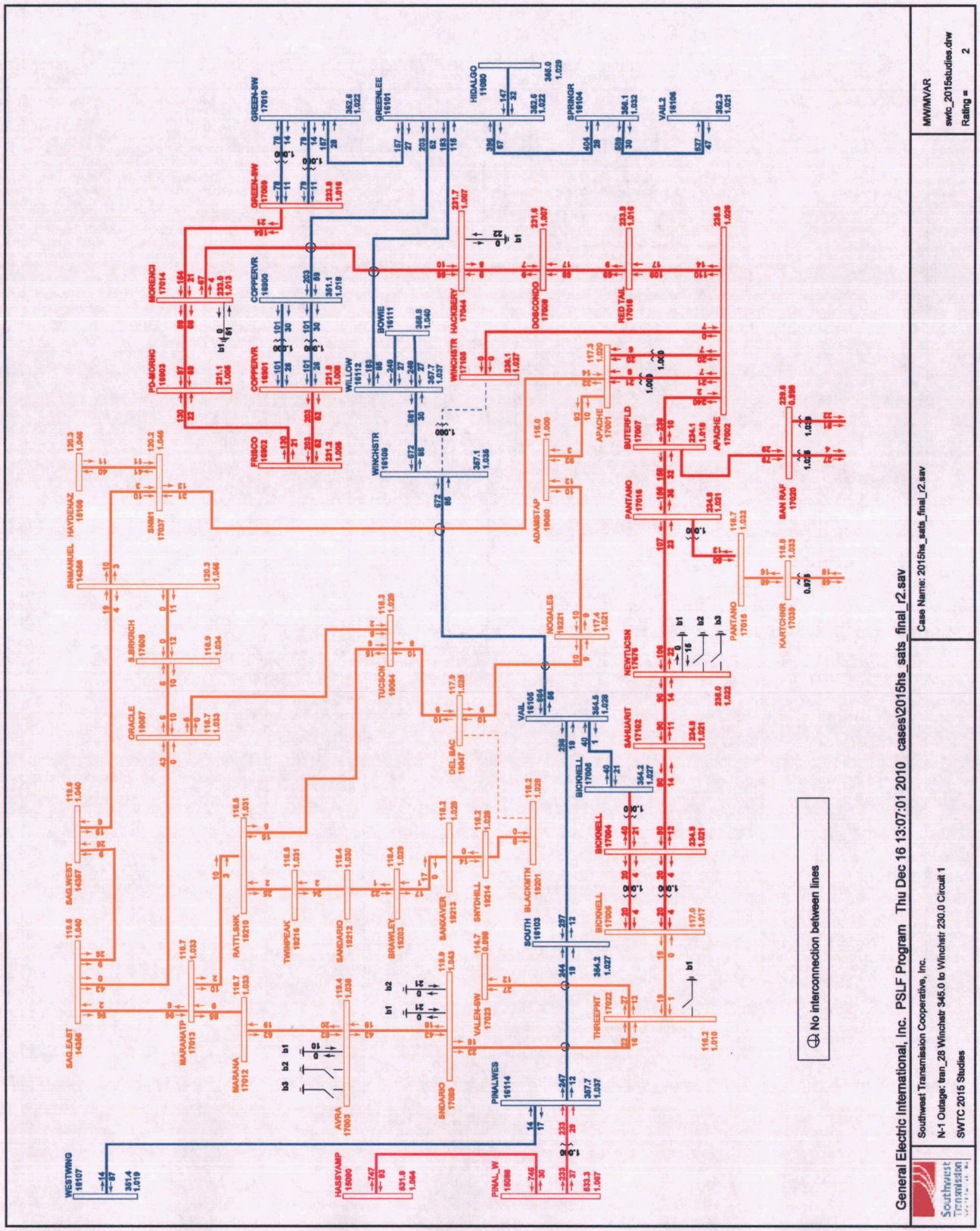
2015HS Southwest Transmission Cooperative Base System with Bicknell 345/230 kV Transformer out of service



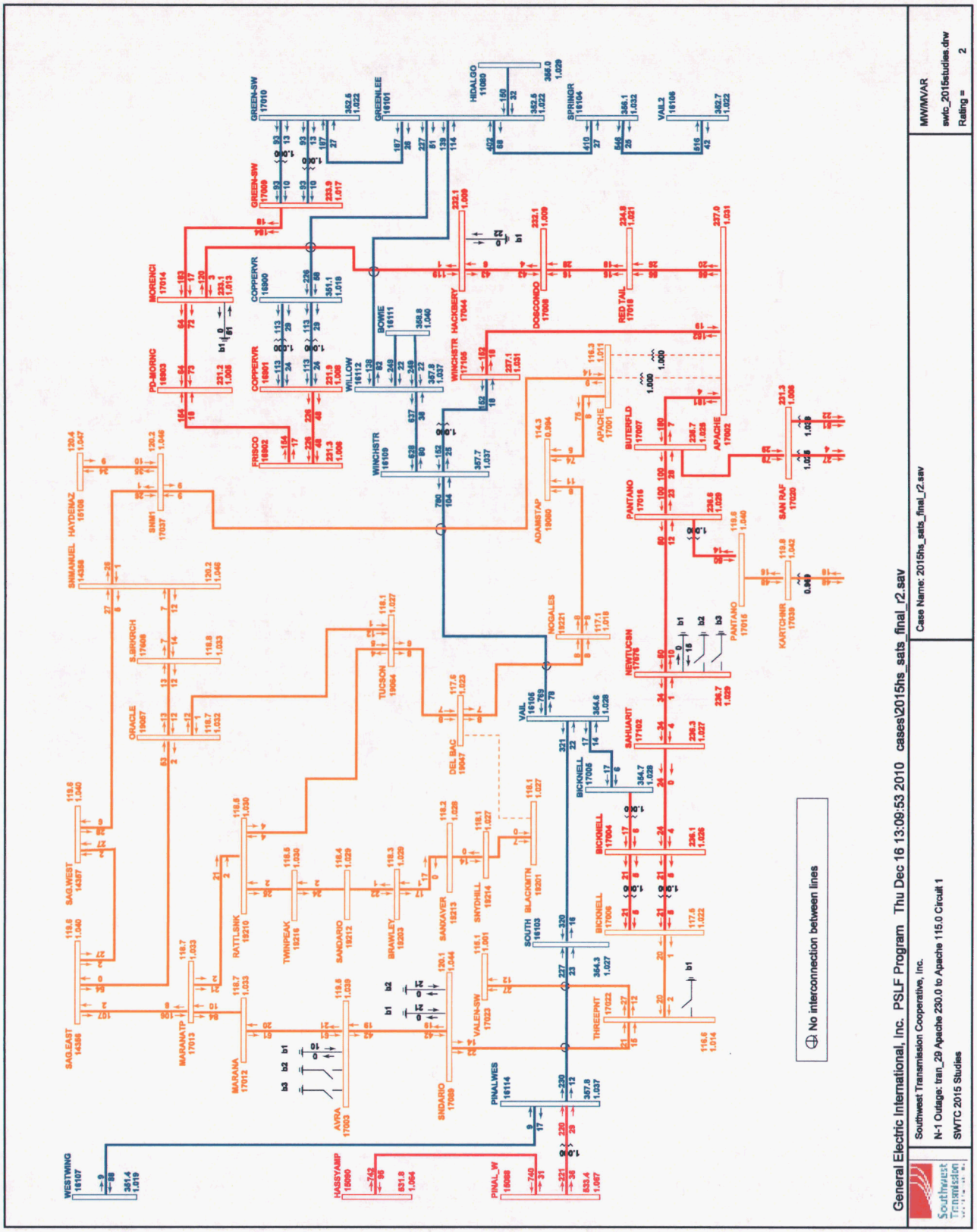
2015HS Southwest Transmission Cooperative Base System with one Greenlee 345/230 Transformer out of service



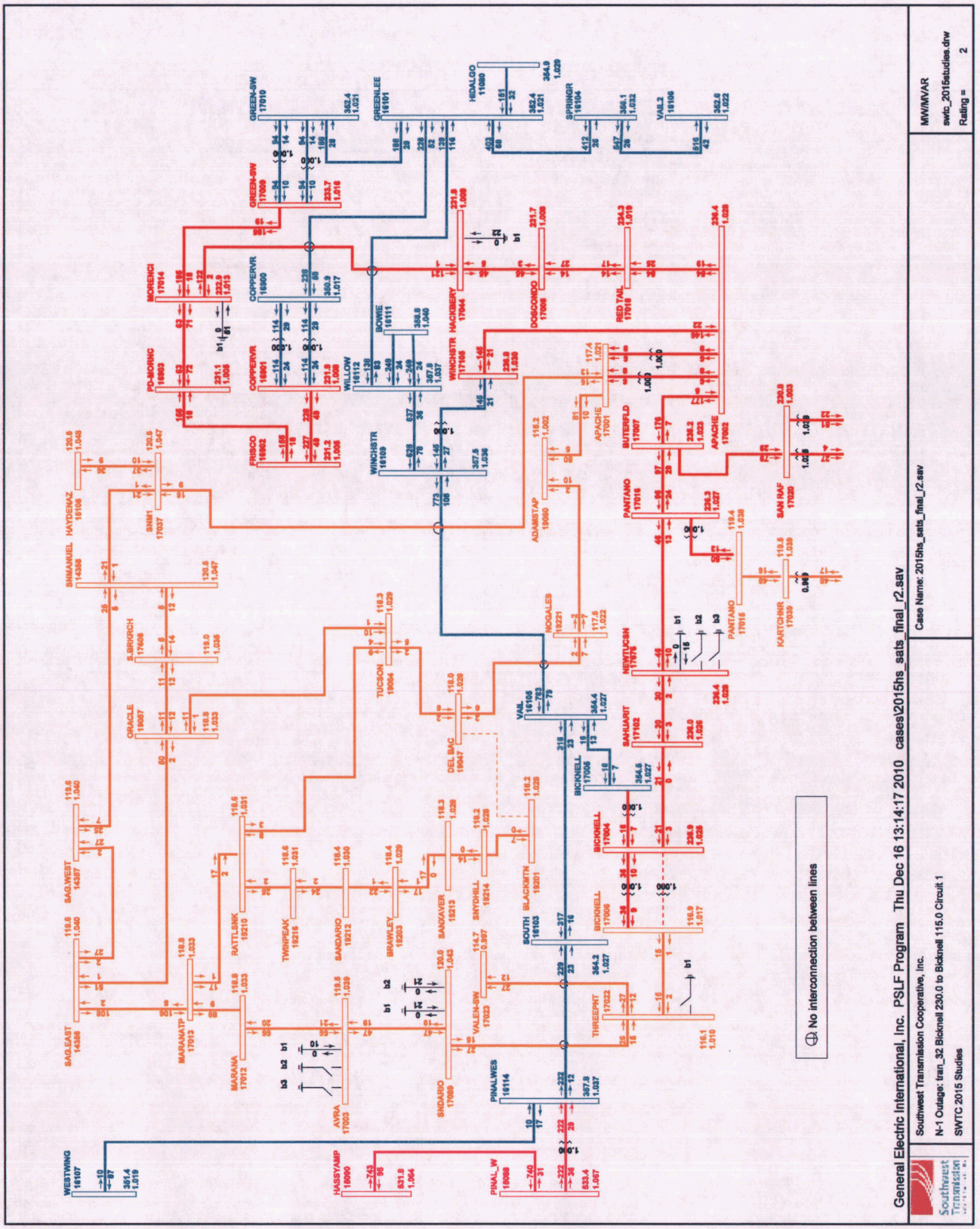
2015HS Southwest Transmission Cooperative Base System with Winchester 345/230 kV Transformer out of service



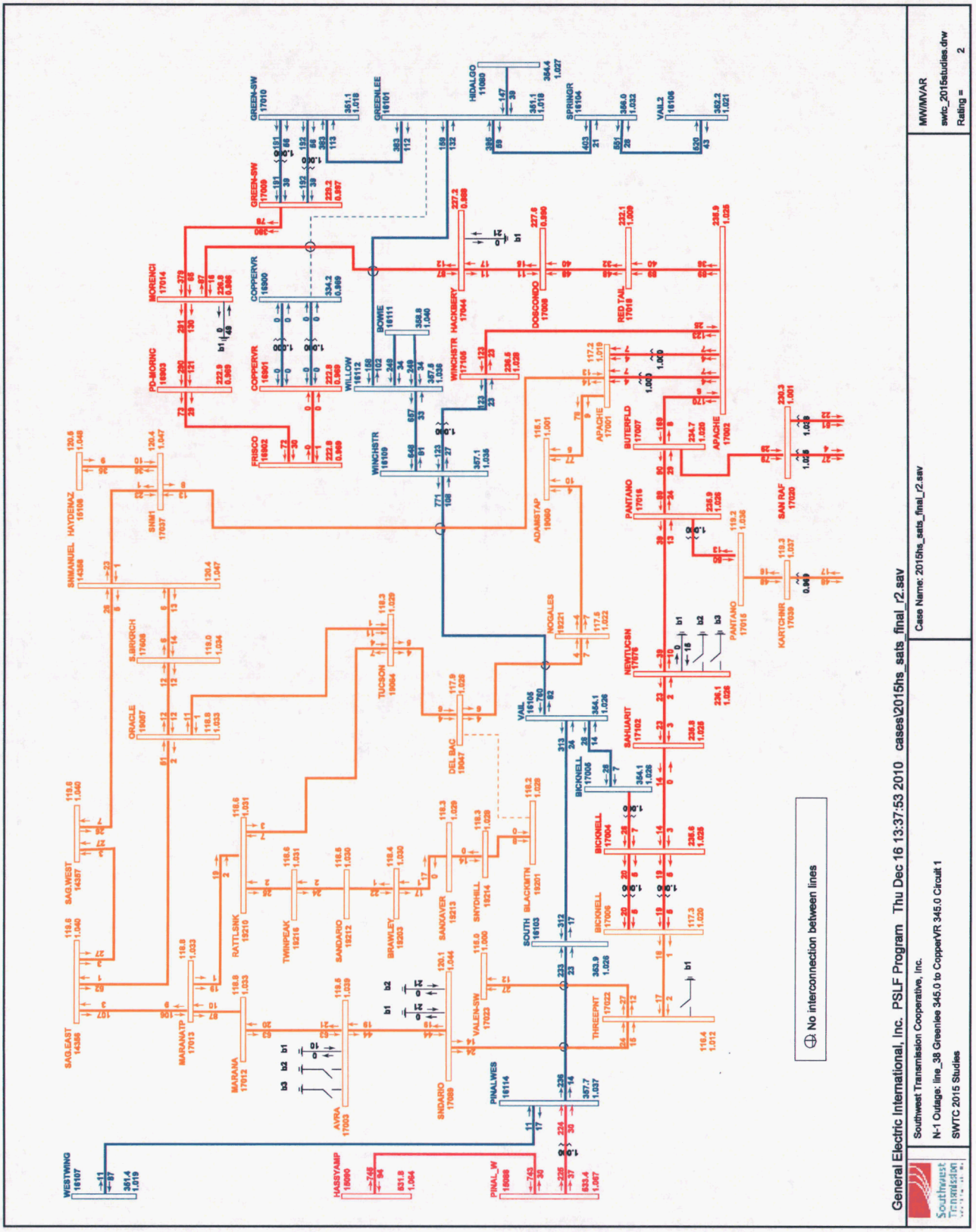
2015HS Southwest Transmission Cooperative Base System with one Apache 230/115 kV Transformer out of service



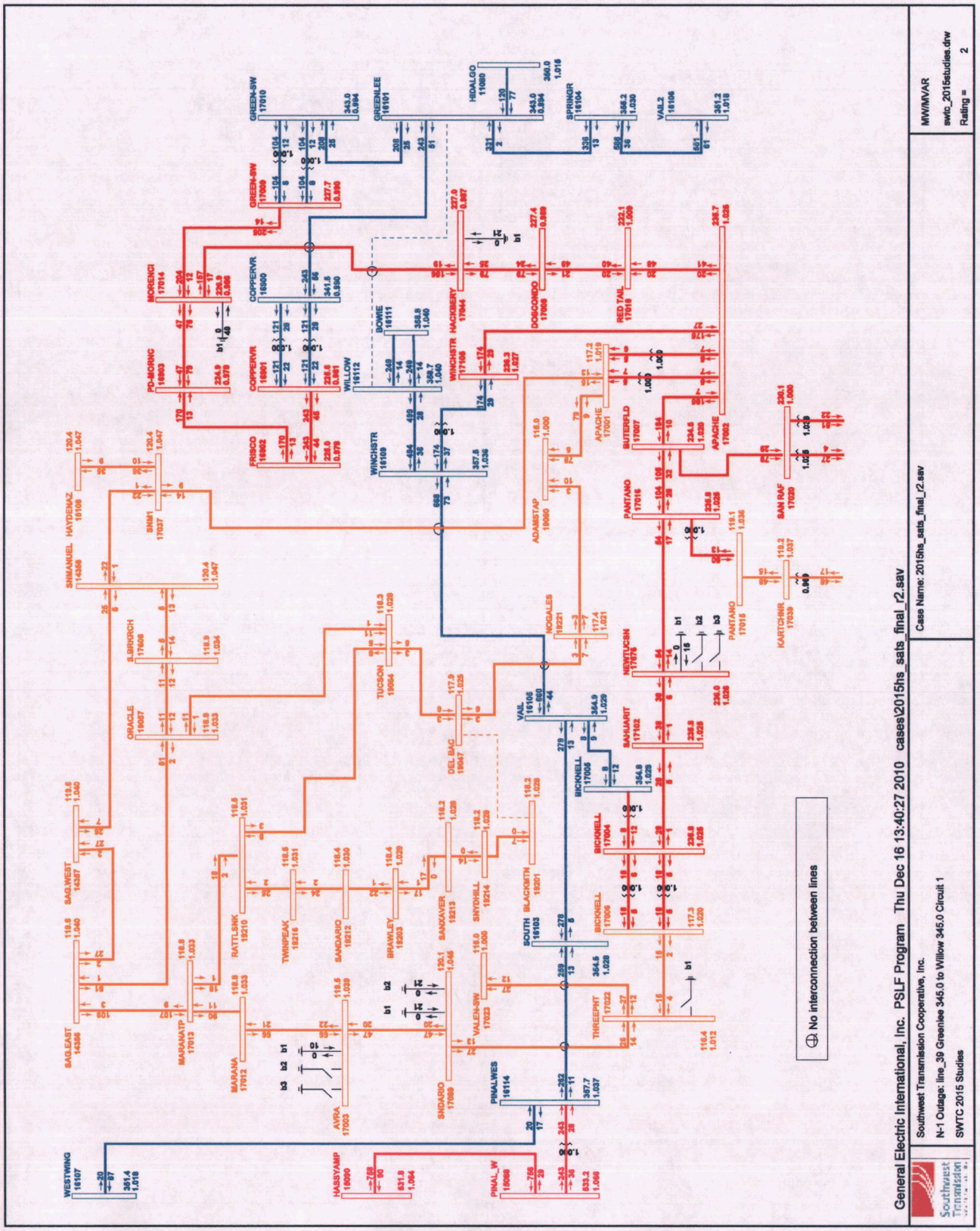
2015HS Southwest Transmission Cooperative Base System with one Bicknell 230/115 kV Transformer out of service



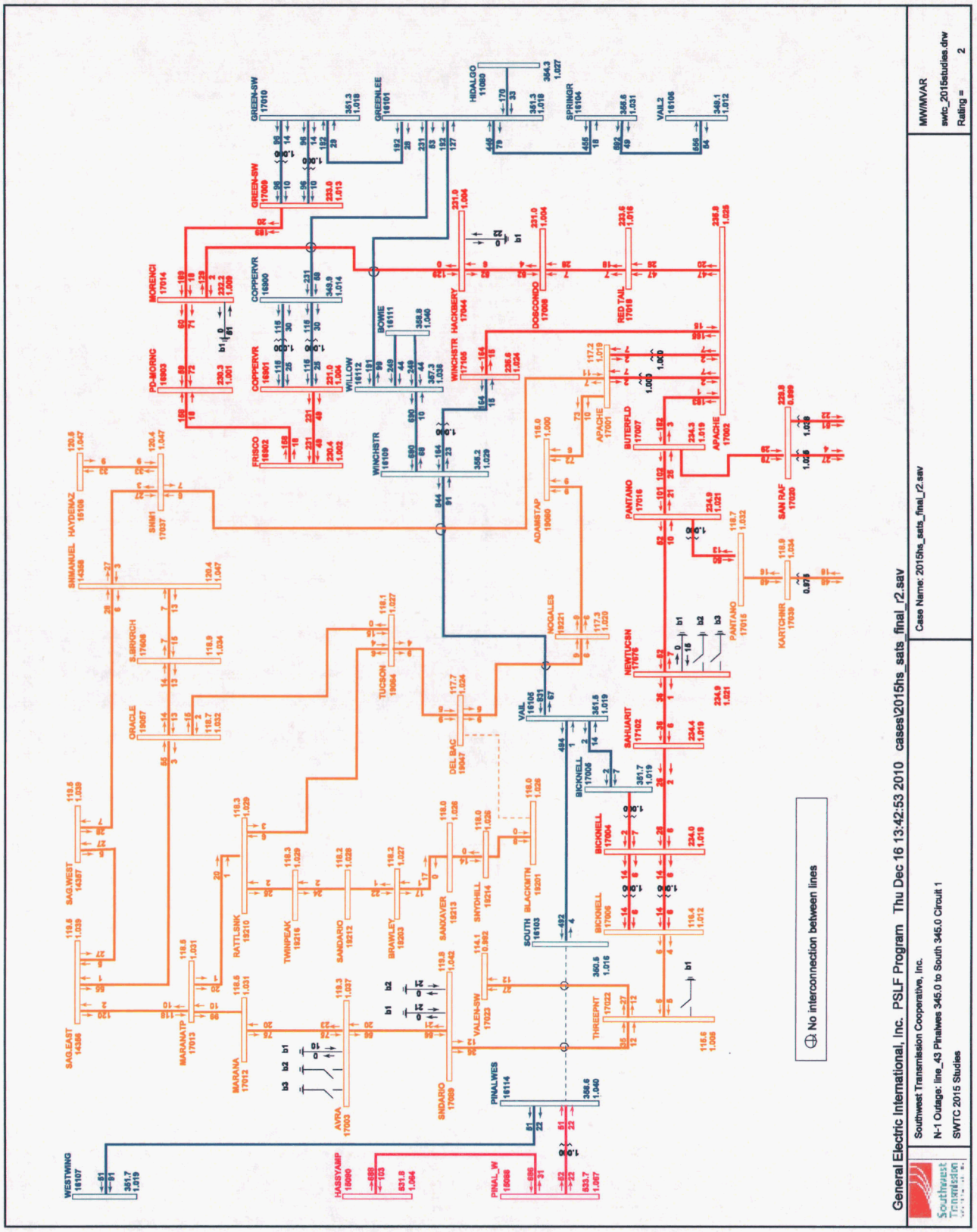
2015HS Southwest Transmission Cooperative Base System with Greenlee to Copper Verde 345 kV Line out of service



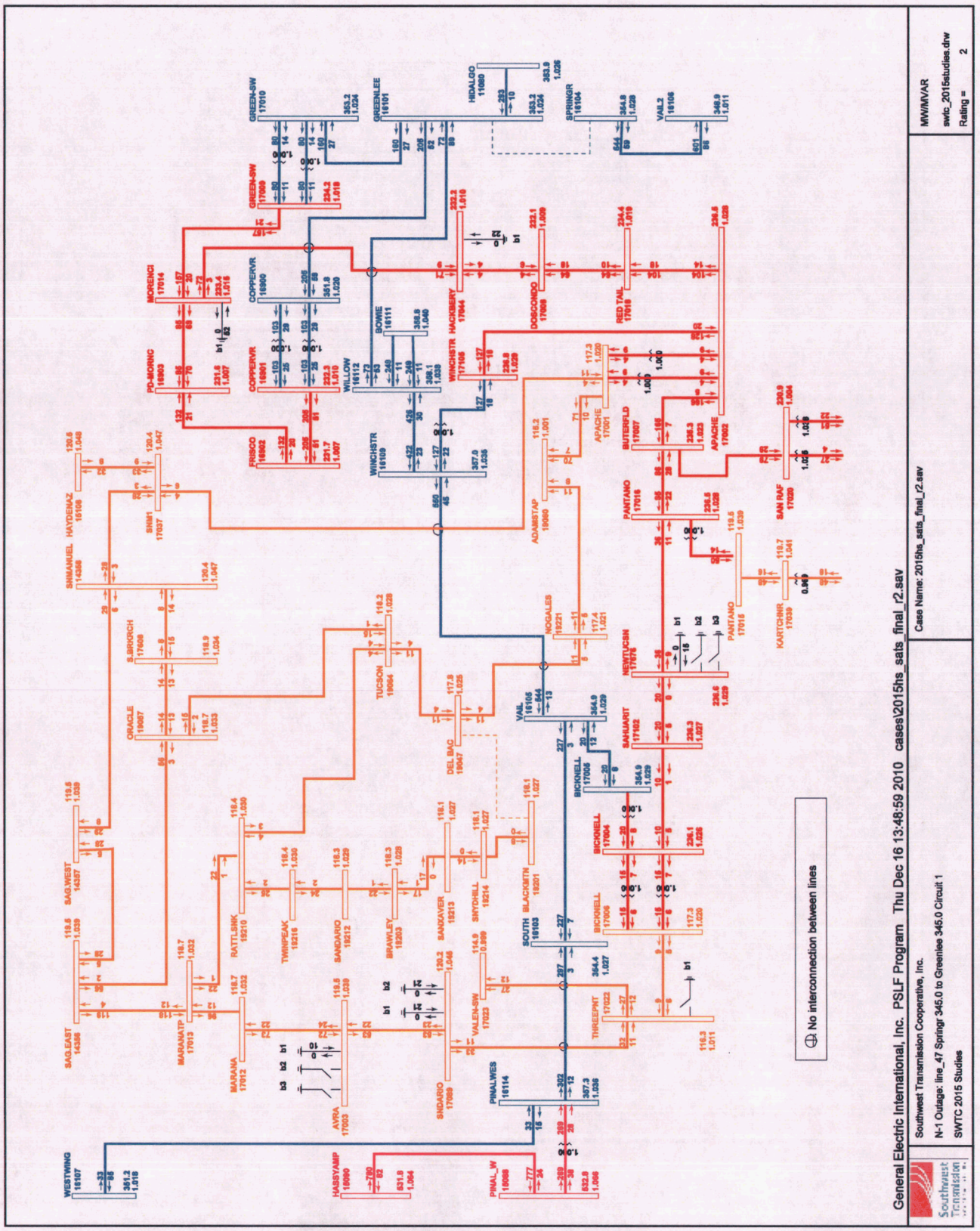
2015HS Southwest Transmission Cooperative Base System with Greenlee to Willow 345 kV Line out of service



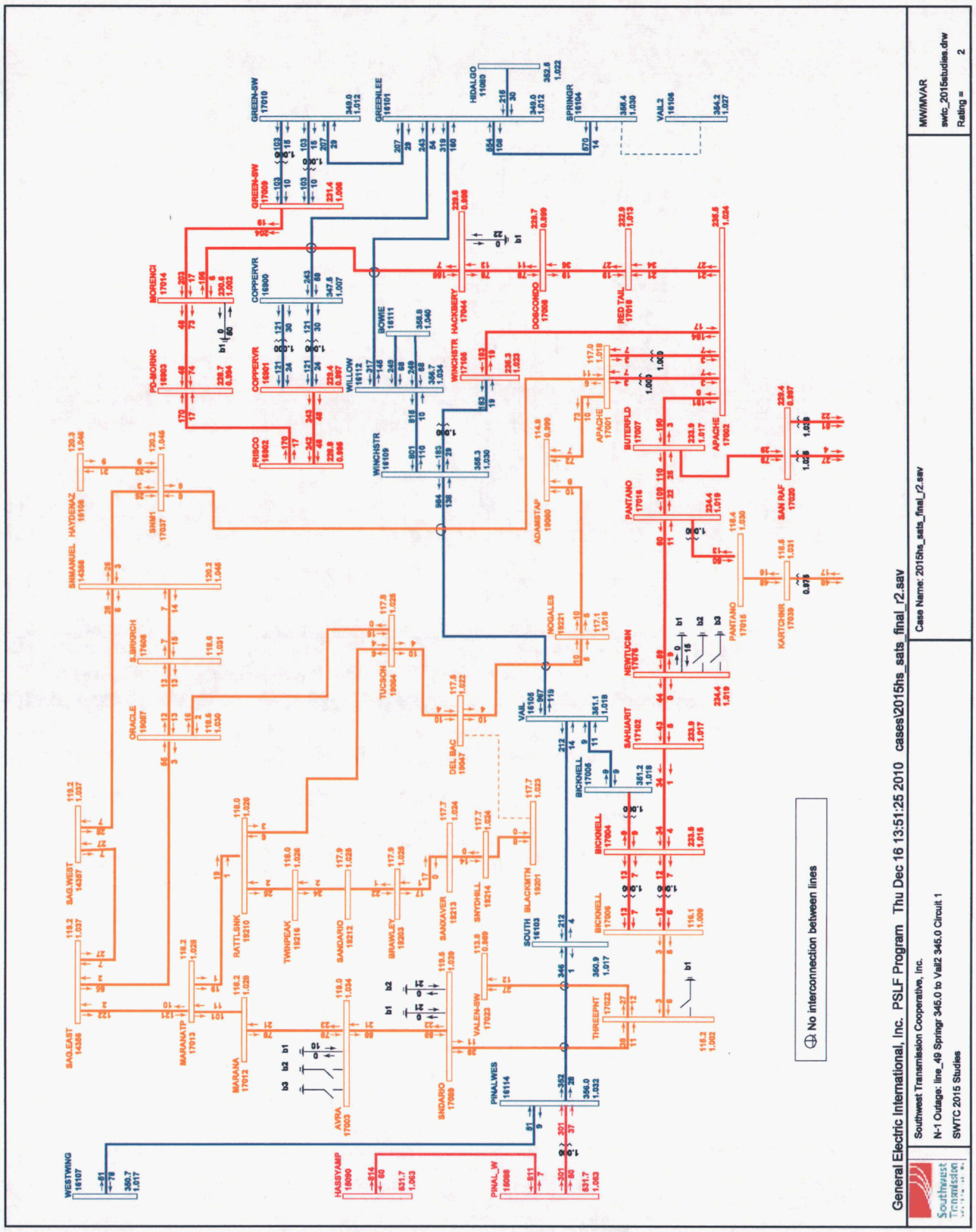
2015HS Southwest Transmission Cooperative Base System with Pinal West to South 345 kV Line out of service



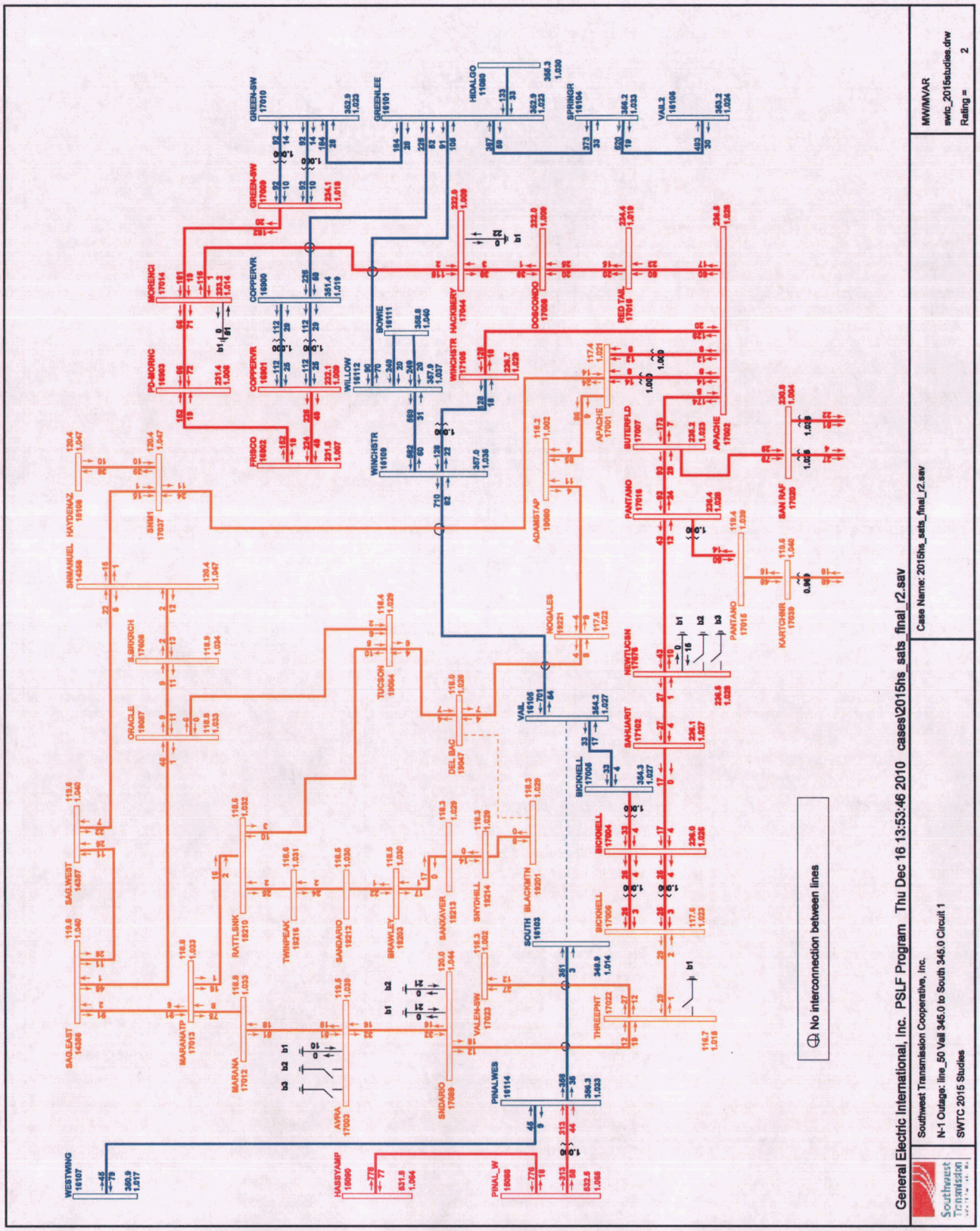
2015HS Southwest Transmission Cooperative Base System with Springerville to Greenlee 345 kV Line out of service



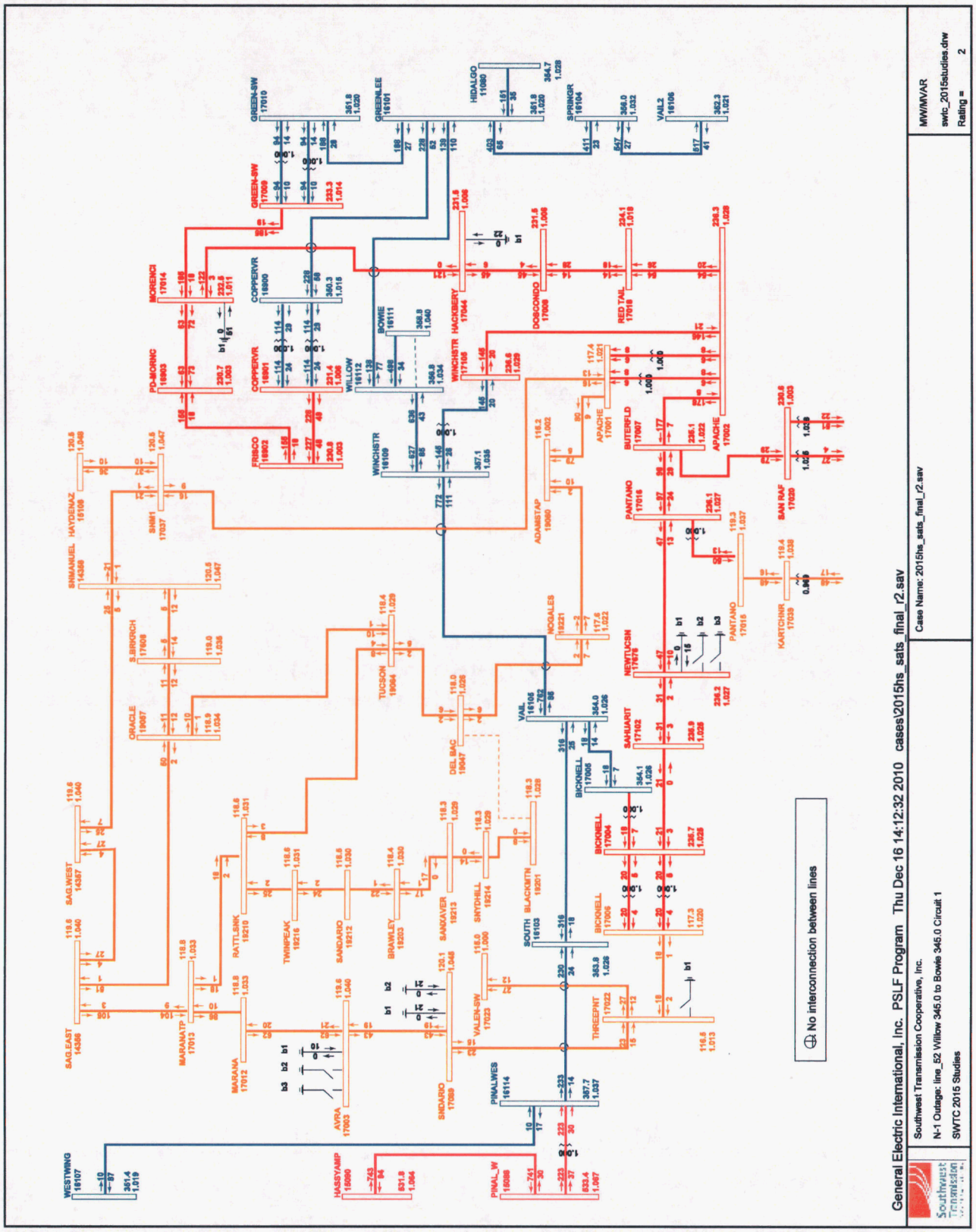
2015HS Southwest Transmission Cooperative Base System with Springerville to Vail2 345 kV Line out of service



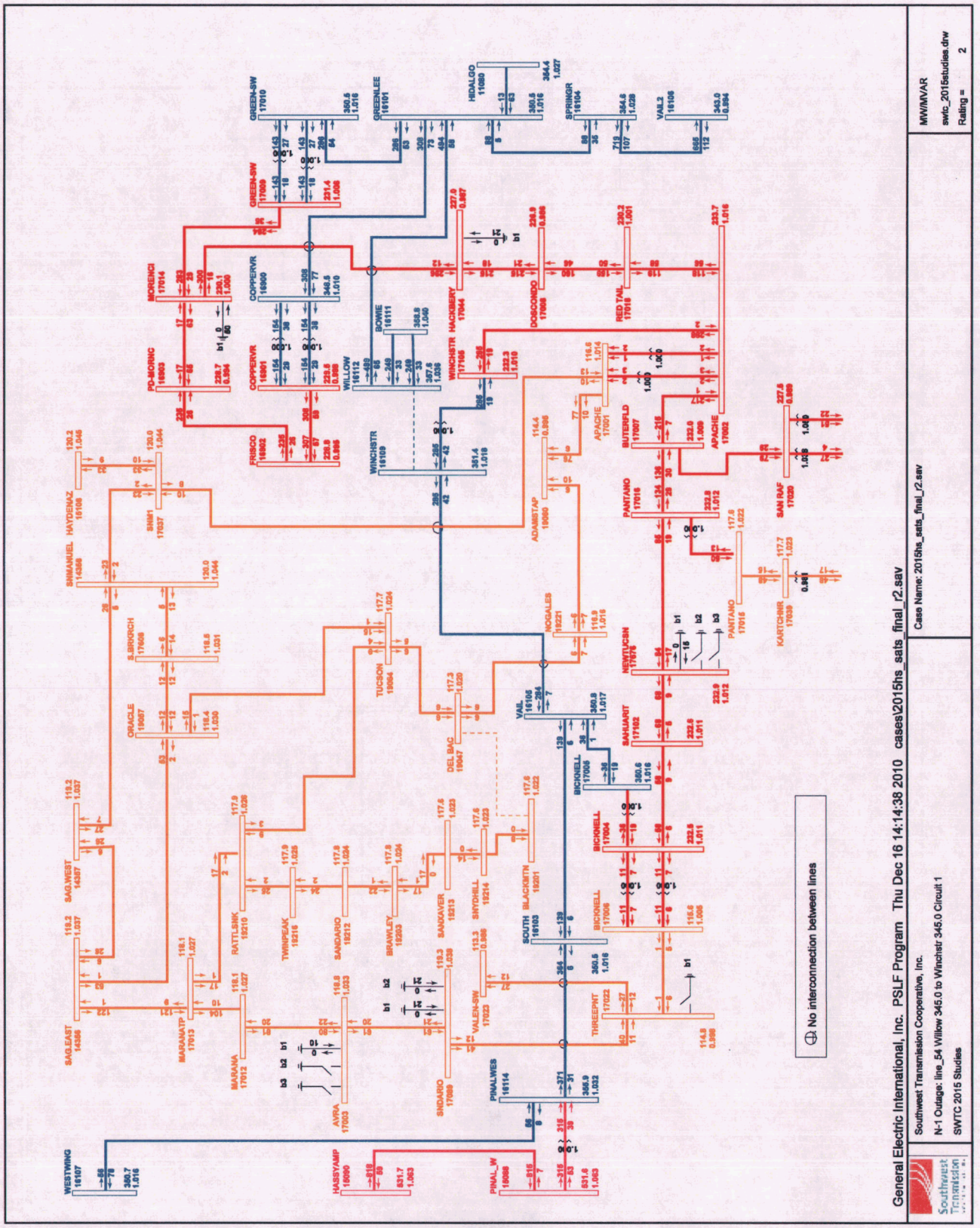
2015HS Southwest Transmission Cooperative Base System with Vail to South 345 kV Line out of service



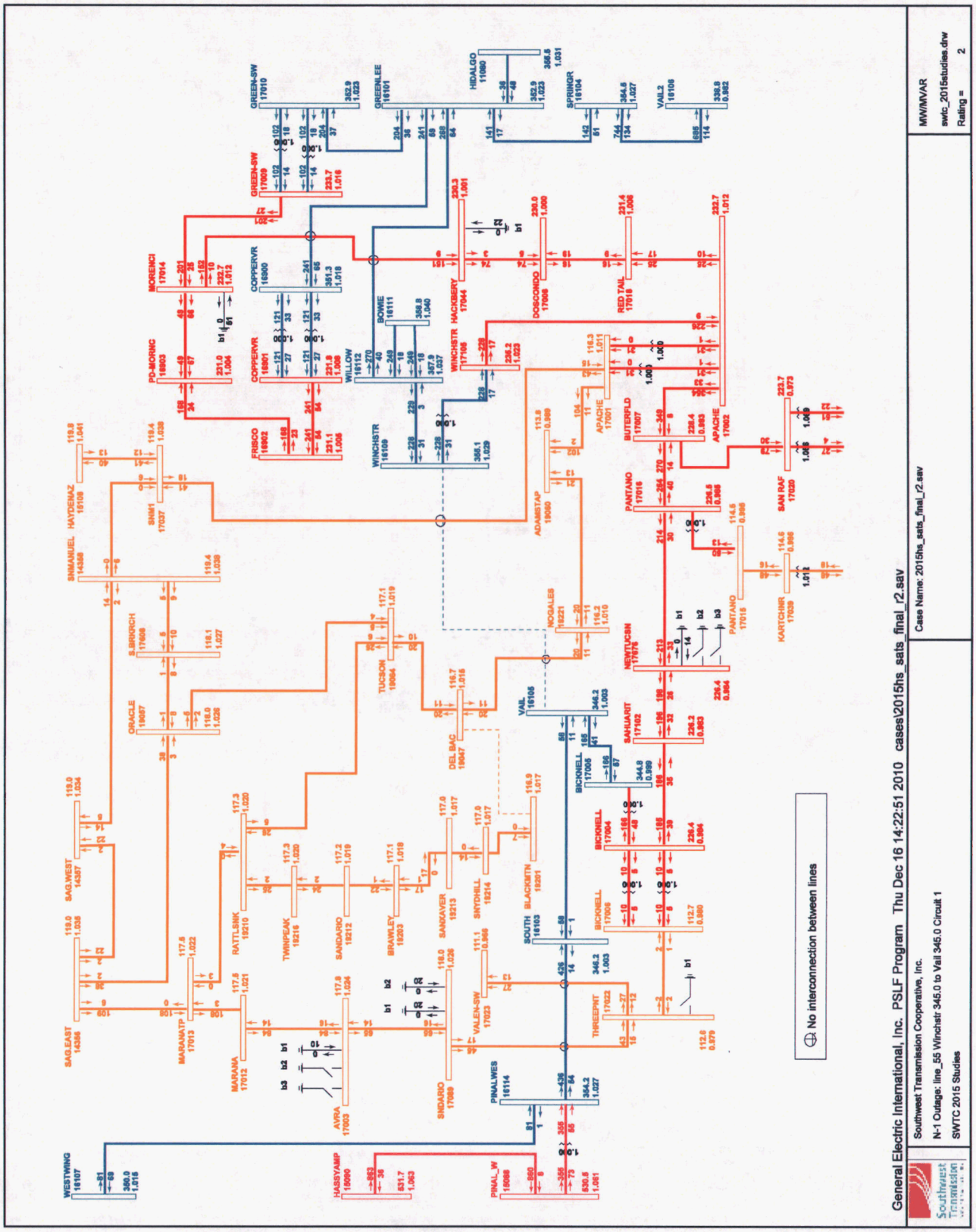
2015HS Southwest Transmission Cooperative Base System with one Willow to Bowie 345 kV Line out of service



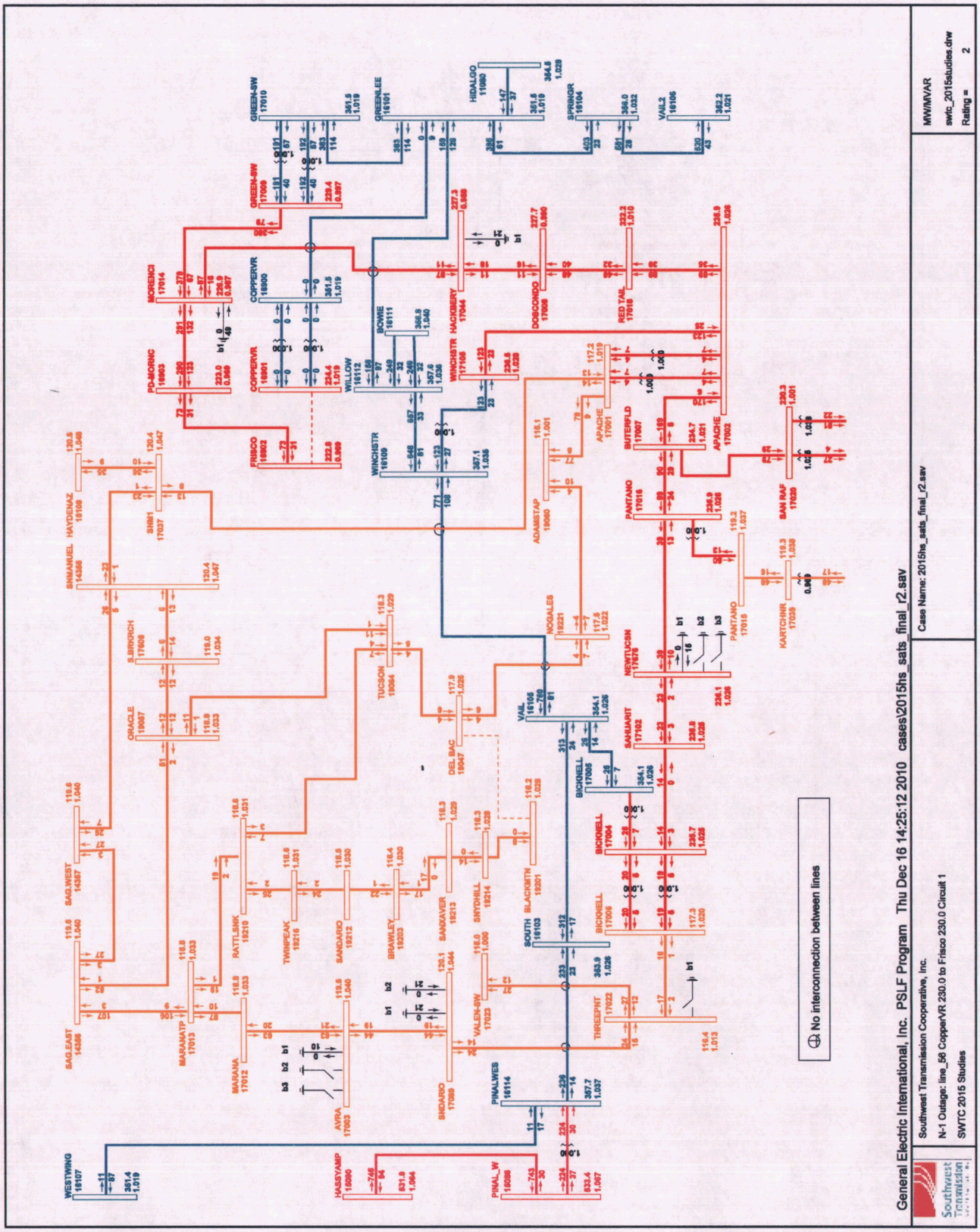
2015HS Southwest Transmission Cooperative Base System with Willow to Winchester 345 kV Line out of service



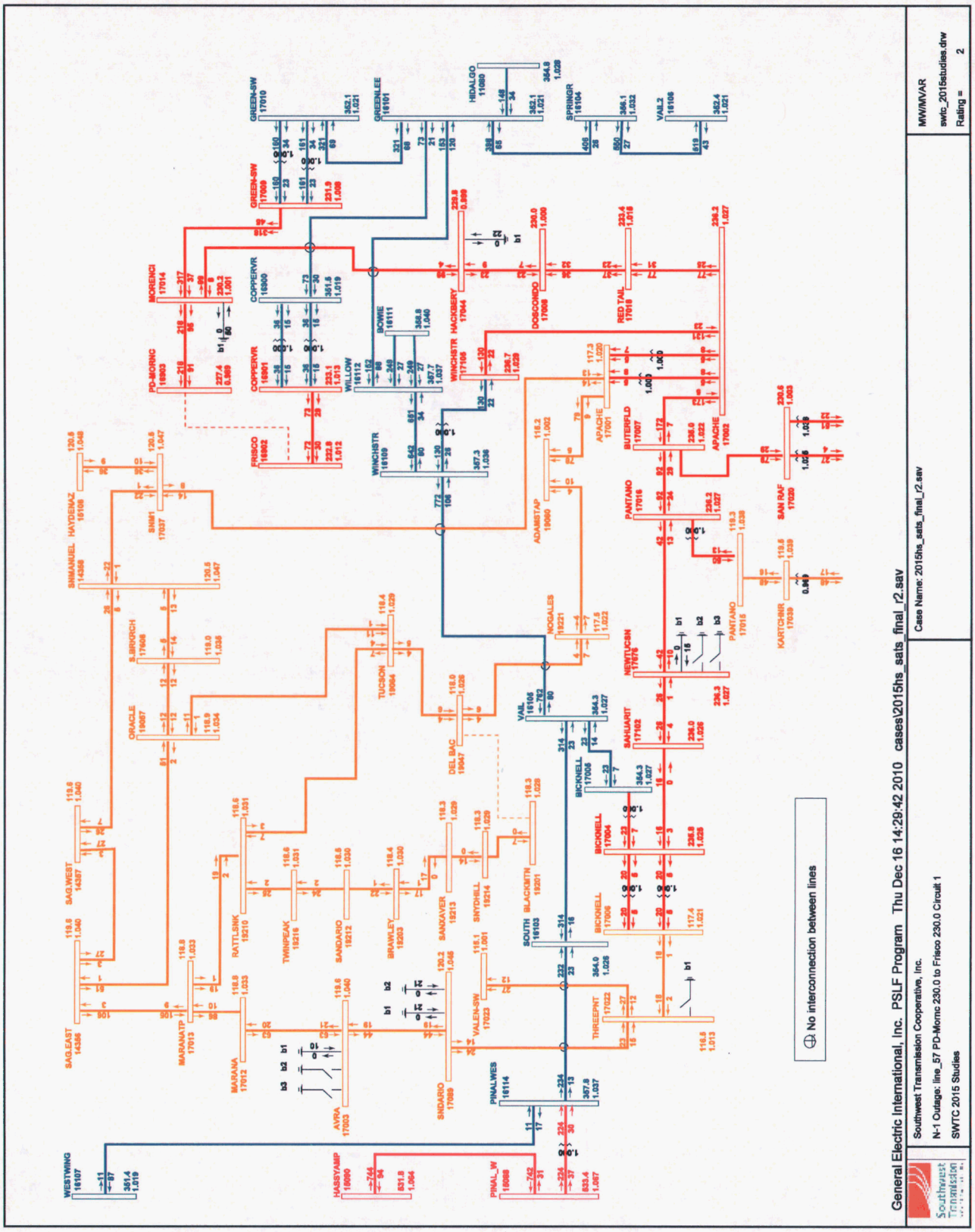
2015HS Southwest Transmission Cooperative Base System with Winchester to Vail 345 kV Line out of service



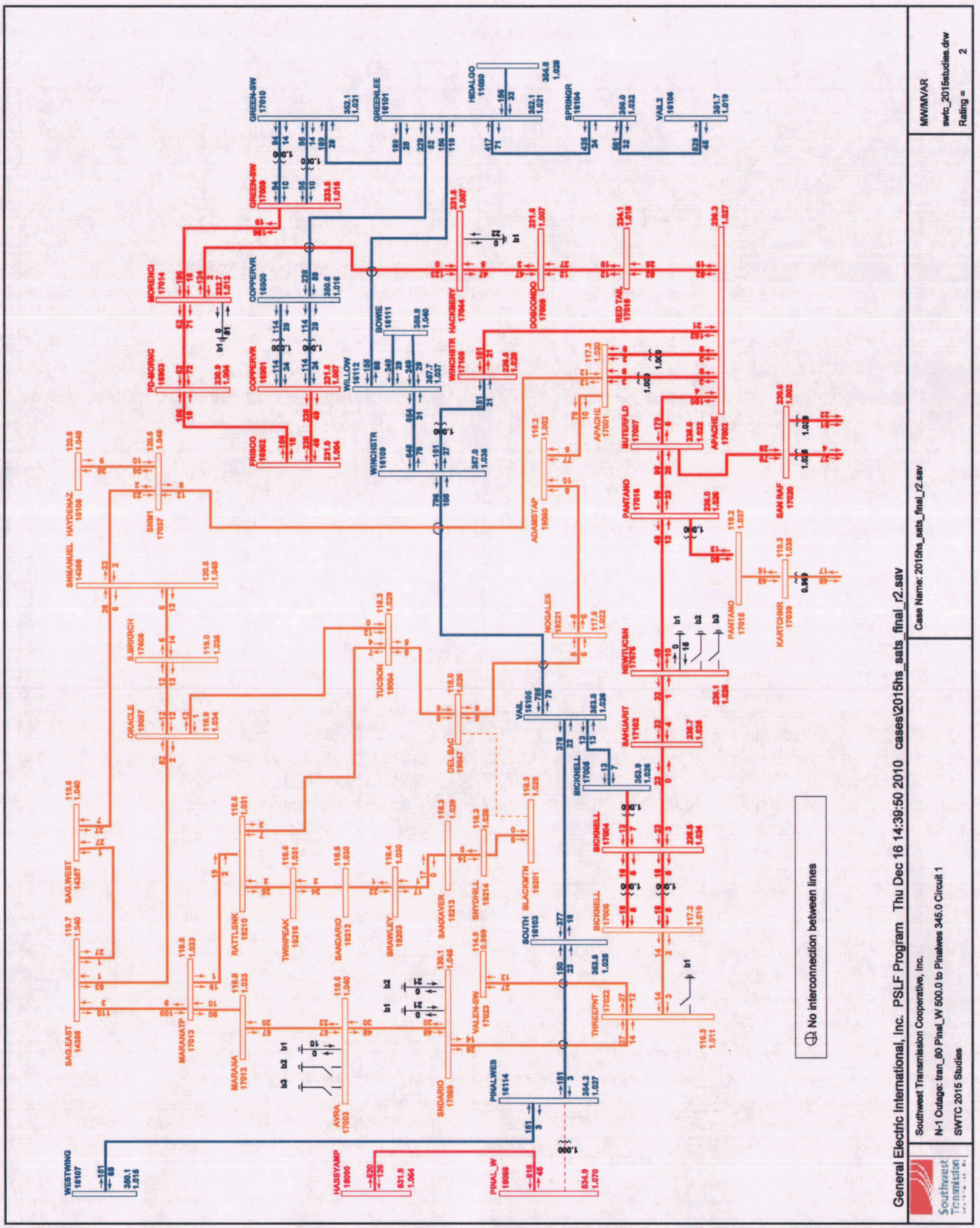
2015HS Southwest Transmission Cooperative Base System with Copper Verde to Frisco 230 kV Line out of service



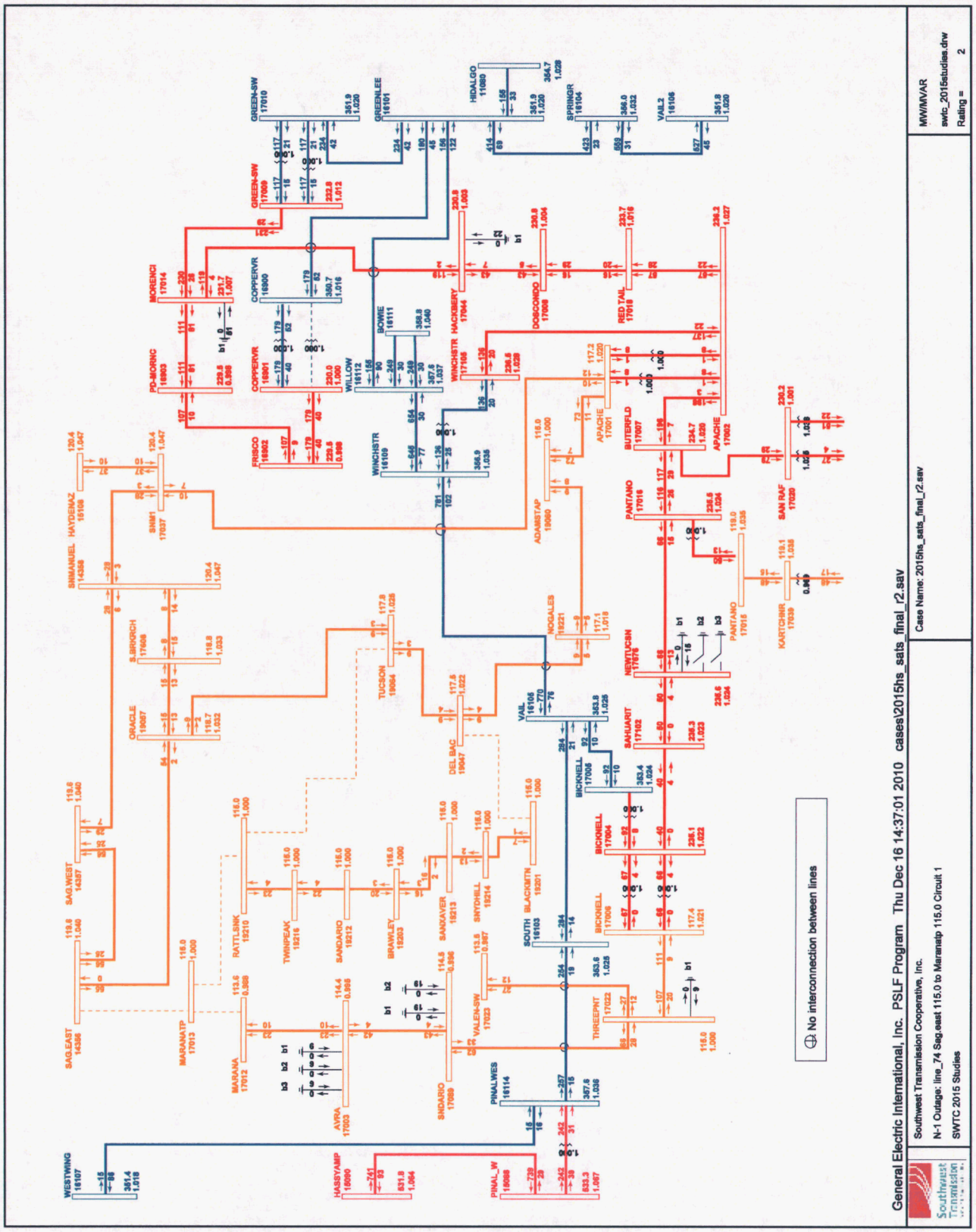
2015HS Southwest Transmission Cooperative Base System with PD Morenci to Frisco 230 kV Line out of service



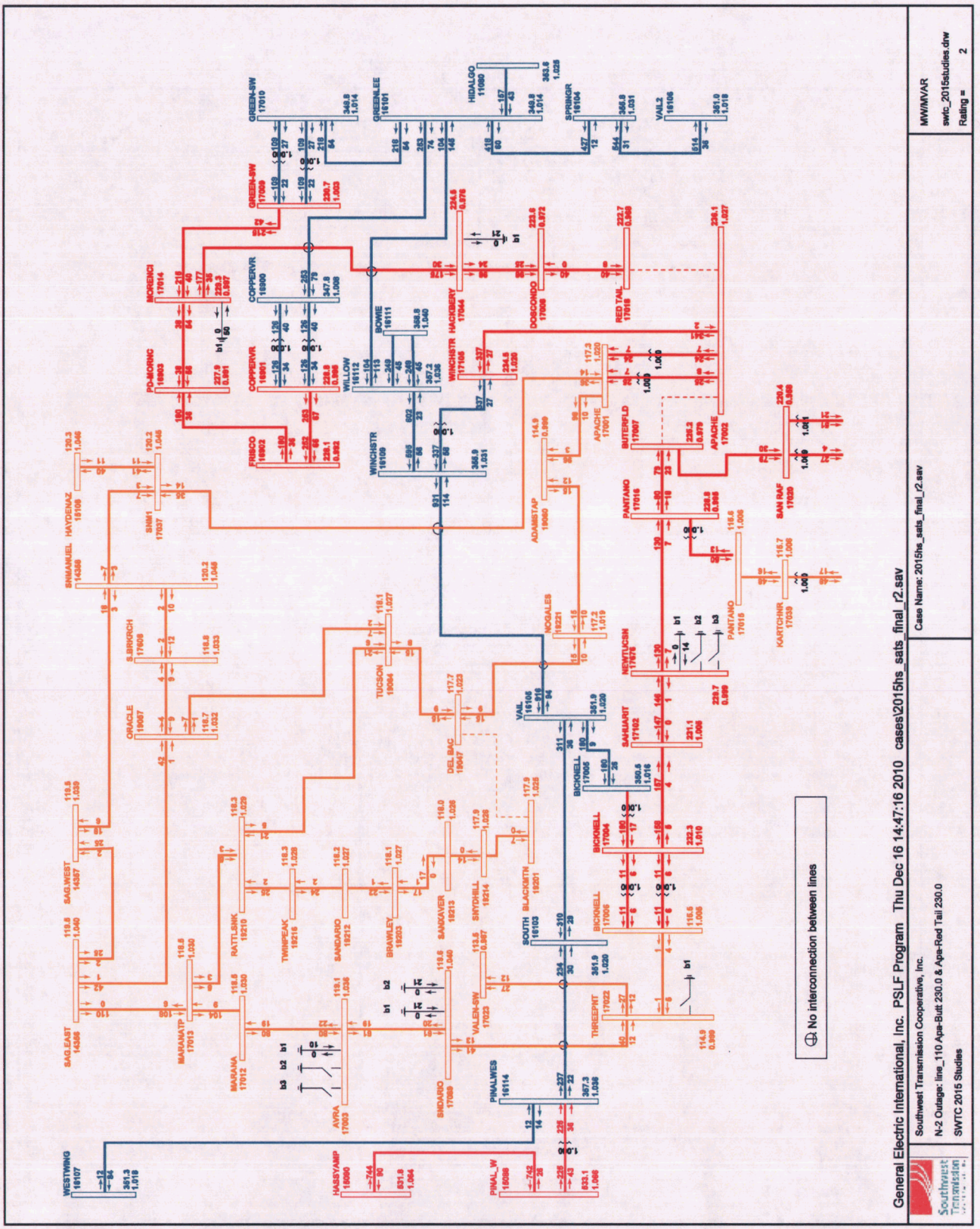
2015HS Southwest Transmission Cooperative Base System with Pinal West 500/345 kV Transformer out of service



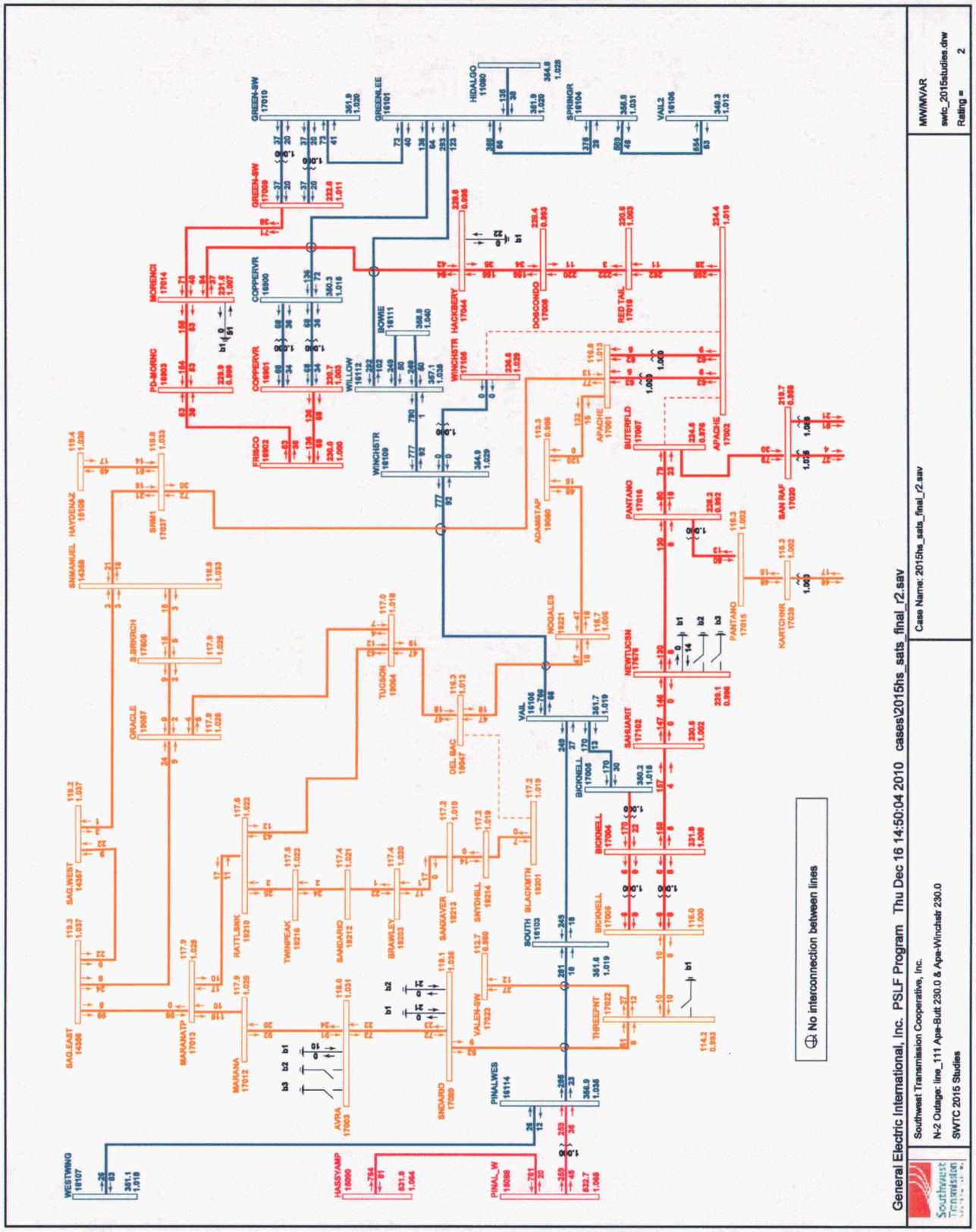
2015HS Southwest Transmission Cooperative Base System with Saguaro East to Marana Tap 115 kV Line out of service



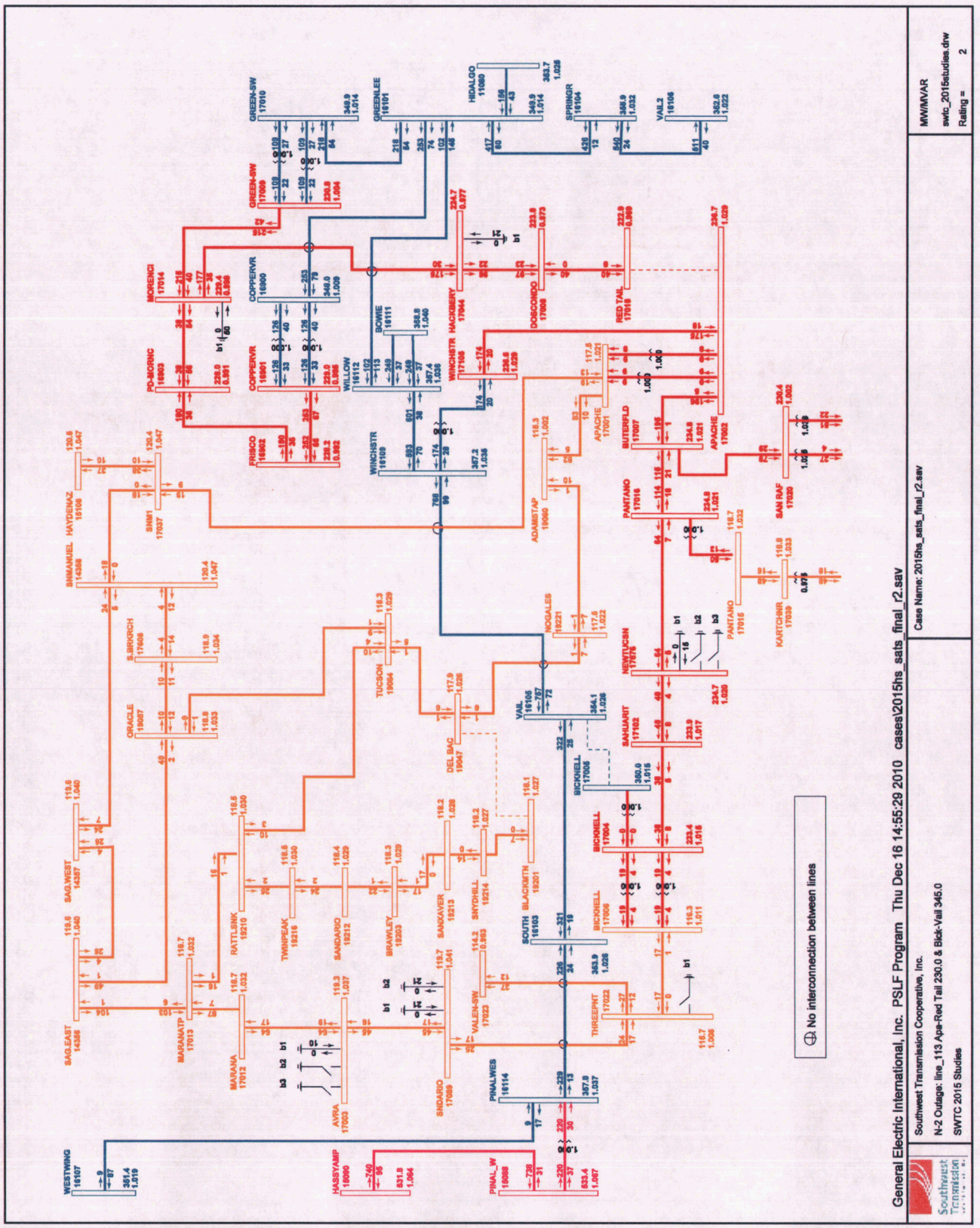
2015HS Southwest Transmission Cooperative Base System with Apache to Butterfield & Apache to Redtail 230 kV Lines out of service



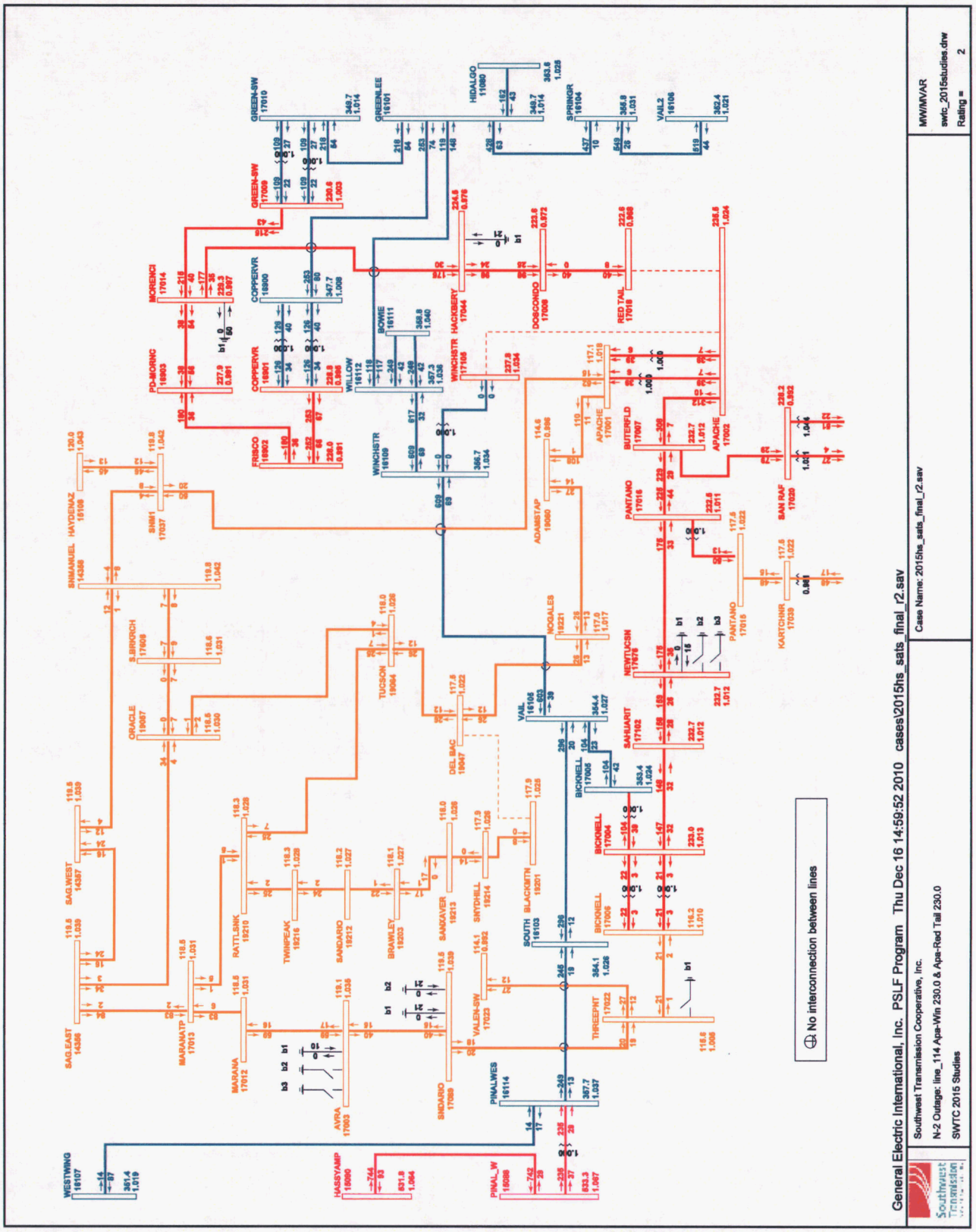
2015HS Southwest Transmission Cooperative Base System with Apache to Butterfield & Apache to Winchester 230 kV Lines out of service



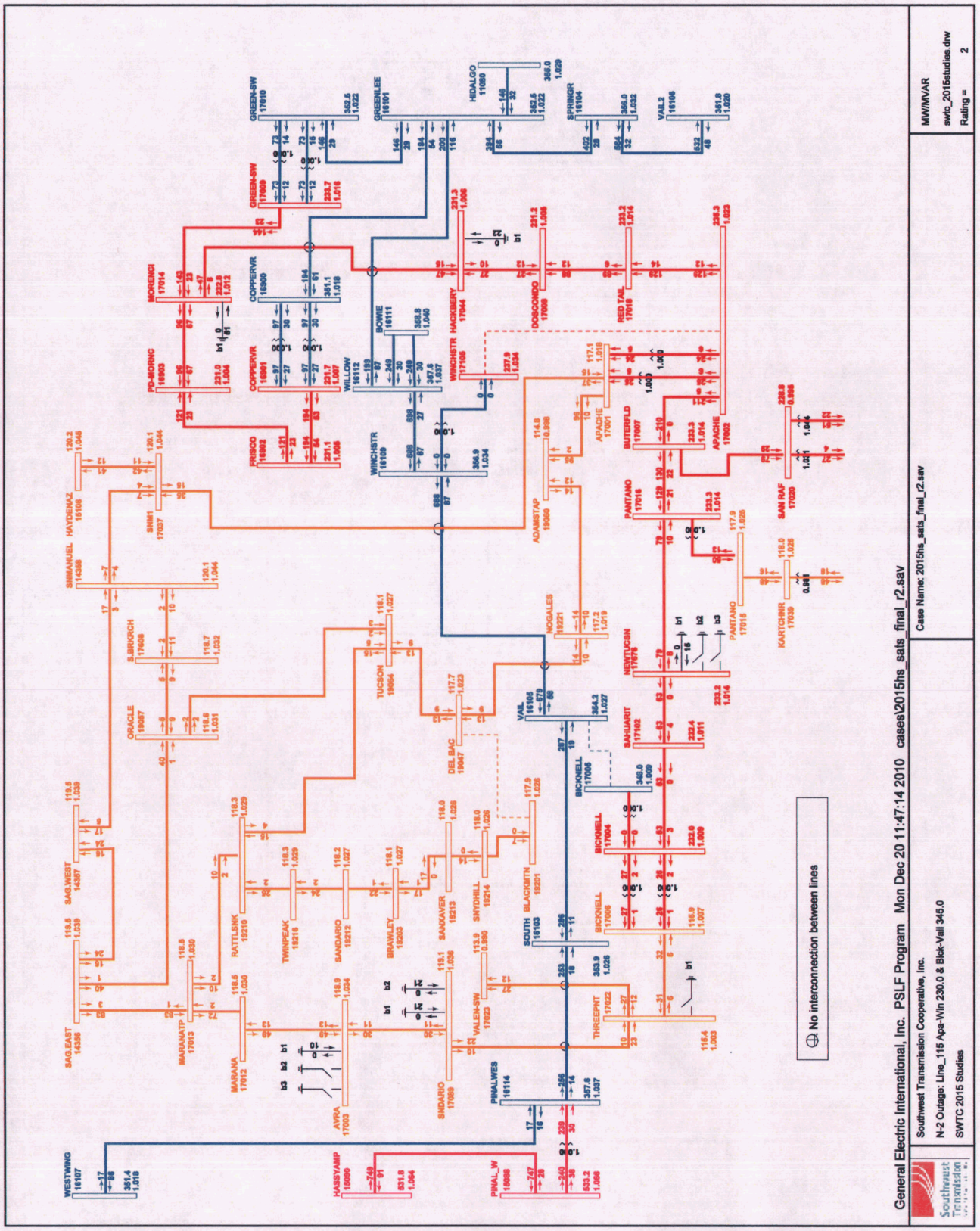
2015HS Southwest Transmission Cooperative Base System with Apache to Redtail 230 kV & Bicknell to Vail 345 kV Lines out of service



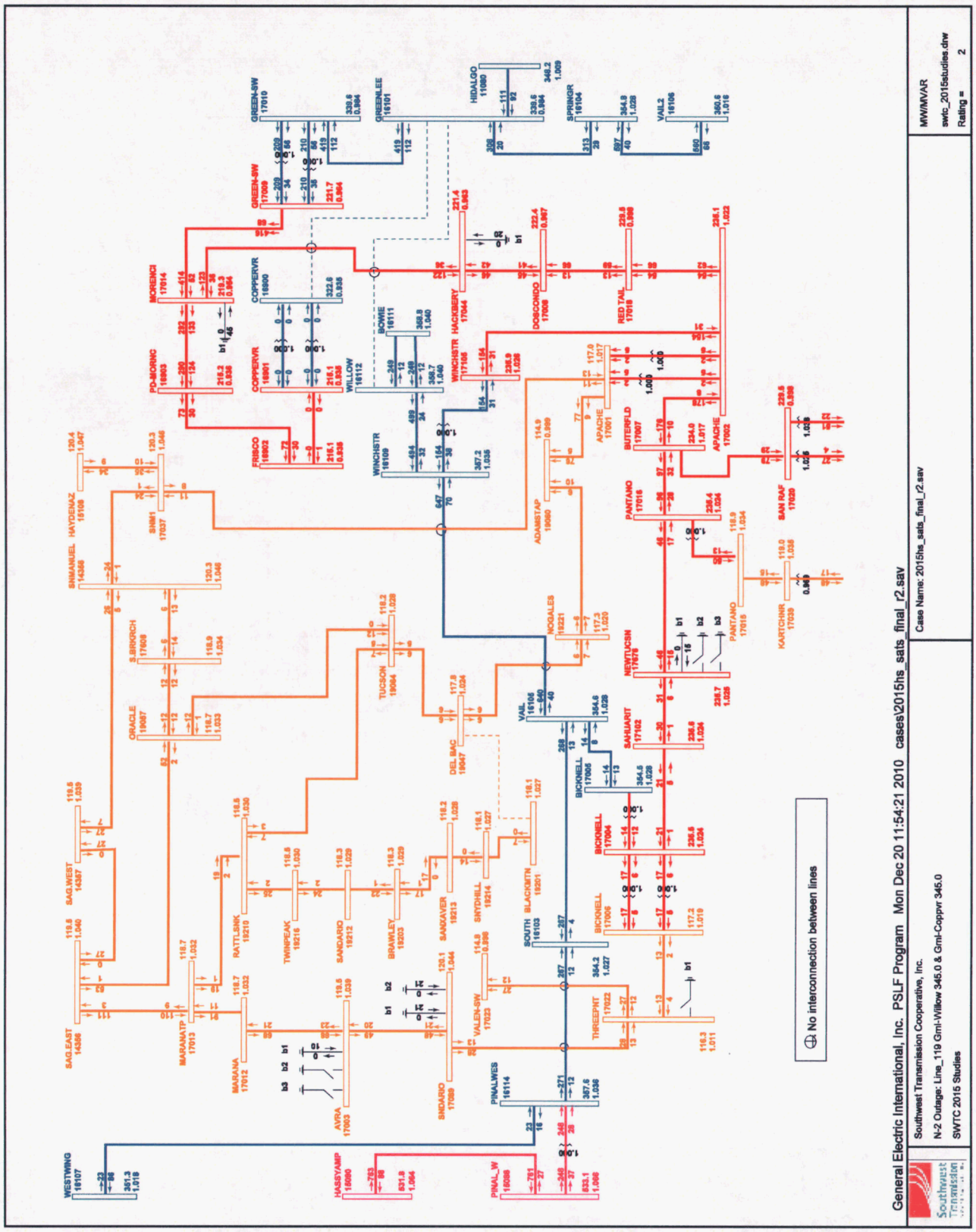
2015HS Southwest Transmission Cooperative Base System with Apache to Winchester and Apache to Redtail 230 kV Lines out of service



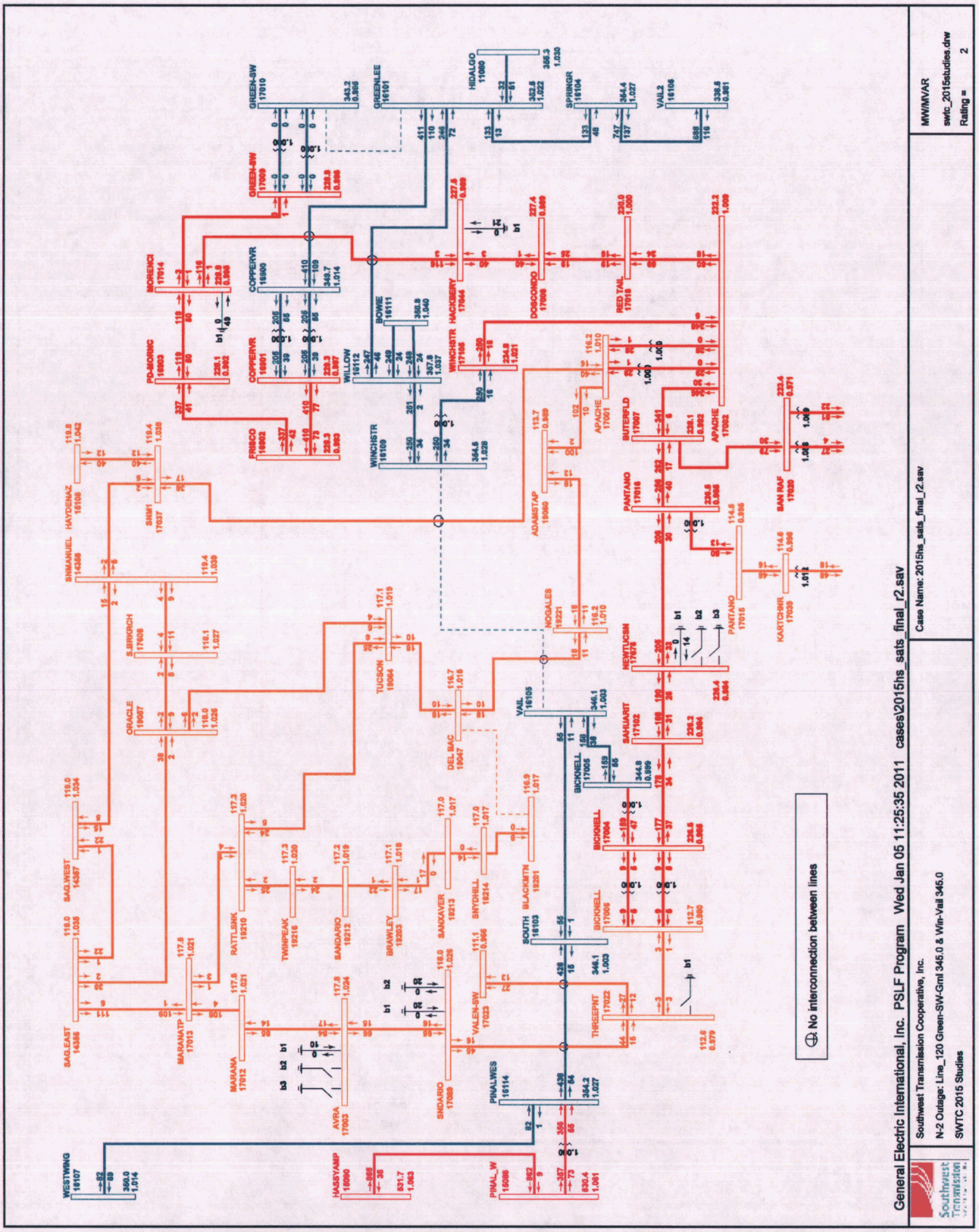
2015HS Southwest Transmission Cooperative Base System with Apache to Winchester 230 kV Line & Bicknell to Vail 345 kV Lines out of service



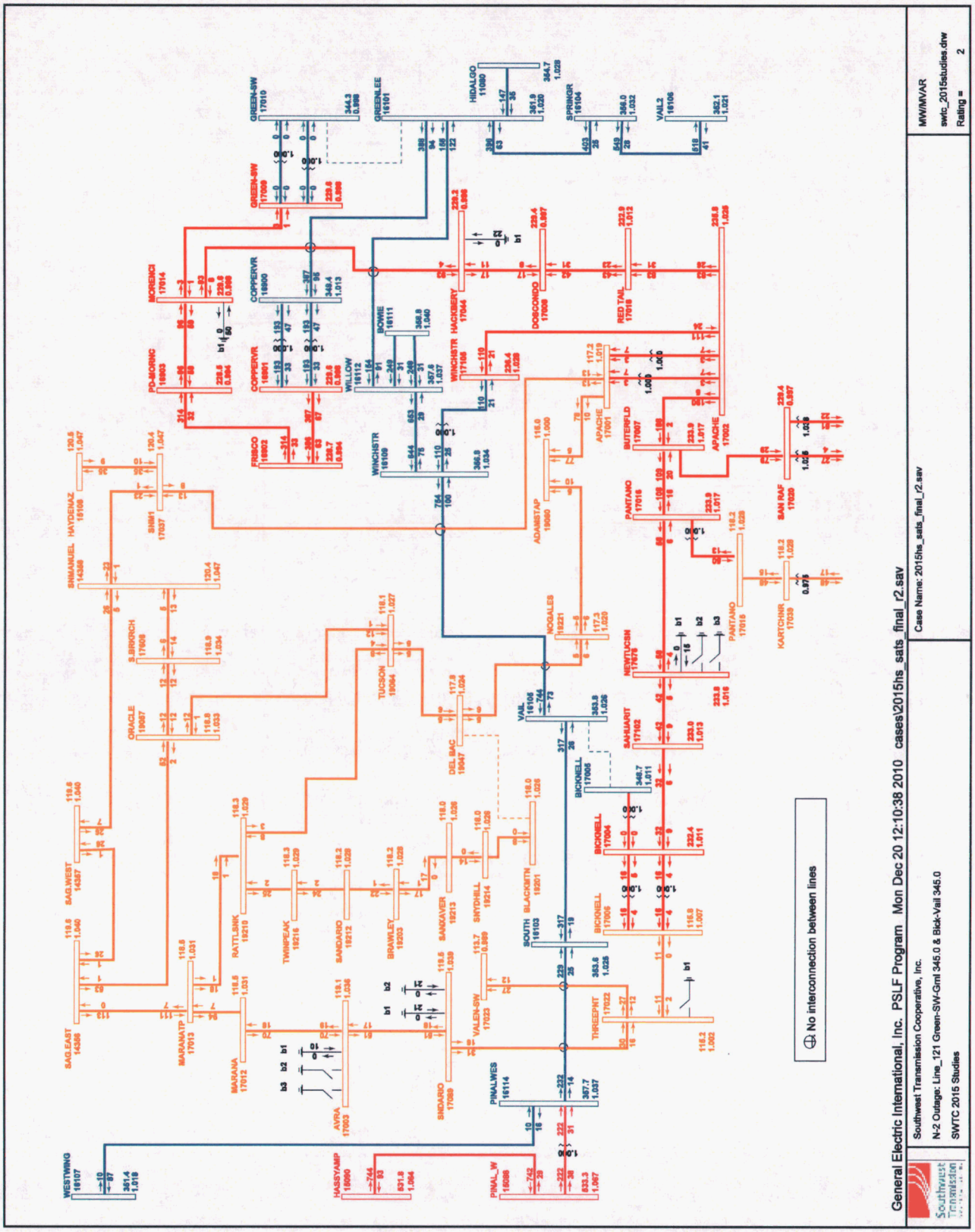
2015HS Southwest Transmission Cooperative Base System with Greenlee to Willow & Greenlee-Copper Verde 345 kV Lines out of service



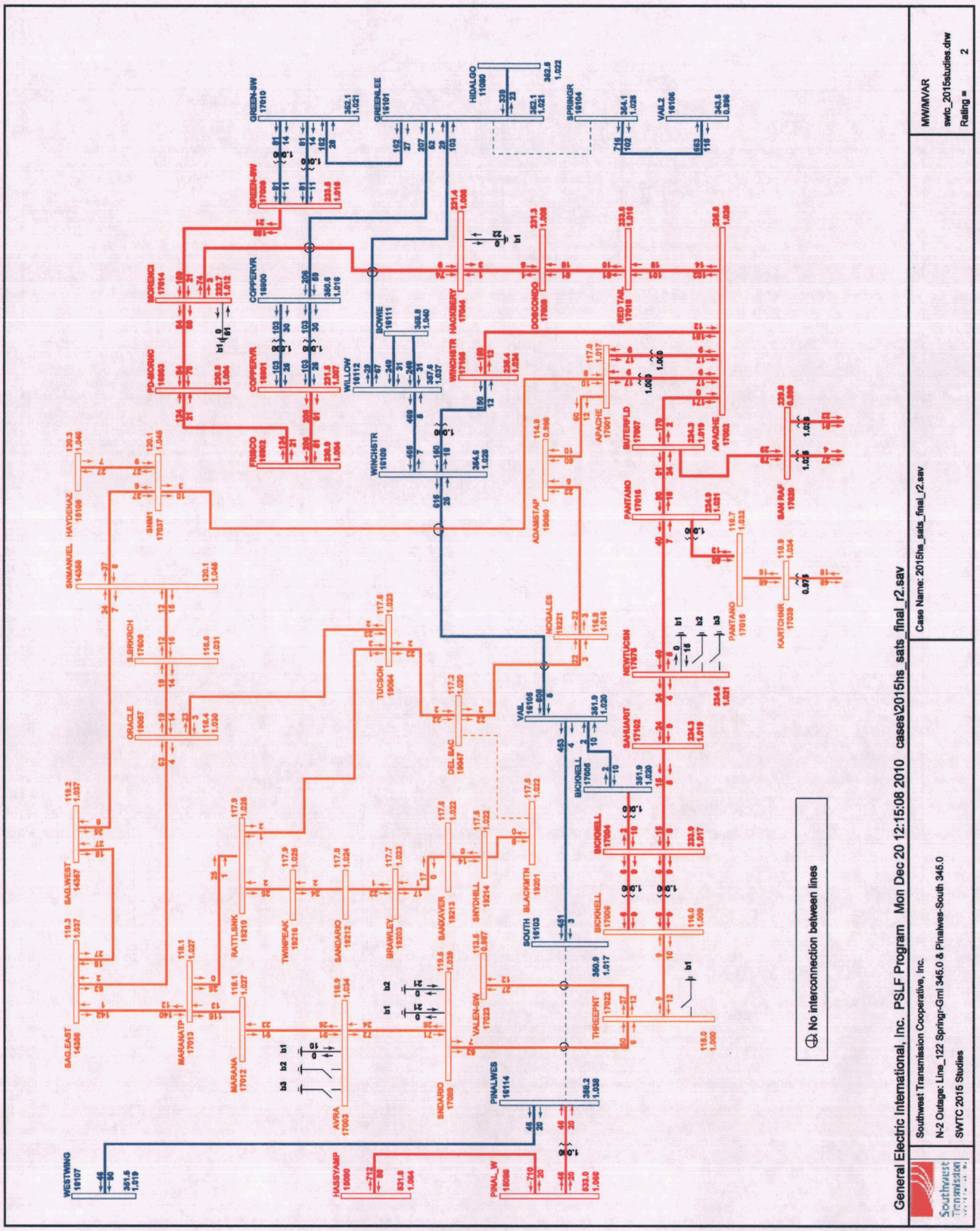
2015HS Southwest Transmission Cooperative Base System with Greenlee-SW to Greenlee & Winchester to Vail 345 kV Lines out of service



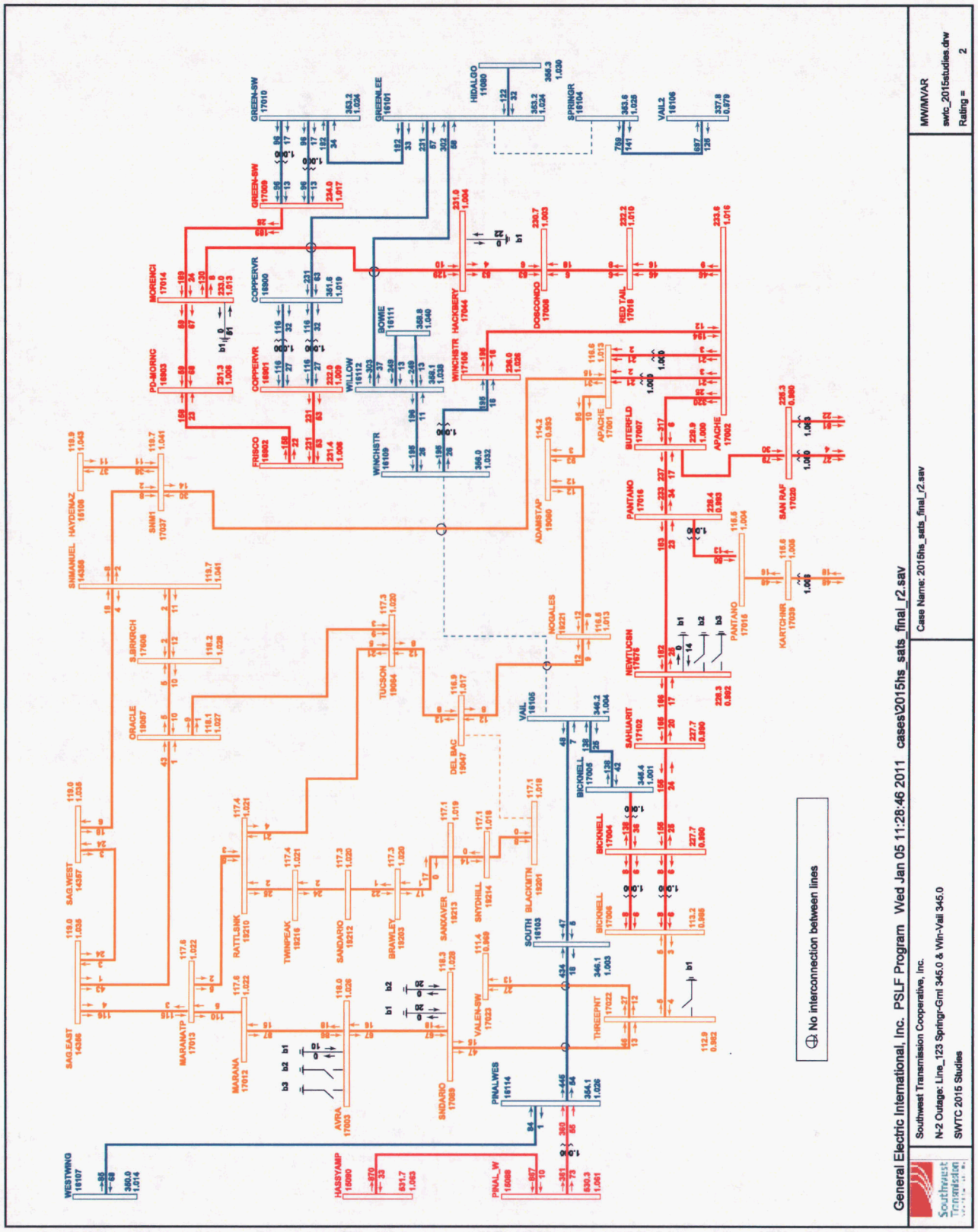
2015HS Southwest Transmission Cooperative Base System with Greenlee-SW to Greenlee & Bicknell to Vail 345 kV Lines out of service



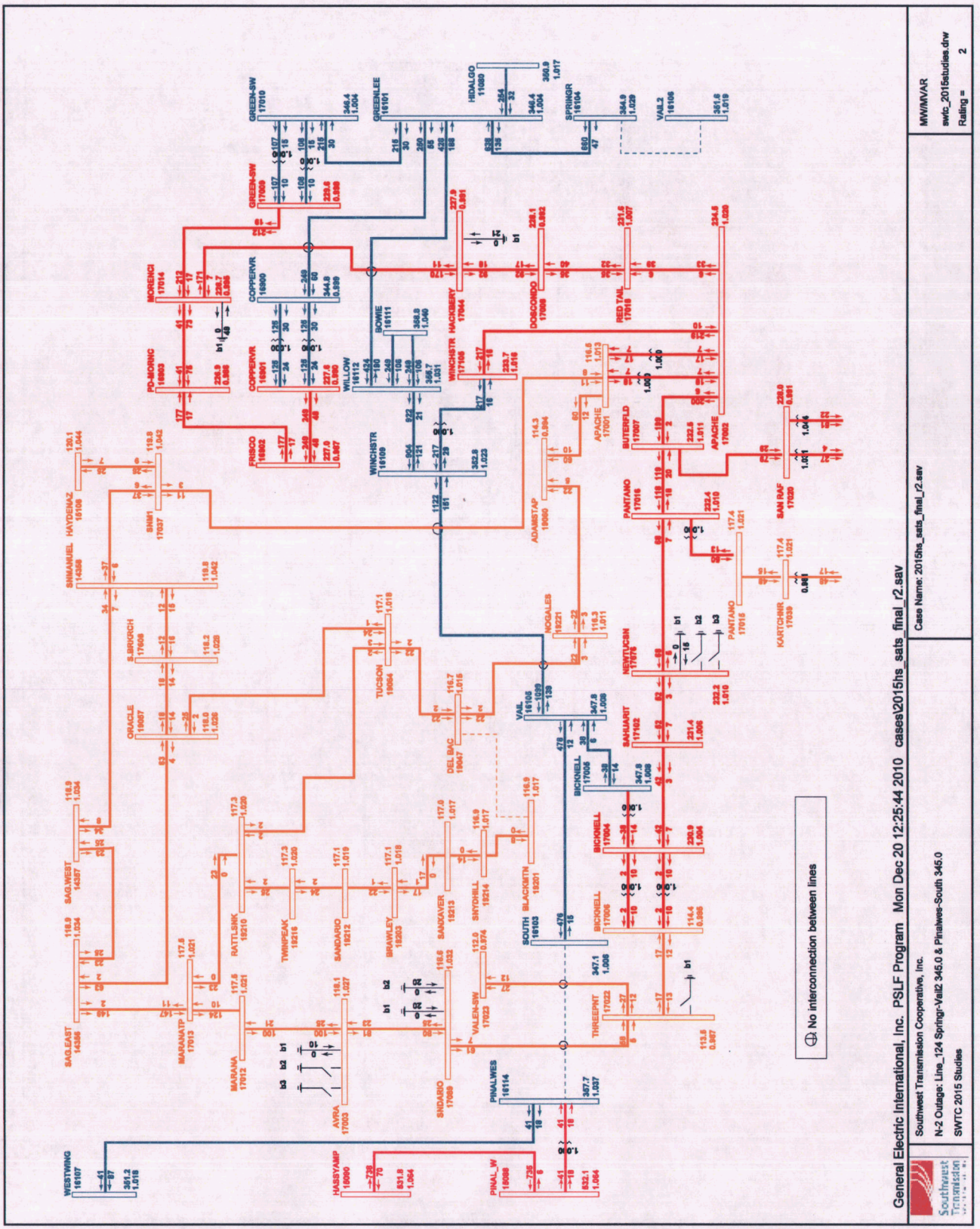
2015HS Southwest Transmission Cooperative Base System with Springerville to Greenlee & Pinal West to South 345 kV Lines out of service



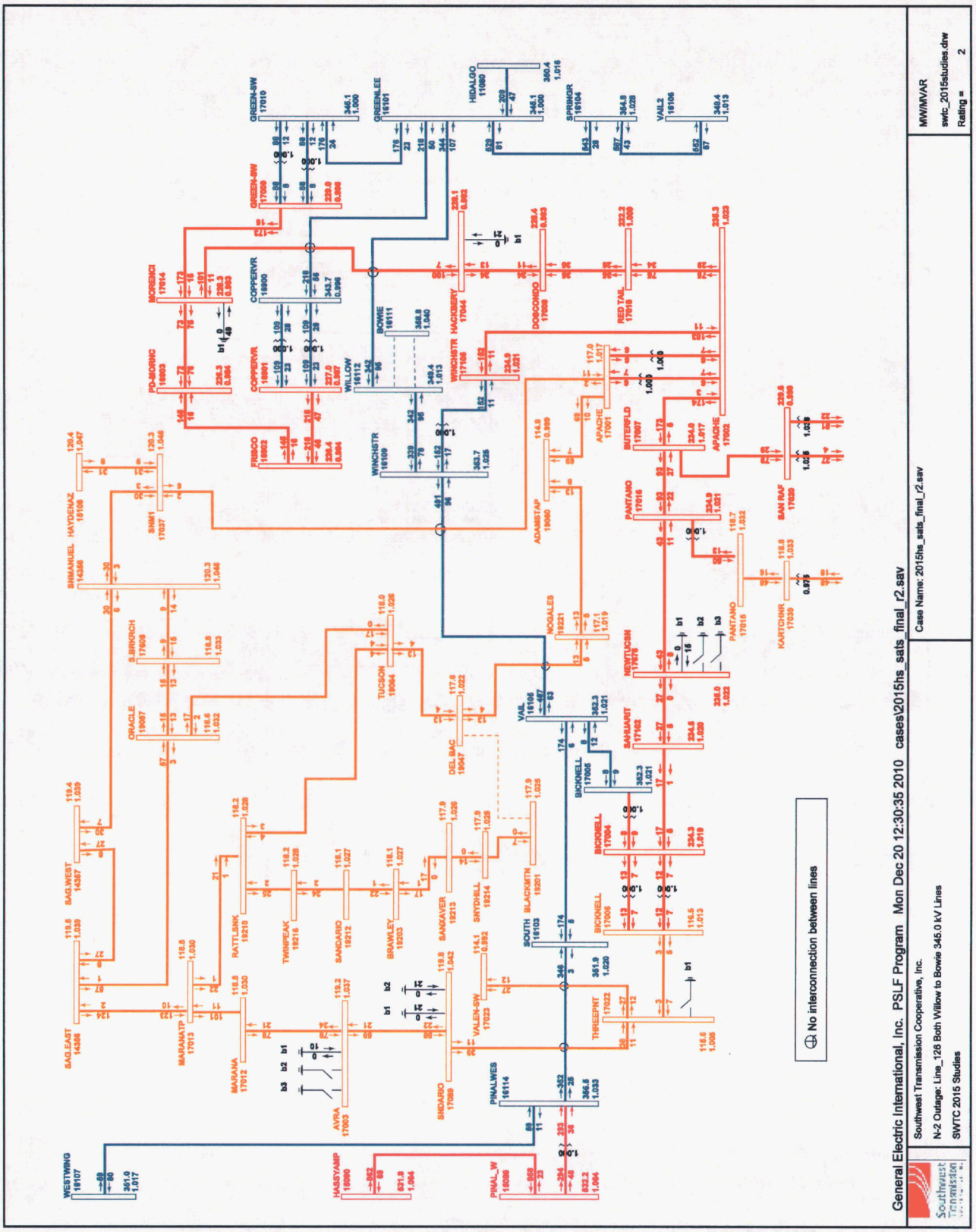
2015HS Southwest Transmission Cooperative Base System with Springerville to Greenlee & Winchester to Vail 345 kV Lines out of service



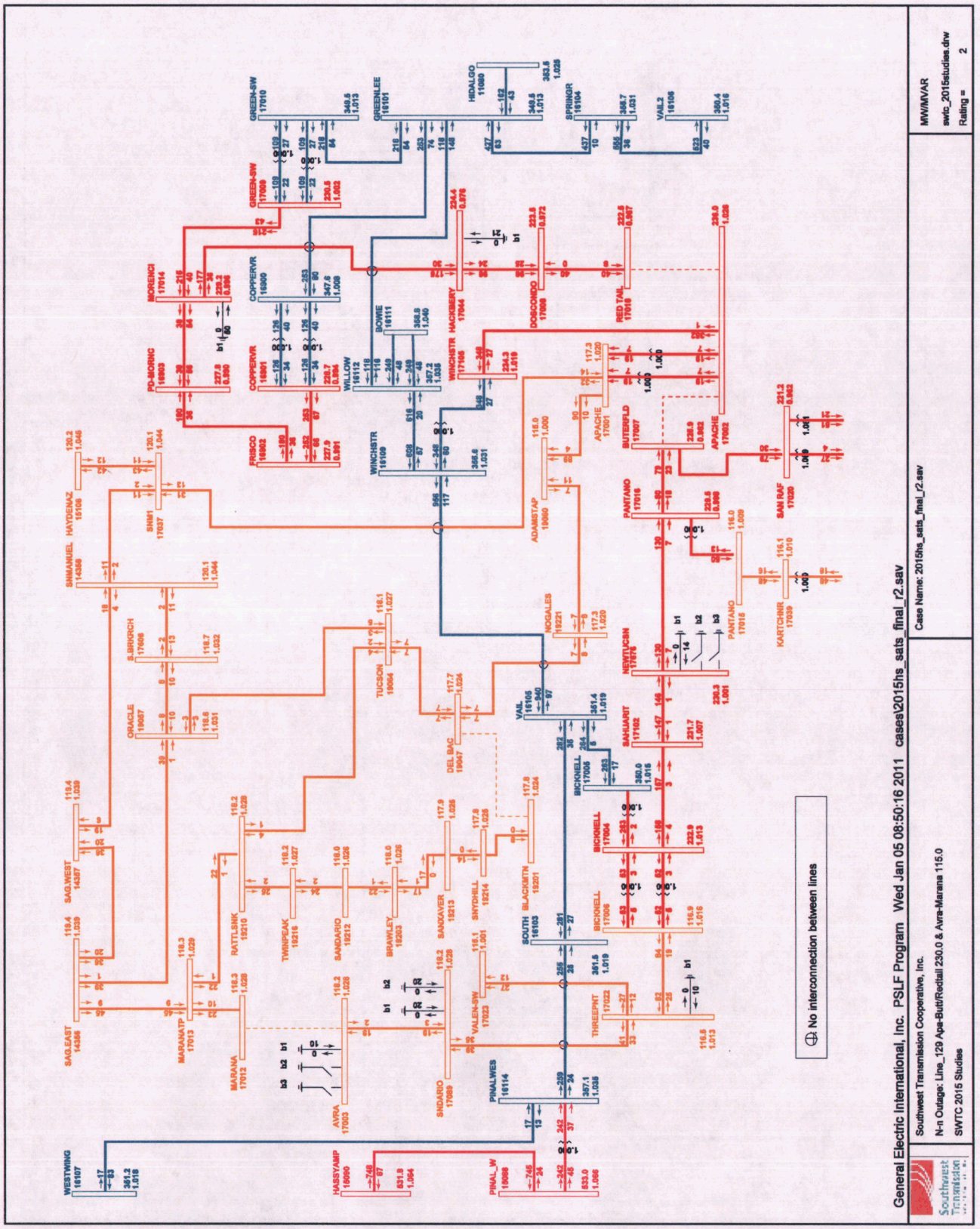
2015HS Southwest Transmission Cooperative Base System with Springerville to Vail2 & Pinal West to South 345 kV Lines out of service



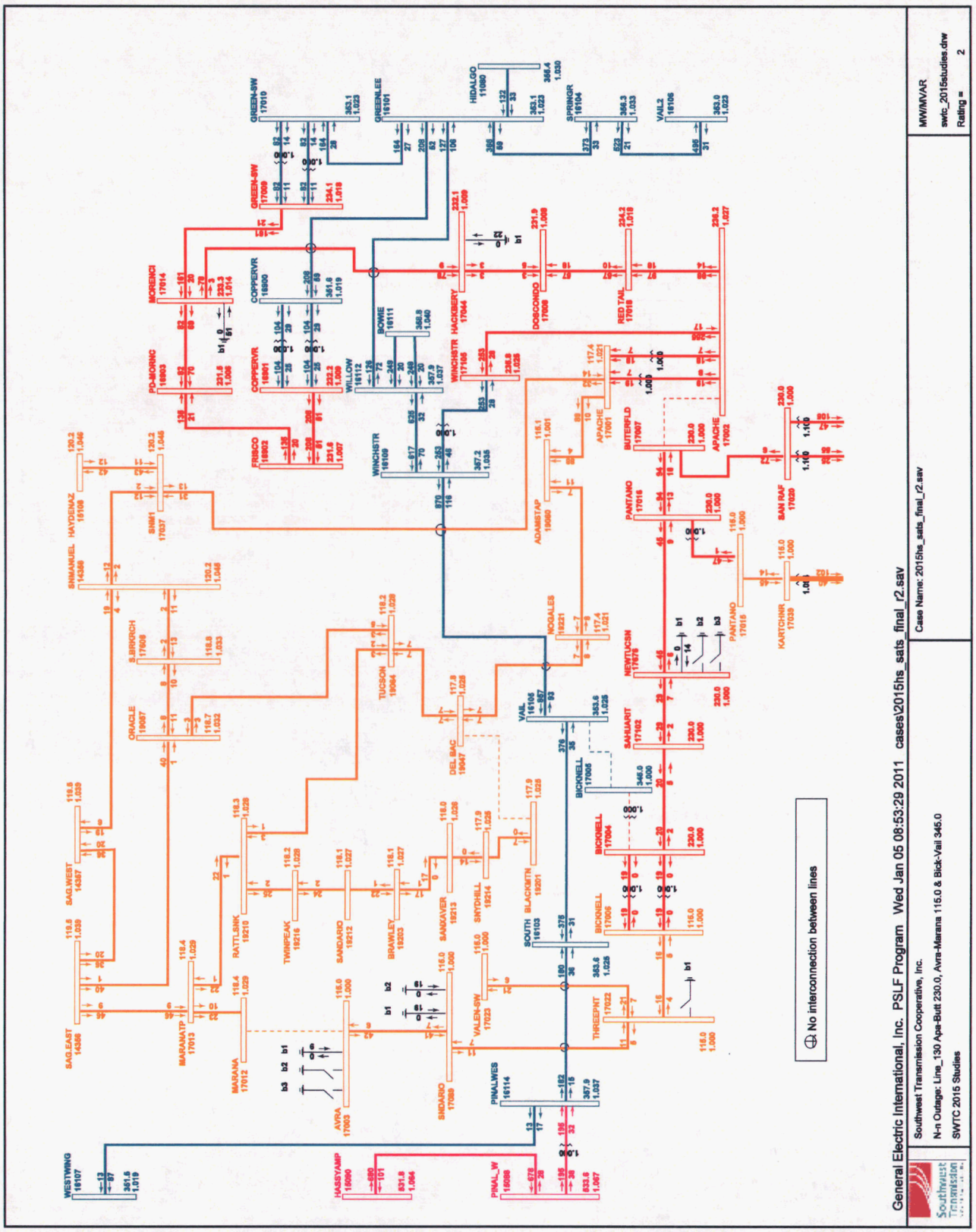
2015HS Southwest Transmission Cooperative Base System with both Willow to Bowie 345 kV Lines out of service



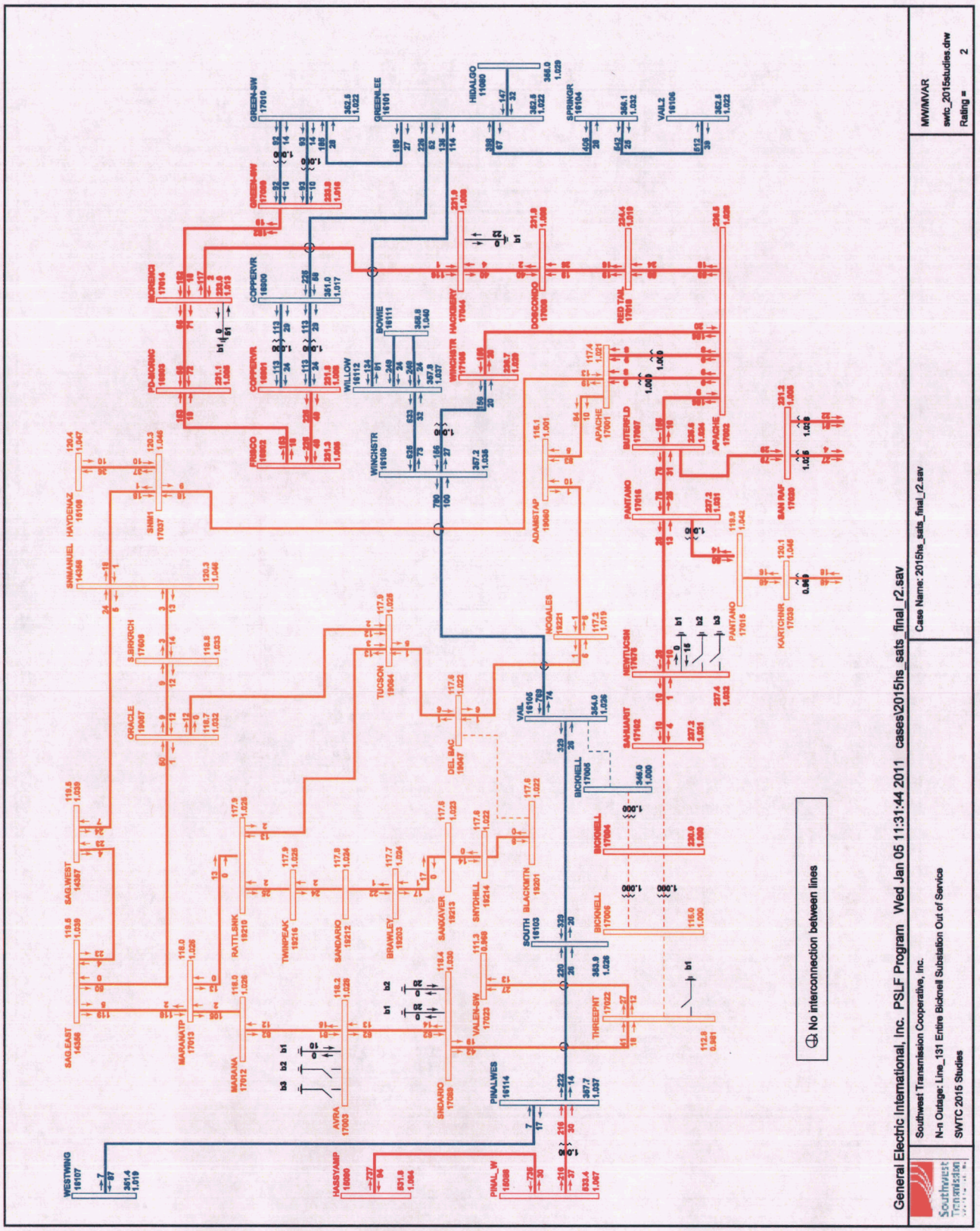
2015HS Southwest Transmission Cooperative Base System with Apache to Butterfield, Apache to Redtail 230 kV & Avra to Marana 115 kV Lines out of service

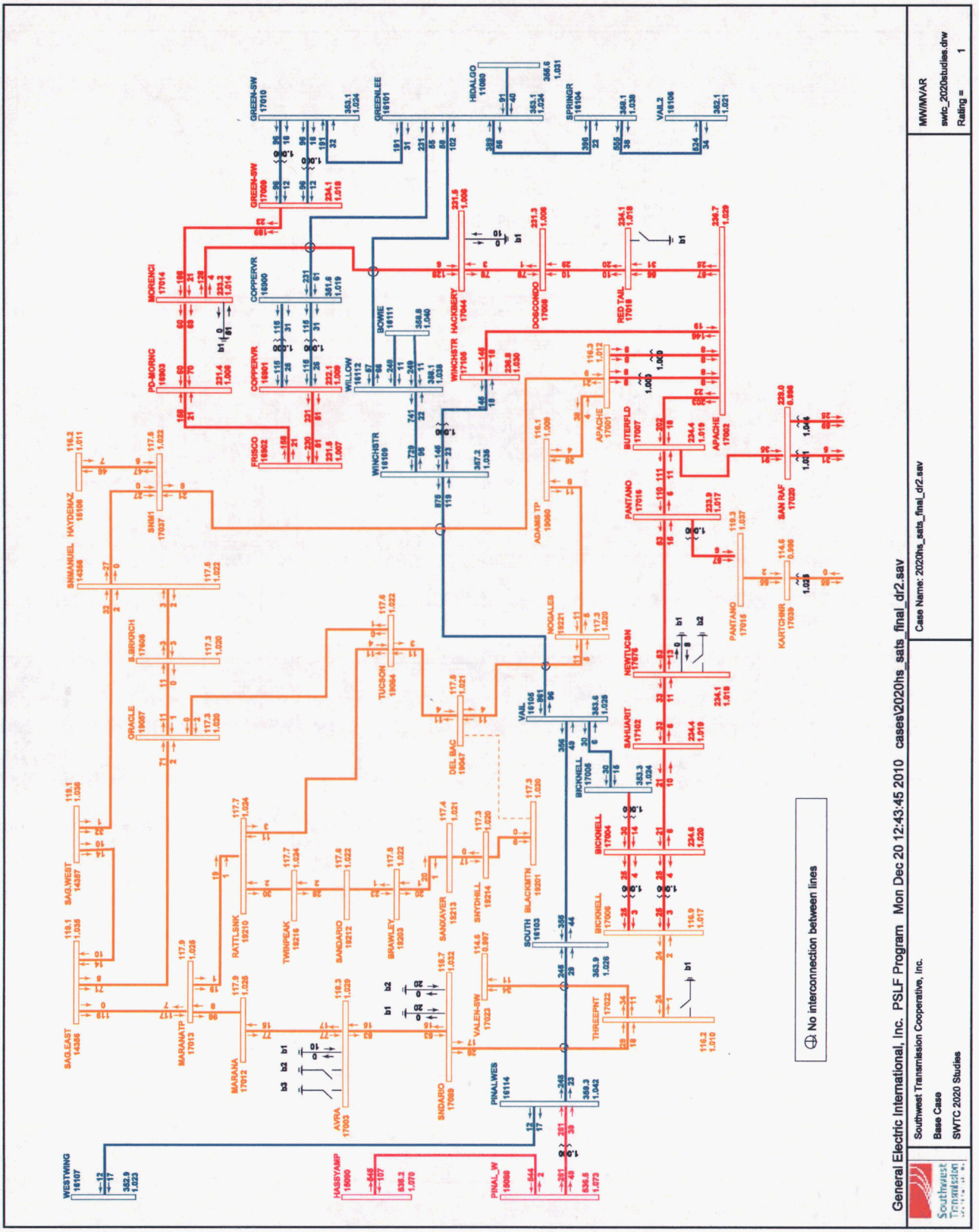


2015HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230, Avra to Marana 115 kV & Bicknell to Vail 345 kV Lines out of service



2015HS Southwest Transmission Cooperative Base System with Loss of Entire Bicknell Substation

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WILLOW 16112
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FRISCO 16902
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BUTTERFLD 17007
PANTANO 17016
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VALEN-SW 17023
SNDARIO 17088
PINALWES 16114
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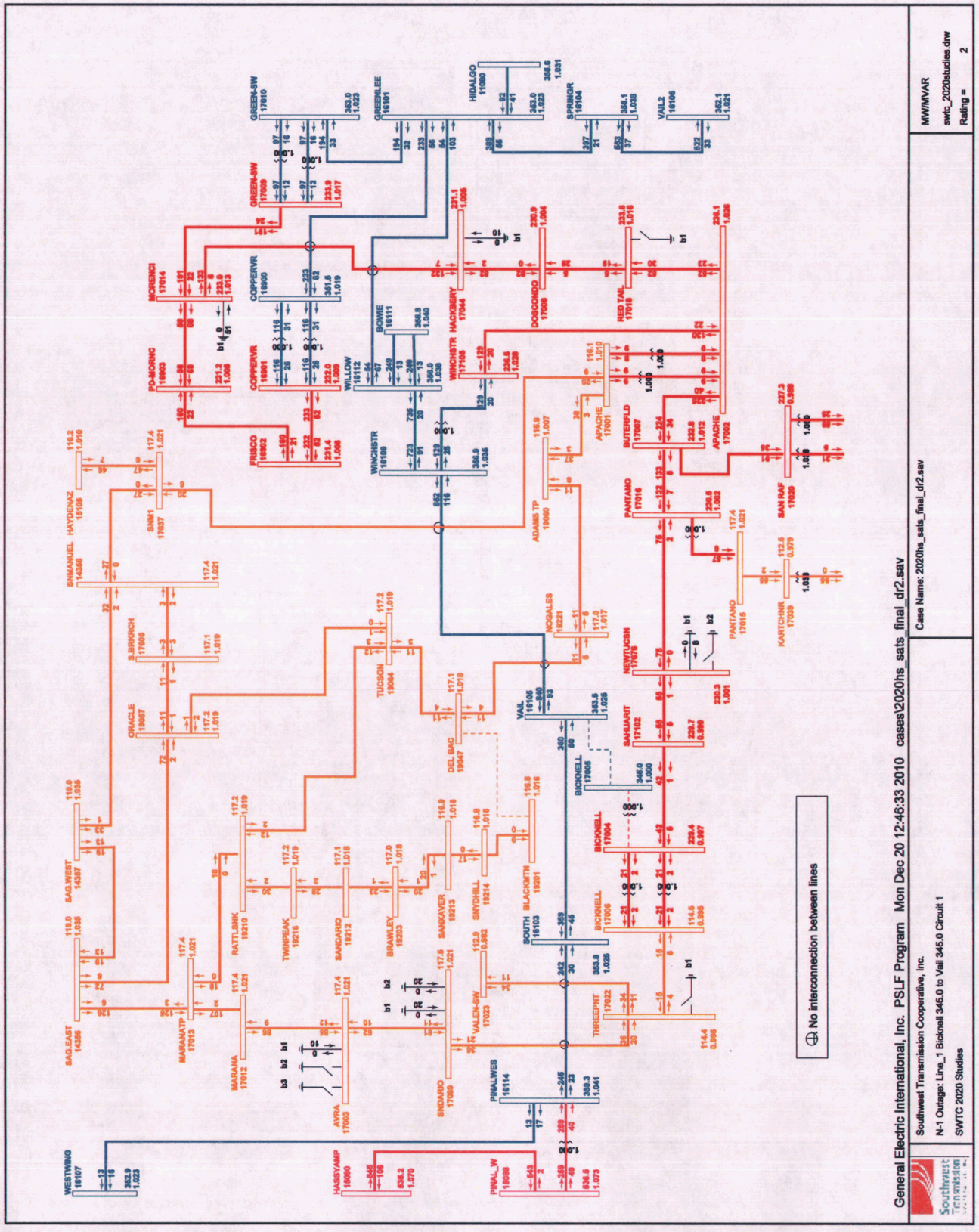
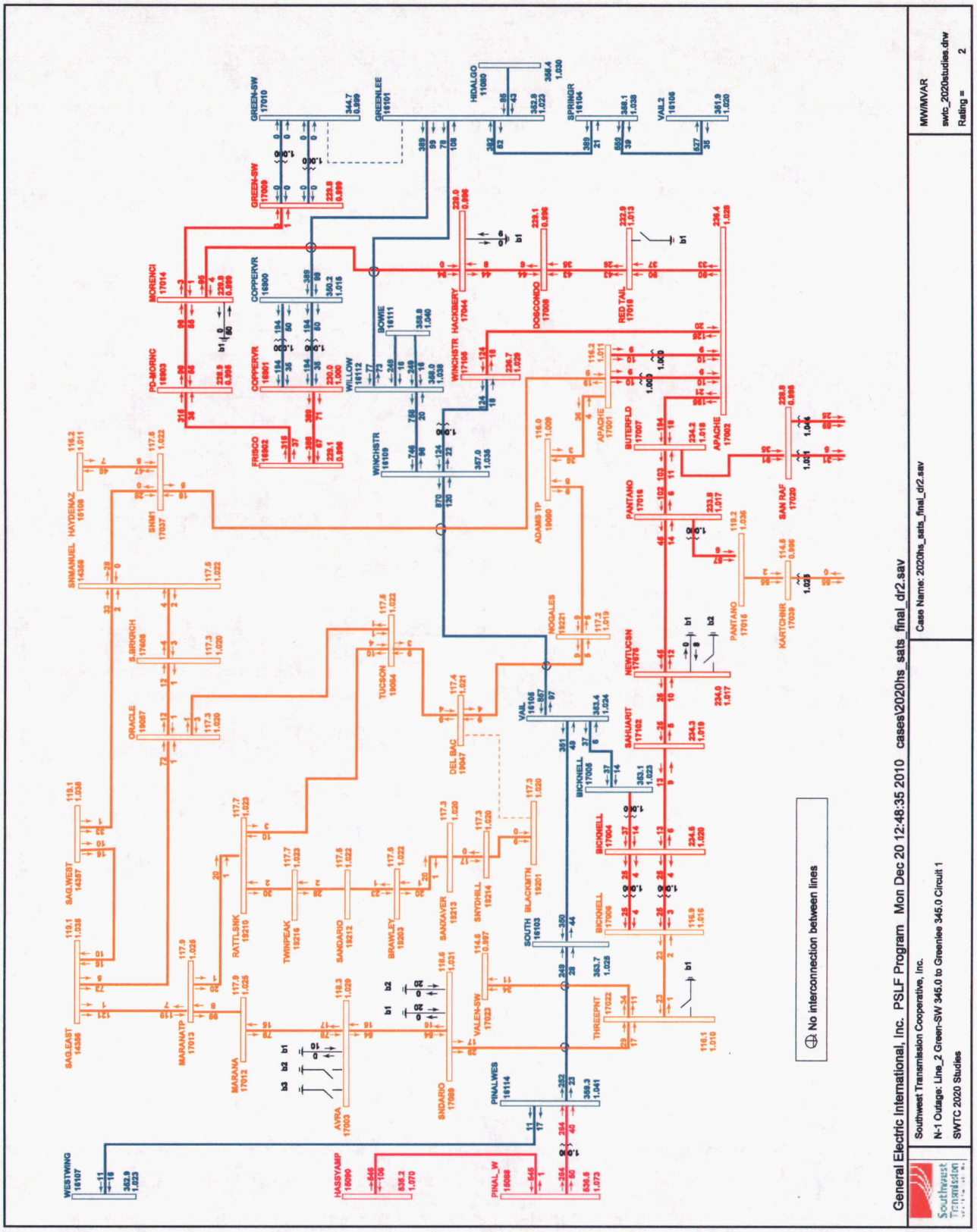
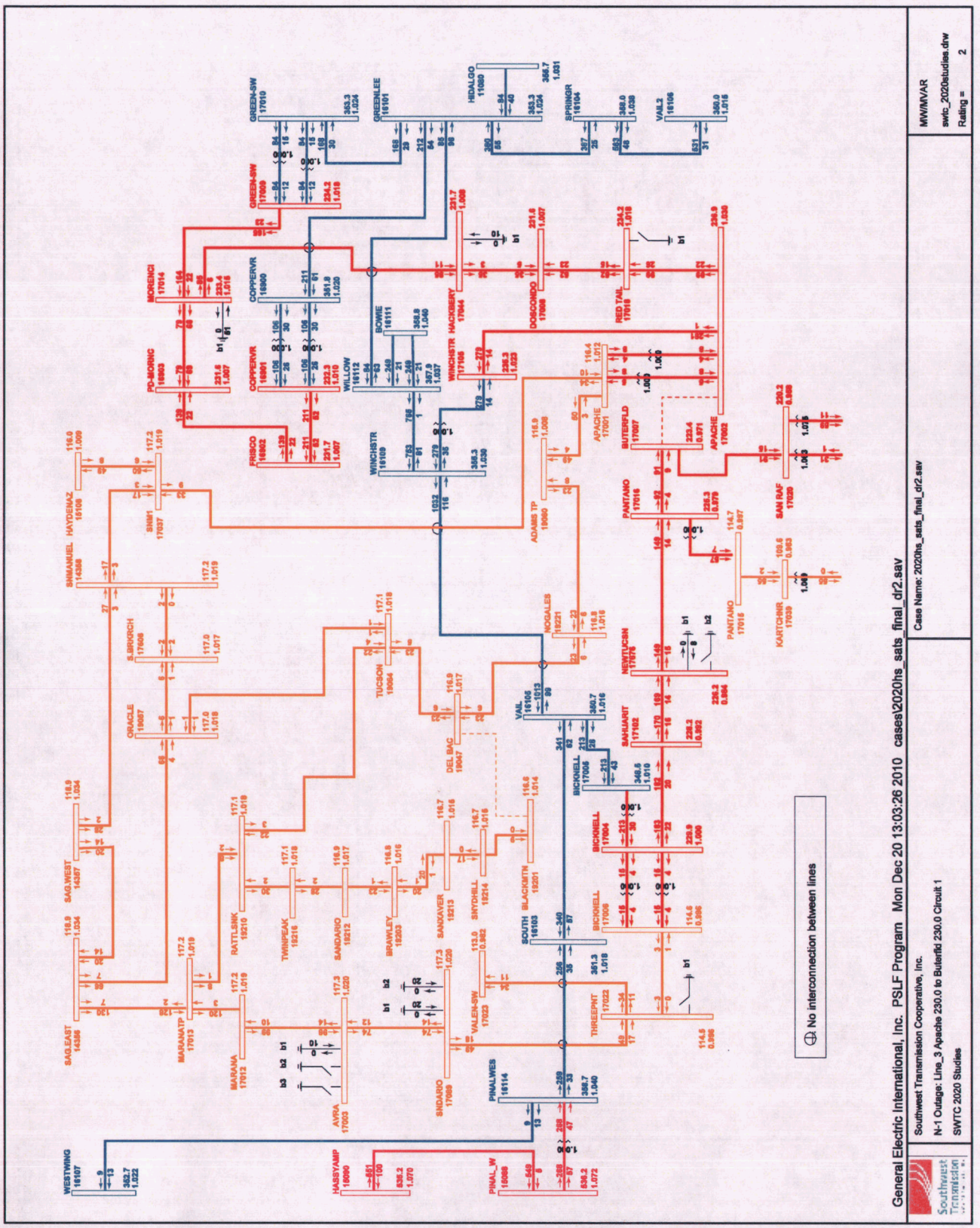
2020HS Southwest Transmission Cooperative Base System with Bicknell to Vail 345 kV Line out of service



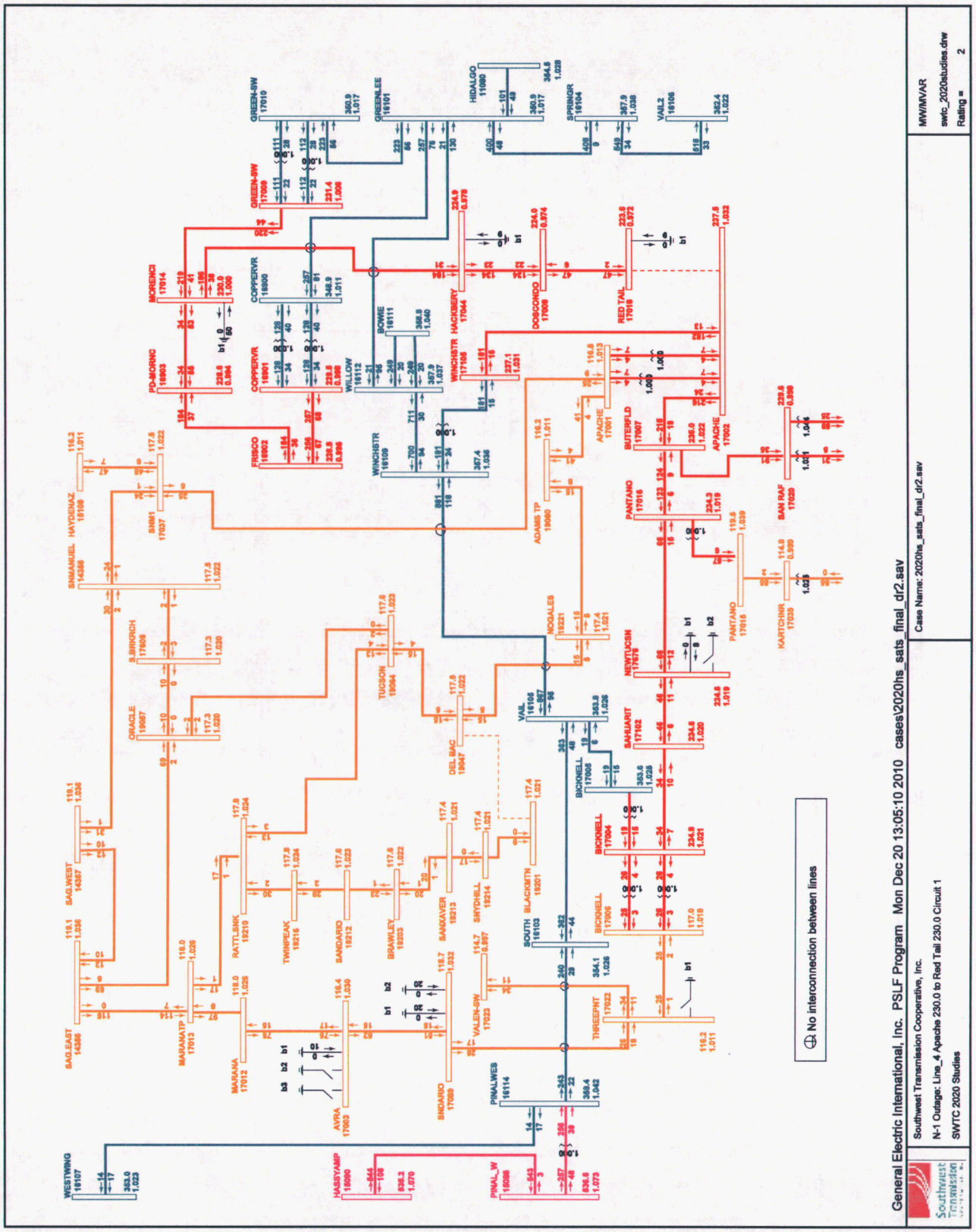
2020HS Southwest Transmission Cooperative Base System with Greenlee to Greenlee 345 kV Line out of service



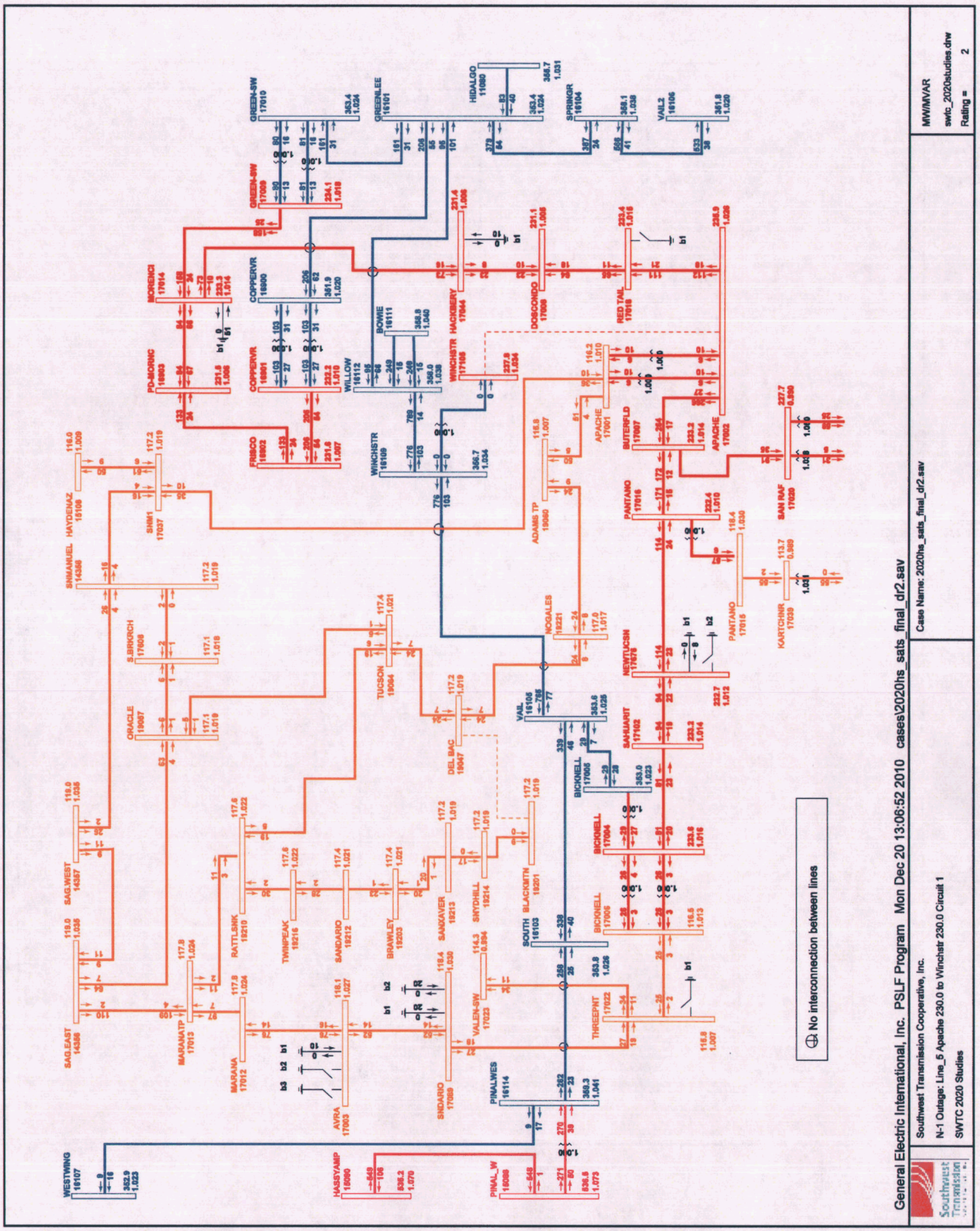
2020HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230 kV Line out of service



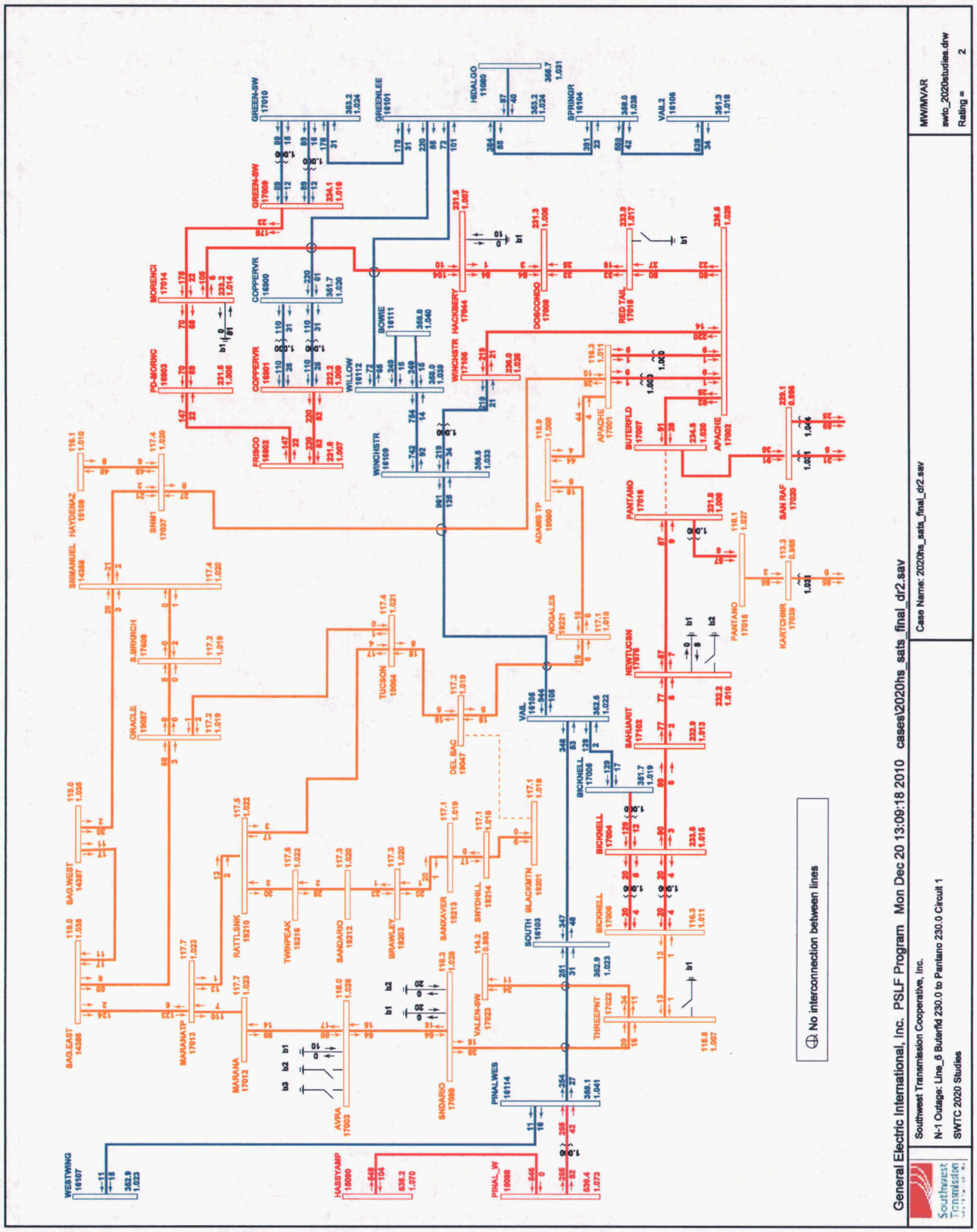
2020HS Southwest Transmission Cooperative Base System with Apache to Redtail 230 kV Line out of service



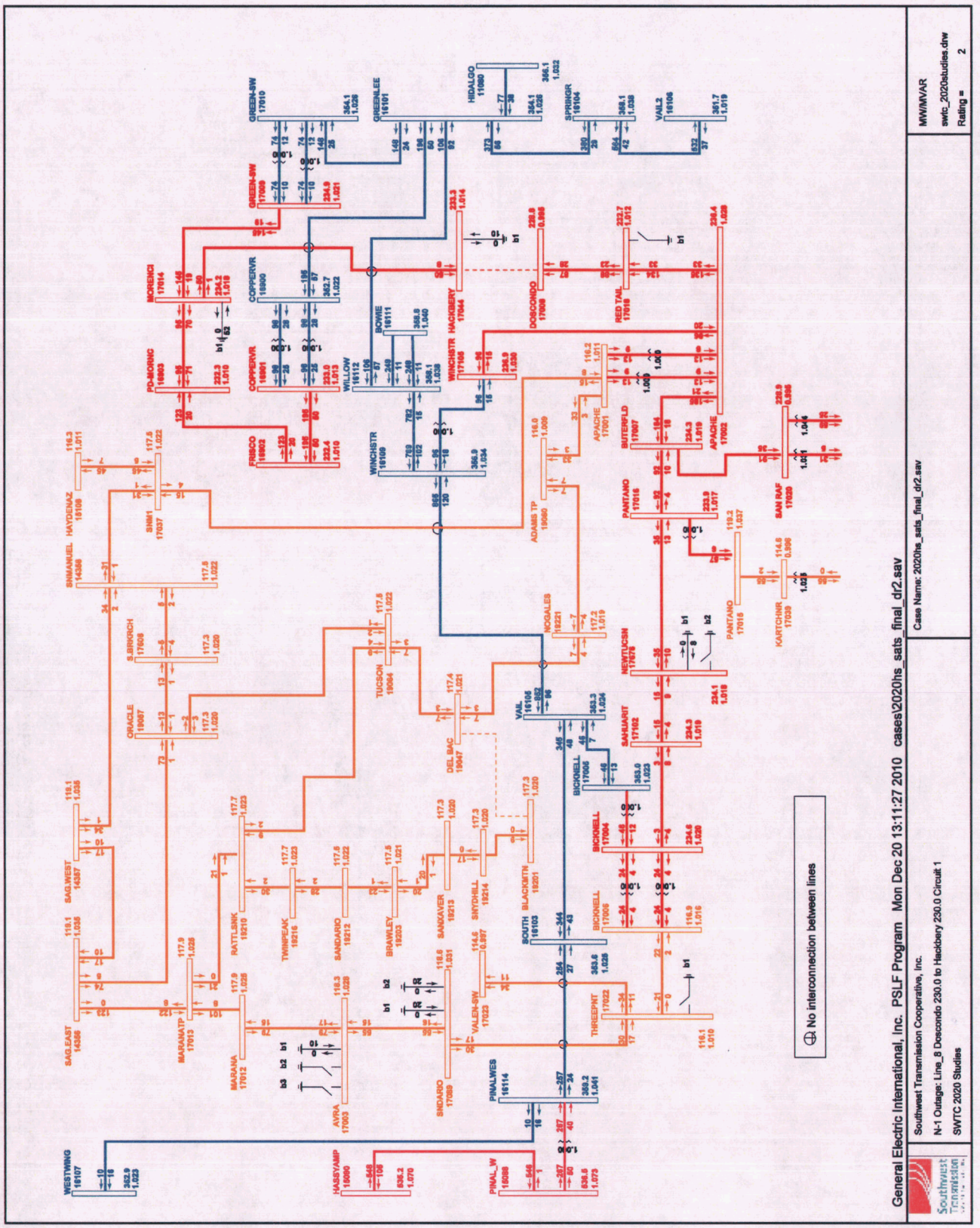
2020HS Southwest Transmission Cooperative Base System with Apache to Winchester 230 kV Line out of service



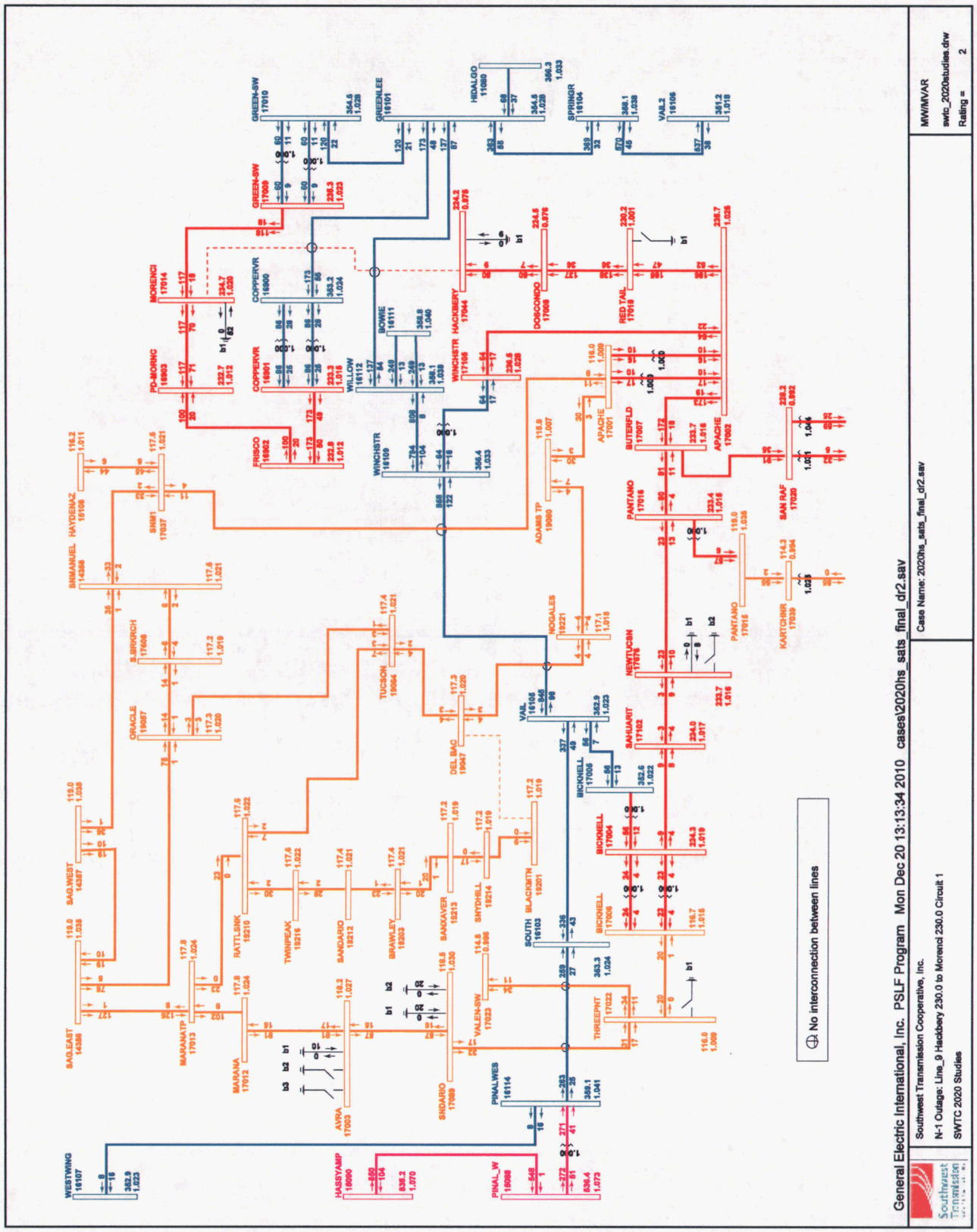
2020HS Southwest Transmission Cooperative Base System with Butterfield to Pantano 230 kV Line out of service



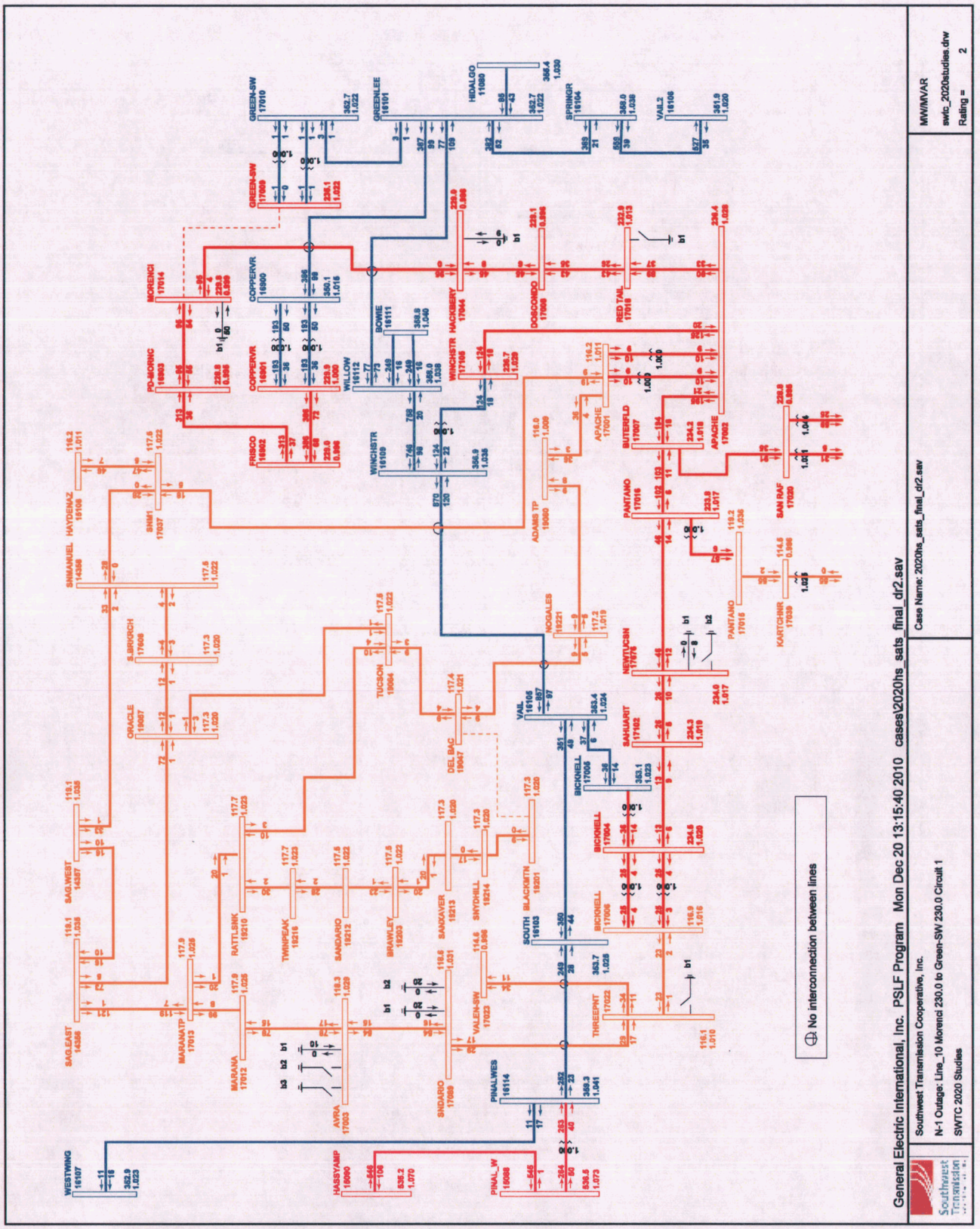
2020HS Southwest Transmission Cooperative Base System with Dos Condados to Hackberry 230 kV Line out of service



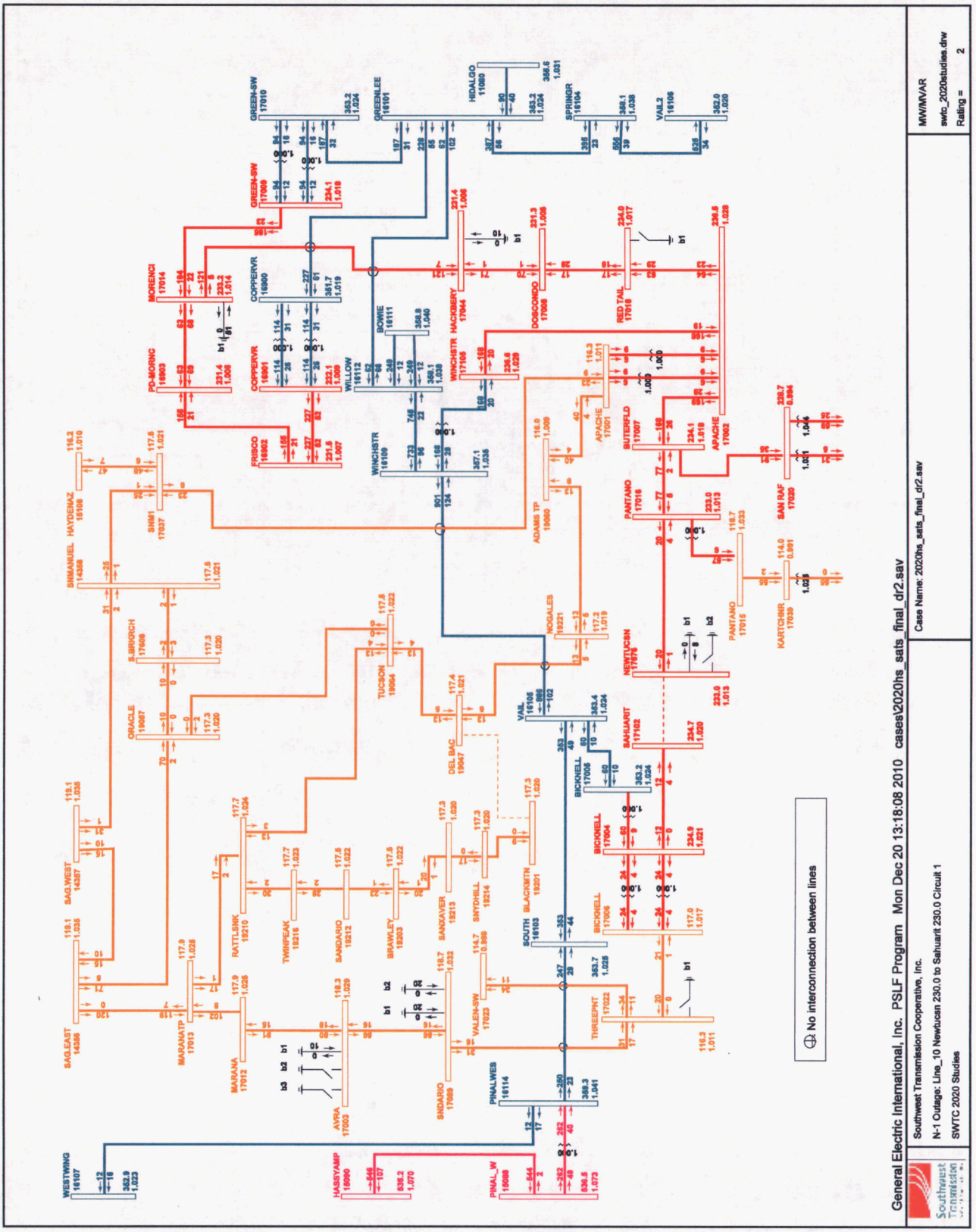
2020HS Southwest Transmission Cooperative Base System with Hackberry to Morenci 230 kV Line out of service



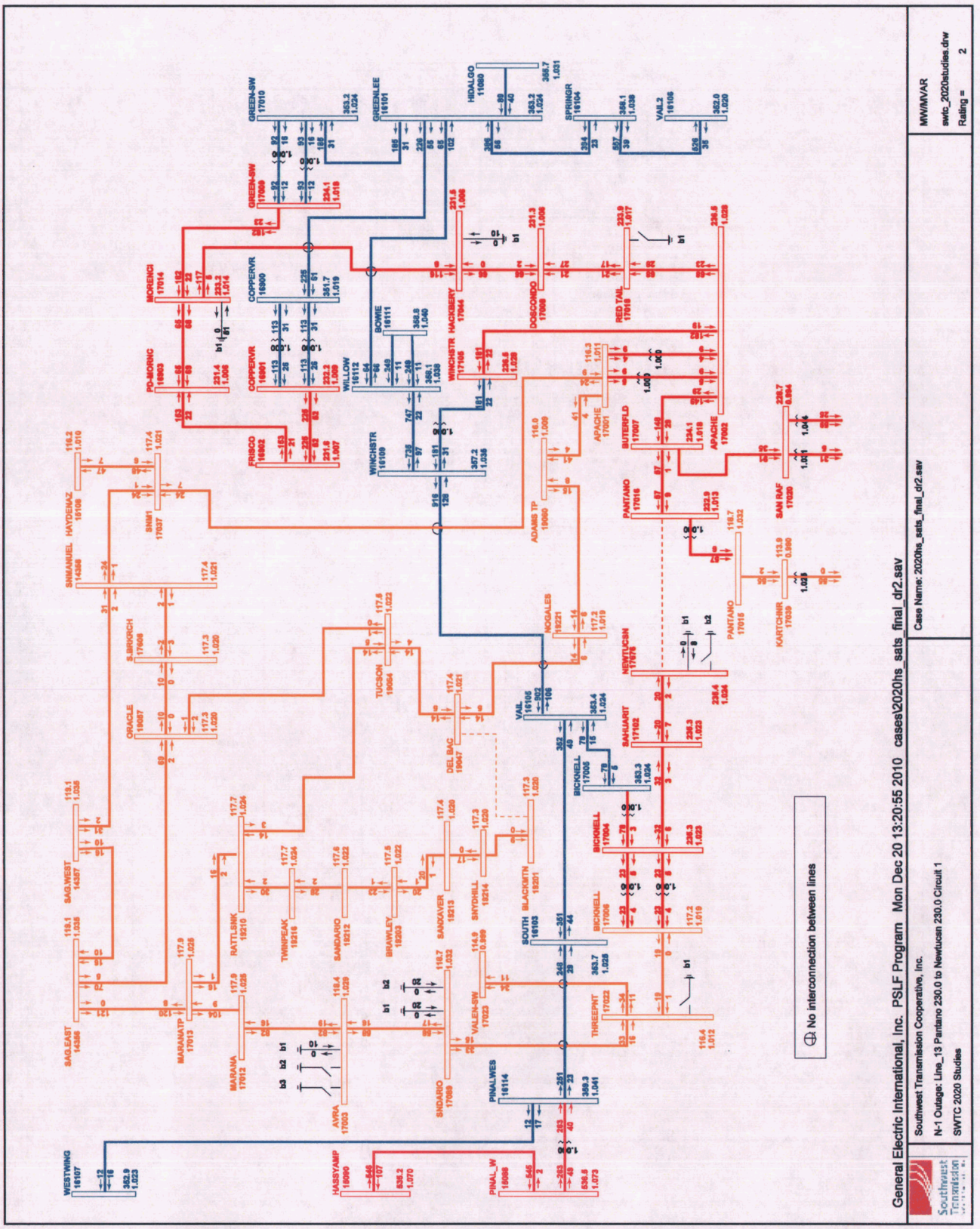
2020HS Southwest Transmission Cooperative Base System with Morenci to Greenlee 230 kV Line out of service



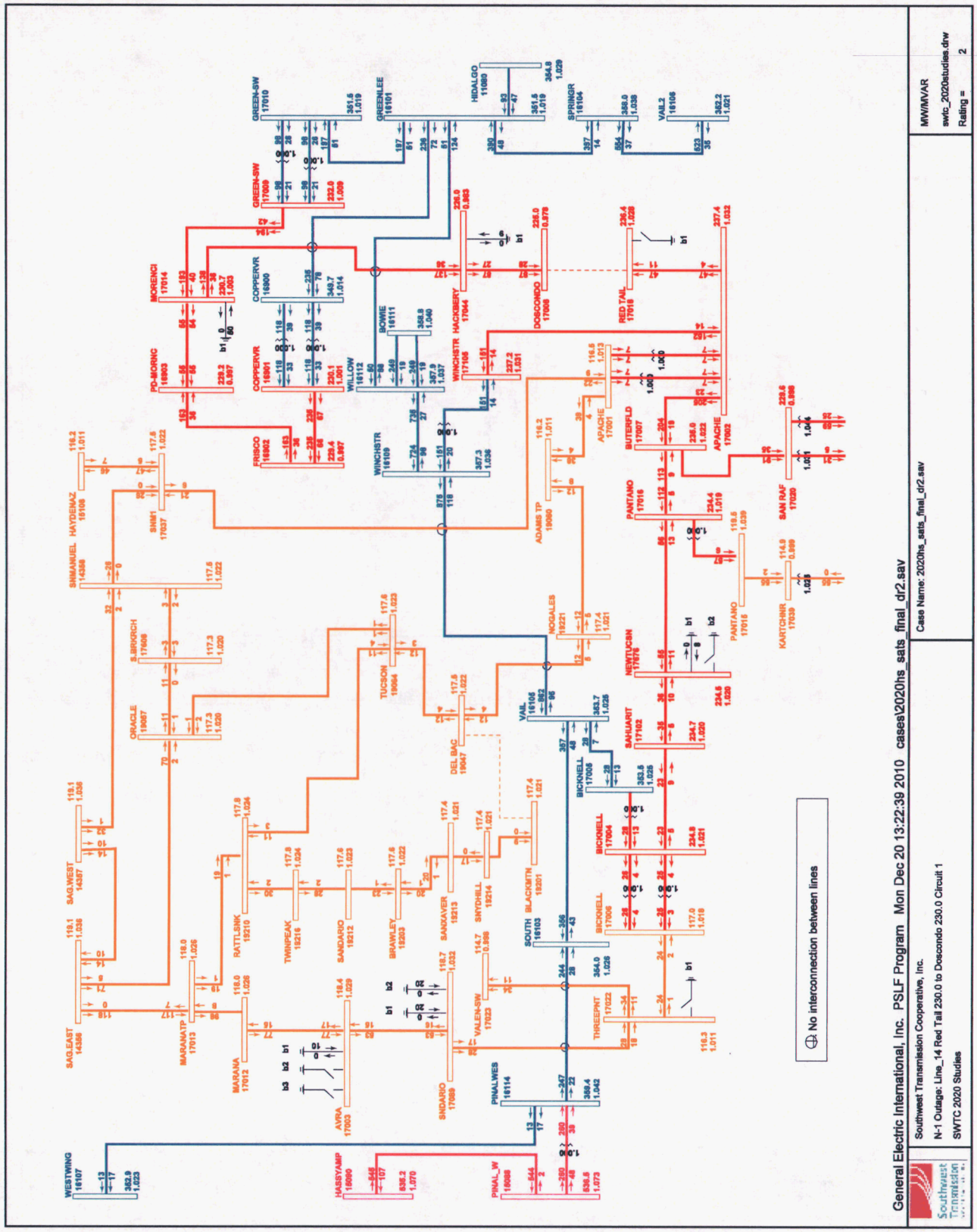
2020HS Southwest Transmission Cooperative Base System with New Tucson to Sahuarita 230 kV Line out of service



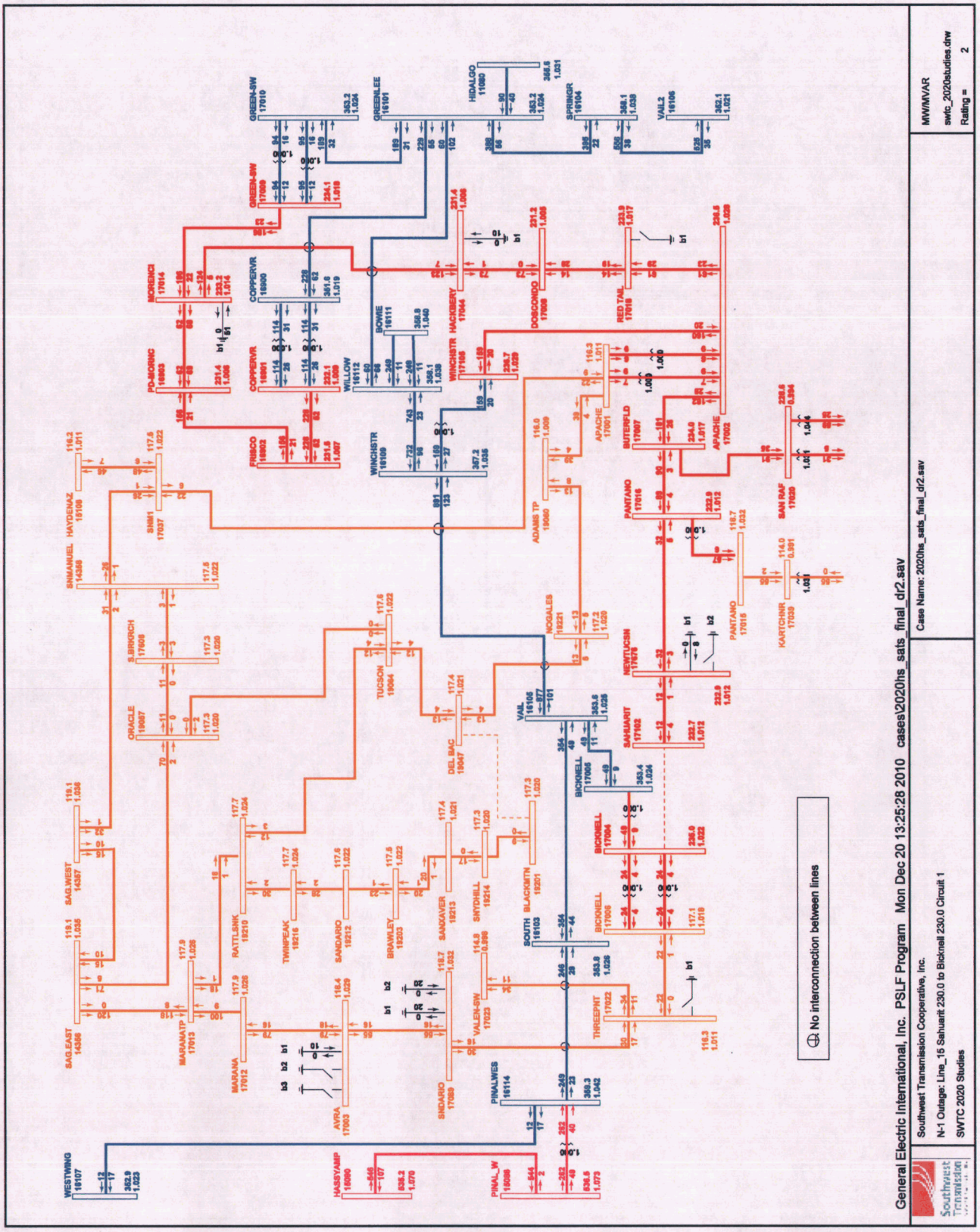
2020HS Southwest Transmission Cooperative Base System with Pantano to New Tucson 230 kV Line out of service



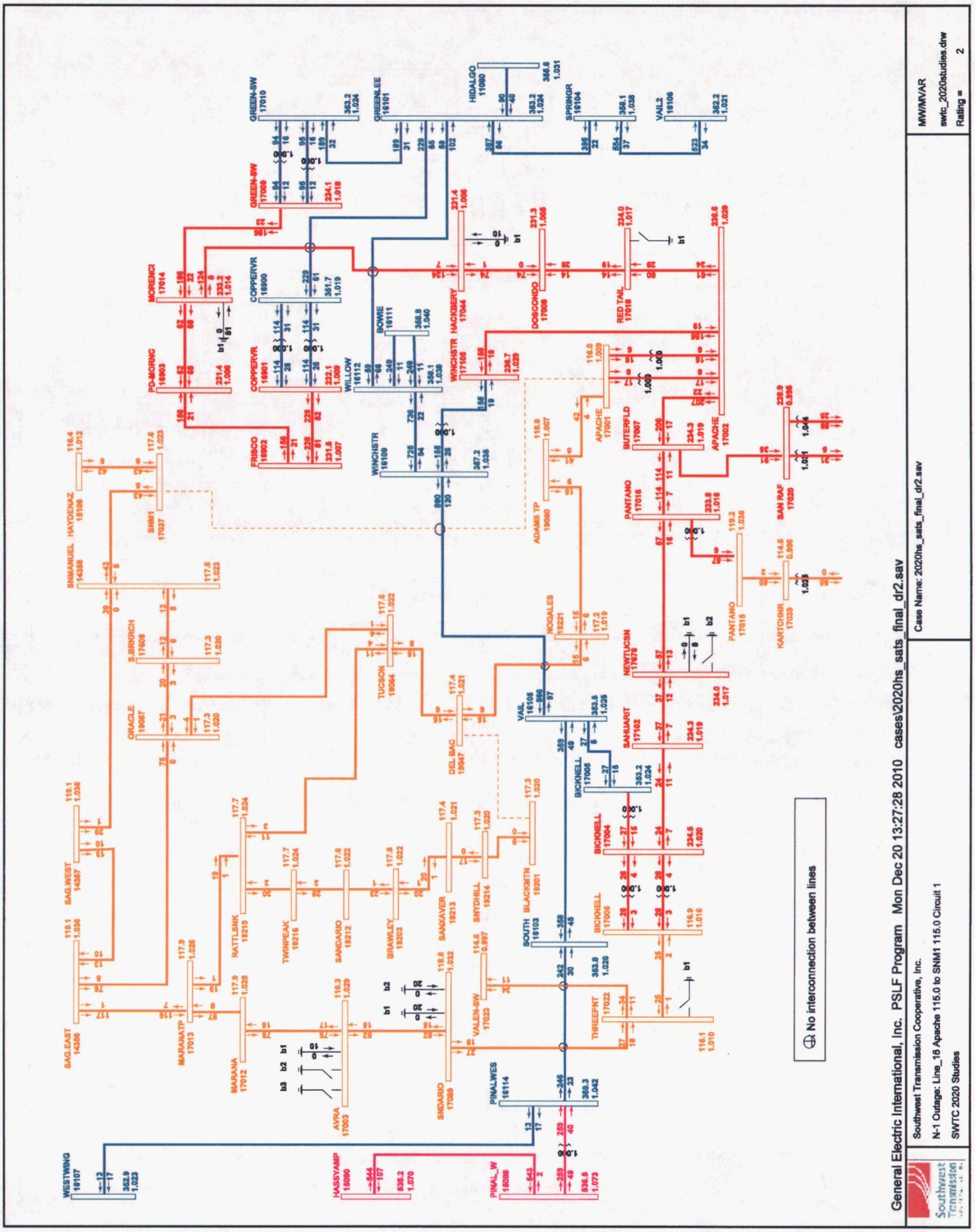
2020HS Southwest Transmission Cooperative Base System with Redtail to Dos Condados 230 kV Line out of service



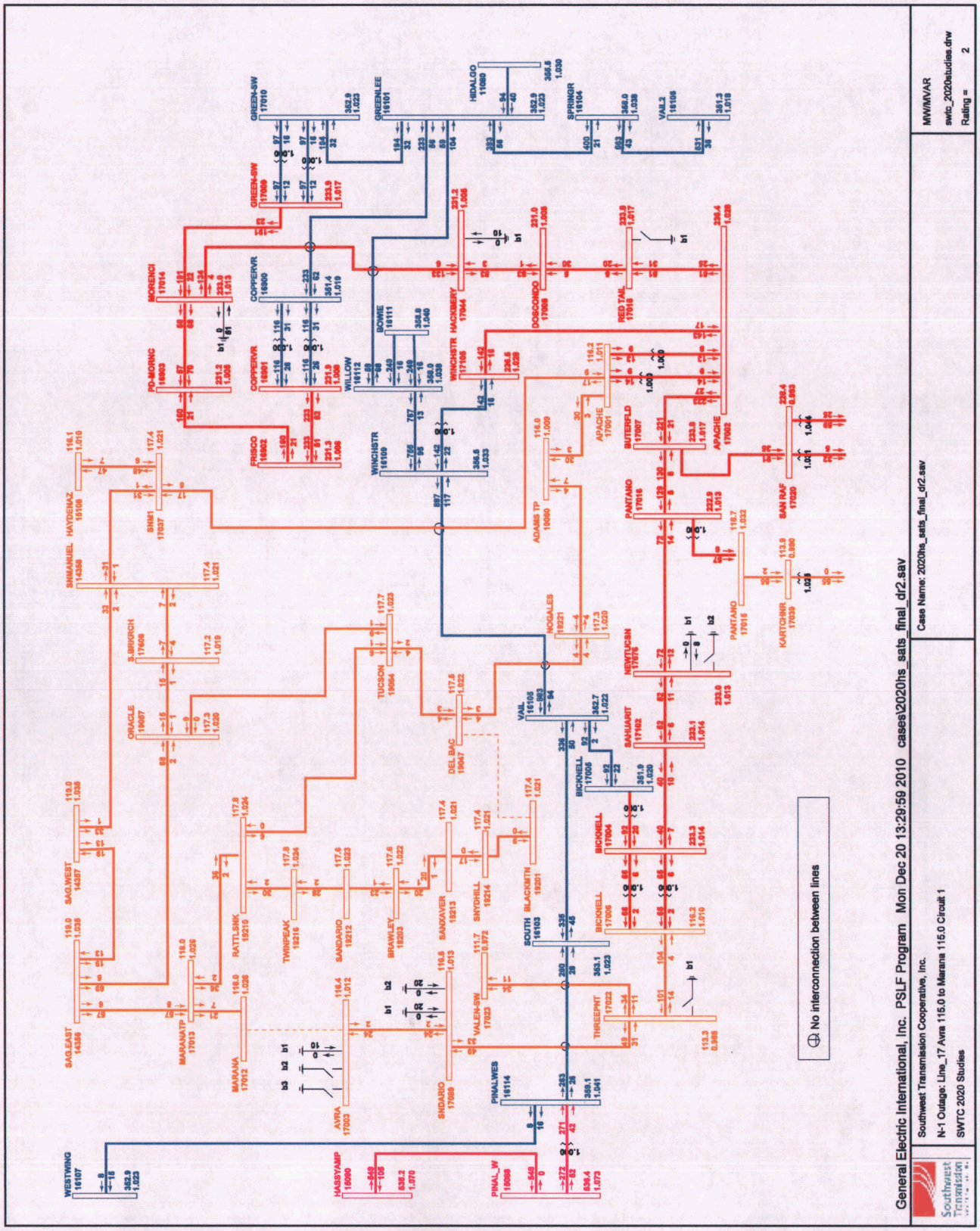
2020HS Southwest Transmission Cooperative Base System with Sahuarita to Bicknell 230 kV Line out of service



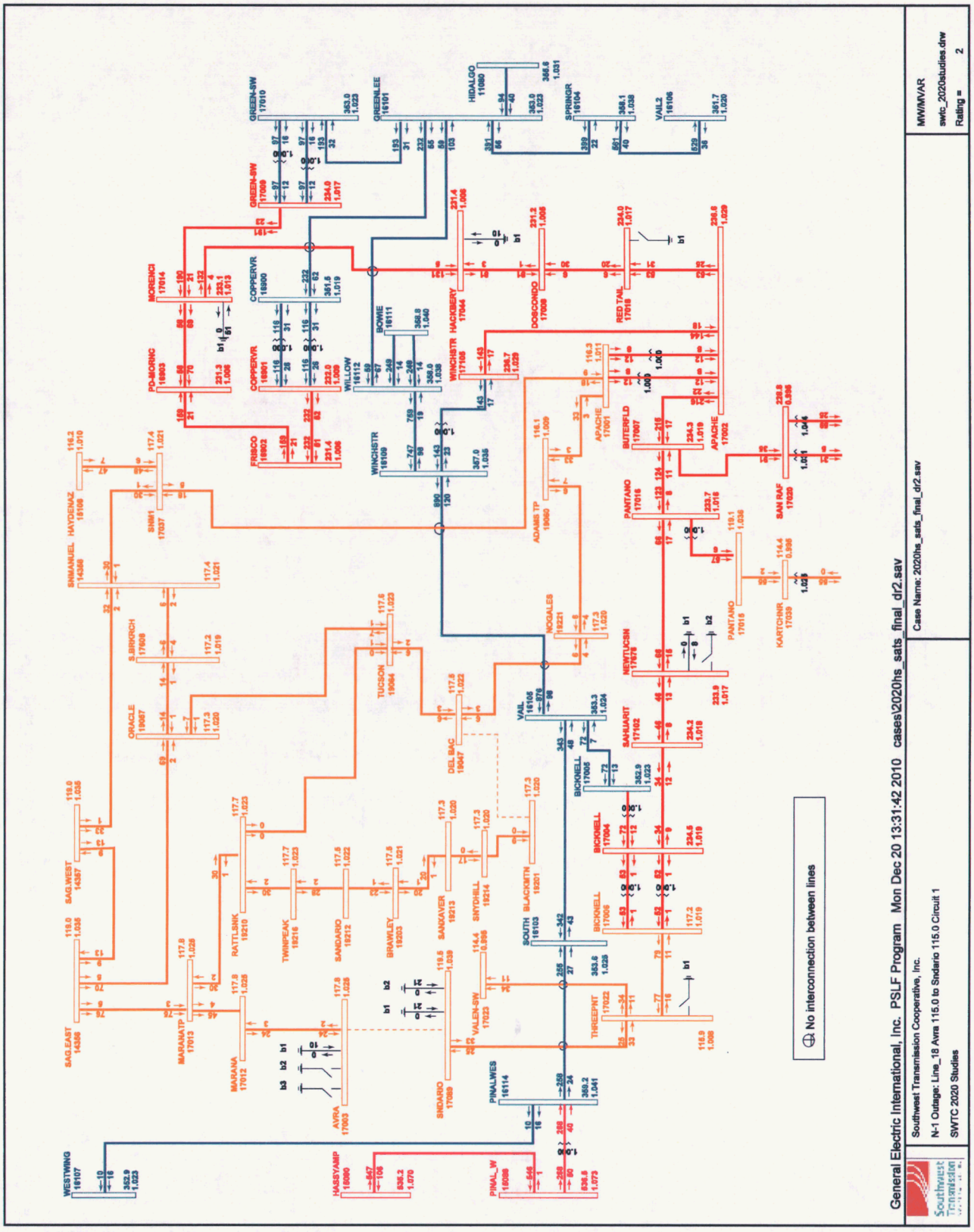
2020HS Southwest Transmission Cooperative Base System with Apache to SNM1 115 kV Line out of service



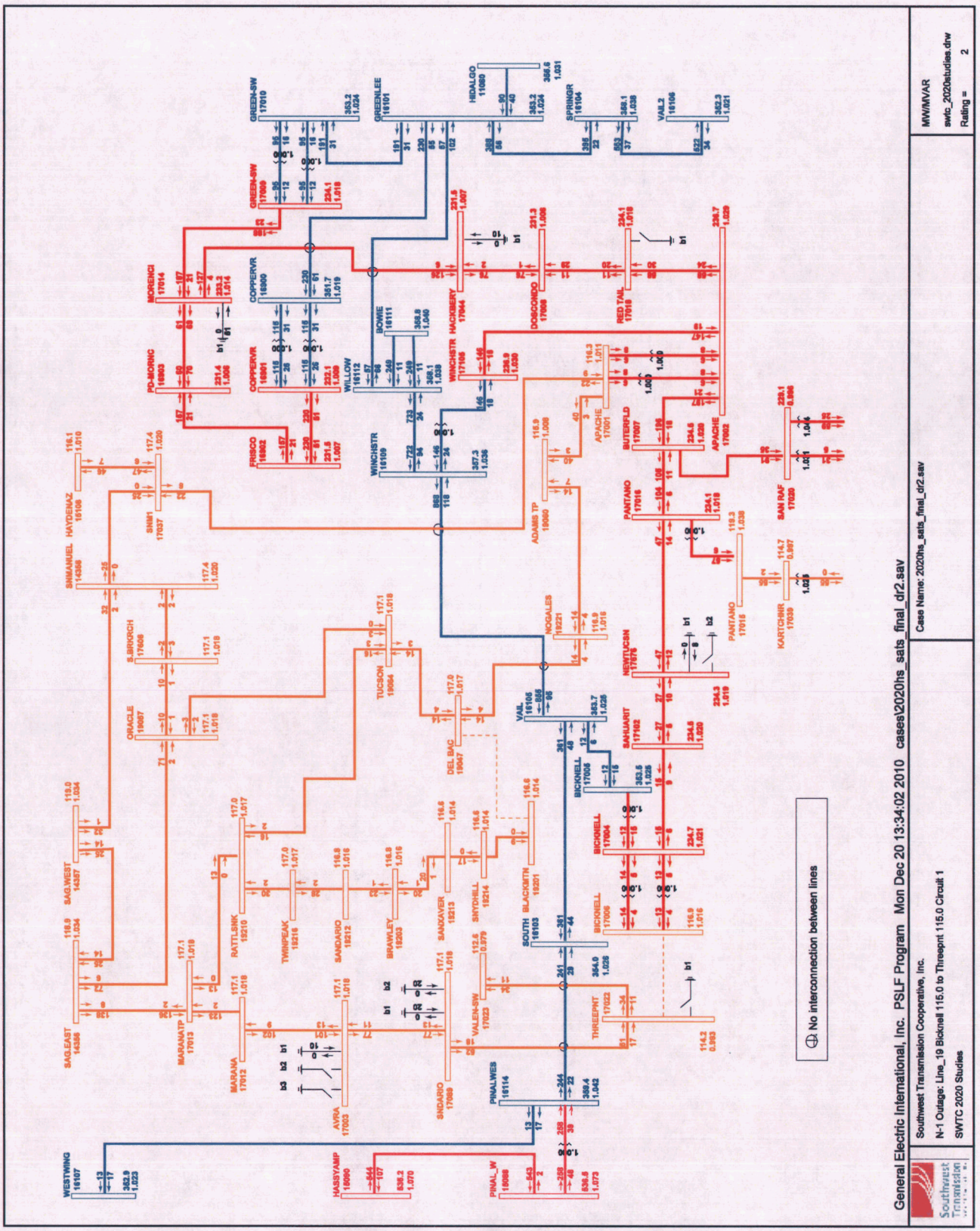
2020HS Southwest Transmission Cooperative Base System with Avra to Marana 115 kV Line out of service



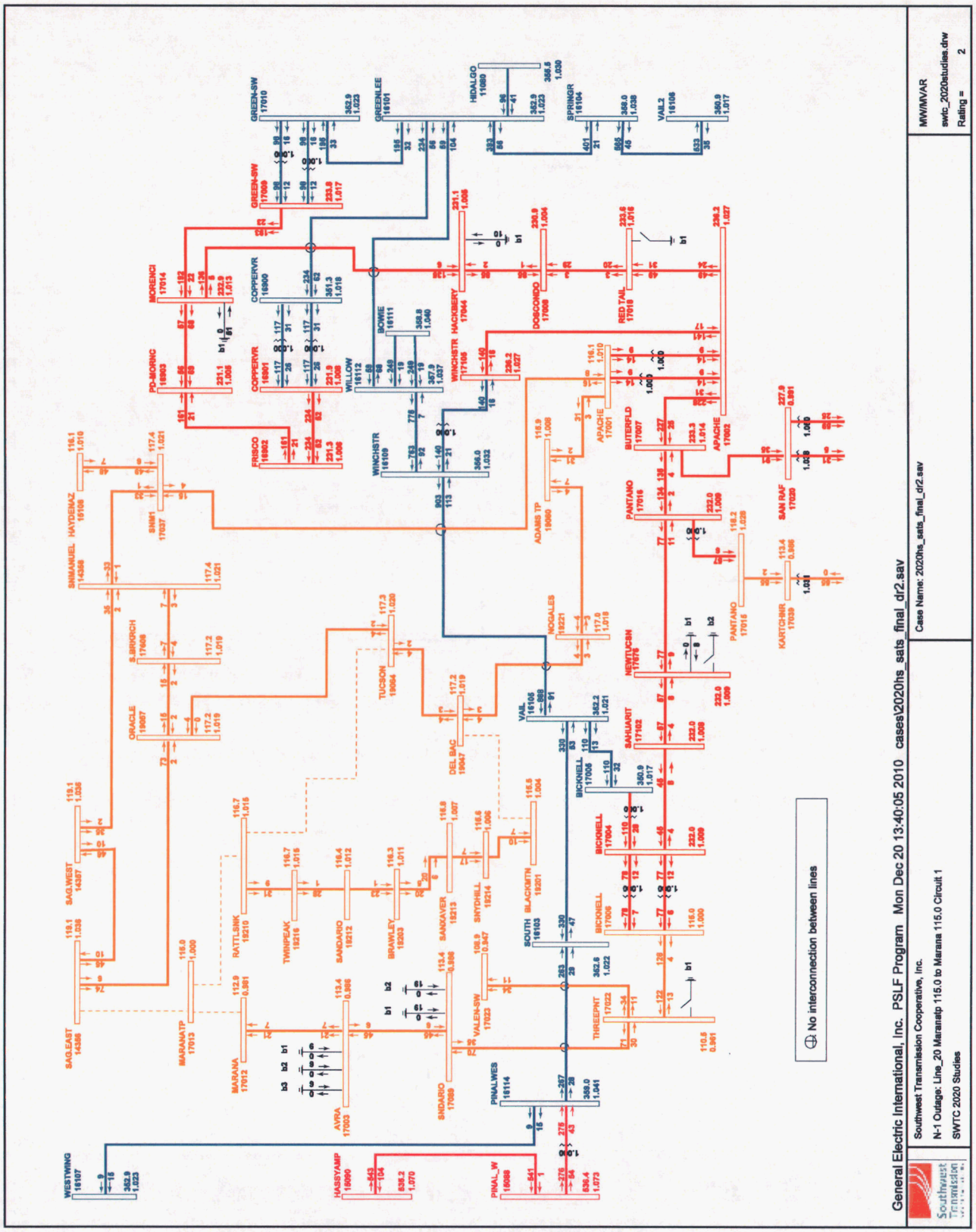
2020HS Southwest Transmission Cooperative Base System with Avra to Sandario 115 kV Line out of service



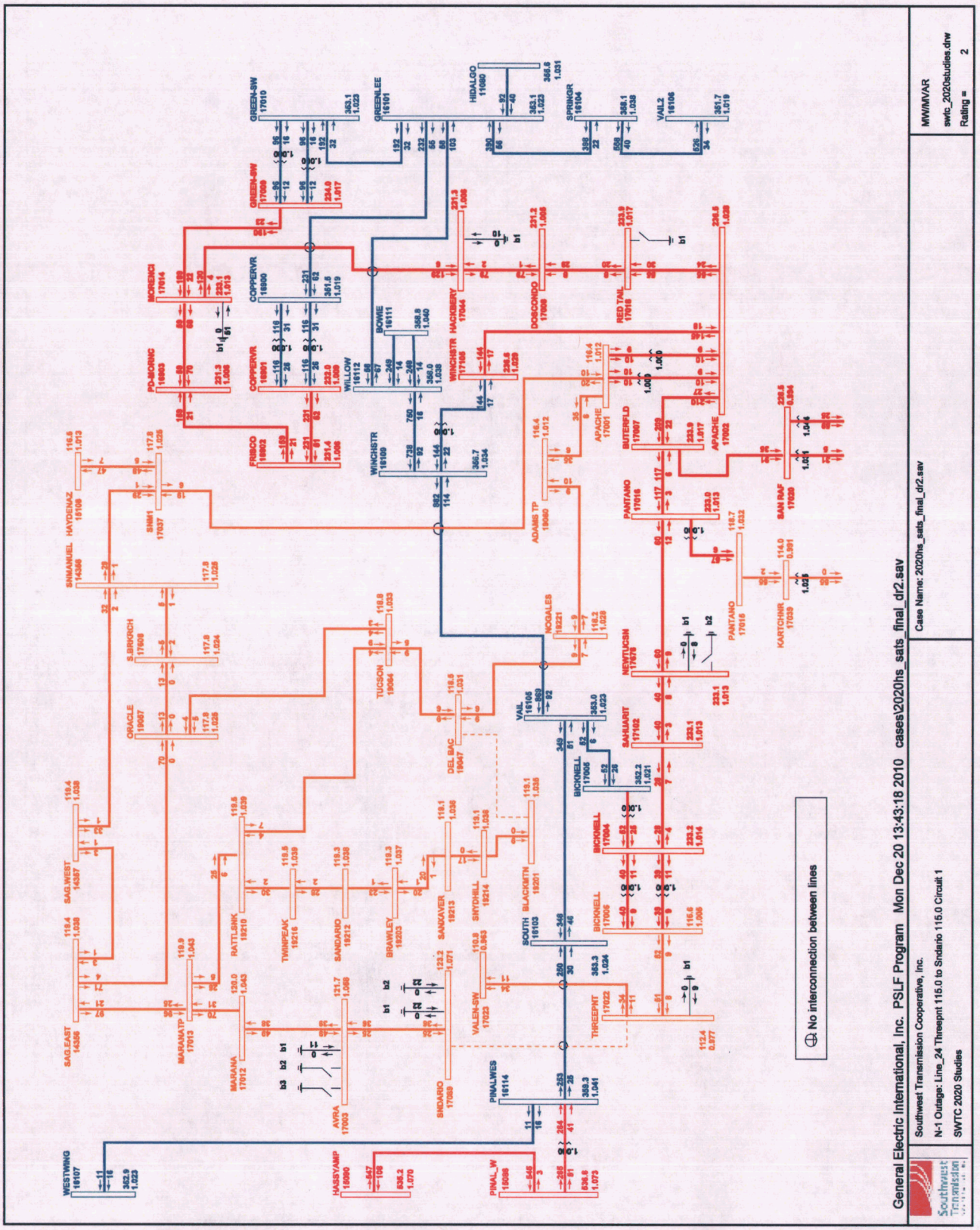
2020HS Southwest Transmission Cooperative Base System with Bicknell to Three Points 115 kV Line out of service



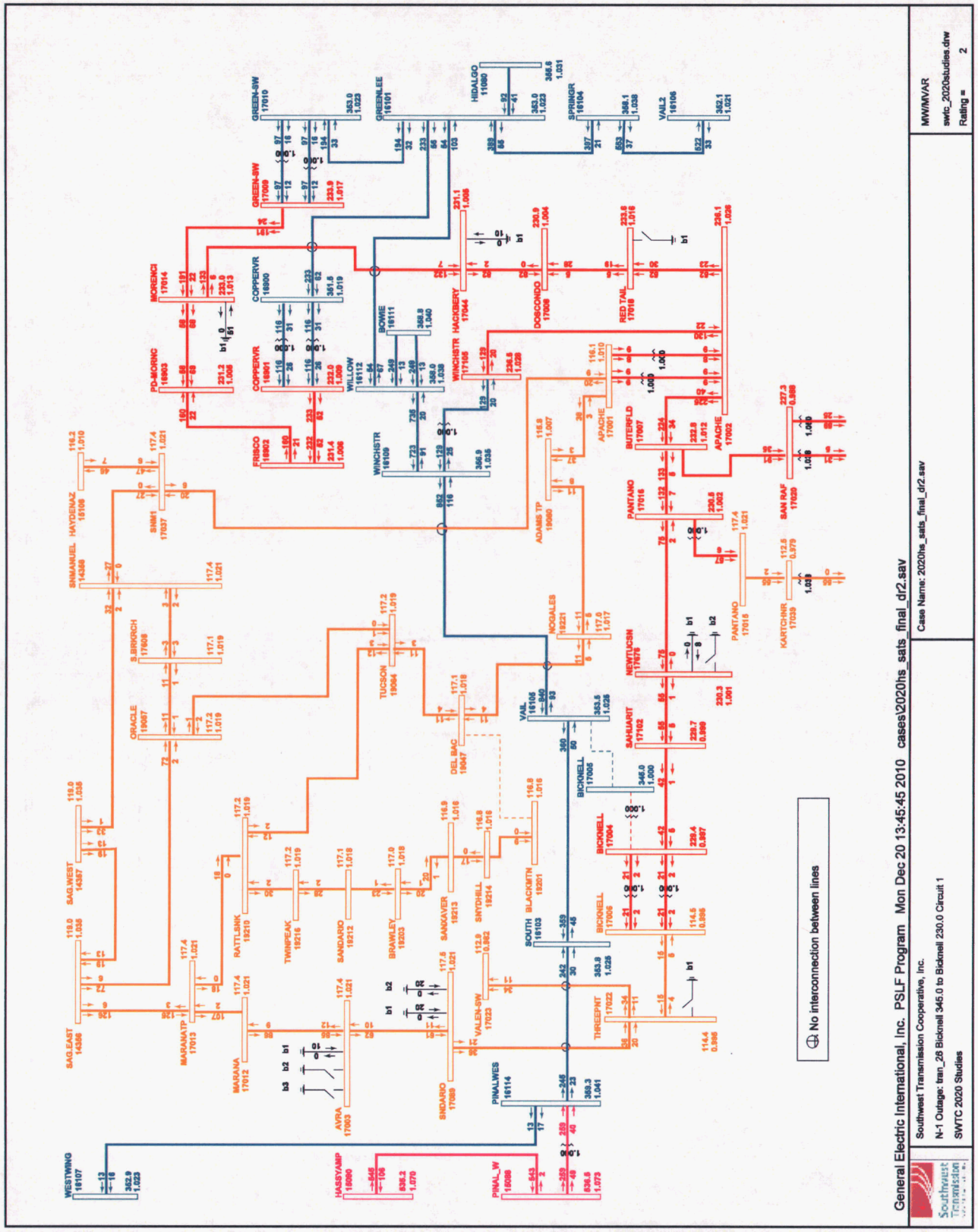
2020HS Southwest Transmission Cooperative Base System with Marana Tap to Marana 115 kV Line out of service



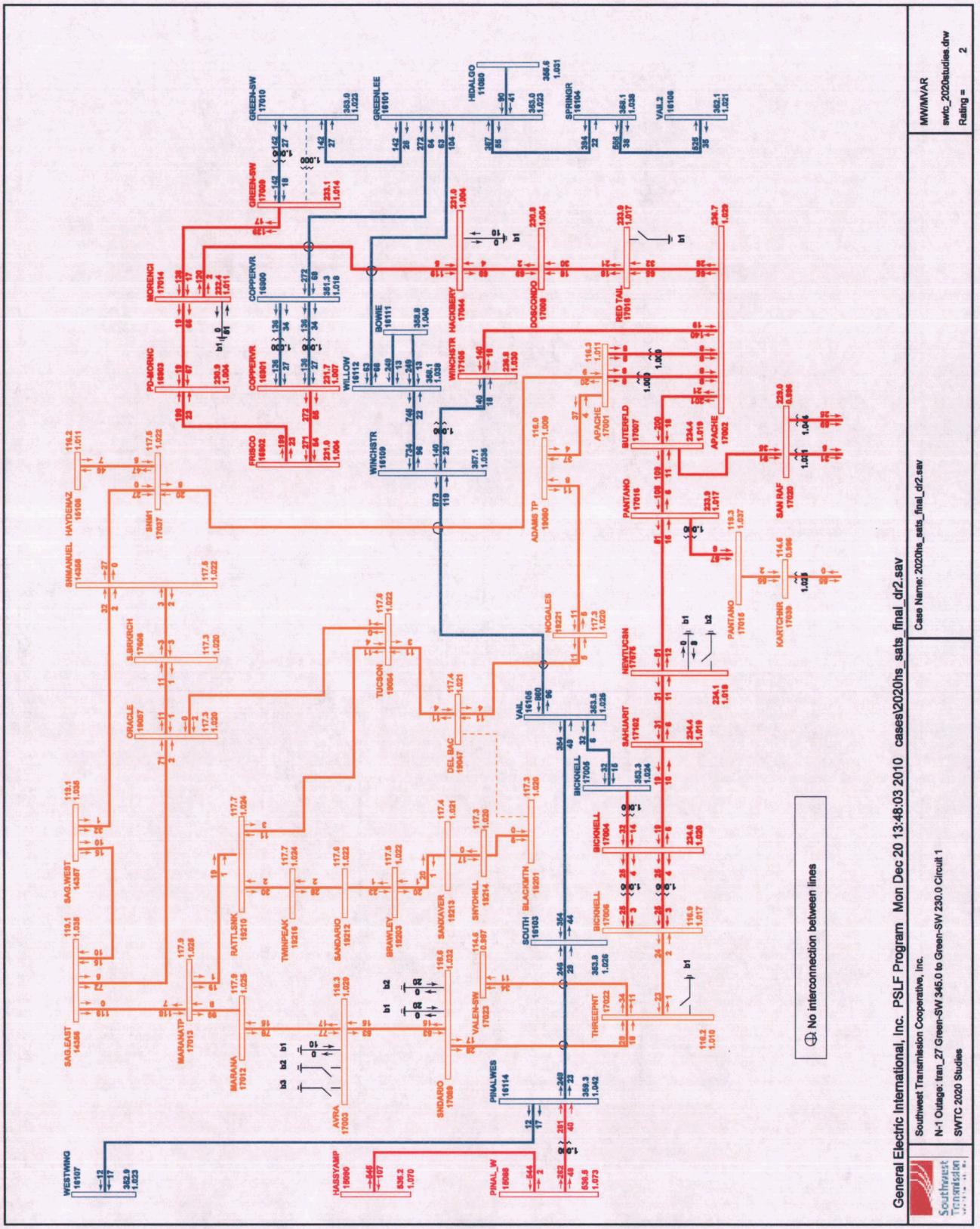
2020HS Southwest Transmission Cooperative Base System with Three Points to Sandario 115 kV Line out of service



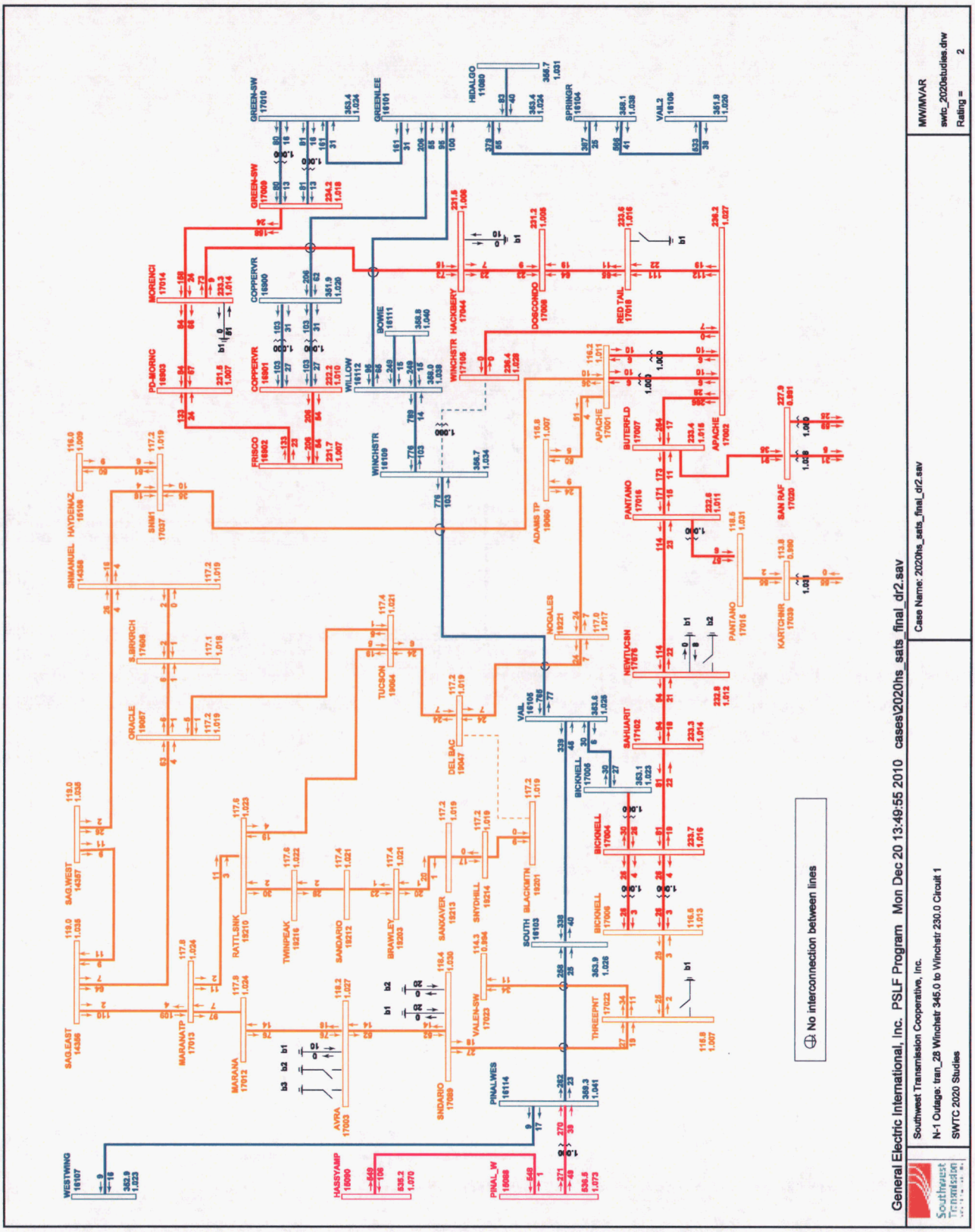
2020HS Southwest Transmission Cooperative Base System with Bicknell 345/230 kV Transformer out of service



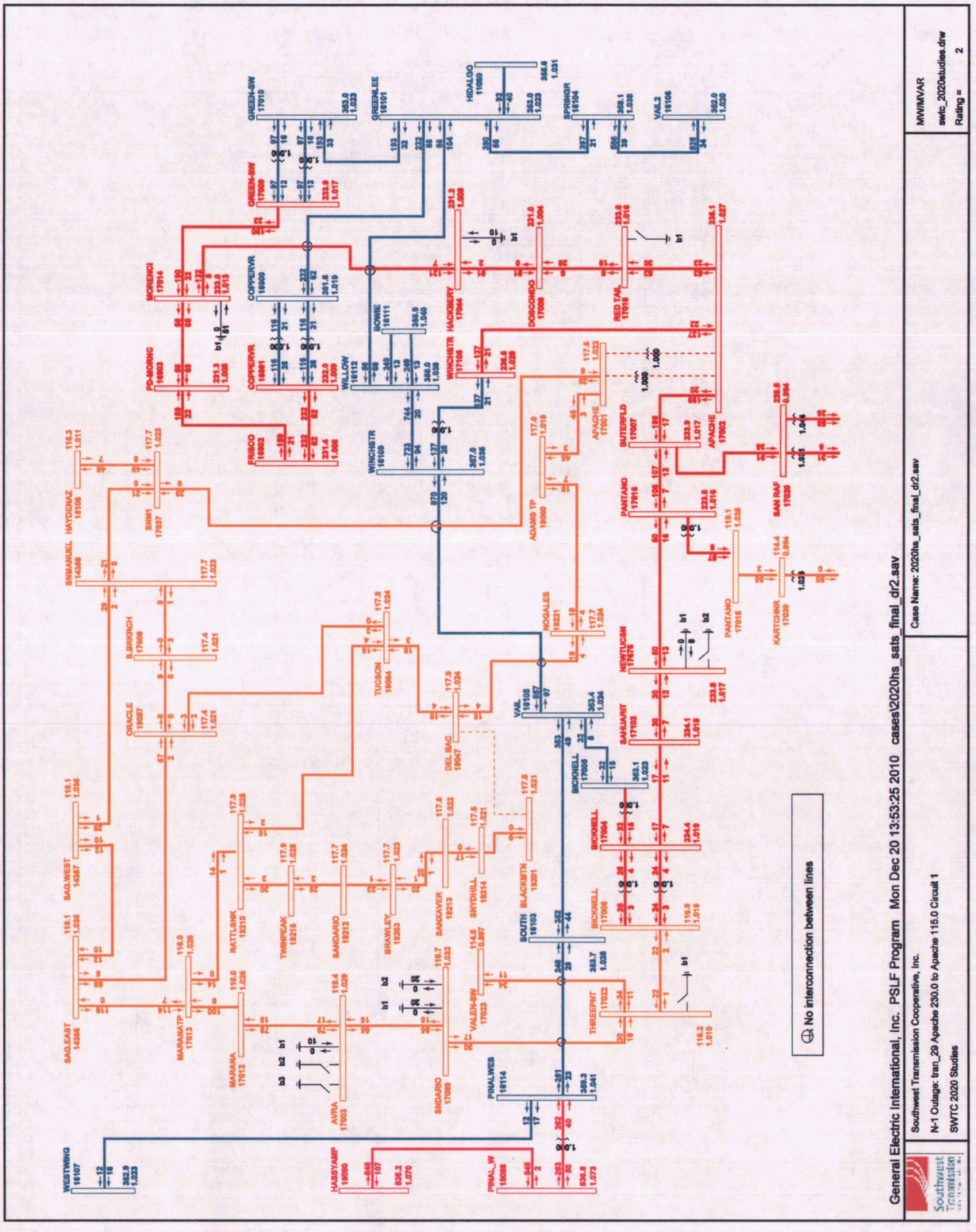
2020HS Southwest Transmission Cooperative Base System with one Greenlee 345/230 kV Transformer out of service



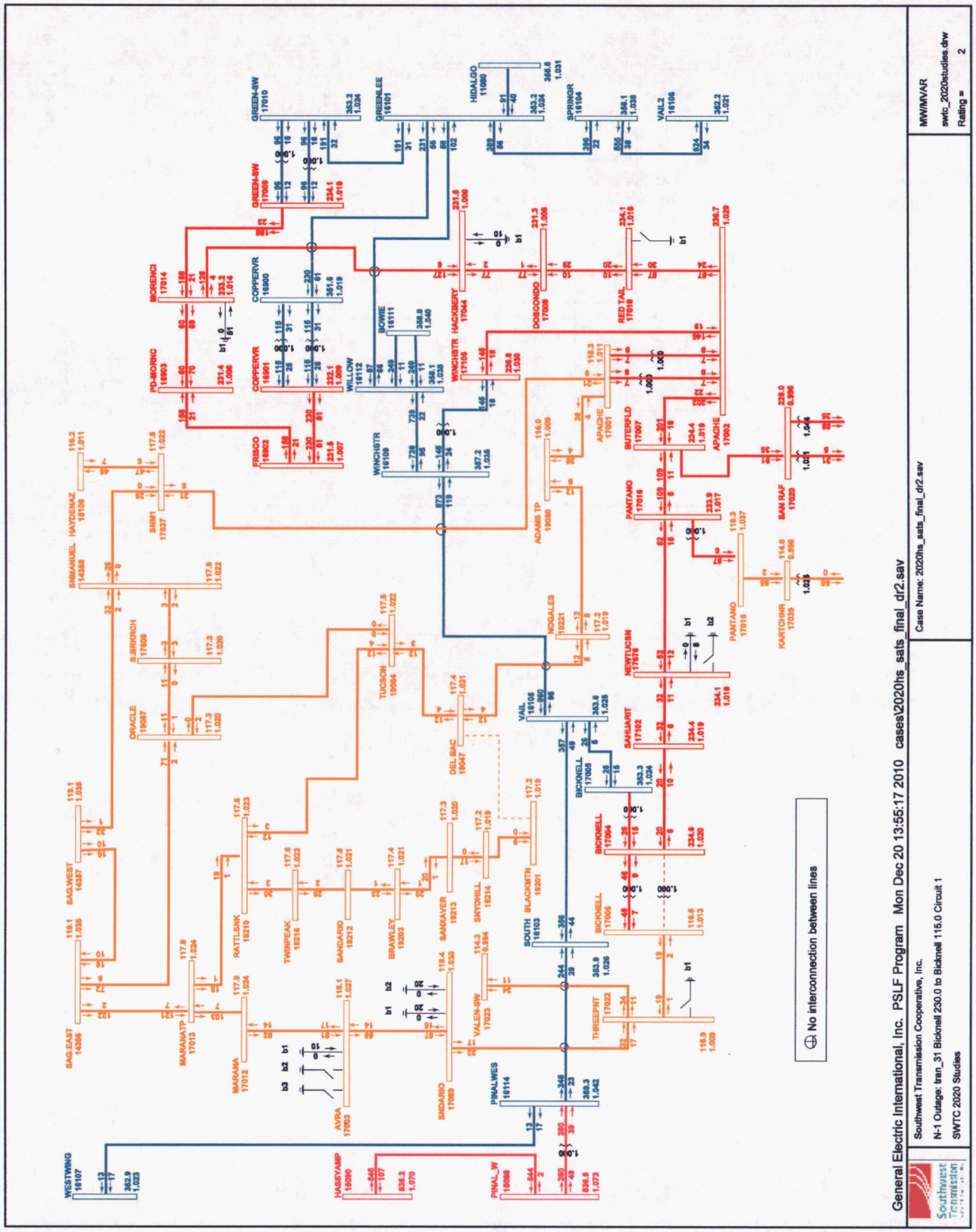
2020HS Southwest Transmission Cooperative Base System with Winchester 345/230 kV Transformer out of service



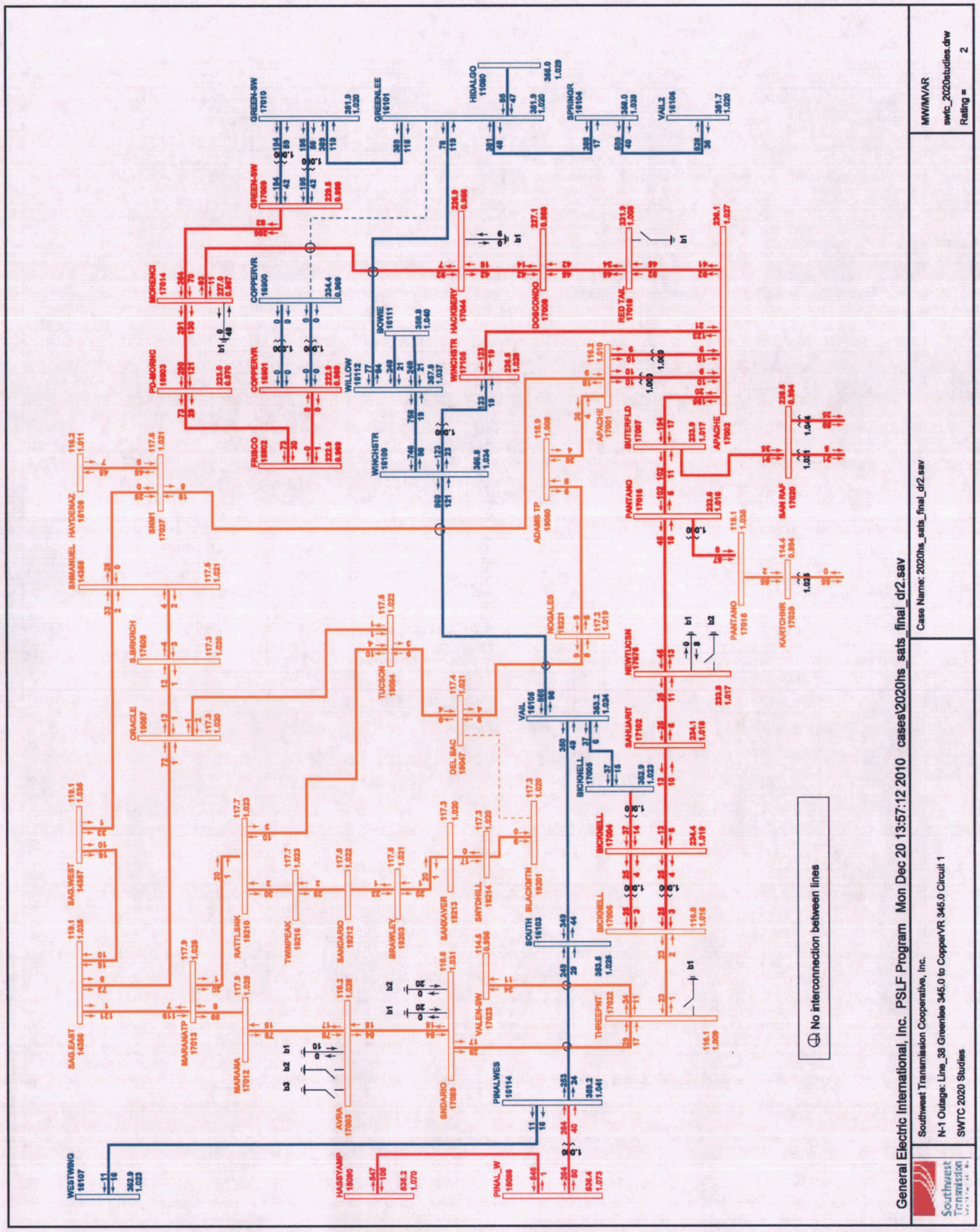
2020HS Southwest Transmission Cooperative Base System with one Apache 230/115 kV Transformer out of service



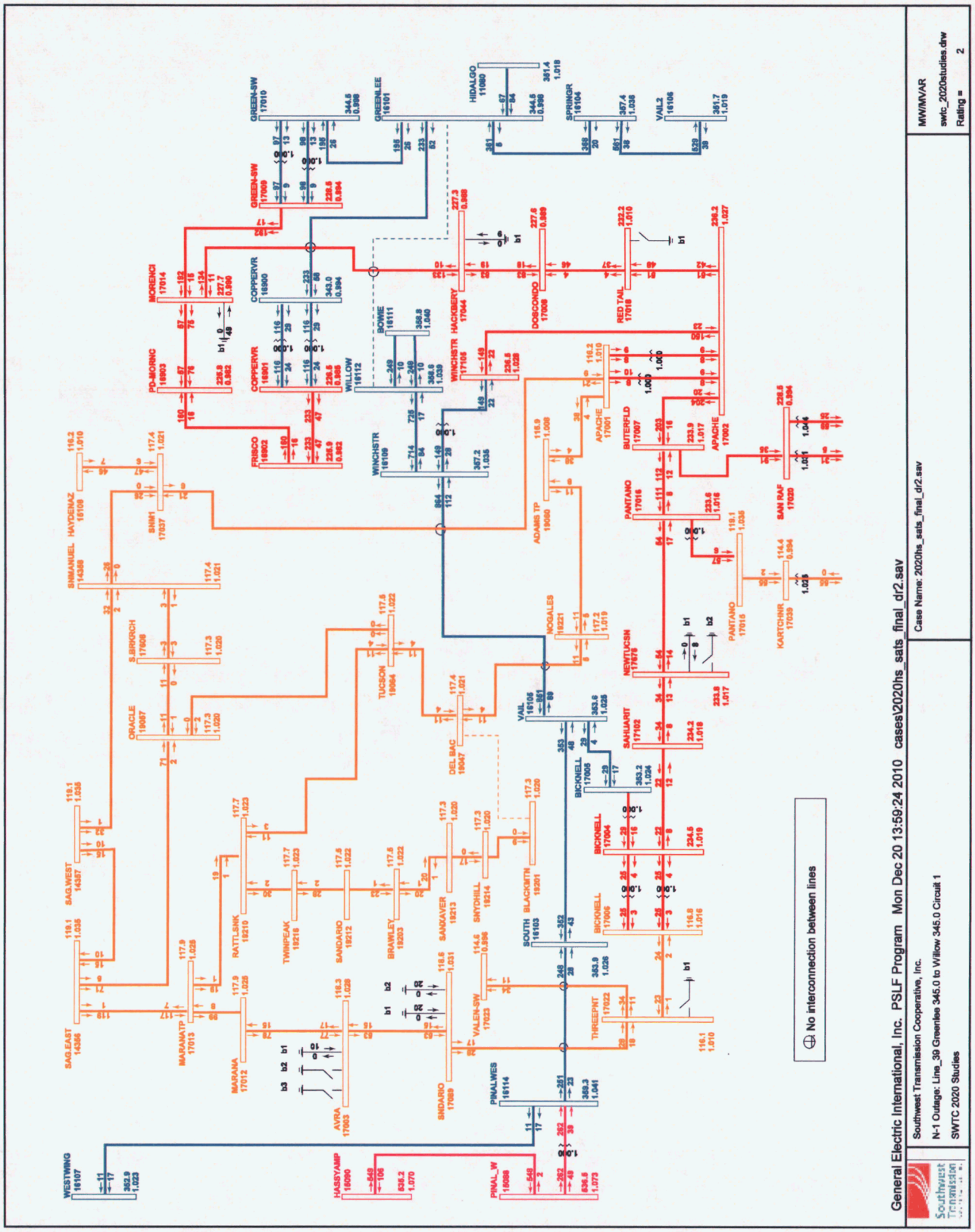
2020HS Southwest Transmission Cooperative Base System with one Bicknell 230/115 kV Transformer out of service



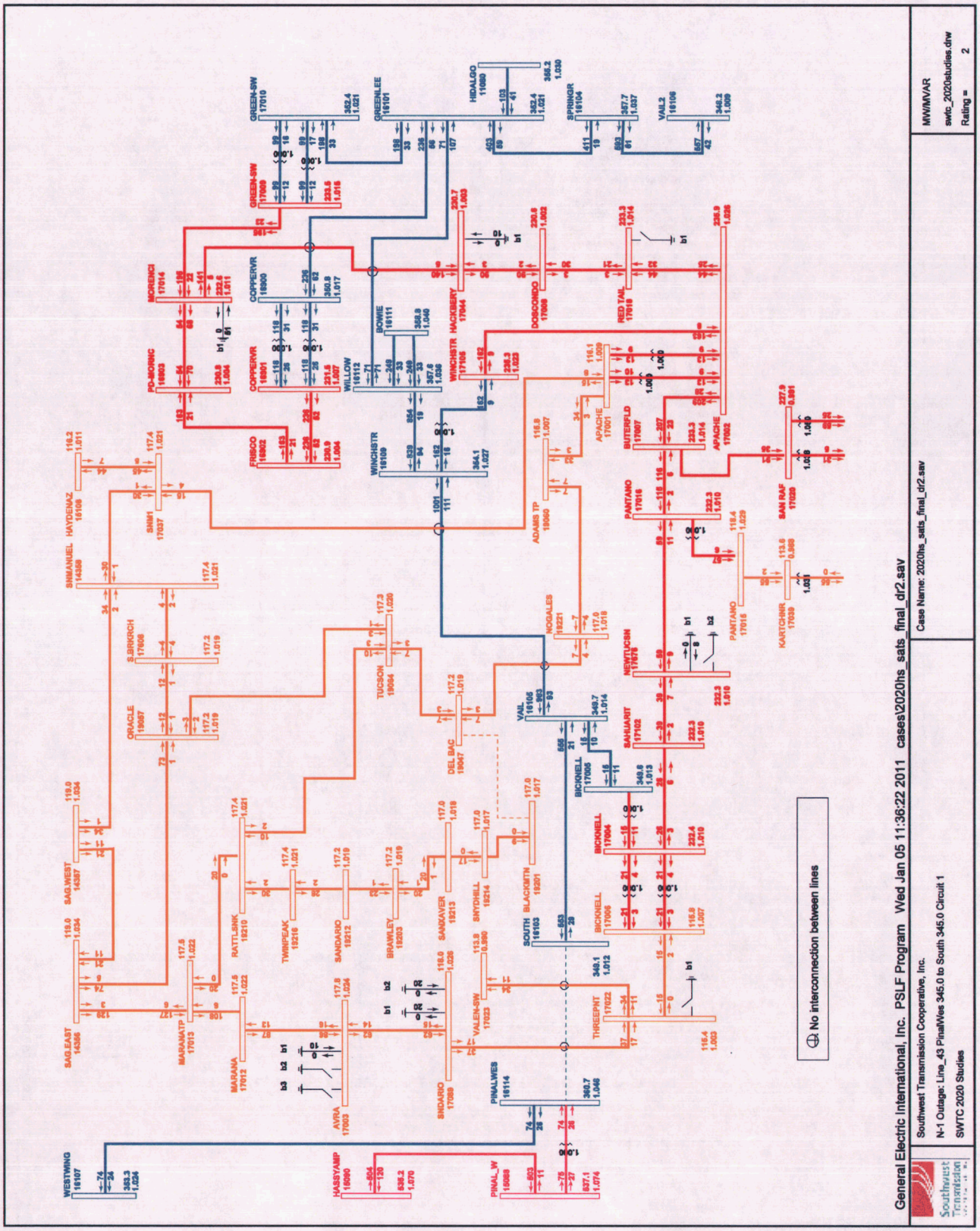
2020HS Southwest Transmission Cooperative Base System with Greenlee to Copper Verde 345 kV Line out of service



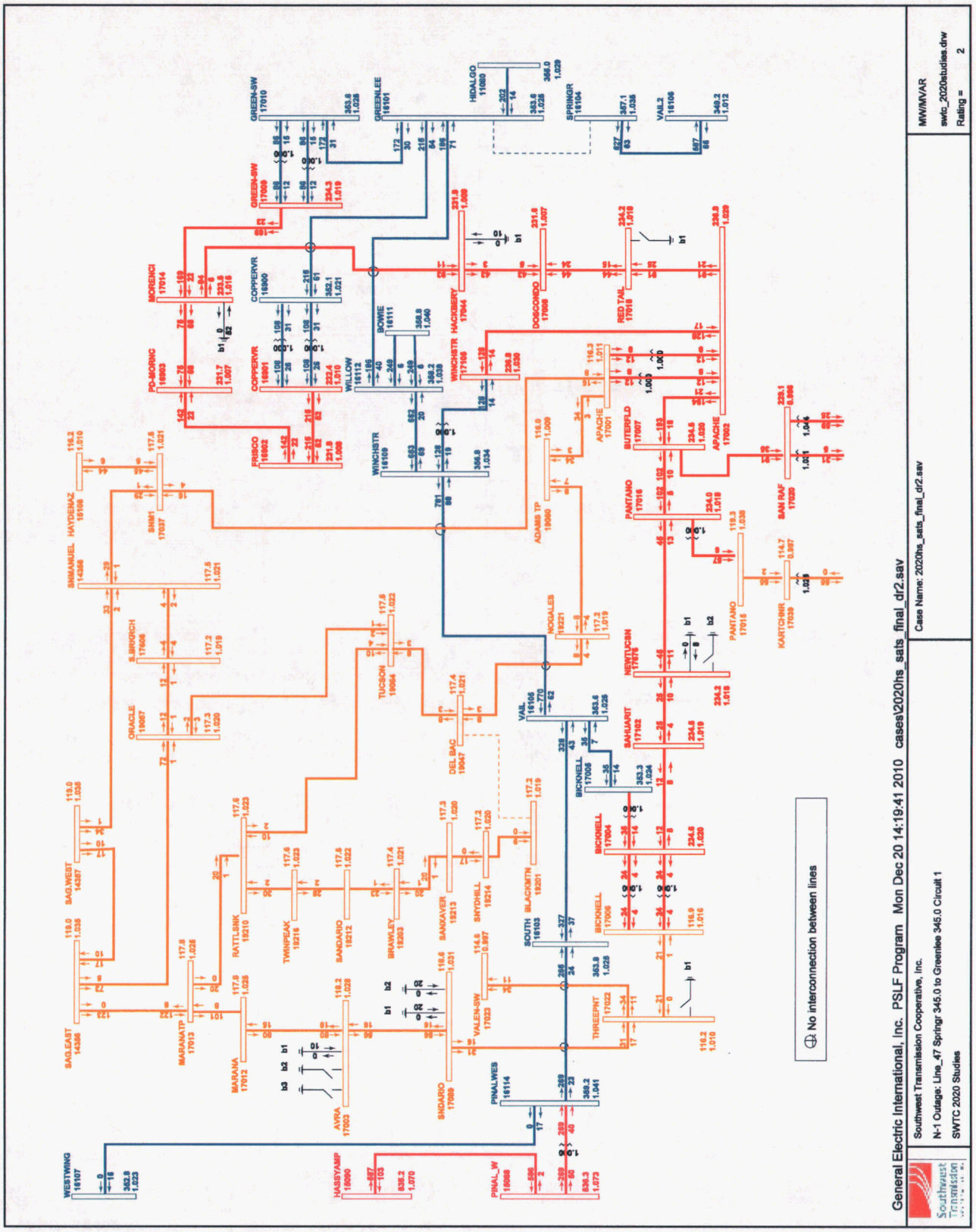
2020HS Southwest Transmission Cooperative Base System with Greenlee to Willow 345 kV Line out of service



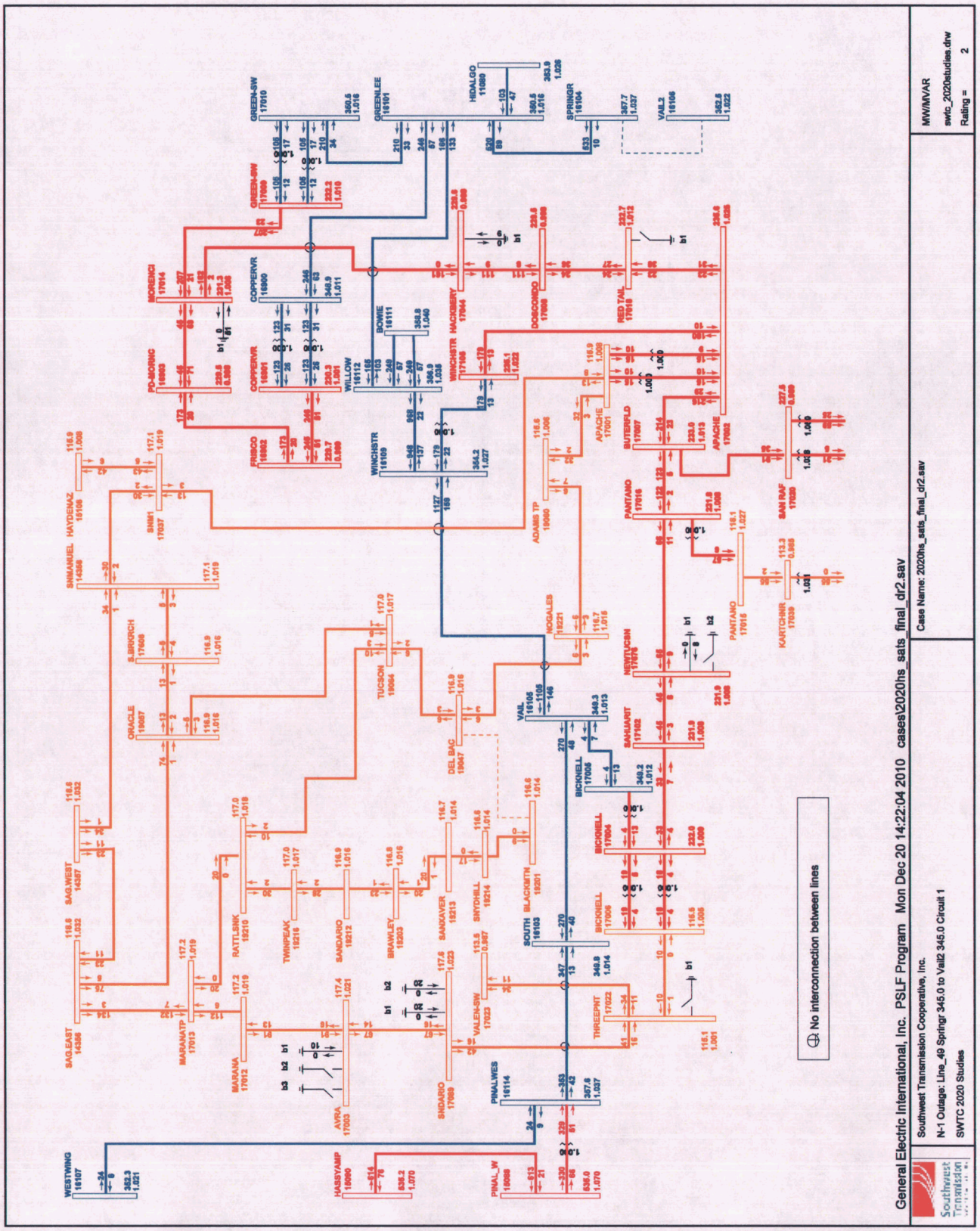
2020HS Southwest Transmission Cooperative Base System with Pinal West to South 345 kV Line out of service



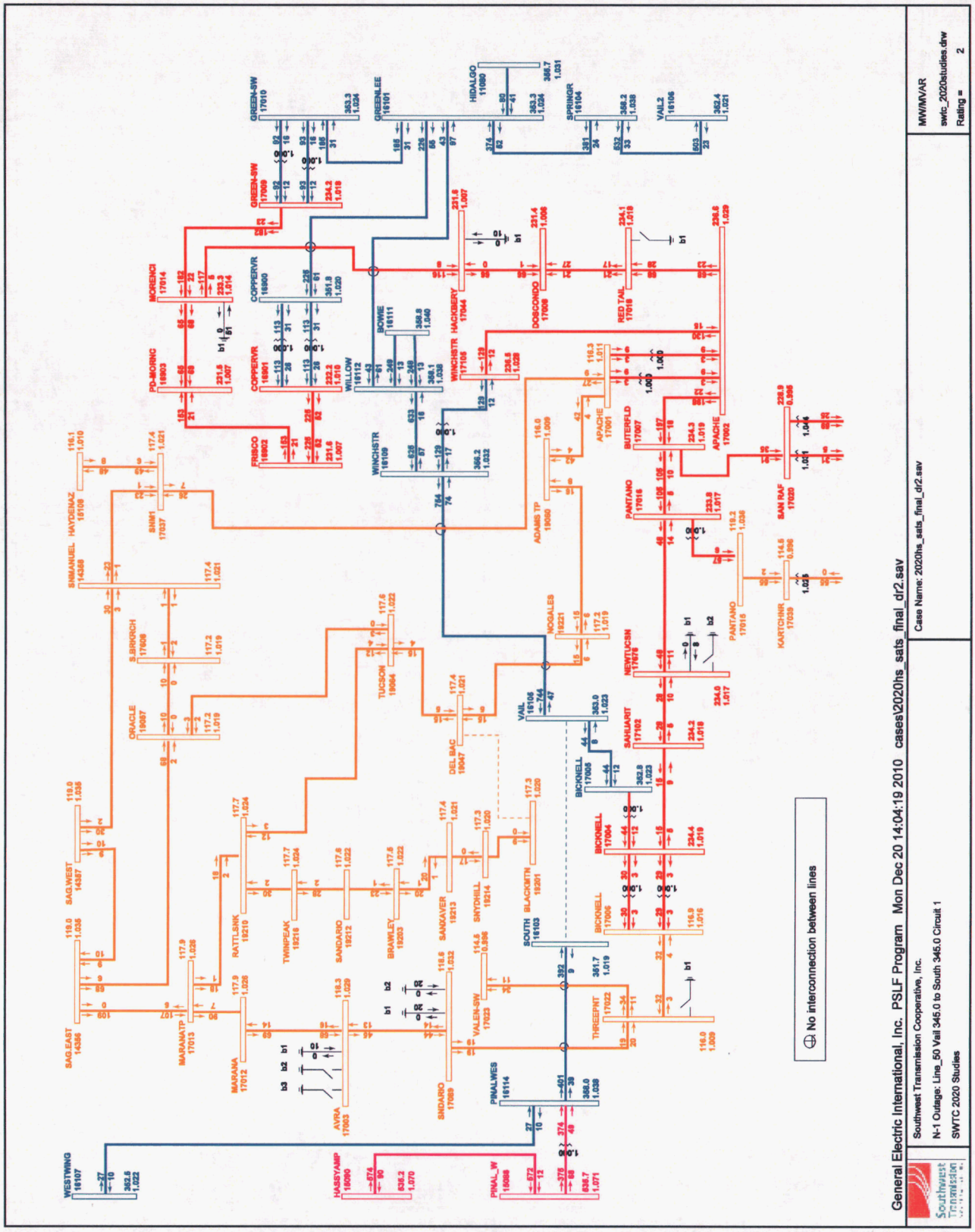
2020HS Southwest Transmission Cooperative Base System with Springerville to Greenlee 345 kV Line out of service



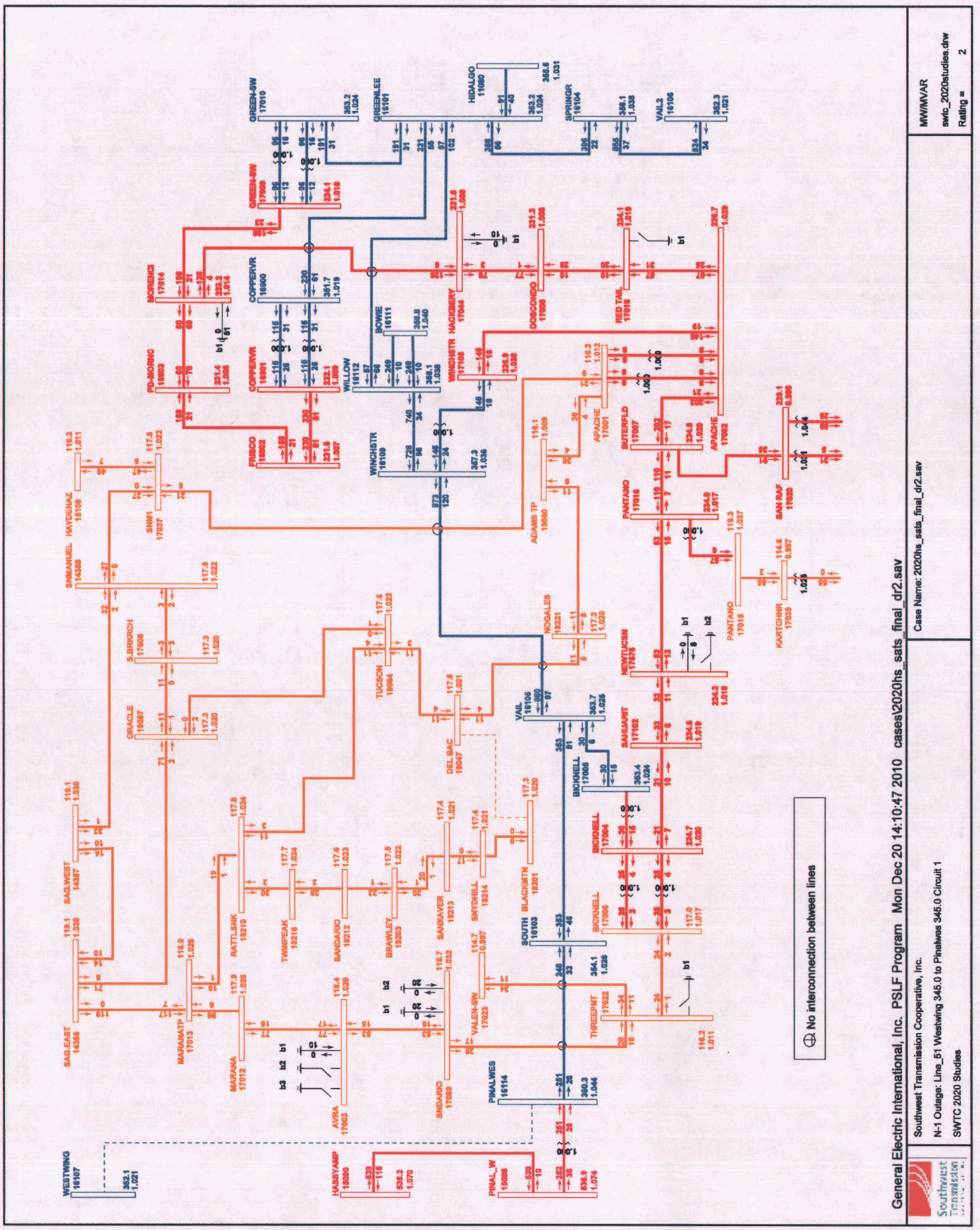
2020HS Southwest Transmission Cooperative Base System with Springerville to Vail2 345 kV Line out of service



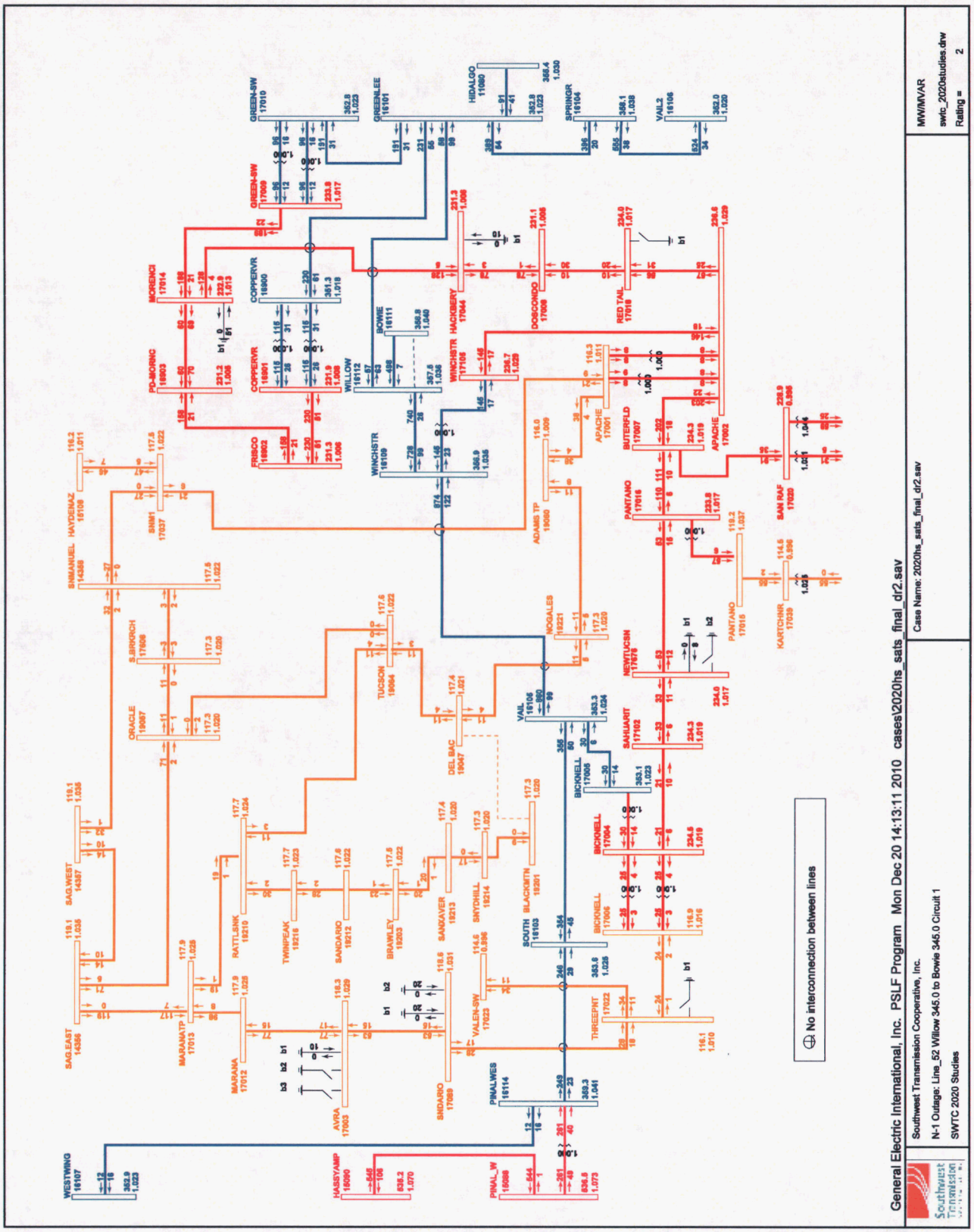
2020HS Southwest Transmission Cooperative Base System with Vail to South 345 kV Line out of service



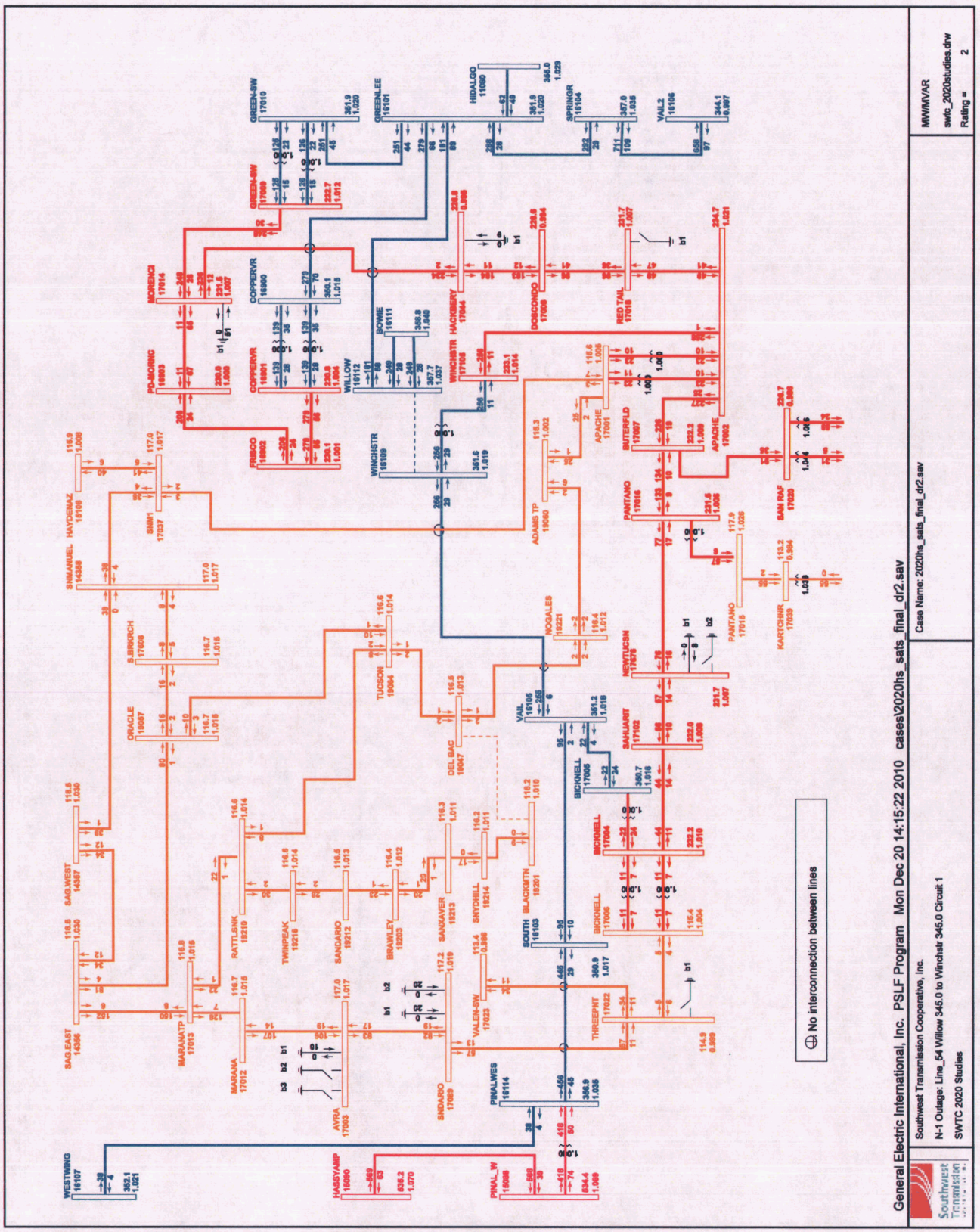
2020HS Southwest Transmission Cooperative Base System with Westwing to Pinal West 345 kV Line out of service



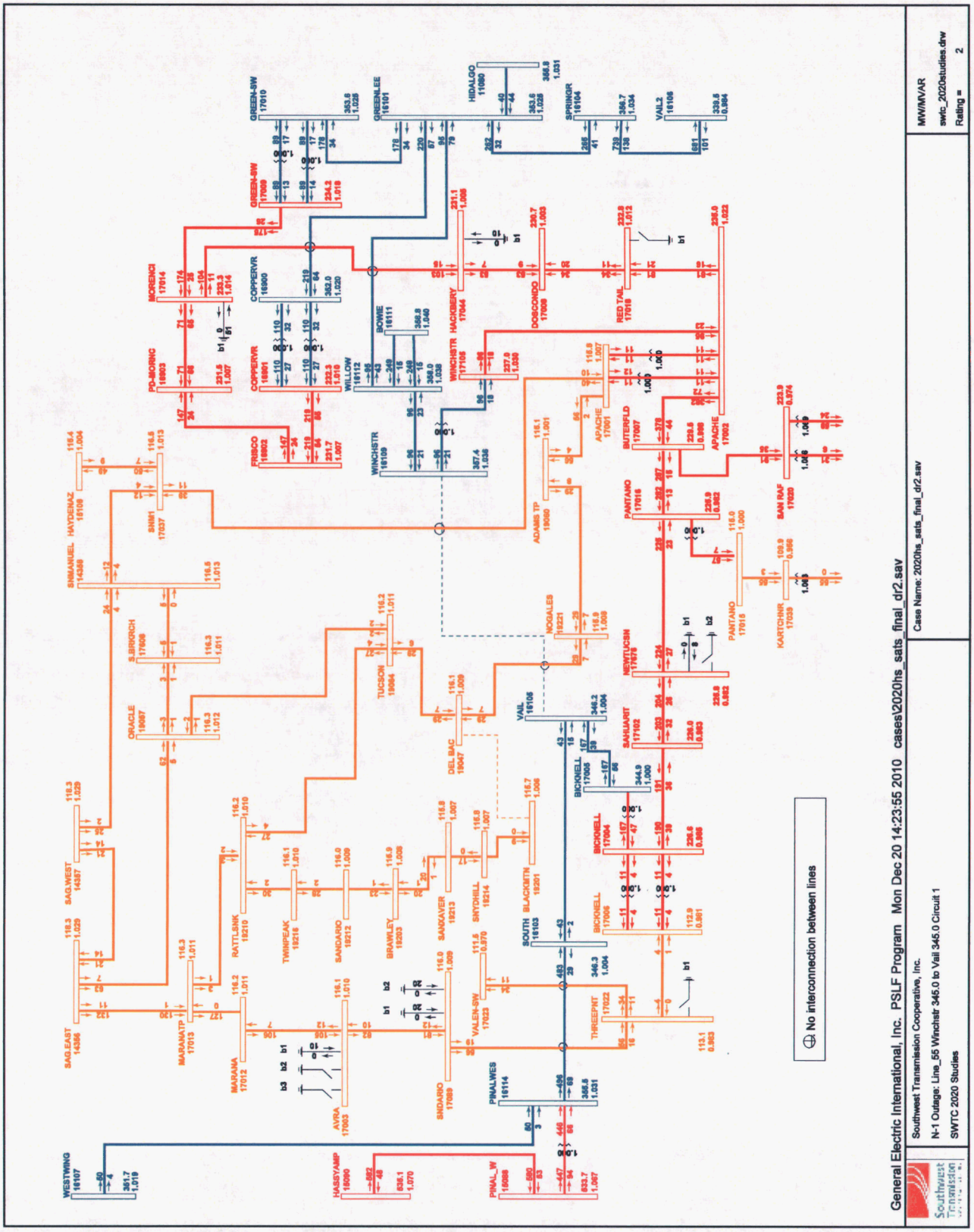
2020HS Southwest Transmission Cooperative Base System with one Willow to Bowie 345 kV Line out of service



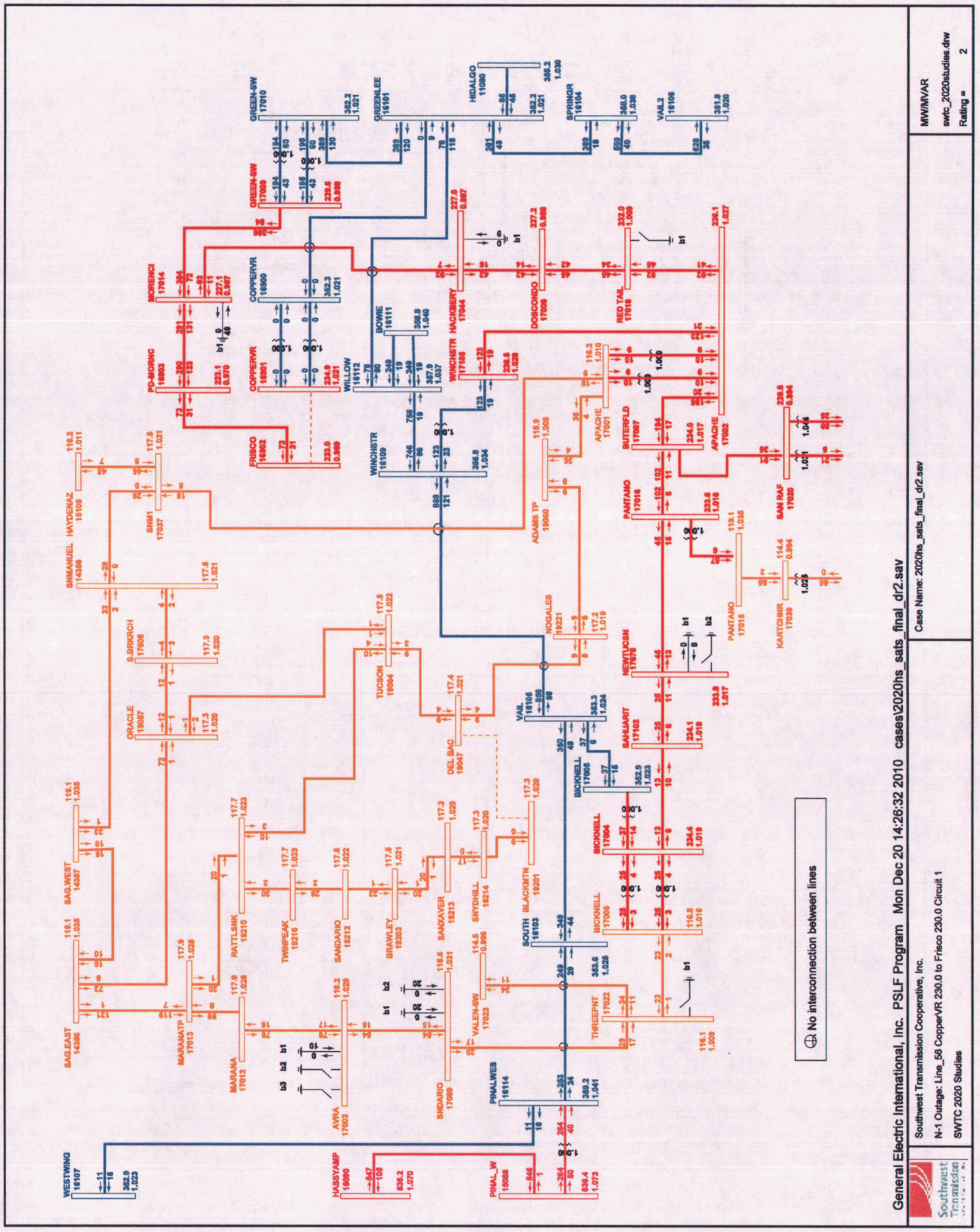
2020HS Southwest Transmission Cooperative Base System with Willow to Winchester 345 kV Line out of service



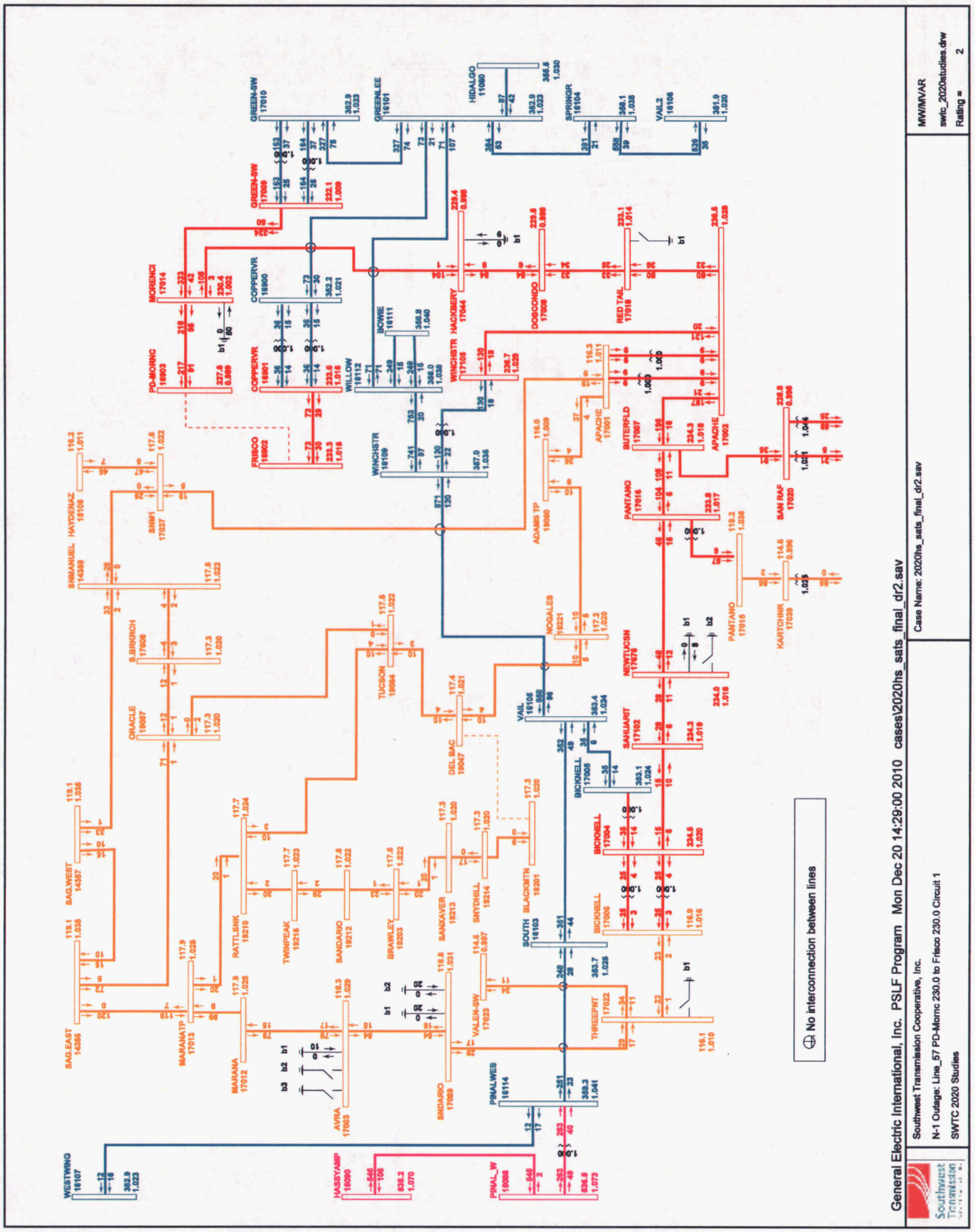
2020HS Southwest Transmission Cooperative Base System with Winchester to Vail 345 kV Line out of service



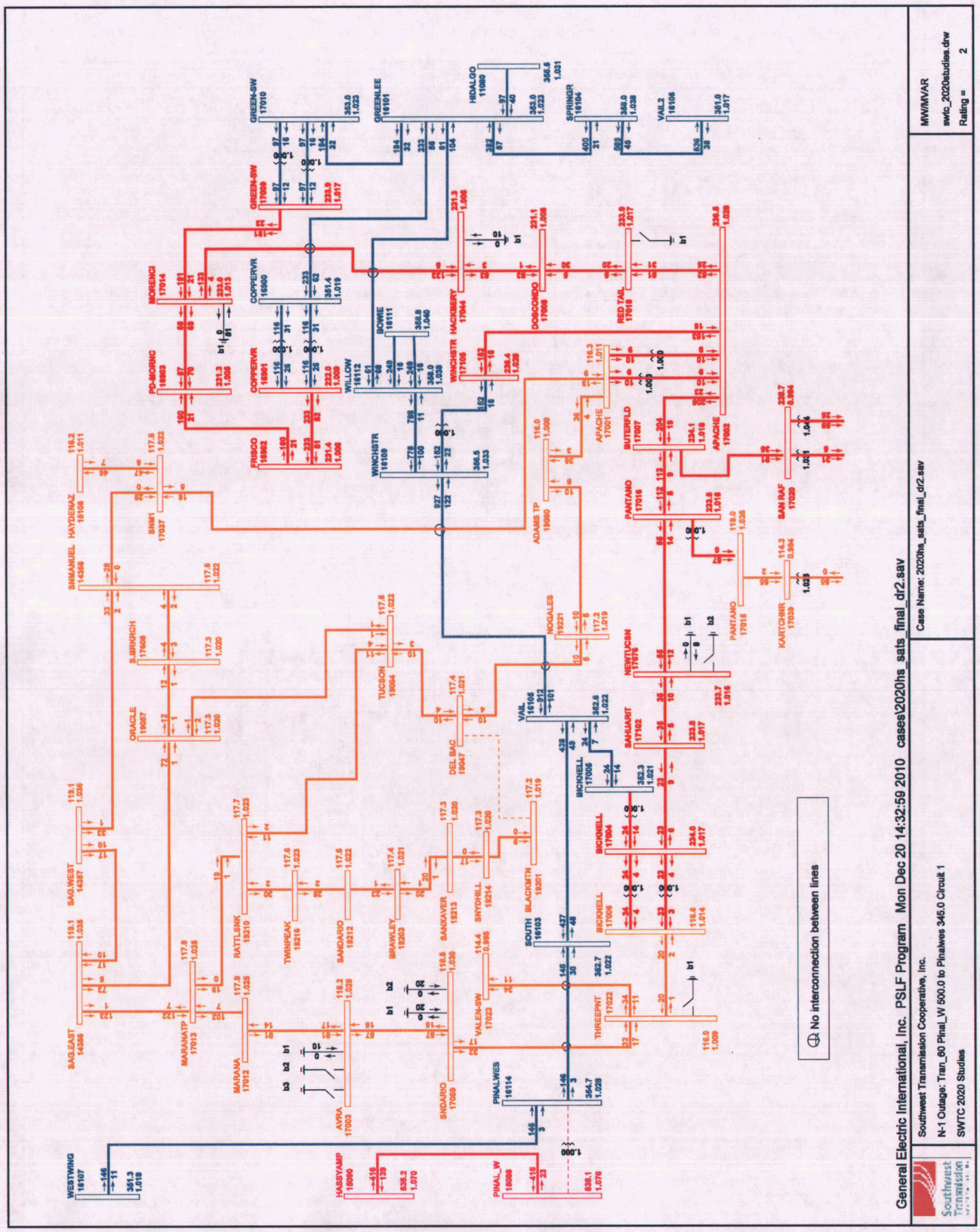
2020HS Southwest Transmission Cooperative Base System with Copper Verde to Frisco 230 kV Line out of service



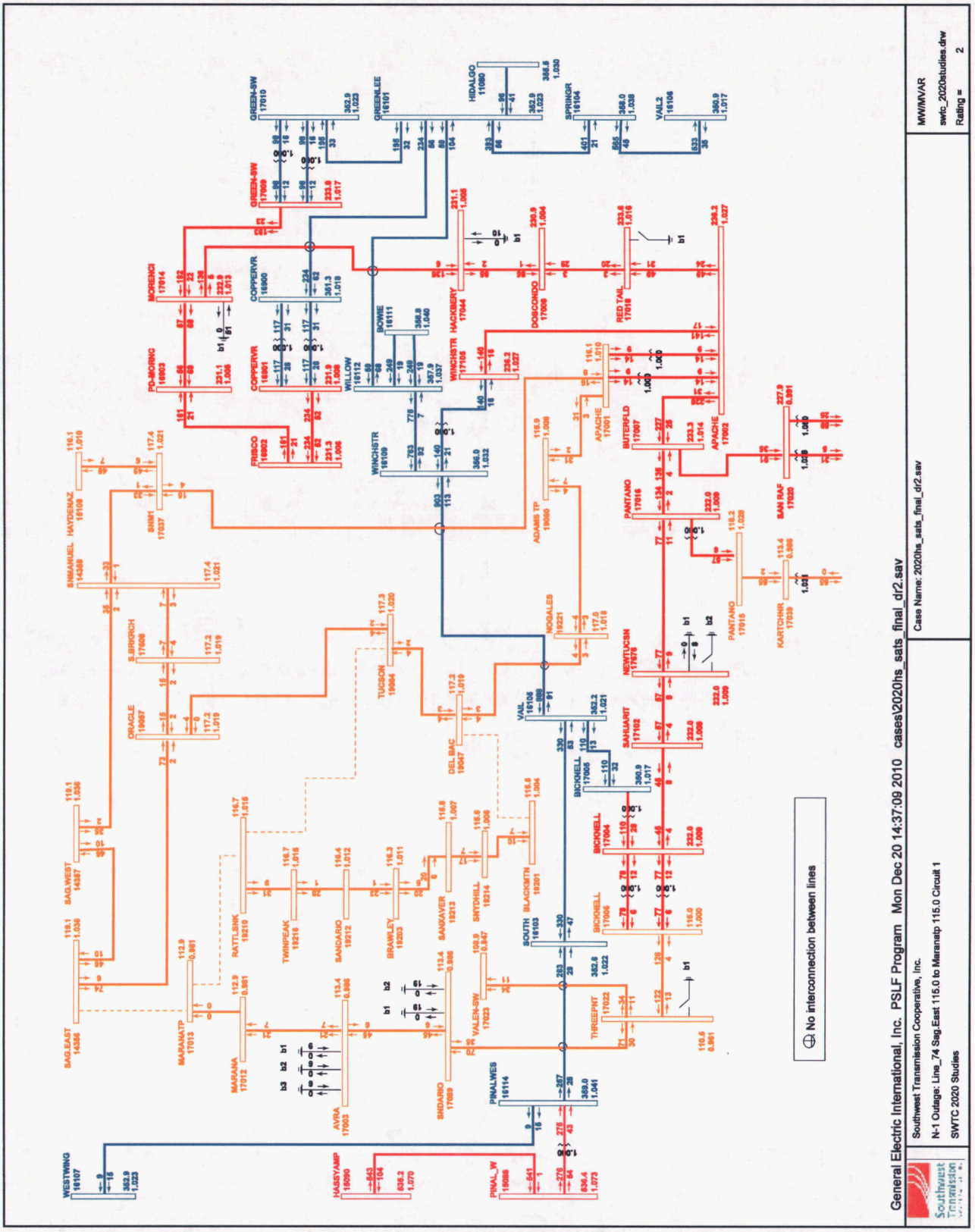
2020HS Southwest Transmission Cooperative Base System with PD Morenci to Frisco 230 kV Line out of service



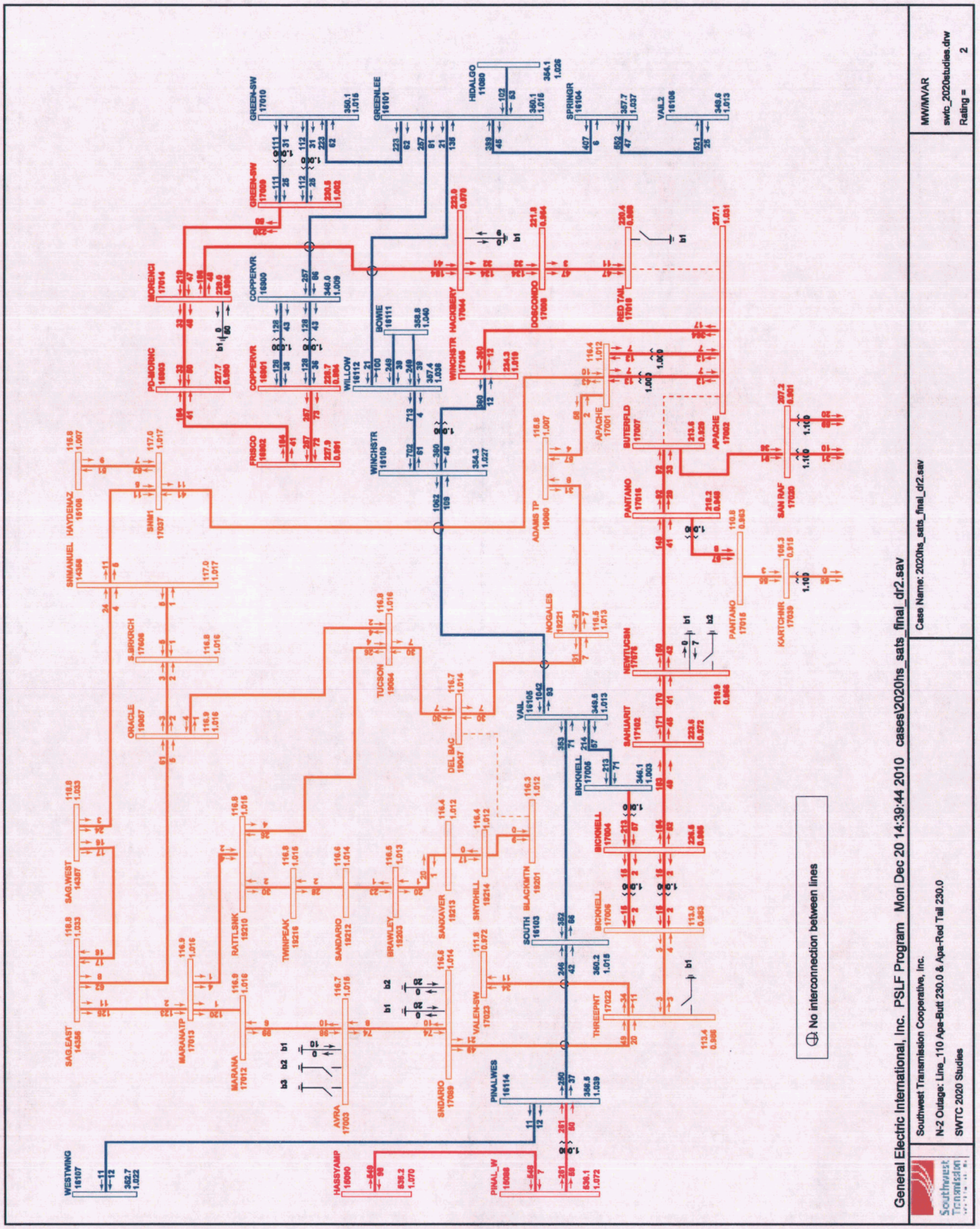
2020HS Southwest Transmission Cooperative Base System with Pinal West 500/345 kV Transformer out of service



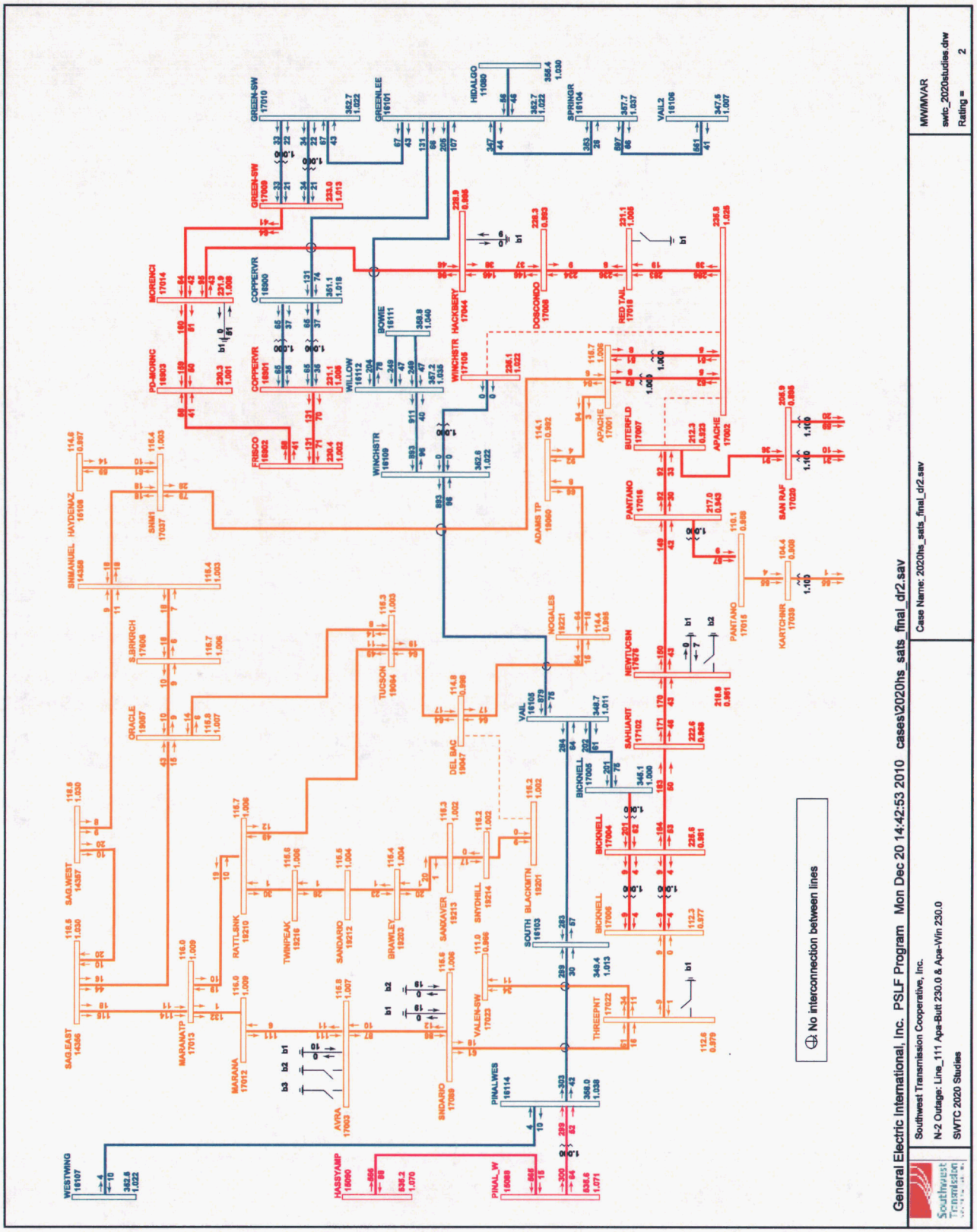
2020HS Southwest Transmission Cooperative Base System with Saguaro East to Marana Tap 115 kV Line out of service



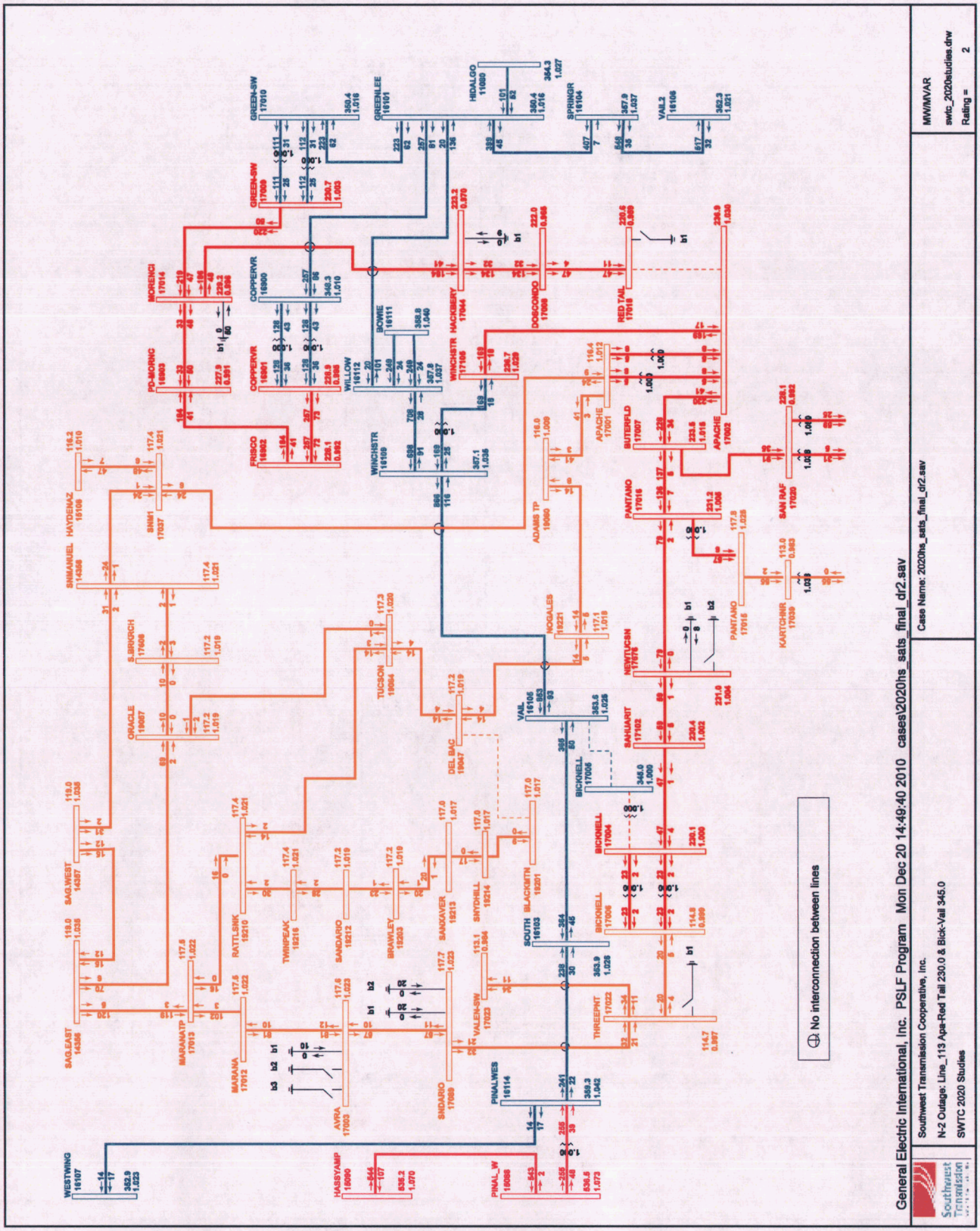
2020HS Southwest Transmission Cooperative Base System with Apache to Butterfield & Apache to Redtail 230 kV Lines out of service



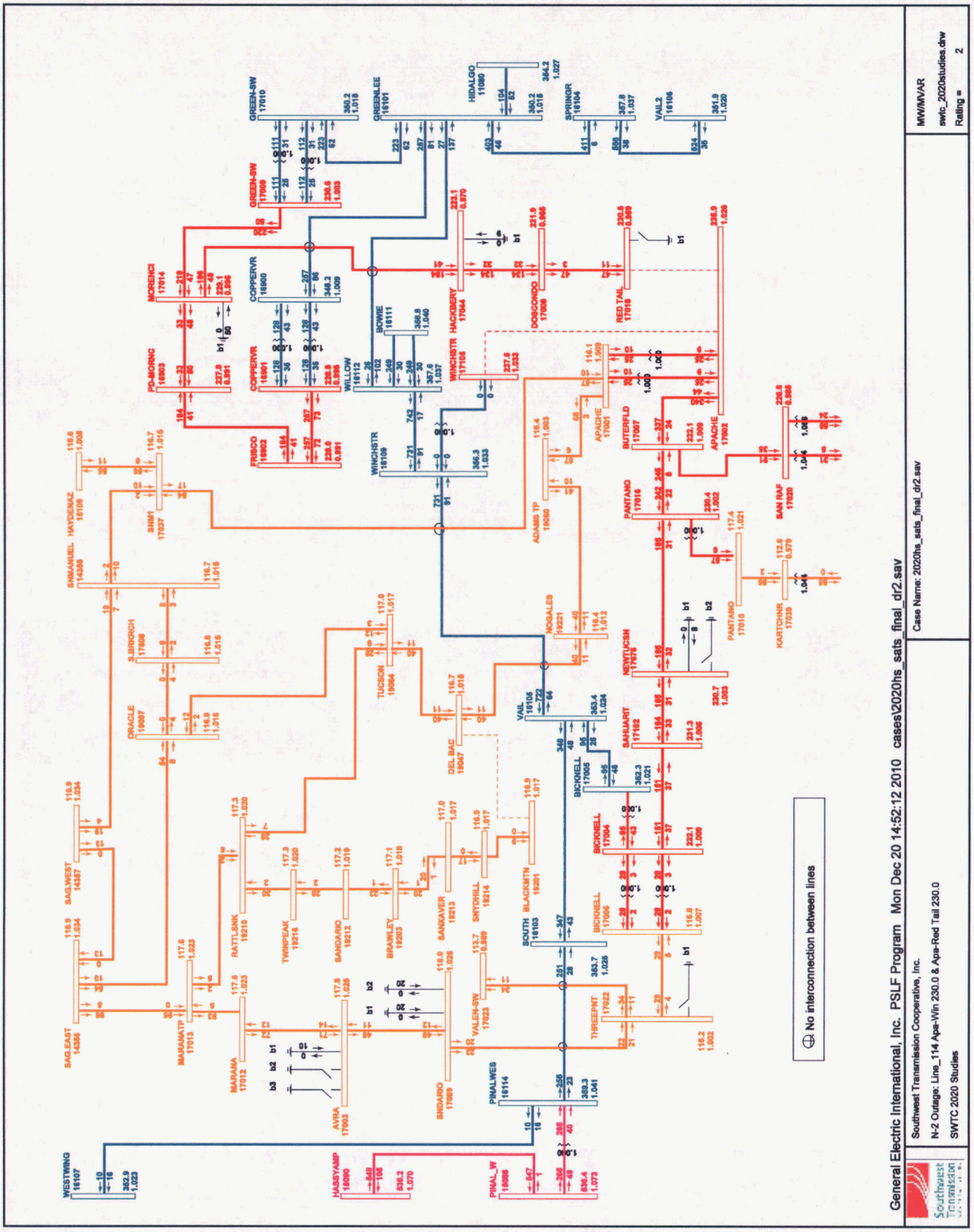
2020HS Southwest Transmission Cooperative Base System with Apache to Butterfield & Apache to Winchester 230 kV Lines out of service



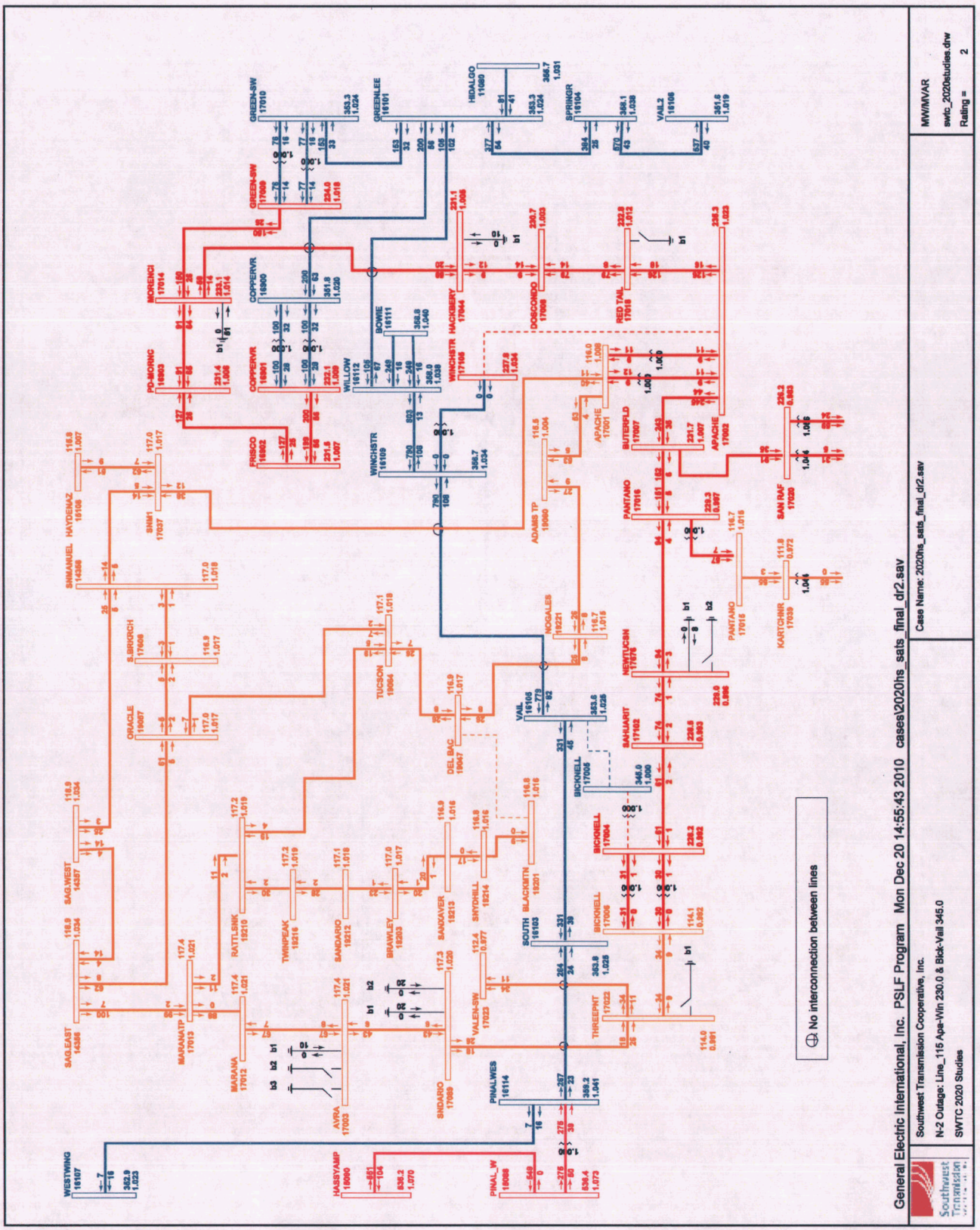
2020HS Southwest Transmission Cooperative Base System with Apache to Redtail 230 kV & Bicknell to Vail 345 kV Lines out of service



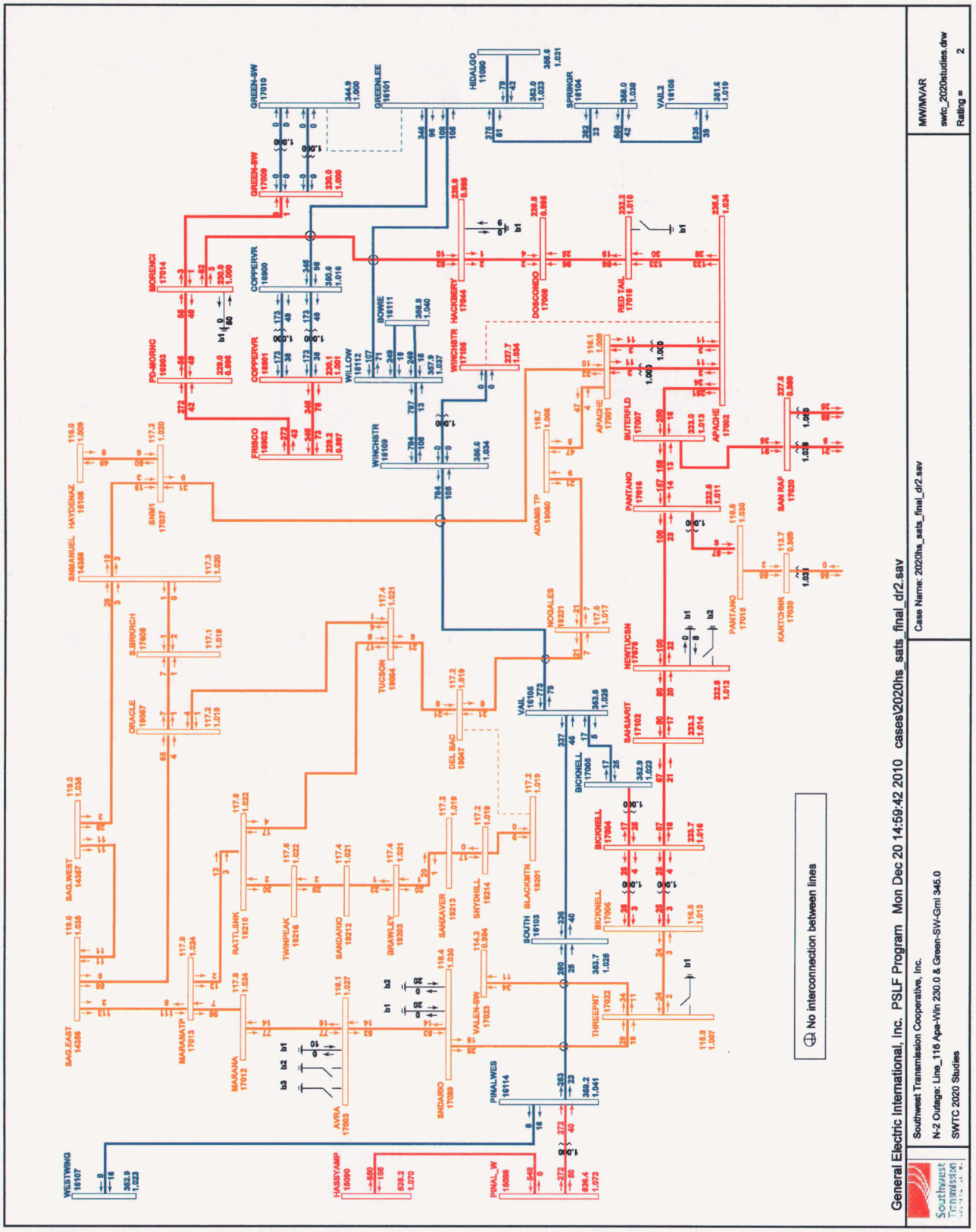
2020HS Southwest Transmission Cooperative Base System with Apache to Winchester & Apache to Redtail 230 kV Lines out of service



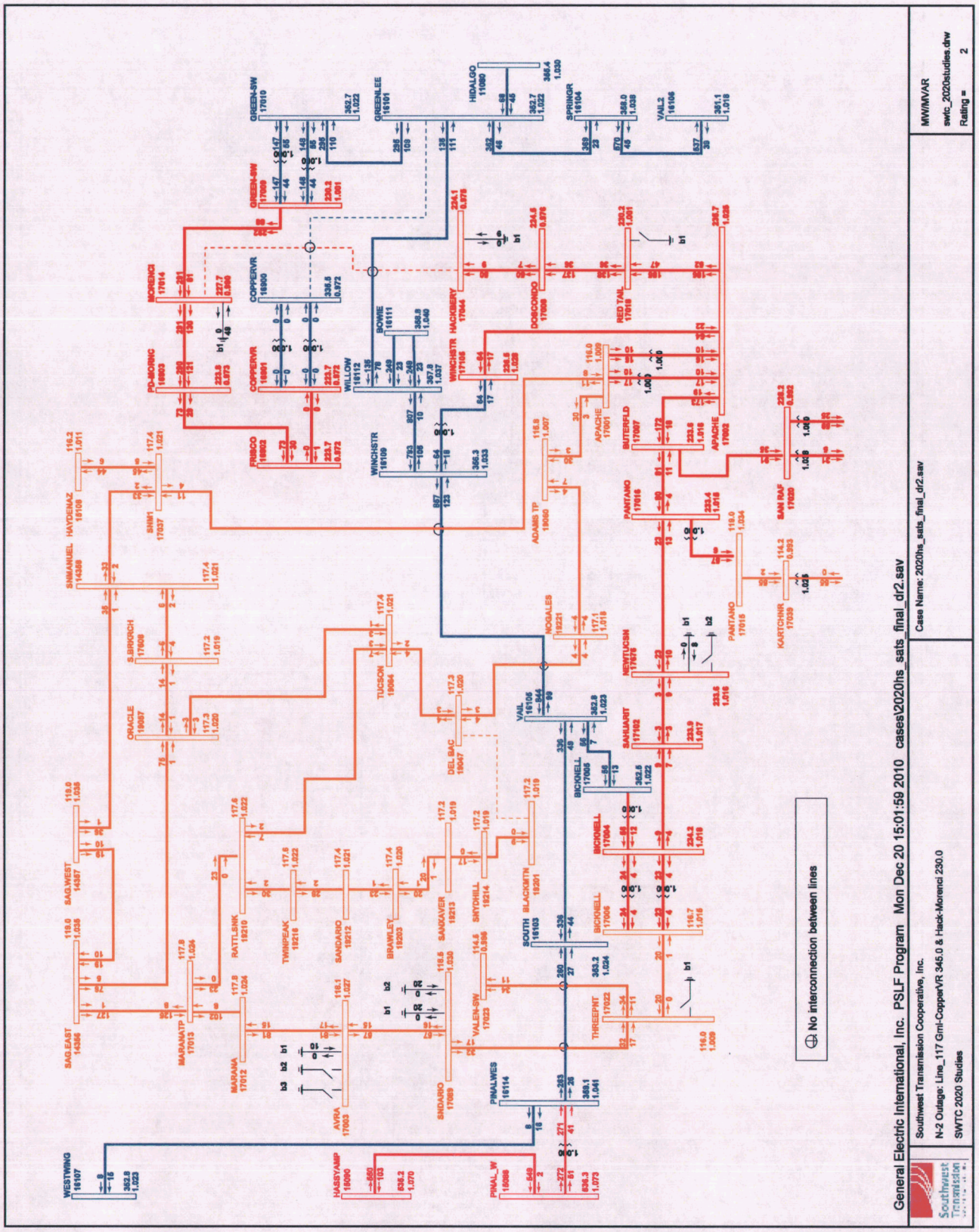
2020HS Southwest Transmission Cooperative Base System with Apache to Winchester 230 kV & Bicknell to Vail 345 kV Lines out of service



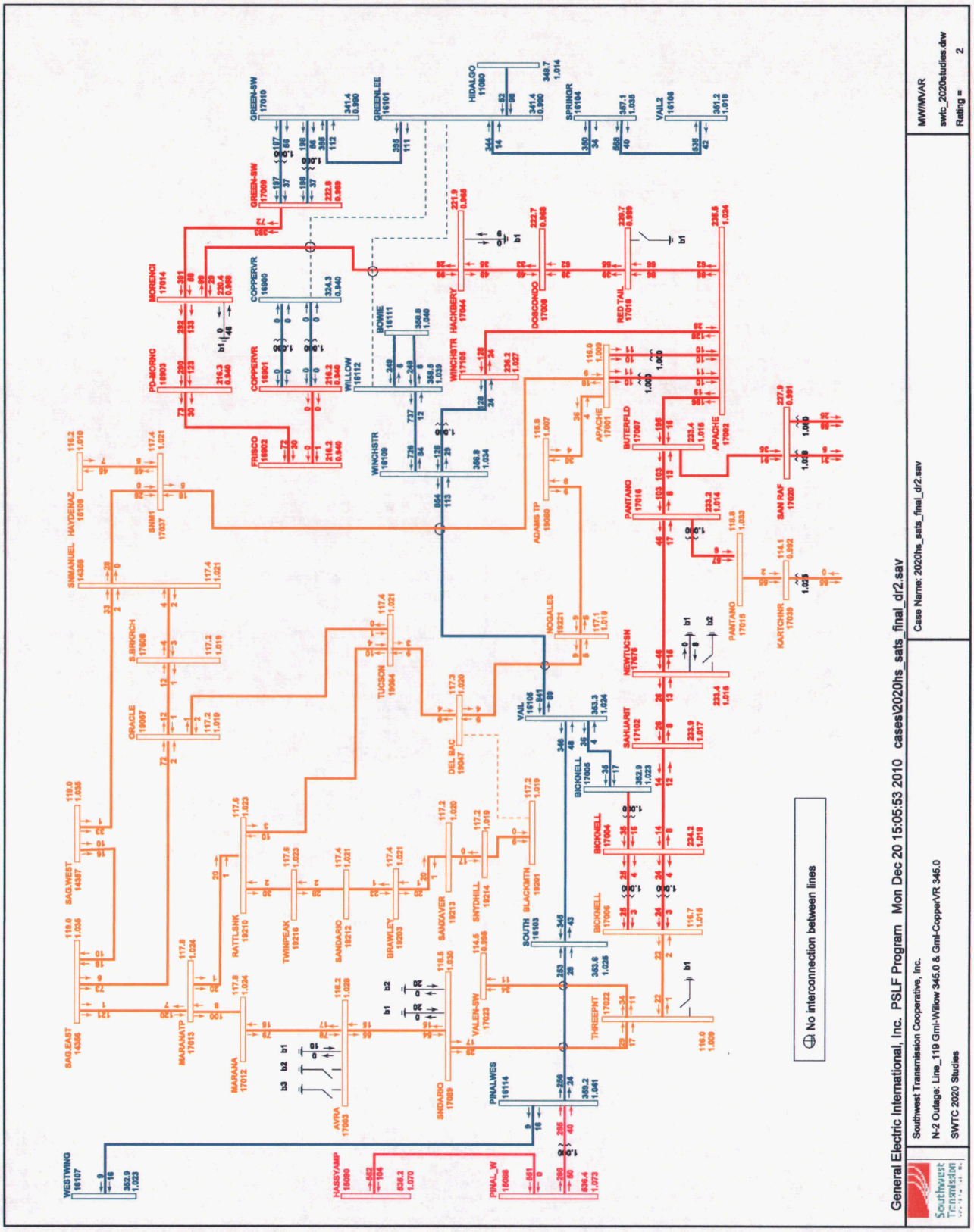
2020HS Southwest Transmission Cooperative Base System with Apache to Winchester 230 kV & Green-SW to Greenlee 345 kV Lines out of service



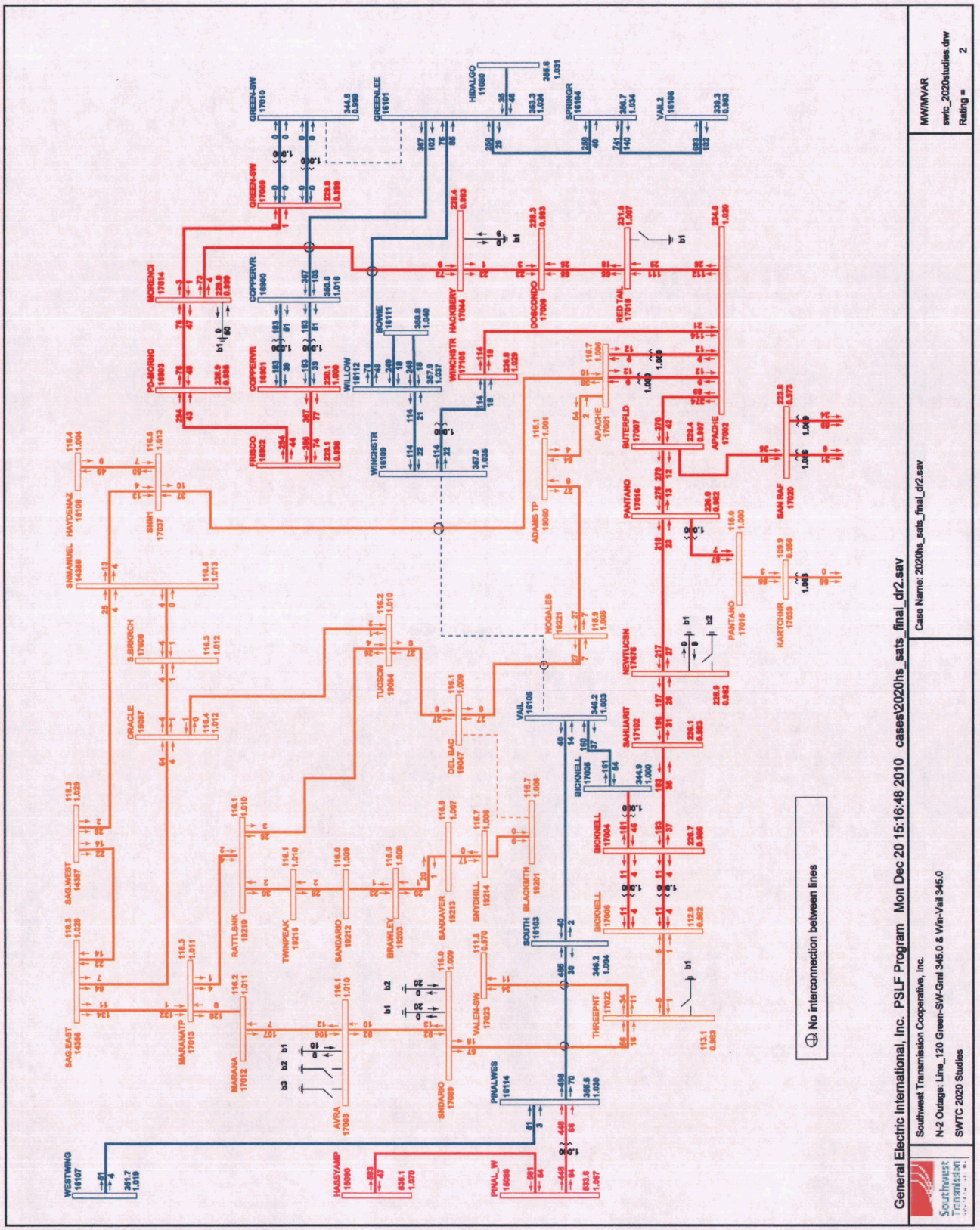
2020HS Southwest Transmission Cooperative Base System with Greenlee to Copper Verde 345 kV & Hackberry to Morenci 230 kV Lines out of service



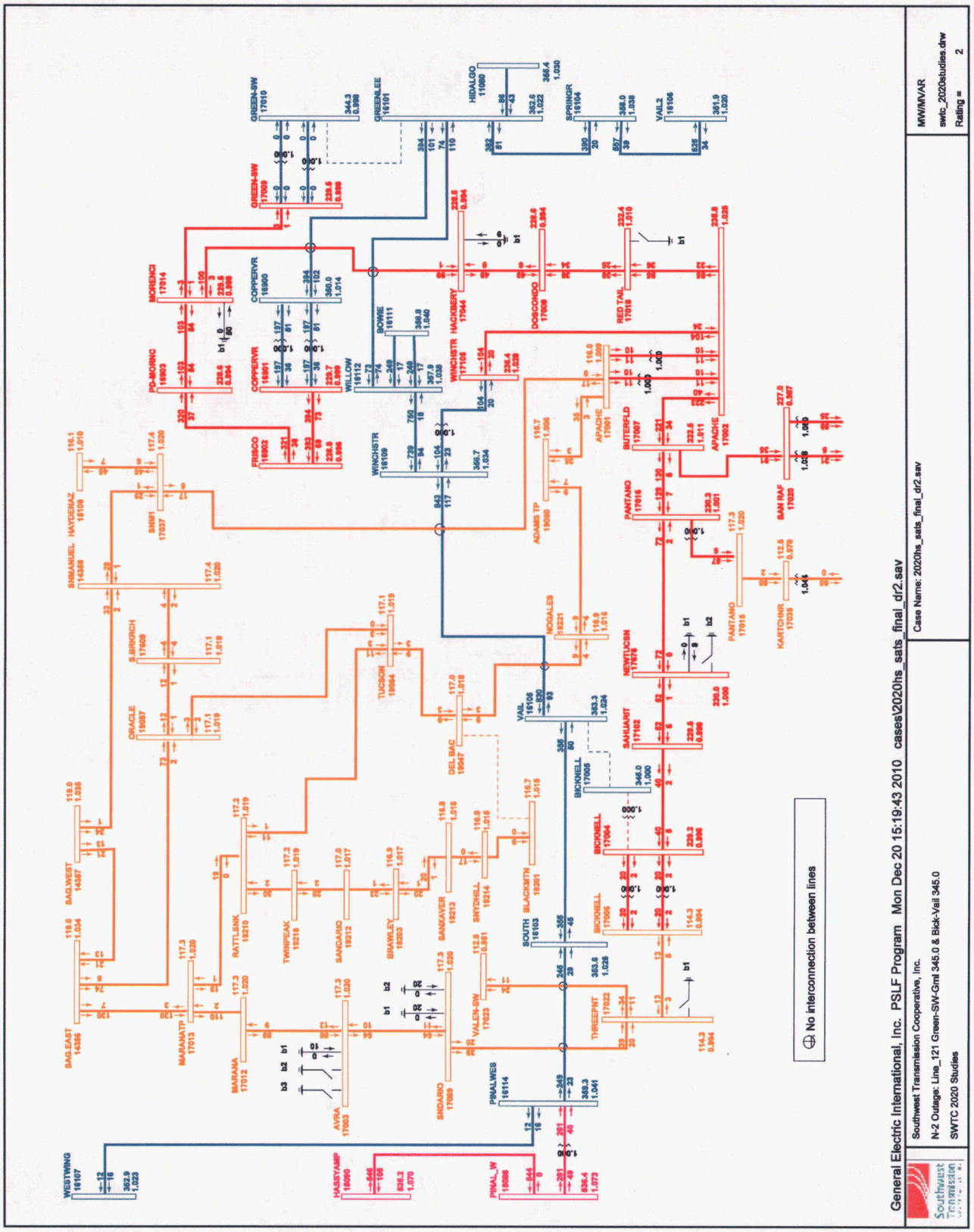
2020HS Southwest Transmission Cooperative Base System with Greenlee to Willow & Greenlee to Copper Verde 345 kV Lines out of service



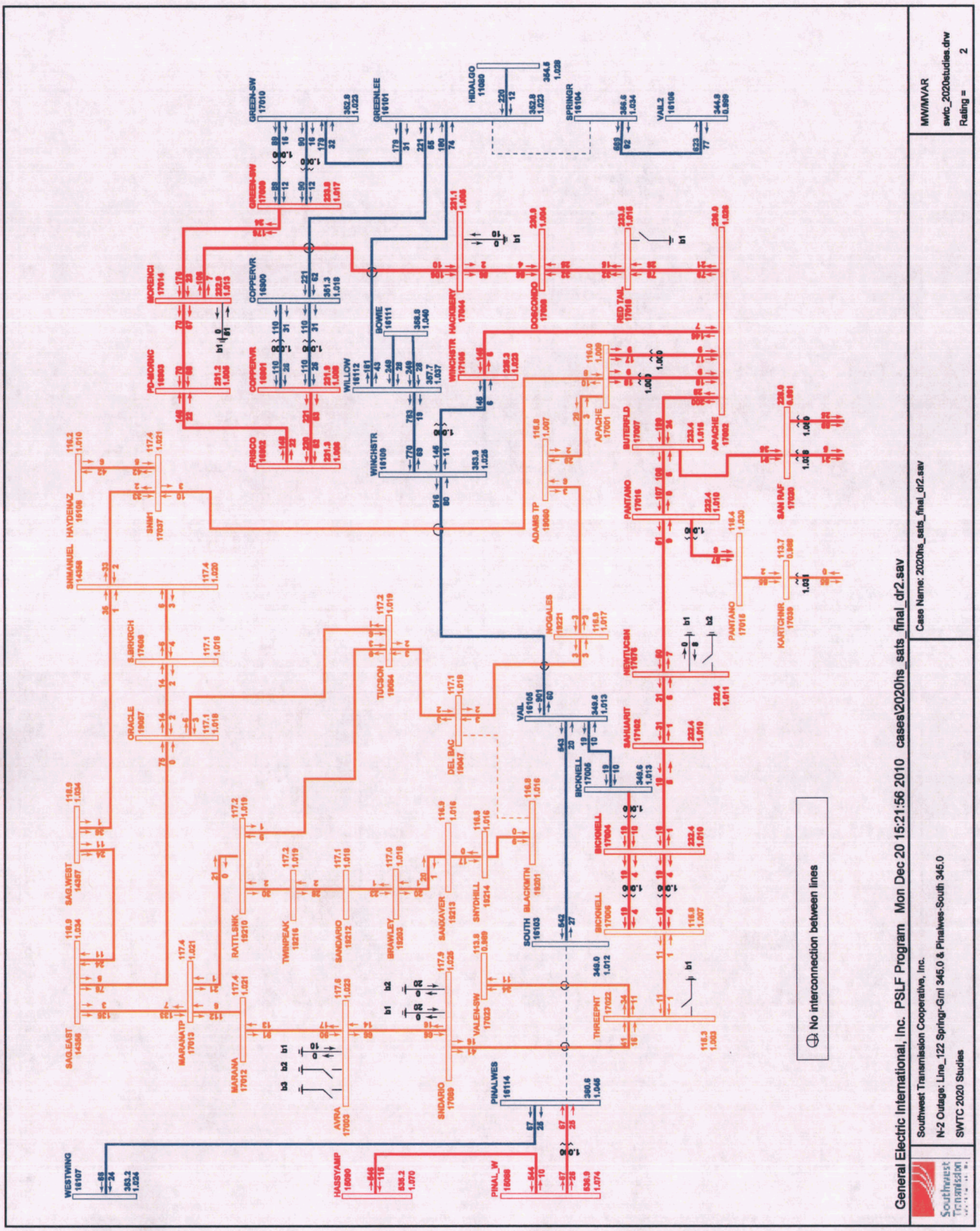
2020HS Southwest Transmission Cooperative Base System with Green-SW to Greenlee & Winchester to Vail 345 kV Lines out of service



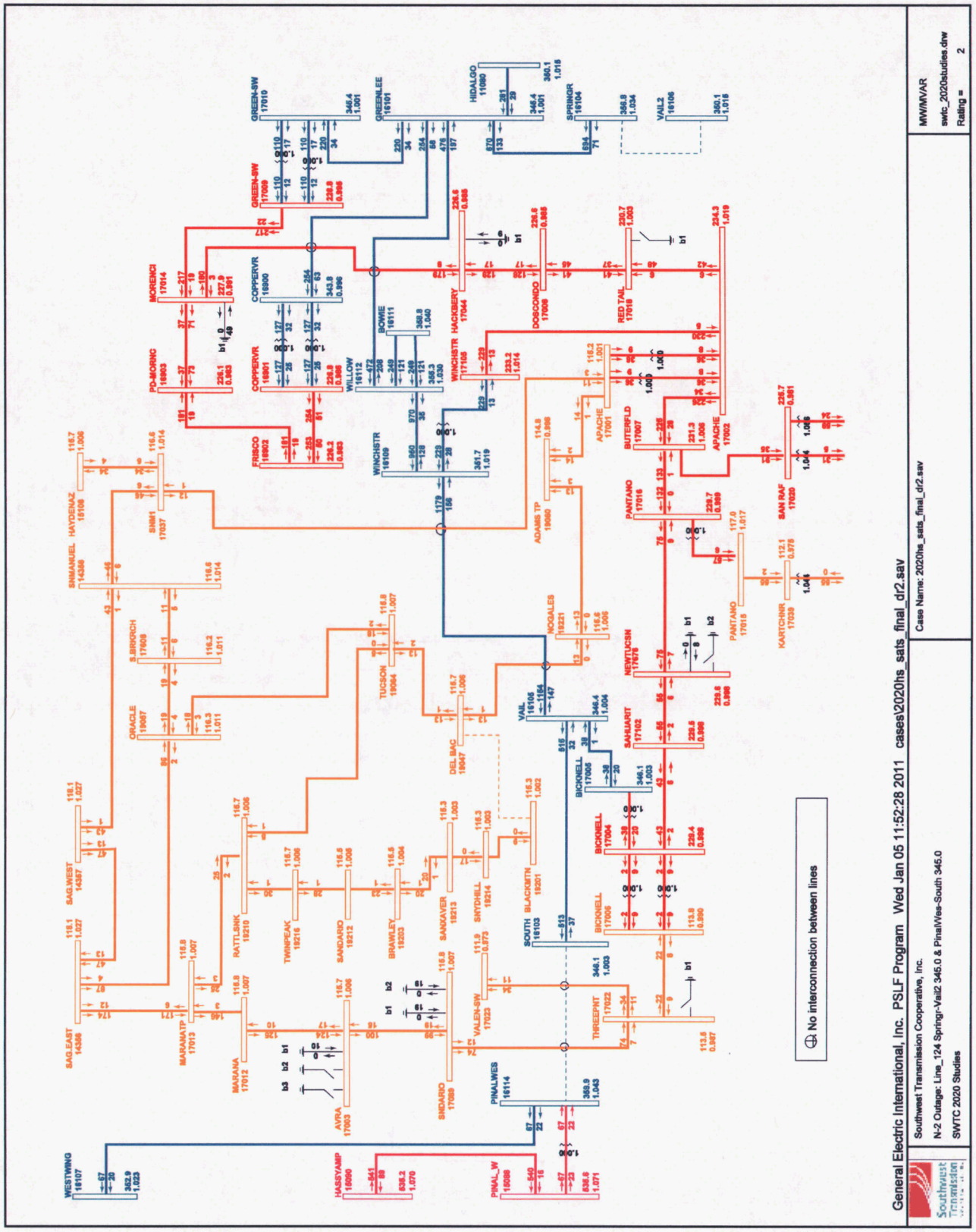
2020HS Southwest Transmission Cooperative Base System with Green-SW to Greenlee & Bicknell to Vail 345 kV Lines out of service



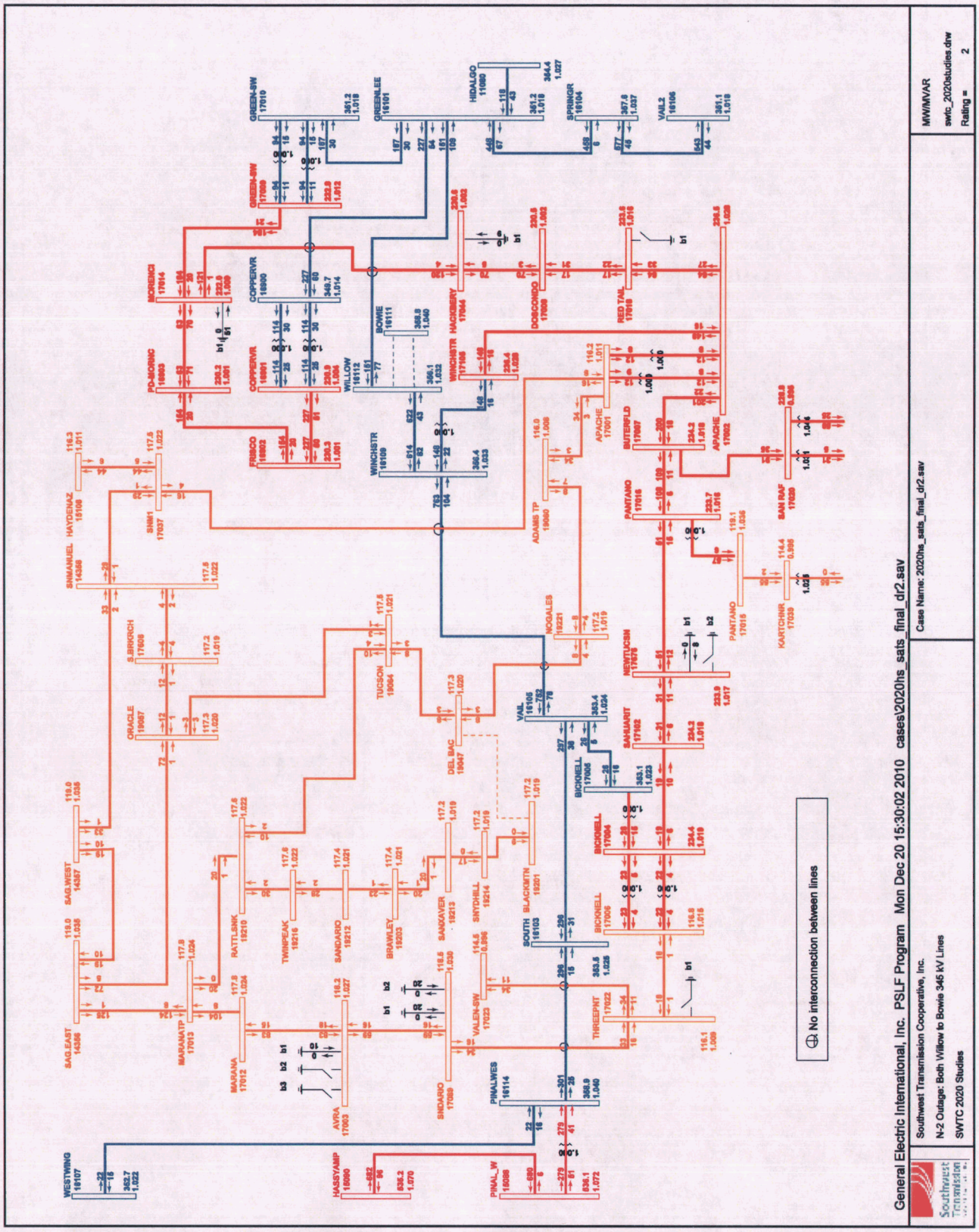
2020HS Southwest Transmission Cooperative Base System with Springerville to Greenlee & Pinal West to South 345 kV Lines out of service



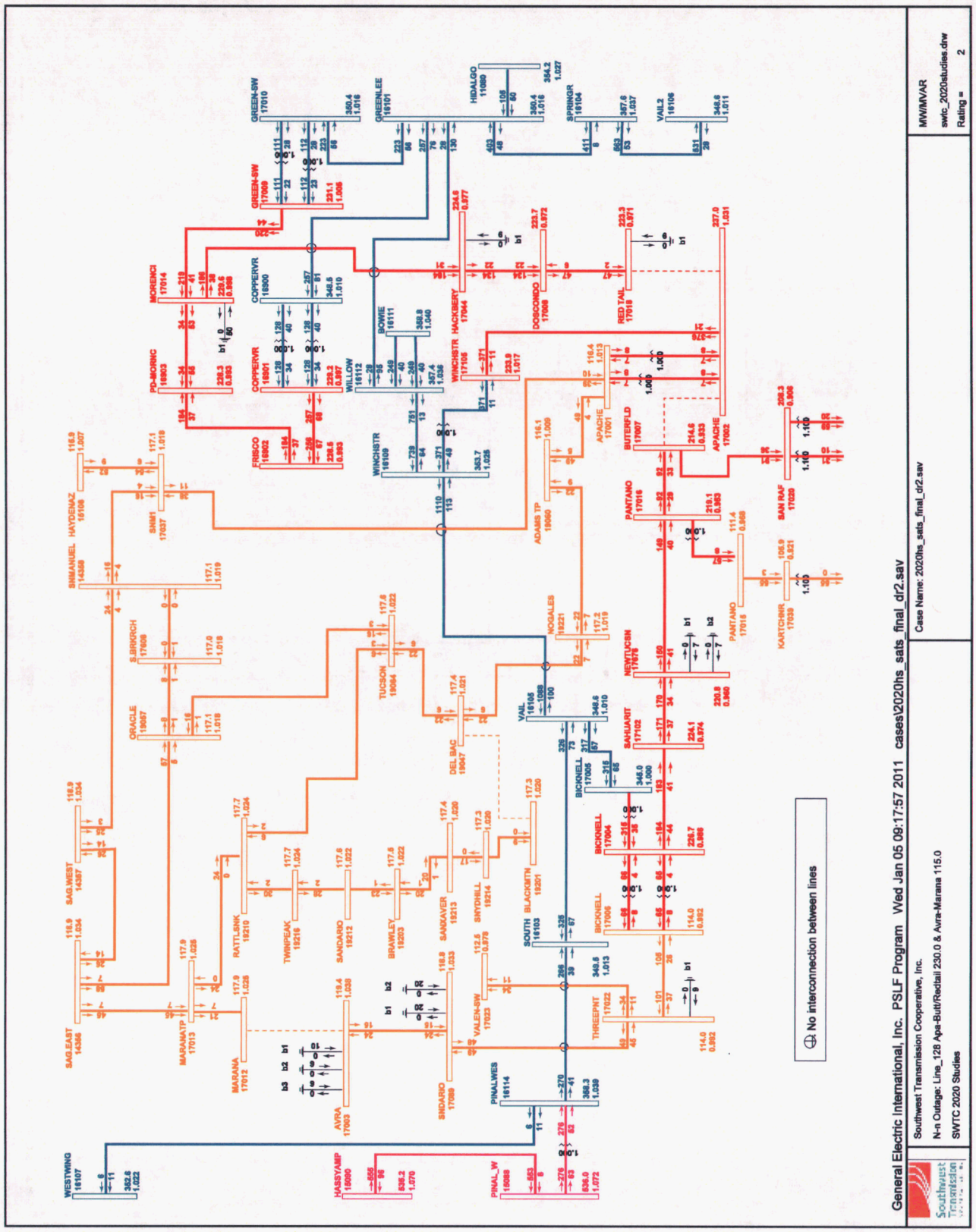
2020HS Southwest Transmission Cooperative Base System with Springerville to Vail2 & Pinal West to South 345 kV Lines out of service



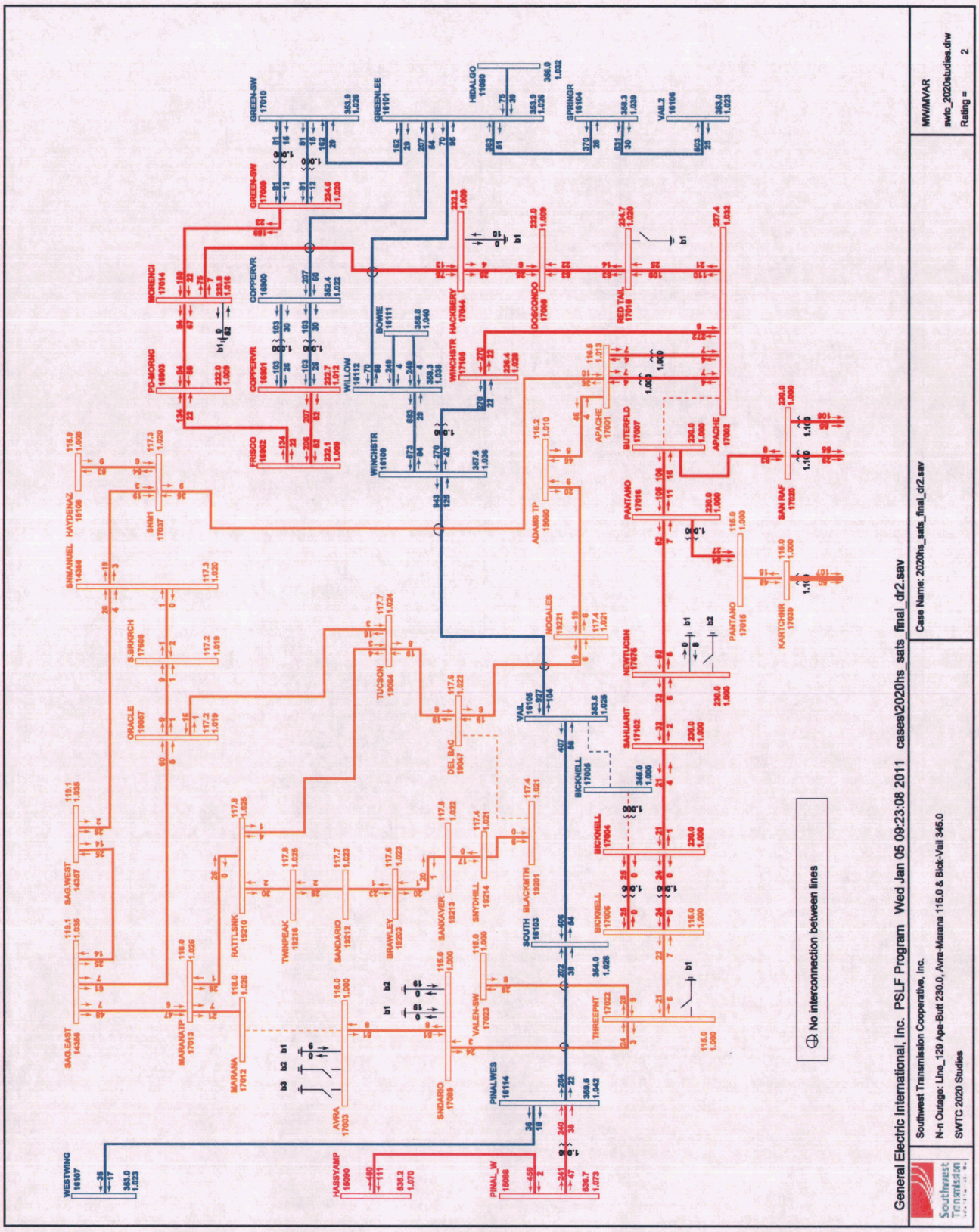
2020HS Southwest Transmission Cooperative Base System with Both Willow to Bowie 345 kV Lines out of service



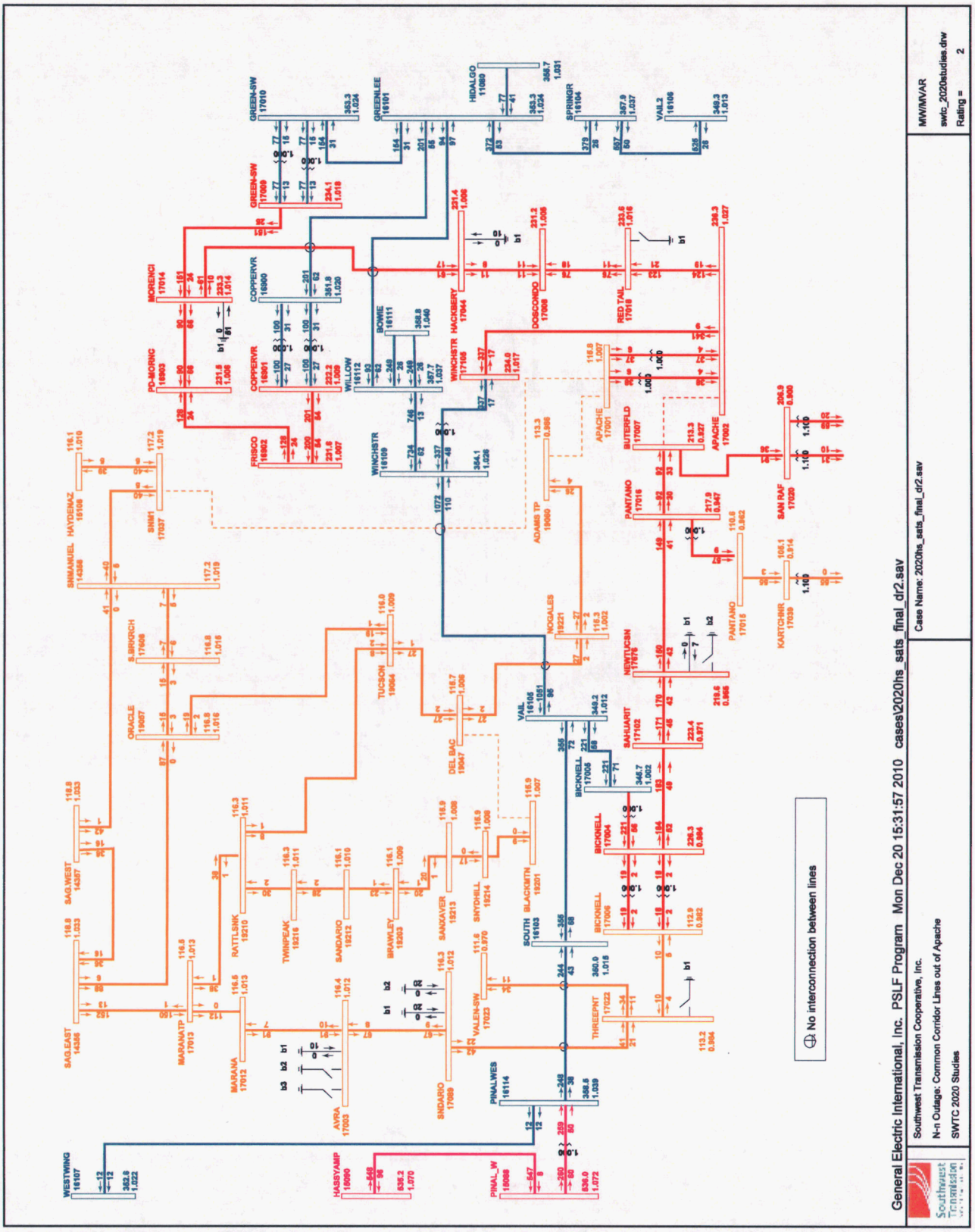
2020HS Southwest Transmission Cooperative Base System with Apache to Butterfield, Apache to Redtail 230 kV & Avra to Marana 115 kV Lines out of service



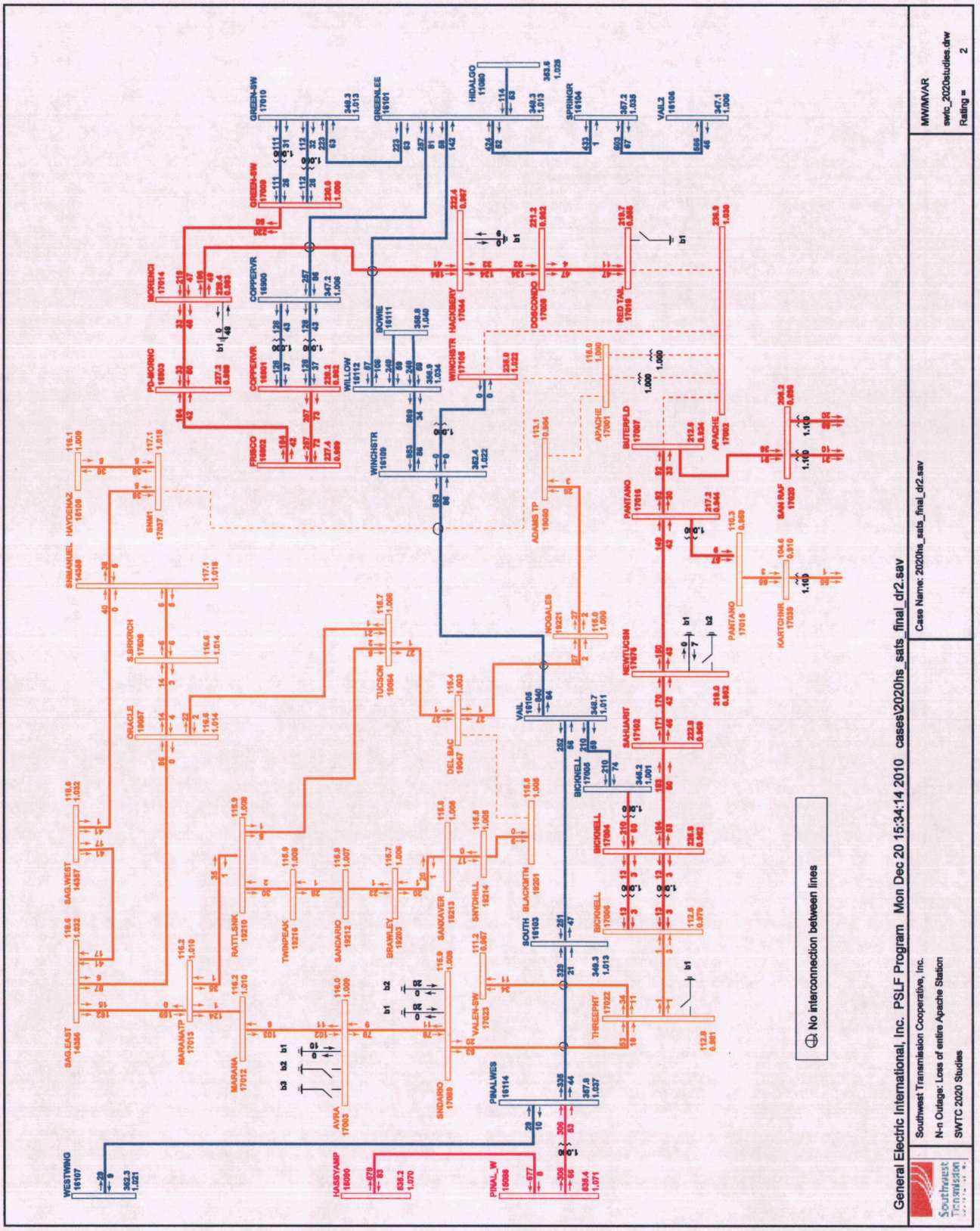
2020HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230, Avra to Marana 115 kV & Bicknell to Vail 345 kV Lines out of service



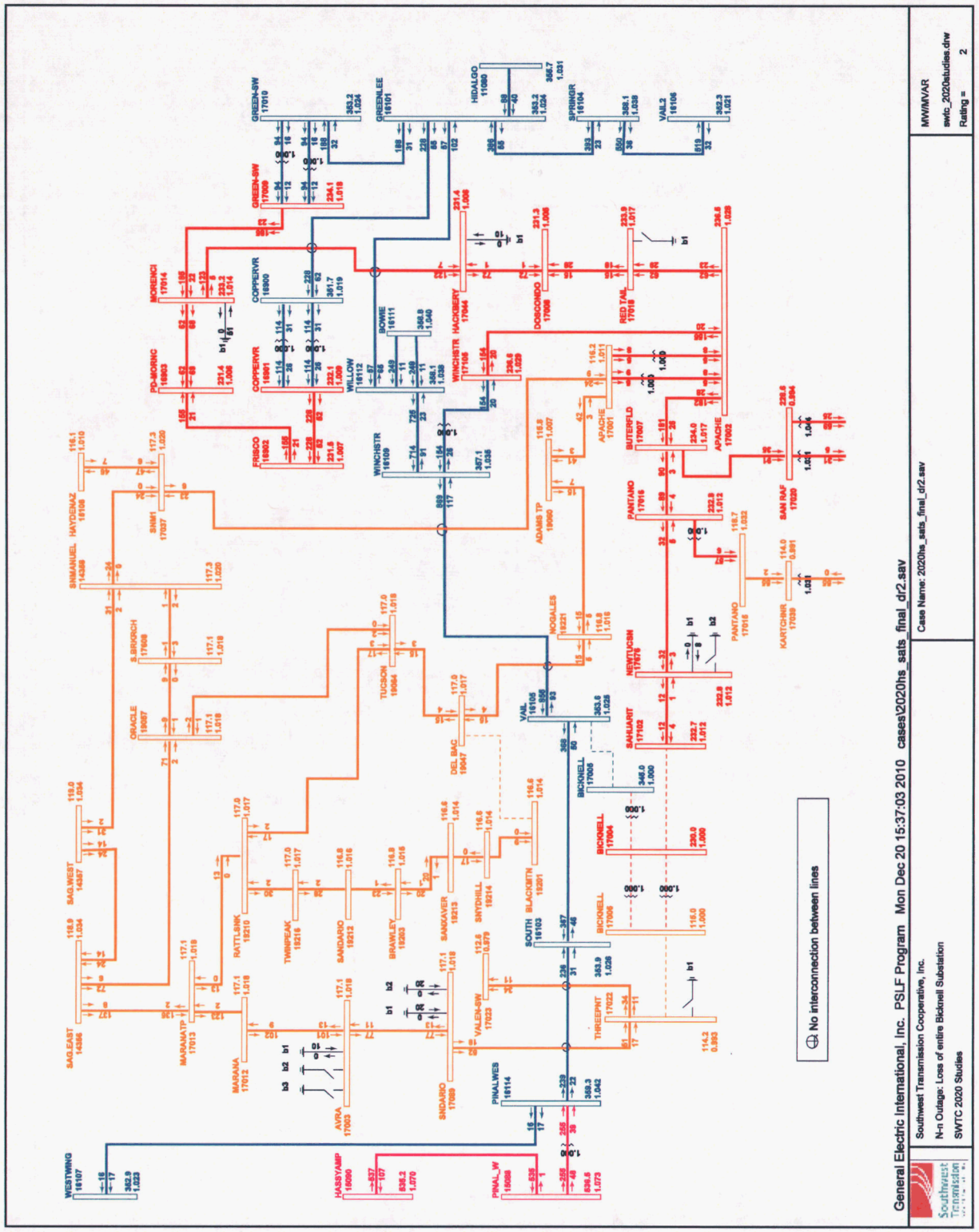
2020HS Southwest Transmission Cooperative Base System with Common Corridor Lines Out of Apache out of service



2020HS Southwest Transmission Cooperative Base System with Loss of Entire Apache Station



2020HS Southwest Transmission Cooperative Base System with Loss of Entire Bicknell Substation



APPENDIX D

TRANSIENT STABILITY PLOTS

2010 Plots:

Apache – Butterfield 230 kV Outage 189

Apache – Redtail 230 kV Outage 196

Bicknell – Vail 345 kV Outage 203

Marana Tap – Marana 115 kV Outage. 210

2014 Plots:

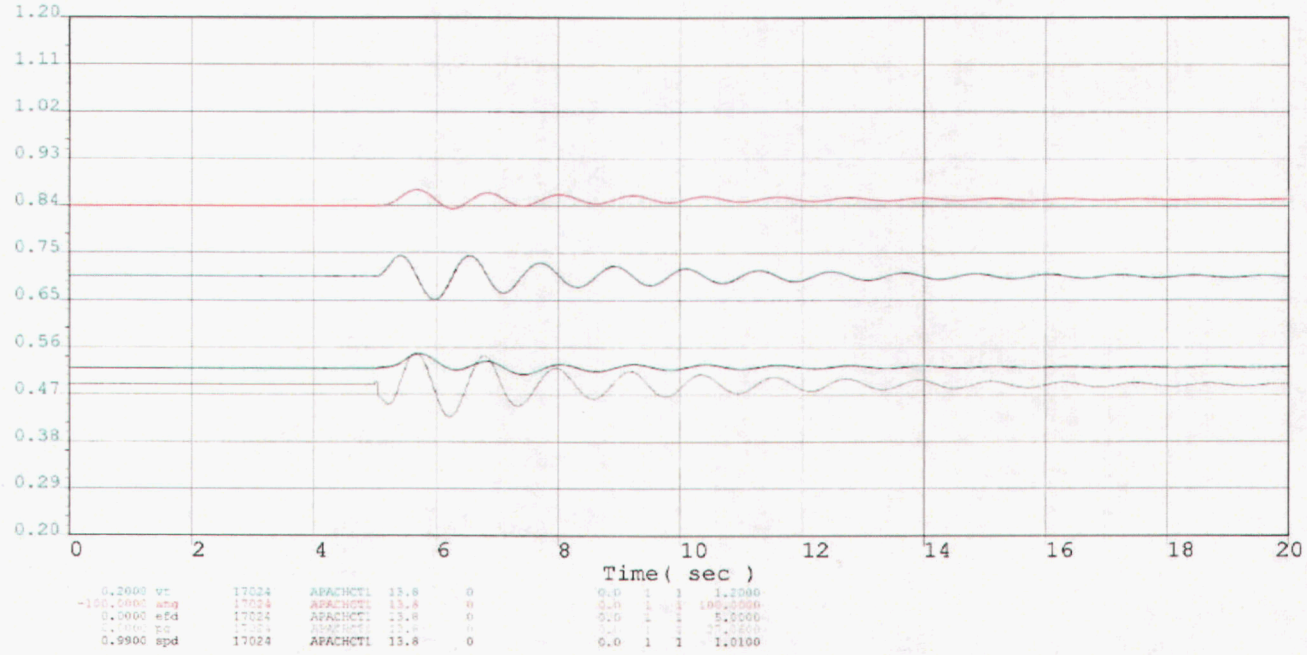
Apache – Butterfield 230 kV Outage 217

Apache – Redtail 230 kV Outage 222

Bicknell – Vail 345 kV Outage 227

Marana Tap – Marana 115 kV Outage. 232

Apache to Butterfield 230 kV Outage



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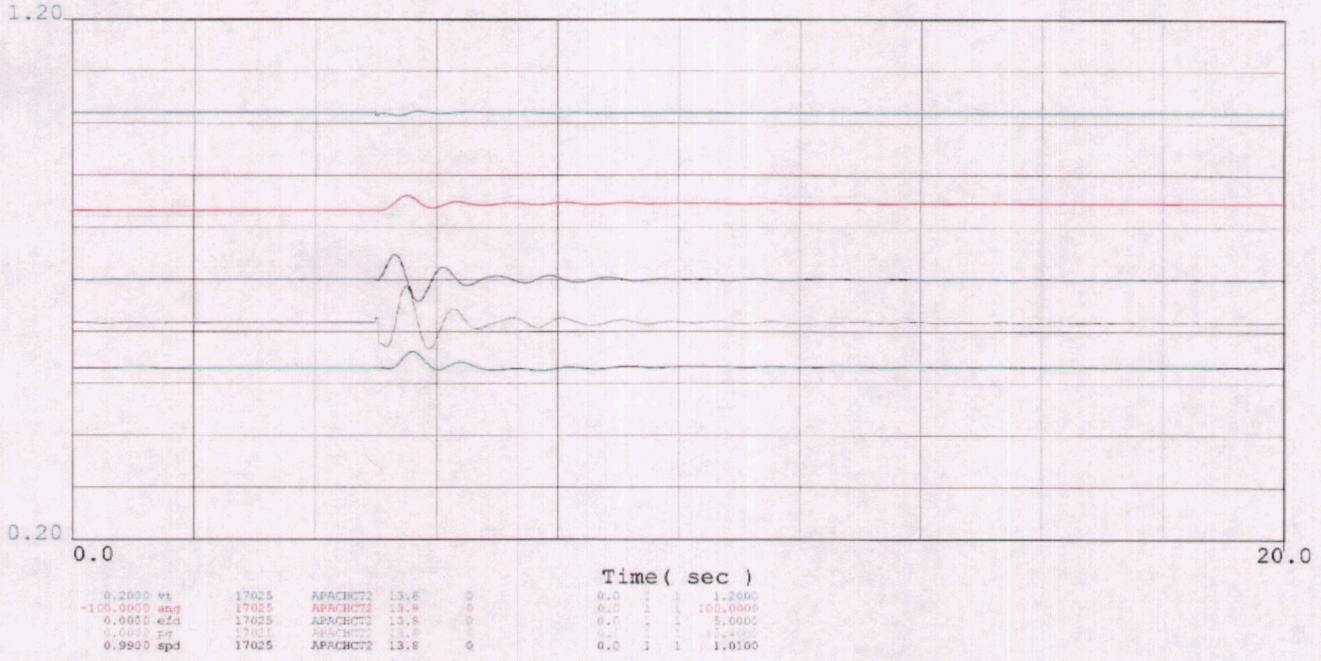
1) wapa/seb 12/7/2009
Clear Both Ends in 5 Cycles

Apache to Butterfield 230 kV Outage



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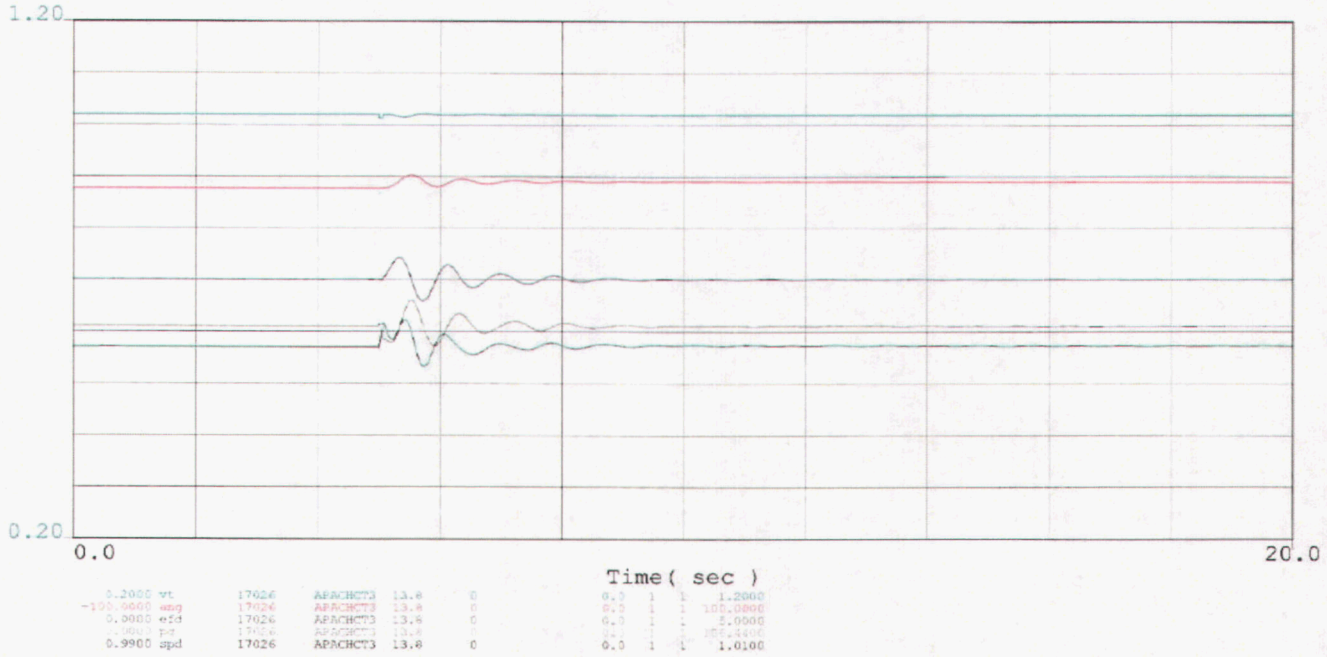
Apache to Butterfield 230 kV Outage



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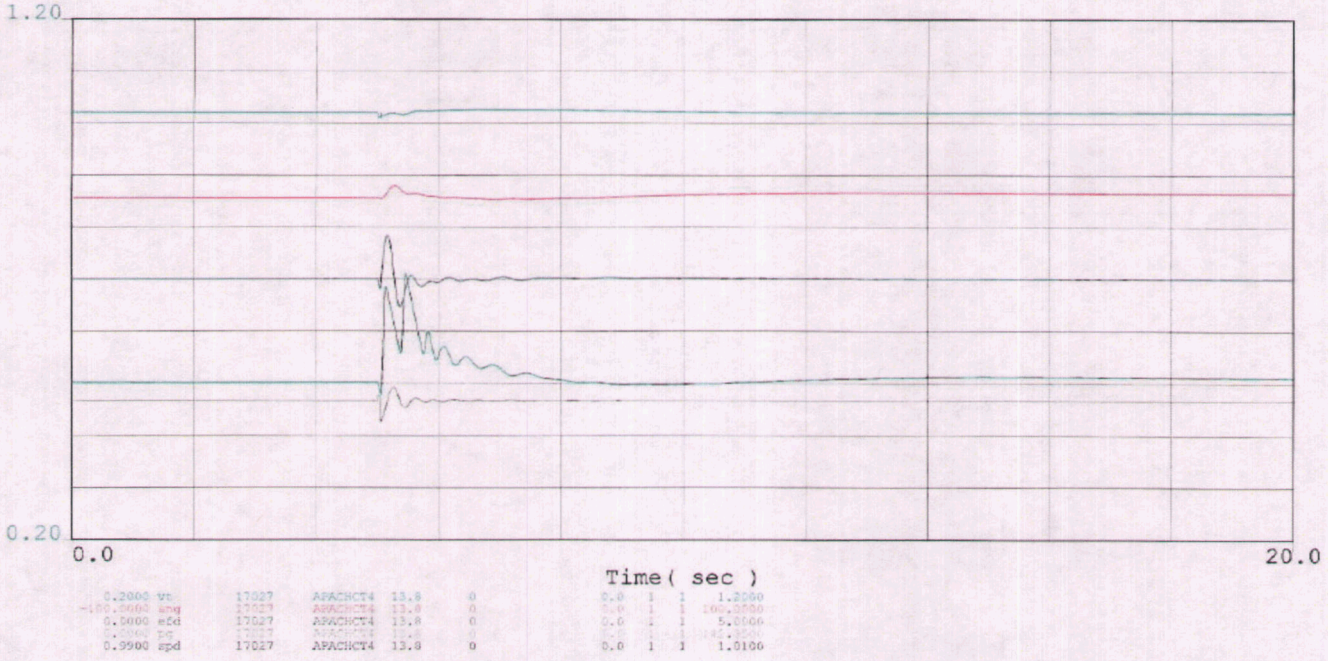
Apache to Butterfield 230 kV Outage



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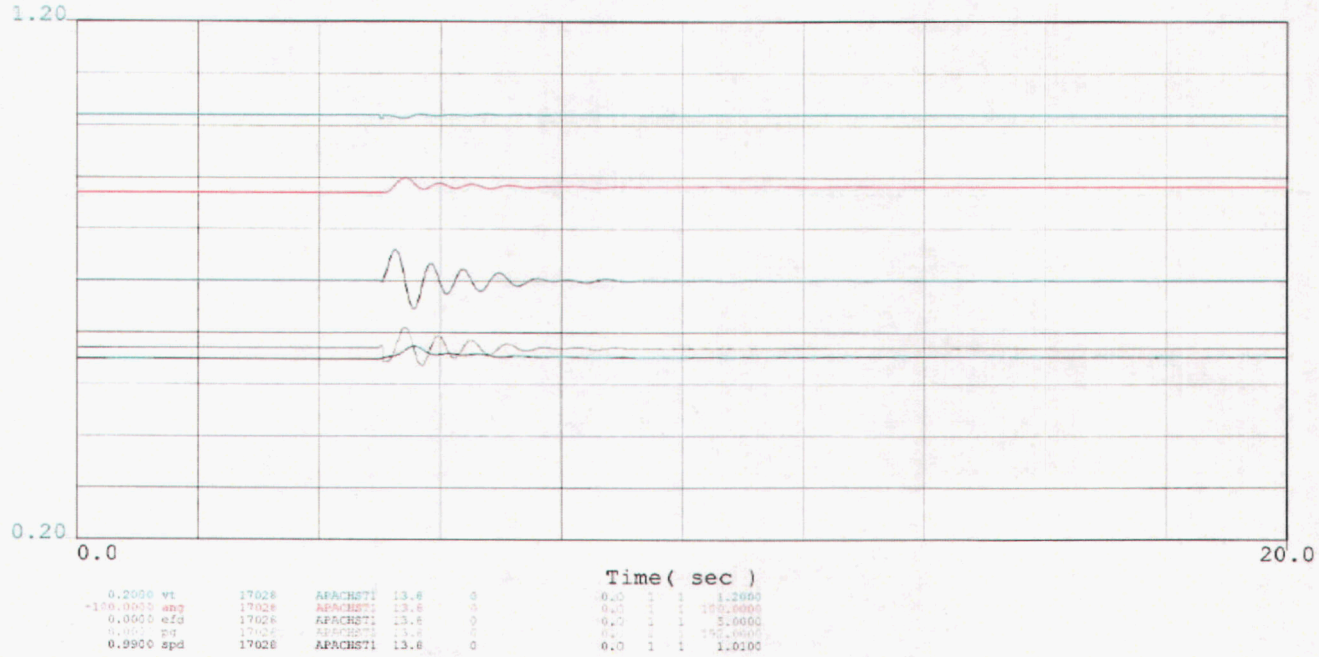
Apache to Butterfield 230 kV Outage



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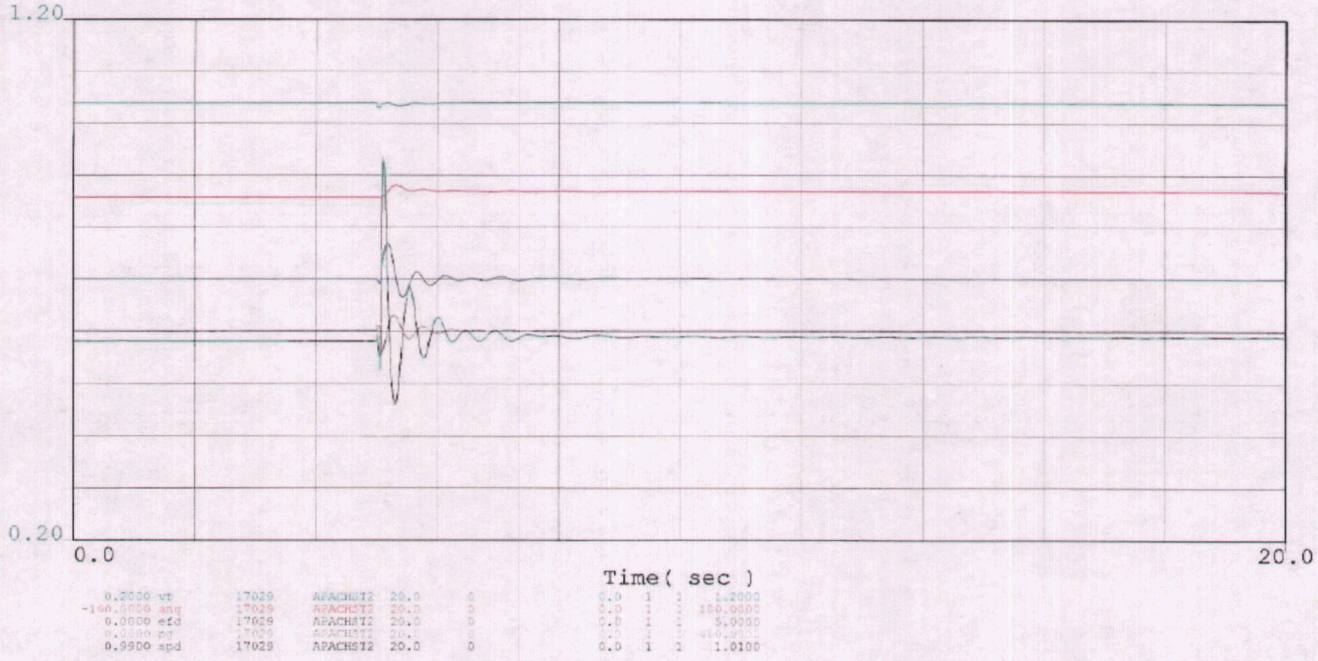
Apache to Butterfield 230 kV Outage



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0.0000 efd	17029	APACHST2	20.0	0	0.0	1	1	5.0000
0.0000 pt	17029	APACHST2	20.0	0	0.0	1	1	60.0000
0.9900 spd	17029	APACHST2	20.0	0	0.0	1	1	1.0100

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Clear Both Ends in 5 Cycles

apache_butterfield.chf

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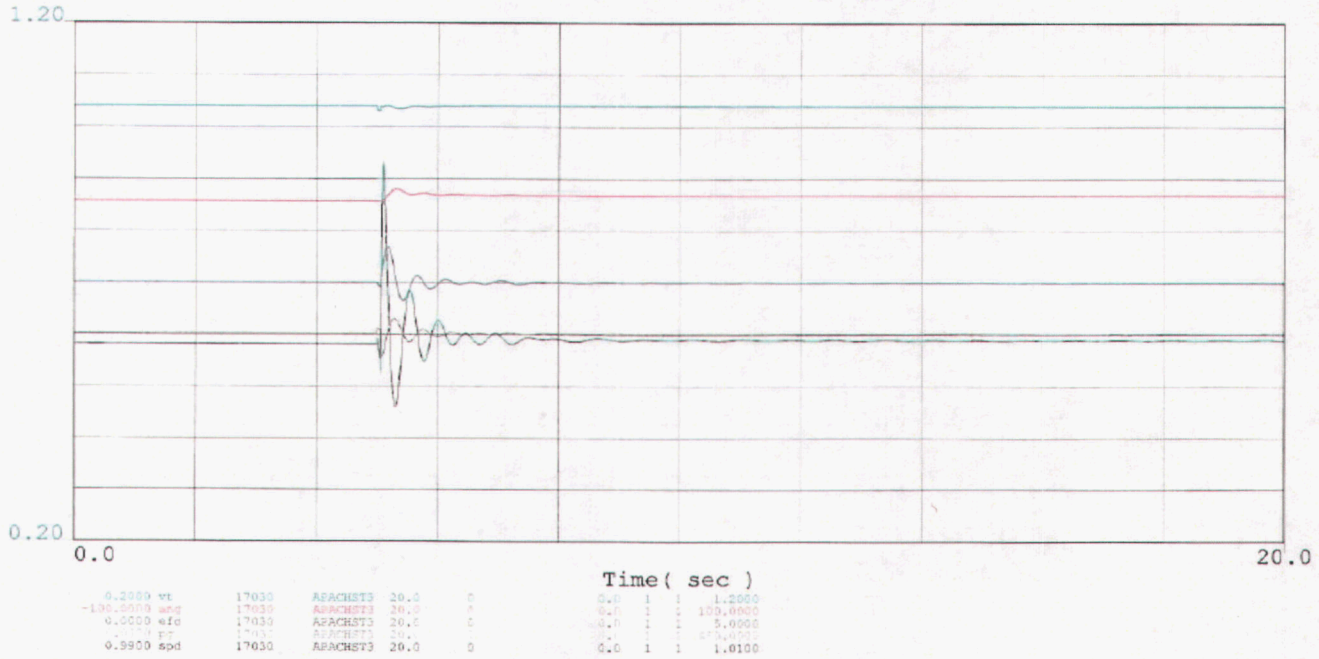
Thu Oct 14 13:11:22 2010

Apache to Butterfield 230 kV Outage



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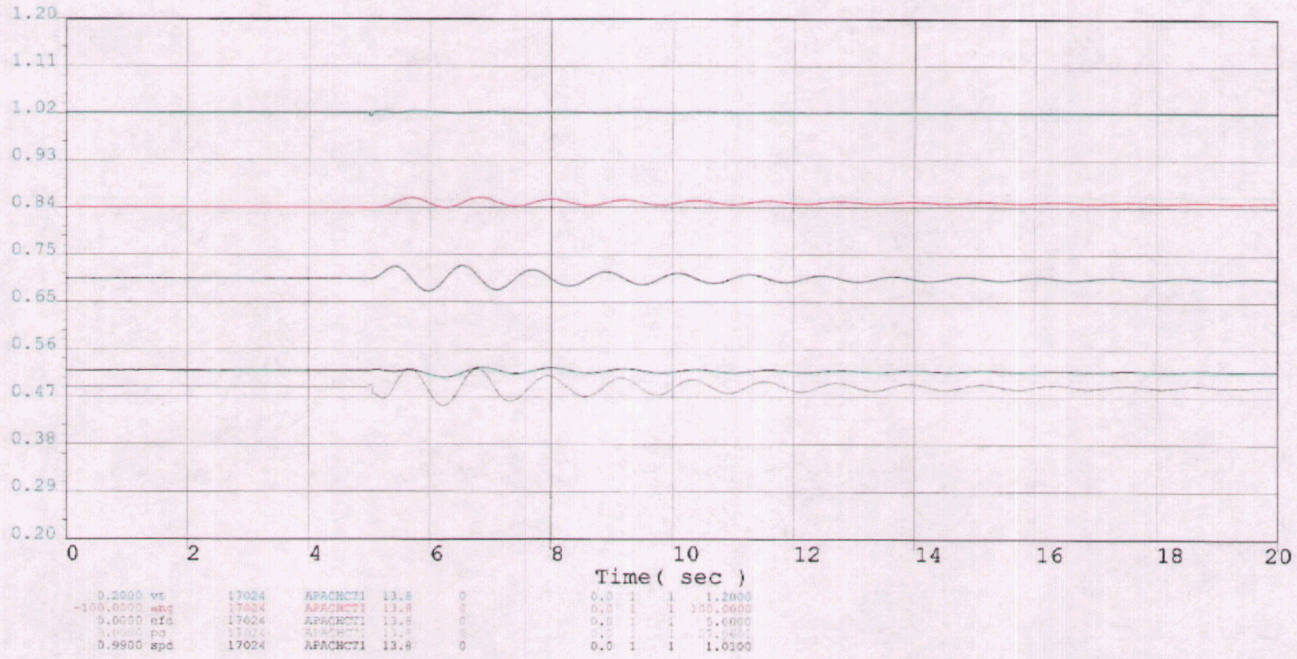
Apache to Red Tail 230 kV Outage



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0.0000 efd	17024	APACHCT1	13.8	0		0.0	1	1	5.0000
[illegible] pq	17024	APACHCT1	13.8	0		[illegible]	1	1	-5.0000
0.9900 spd	17024	APACHCT1	13.8	0		0.0	1	1	1.0100

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Clear Both Ends in 5 Cycles

Southwest Transmission

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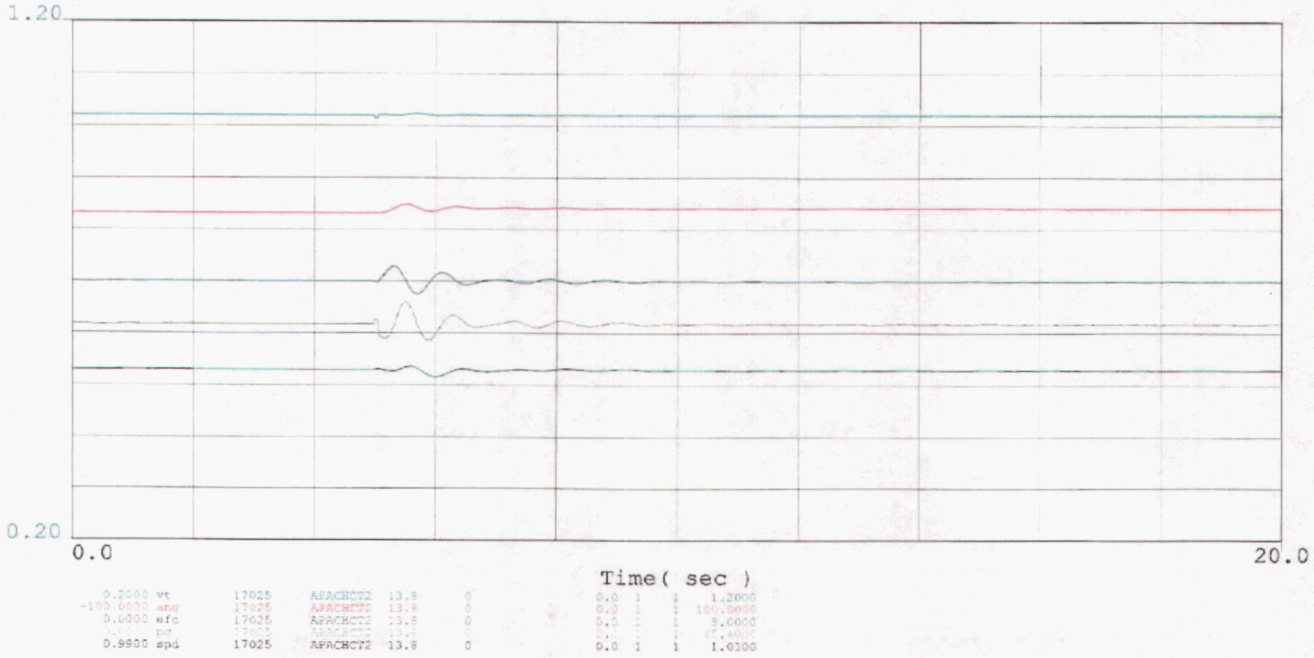
Thu Oct 14 13:26:24 2010

Apache to Red Tail 230 kV Outage



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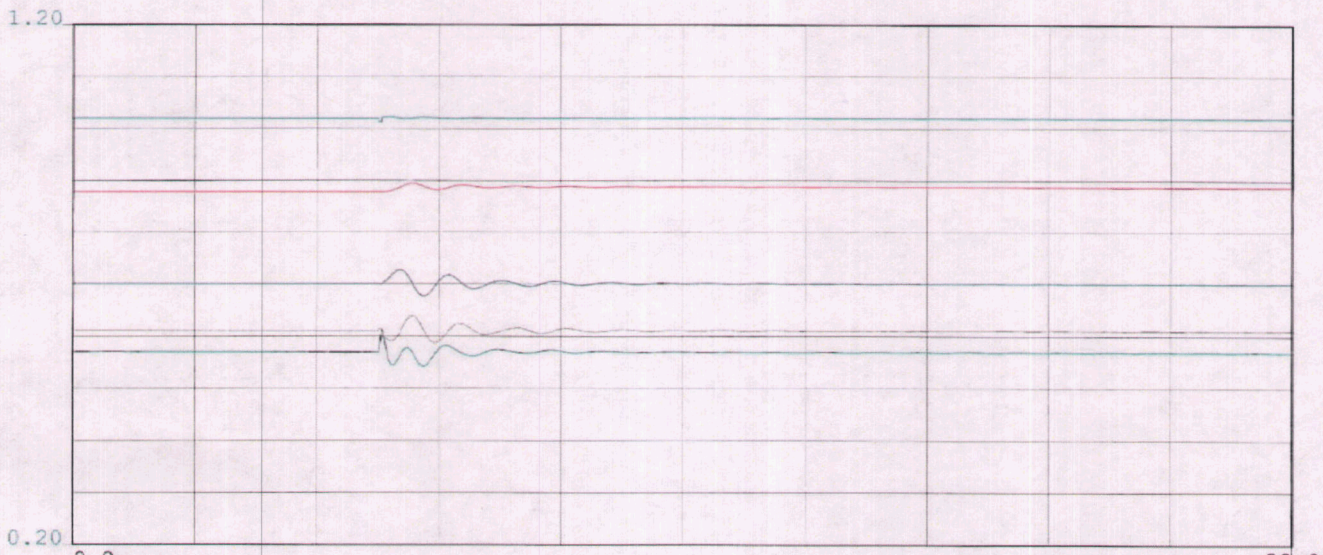
Apache to Red Tail 230 kV Outage



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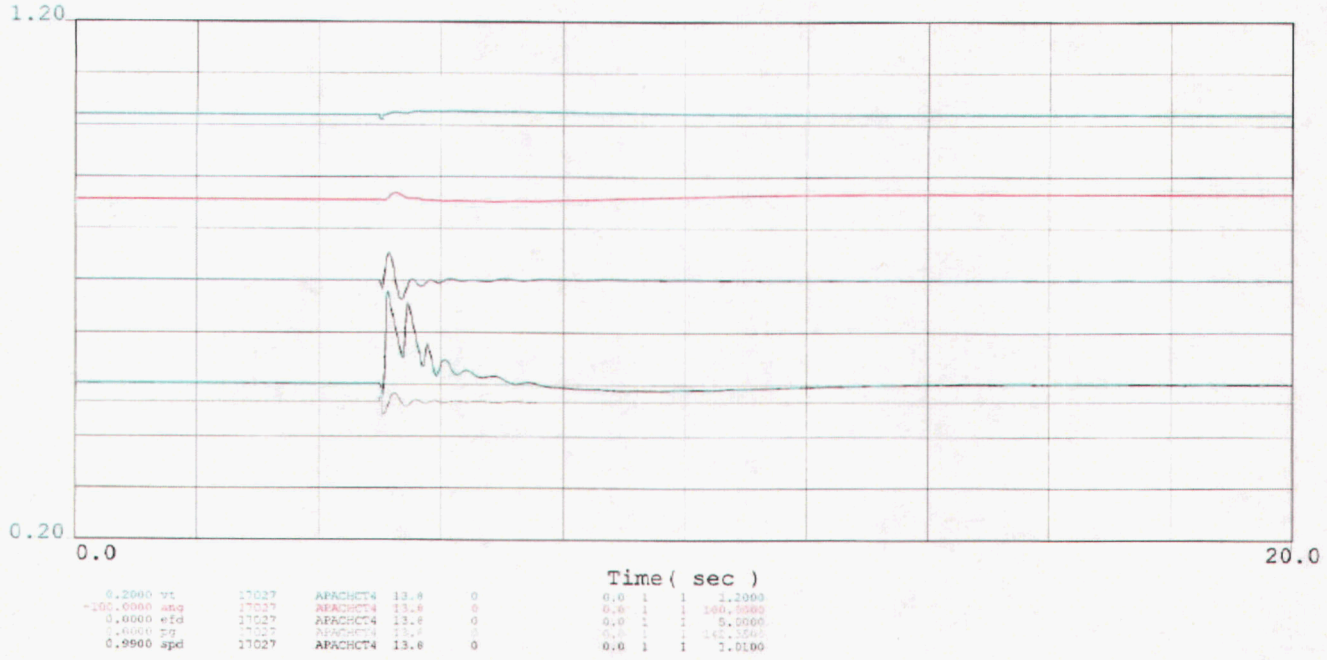
Final review - APS, TEP - 4/2/09
1] wapa/seb 12/7/2009
Clear Both Ends in 5 Cycles

apache_redtail.chf

ts_cases\new 2009 studies

Thu Oct 14 13:26:25 2010

Apache to Red Tail 230 kV Outage



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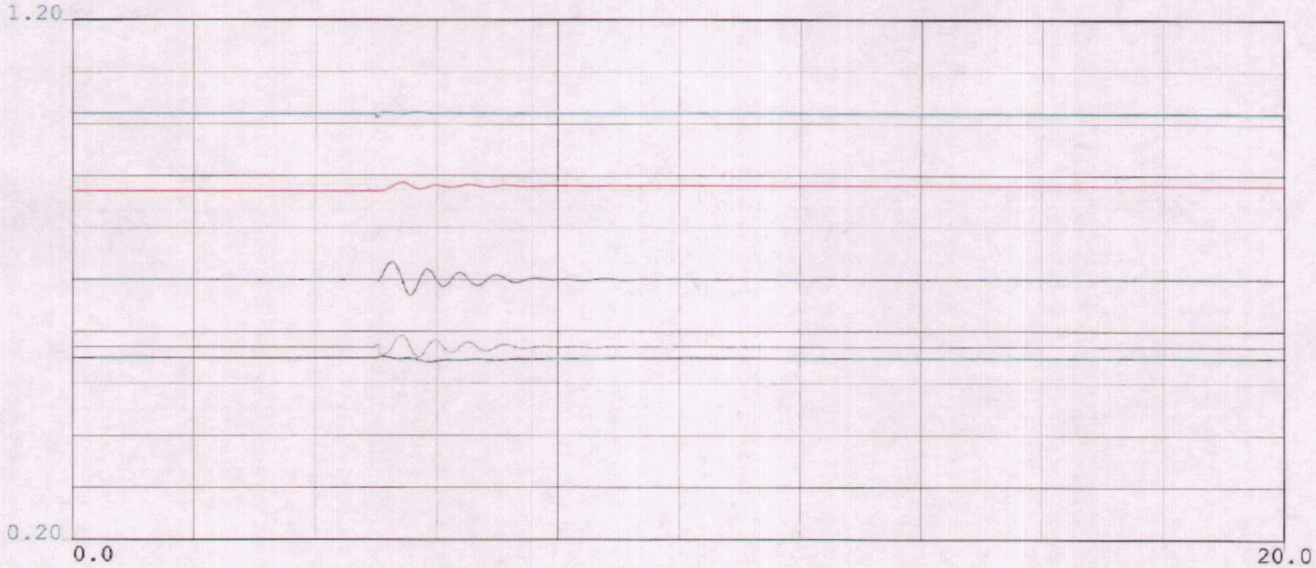
Apache to Red Tail 230 kV Outage



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0.9900	spd	17028	APACHST1	13.8	0	0.0	1	1	1.0100

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Clear Both Ends in 5 Cycles

Southwest Transmission

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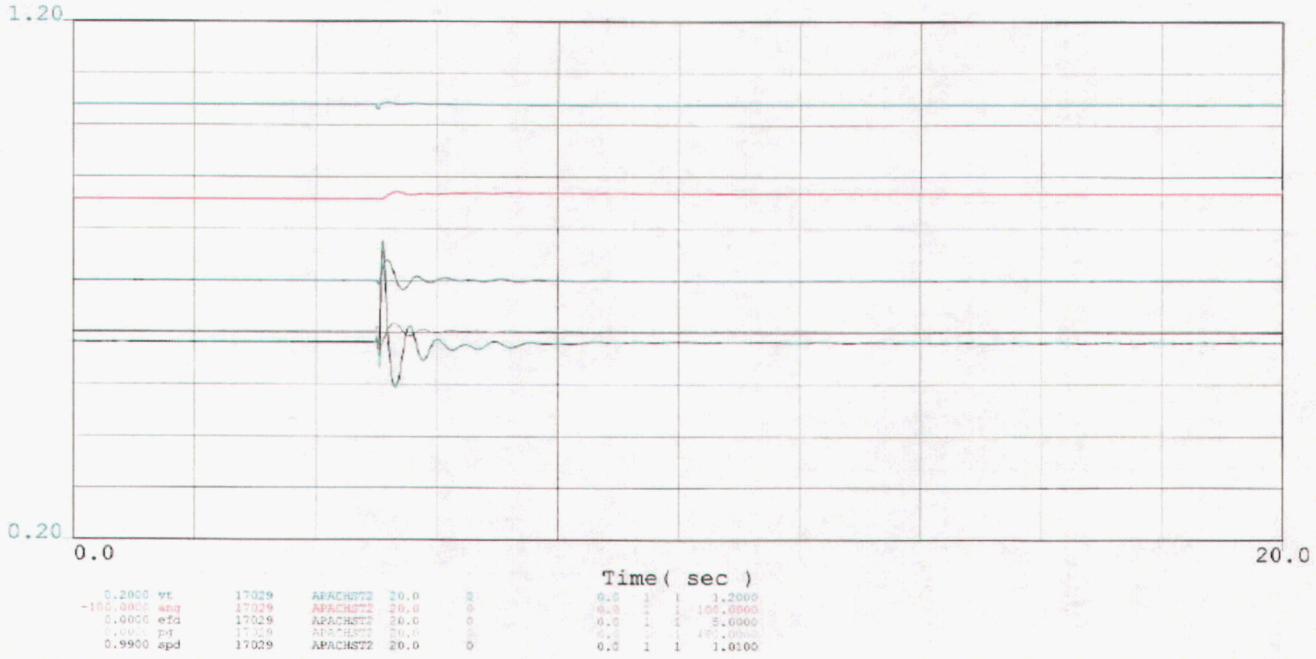
Apache to Red Tail 230 kV Outage



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.000	pt	17029	APACHST2	20.0	0	0.0	1	1	107.0000
0.9900	spd	17029	APACHST2	20.0	0	0.0	1	1	1.0100

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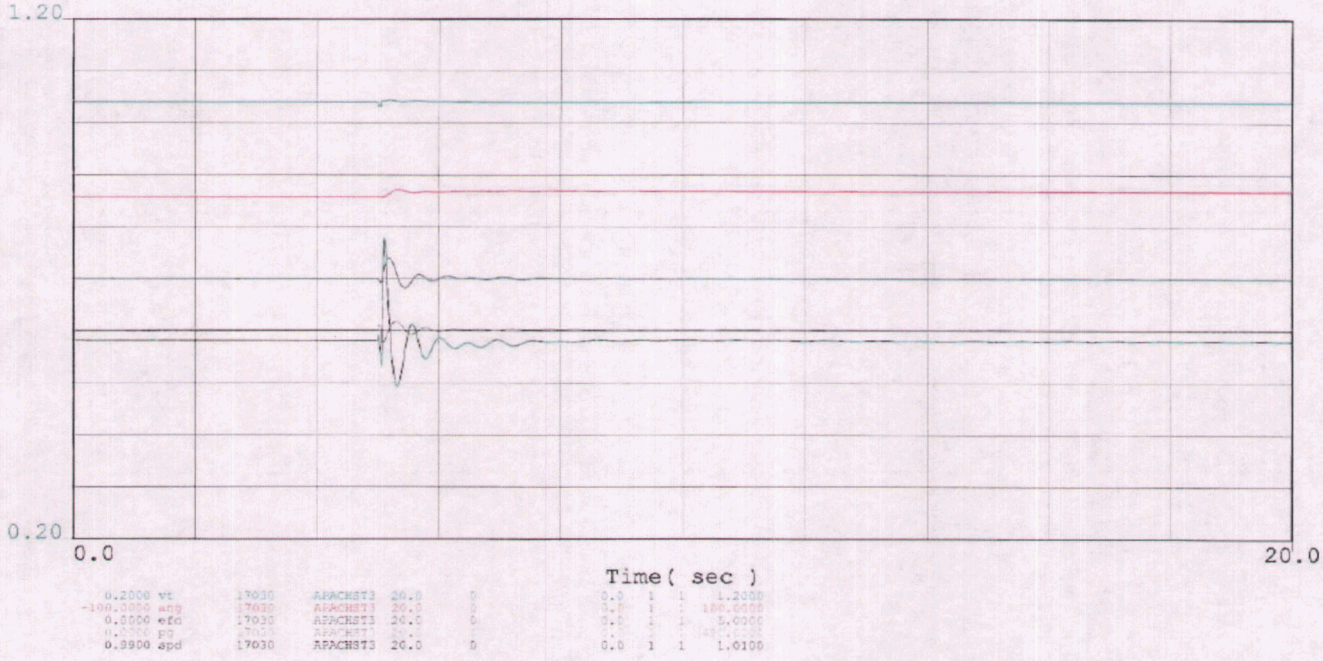
Apache to Red Tail 230 kV Outage



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Final review - APS, TEP - 4/2/09
1) wapa/seb 12/7/2009
Clear Both Ends in 5 Cycles

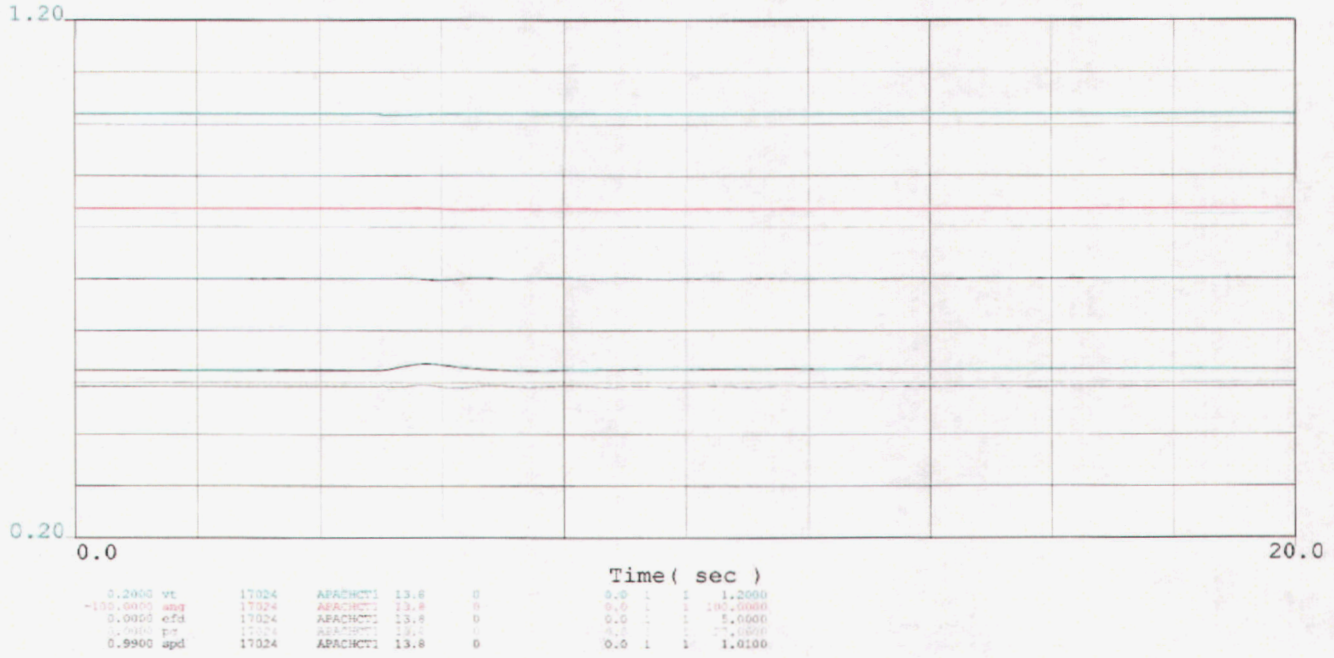
Southwest Transmission

apache_redtail.chf

ts_cases\new 2009 studies

Thu Oct 14 13:26:26 2010

Bicknell to Vail 345 kV Outage



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0.0000	efd	17024	APACHCT1	13.8	0	0.0	1	1	5.0000
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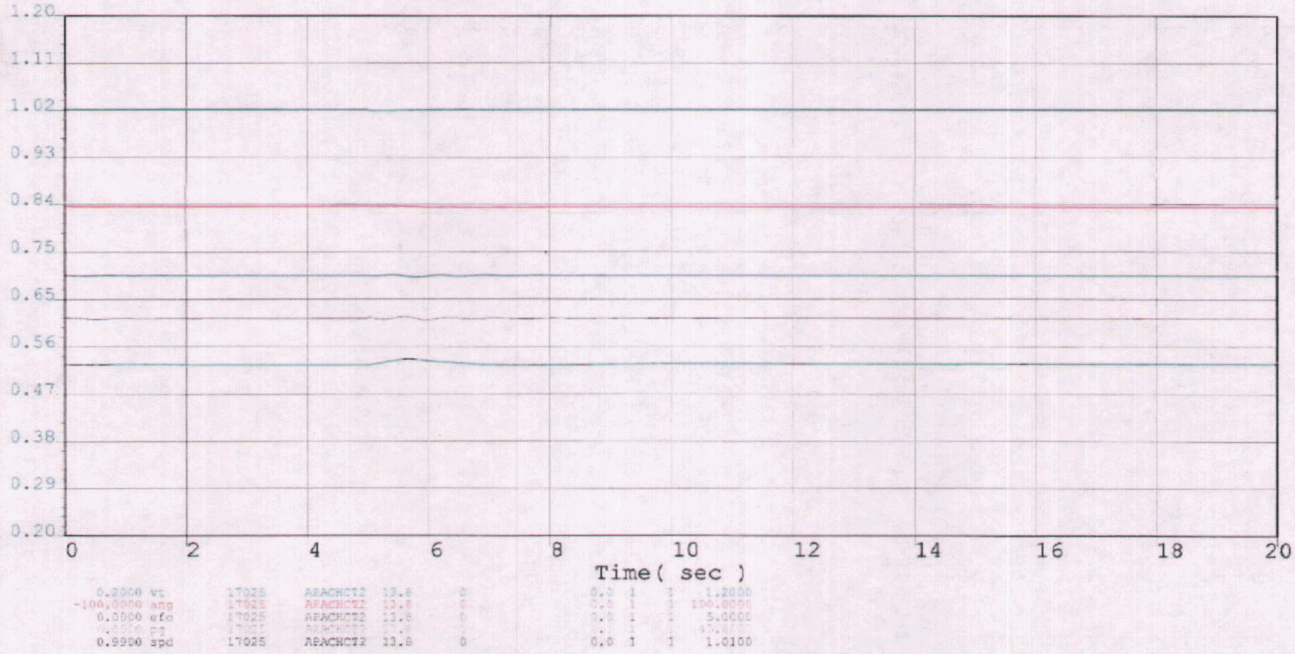
Southwest Transmission

Bicknell_Vail.chf

Thu Oct 14 13:37:16 2010

Bicknell to Vail 345 kV Outage



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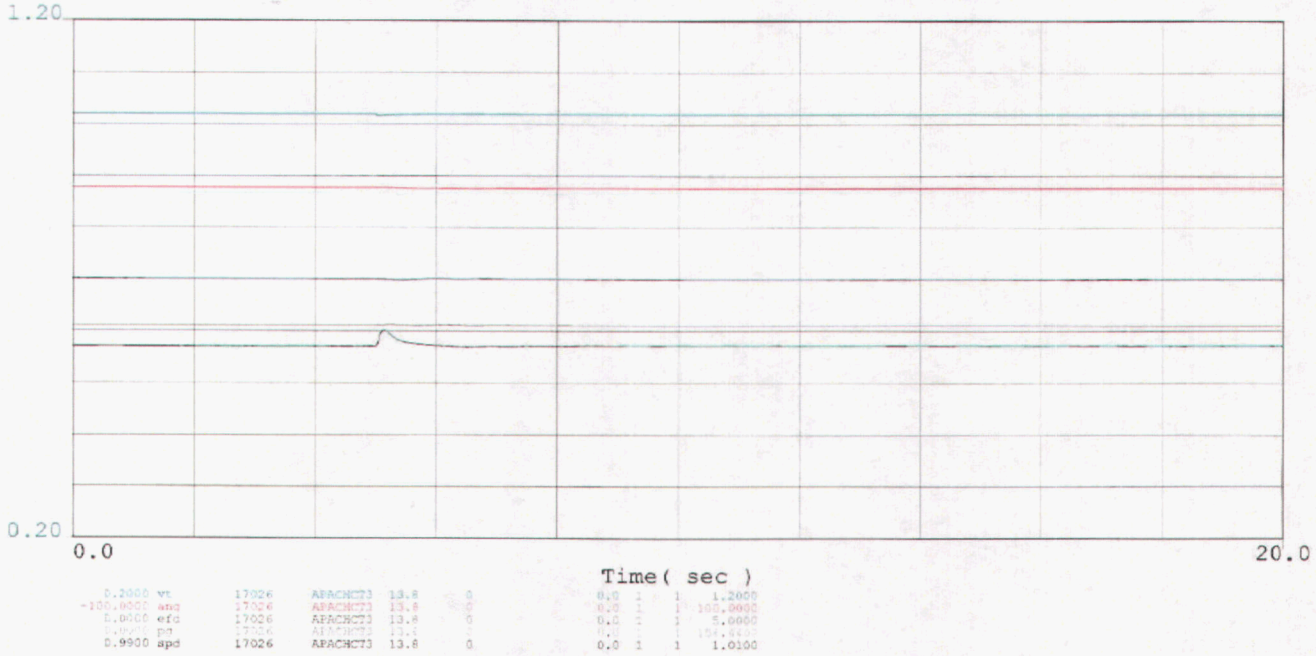
Southwest Transmission

Bicknell_Vail.chf

Thu Oct 14 13:37:14 2010

Bicknell to Vail 345 kV Outage



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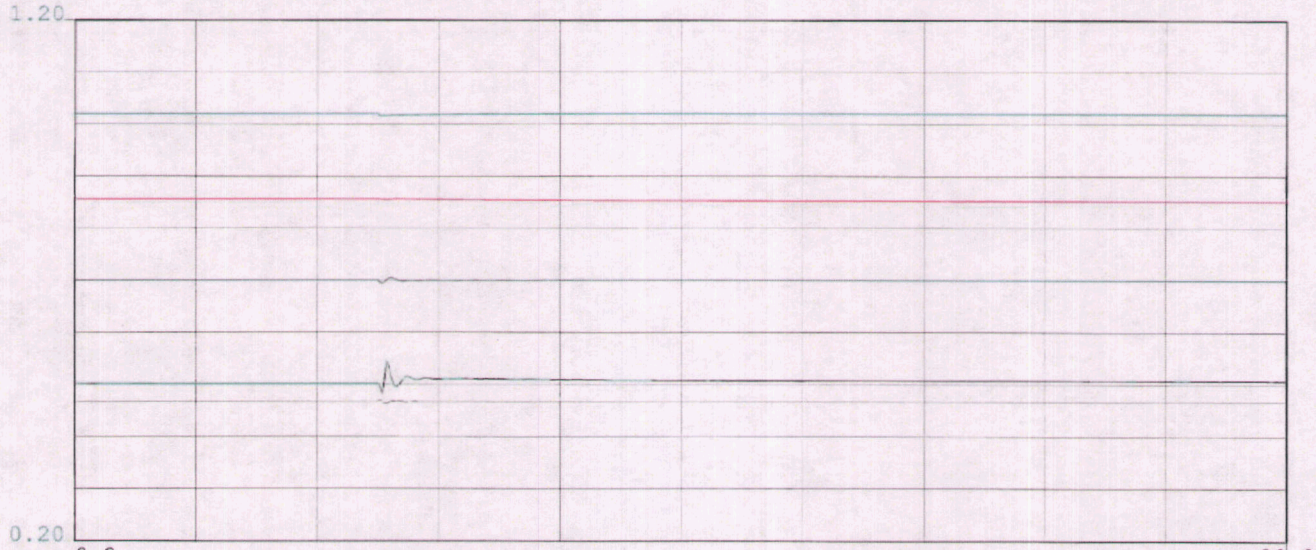
Bicknell to Vail 345 kV Outage



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Final review - APS, TEP - 4/2/09
1) wapa/seb 12/7/2009
Clear Both Ends in 5 Cycles

Southwest Transmission

Bicknell_Vail.chf

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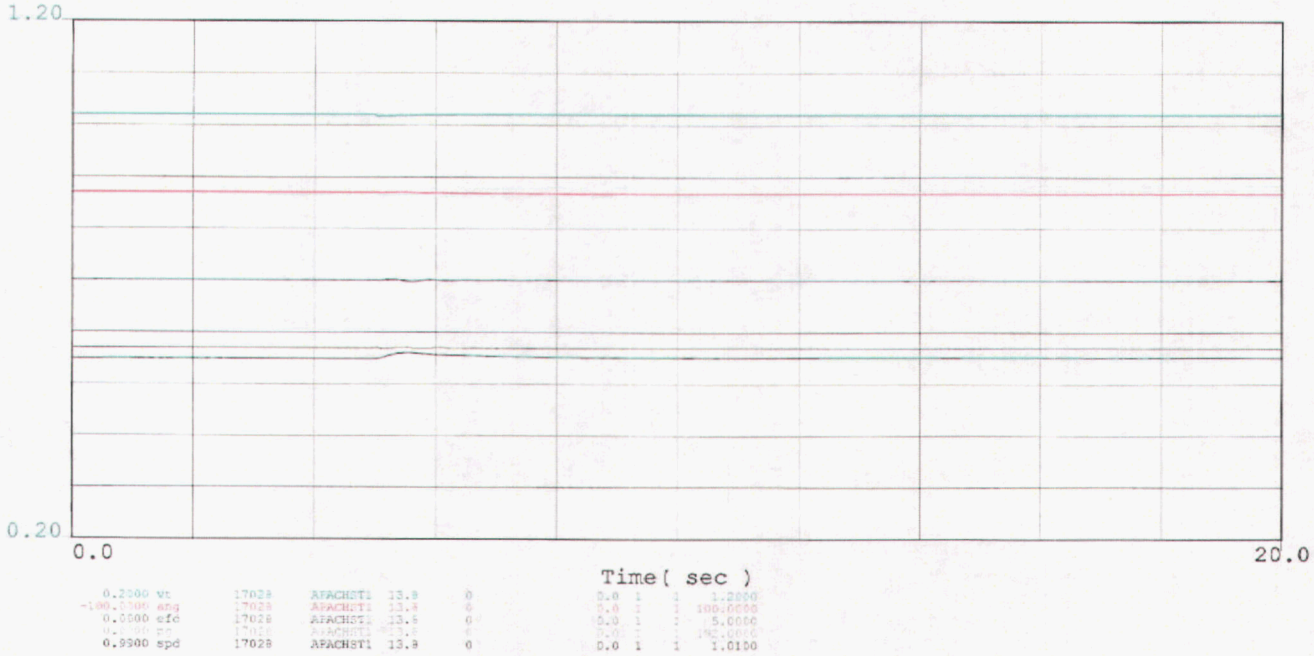
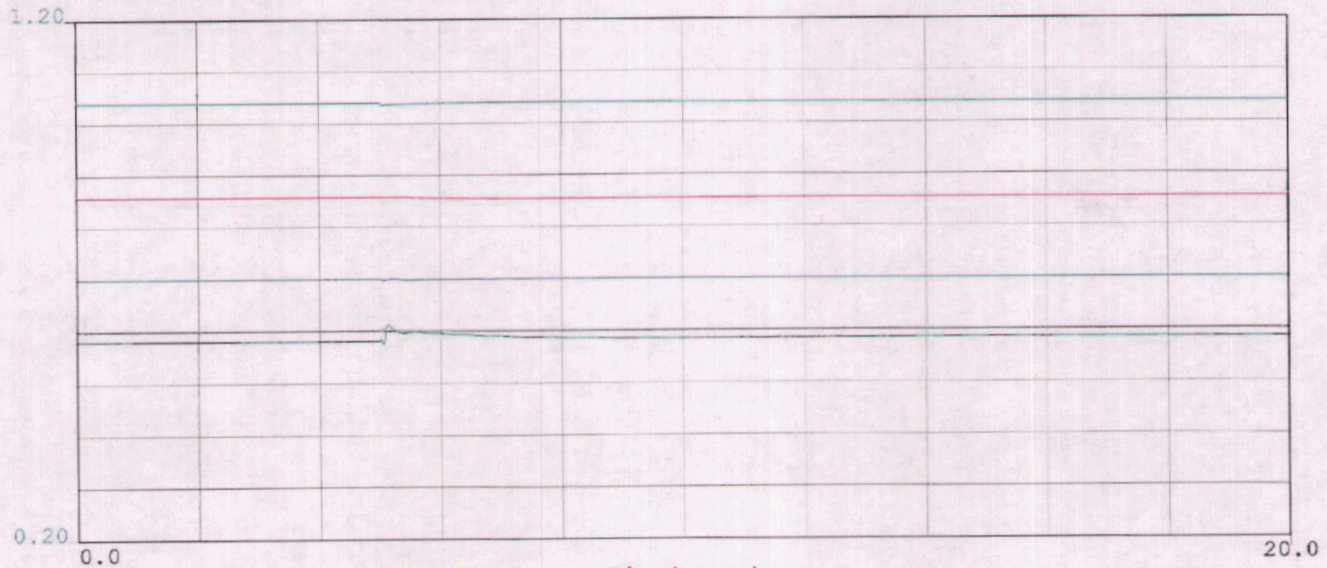
Thu Oct 14 13:37:14 2010

Bicknell to Vail 345 kV Outage



2010 SATS Heavy Summer Case
Developed from WECC 2009 HS3A APPROVED OPERATING CASE
Initial case reviewed by TEP, SWTC, and WAPA
Final review - APS, TEP - 4/2/09
1) wapa/seb 12/7/2009
Clear Both Ends in 5 Cycles

Bicknell to Vail 345 kV Outage



0.2000 vt	17029	APACHET2	20.0	0	0.0	1	1	1.2000
-100.0000 ang	17029	APACHET2	20.0	0	0.0	1	1	100.0000
0.0000 efd	17029	APACHET2	20.0	0	0.0	1	1	5.0000
0.0000 pg	17029	APACHET2	20.0	0	0.0	1	1	400.0000
0.9900 spd	17029	APACHET2	20.0	0	0.0	1	1	1.0100

2010 SATS Heavy Summer Case
Developed from WECC 2009 HS3A APPROVED OPERATING CASE
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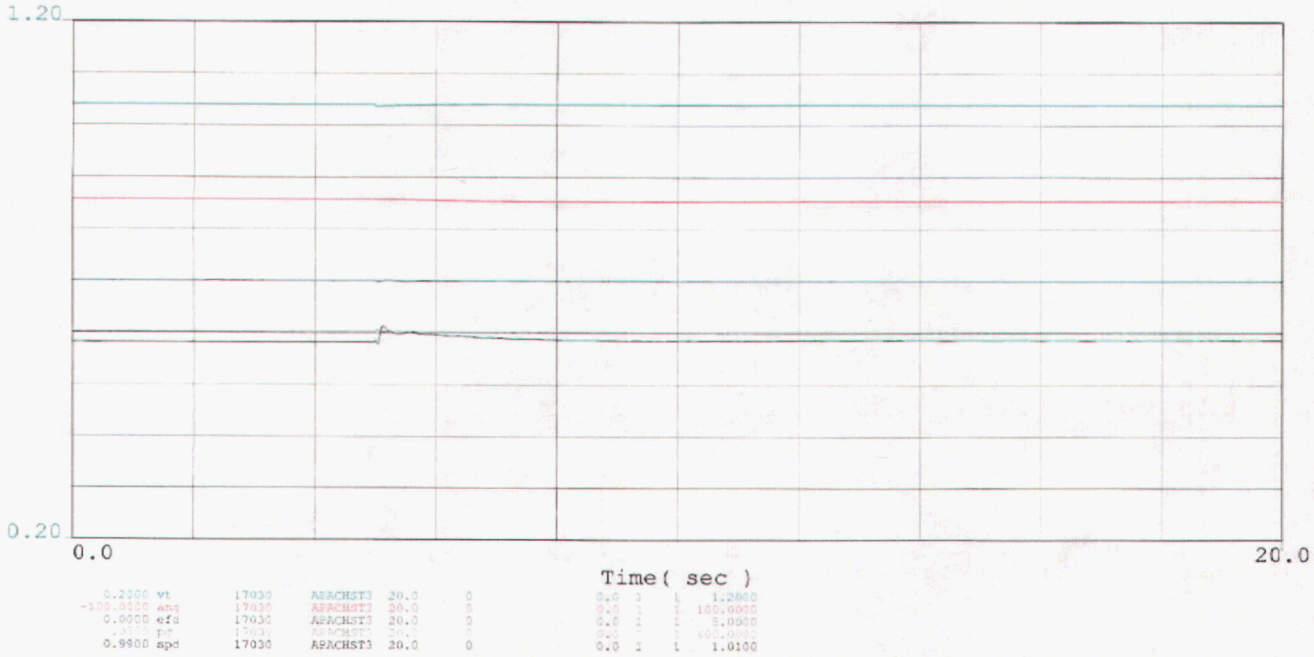
Final review - APS, TEP - 4/2/09
1) wapa/seb 12/7/2009
Clear Both Ends in 5 Cycles

Bicknell_Vail.chf

Thu Oct 14 13:37:15 2010

Bicknell to Vail 345 kV Outage



2010 SATS Heavy Summer Case
Developed from WECC 2009 HS3A APPROVED OPERATING CASE
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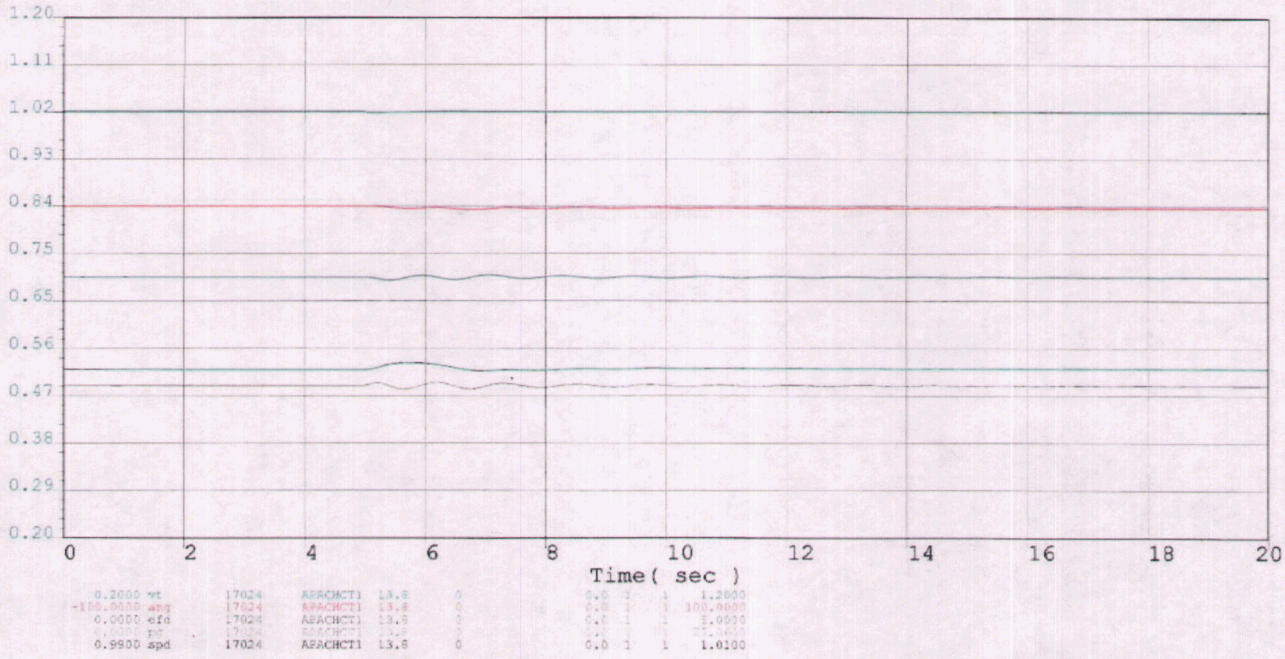
Final review - APS, TEP - 4/2/09
1) wapa/seb 12/7/2009
Clear Both Ends in 5 Cycles

Marana Tap to Marana 115 kV Outage

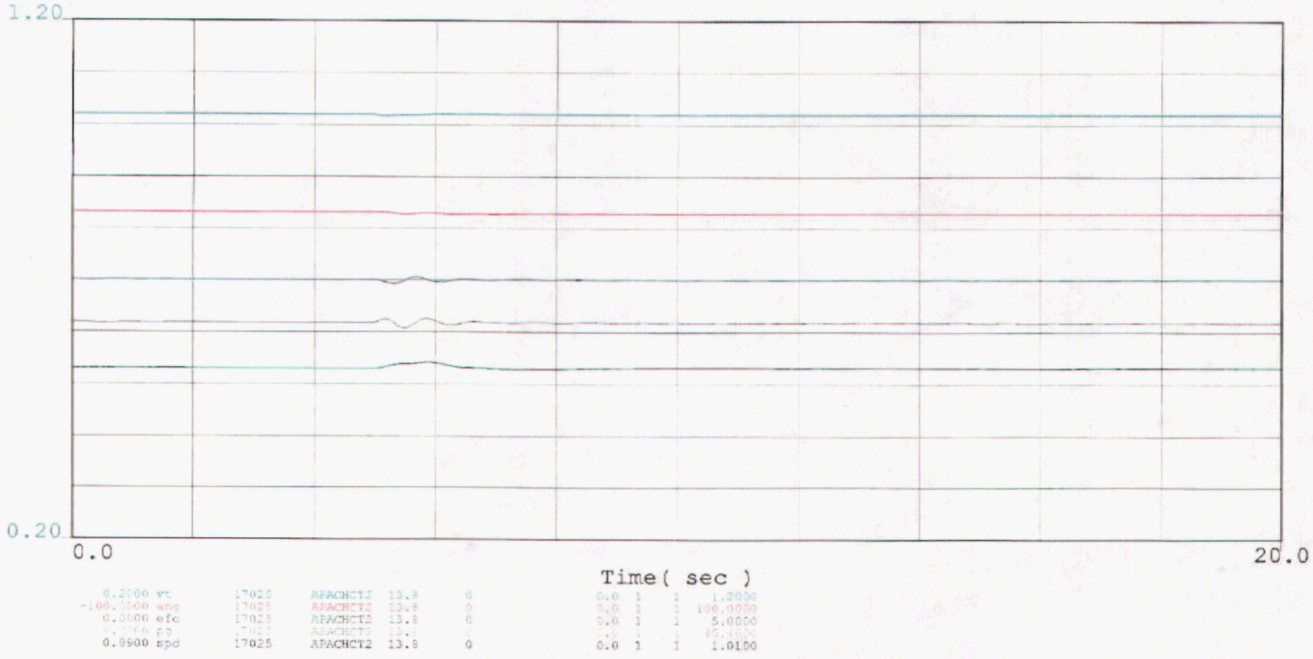


2010 SATS Heavy Summer Case
Developed from WECC 2009 HS3A APPROVED OPERATING CASE
Initial case reviewed by TEP, SWTC, and WAPA
Final review - APS, TEP - 4/2/09
1) wapa/seb 12/7/2009
Clear Both Ends in 5 Cycles

maranatap_marana.chf

Thu Oct 14 13:46:49 2010

Marana Tap to Marana 115 kV Outage



2010 SATS Heavy Summer Case
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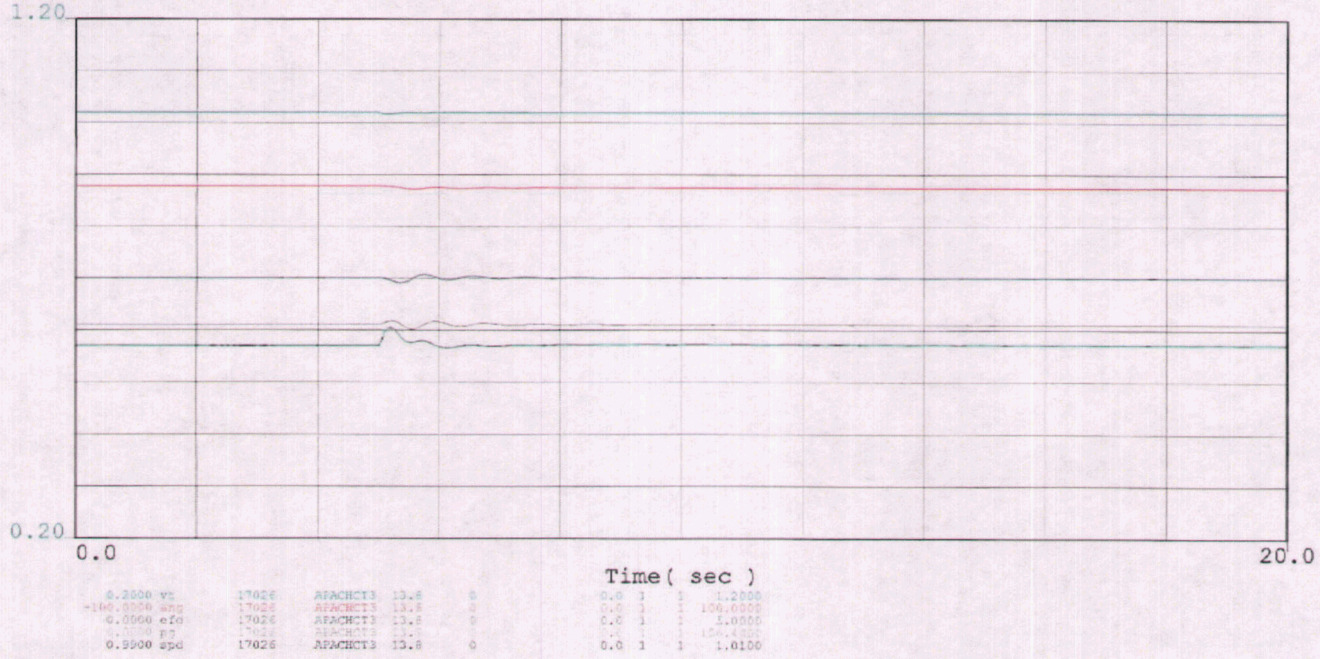
Initial case reviewed by TEP, SWTC, and WAPA
Final review - APS, TEP - 4/2/09
1) wapa/seb 12/7/2009
Clear Both Ends in 5 Cycles

Marana Tap to Marana 115 kV Outage



2010 SATS Heavy Summer Case
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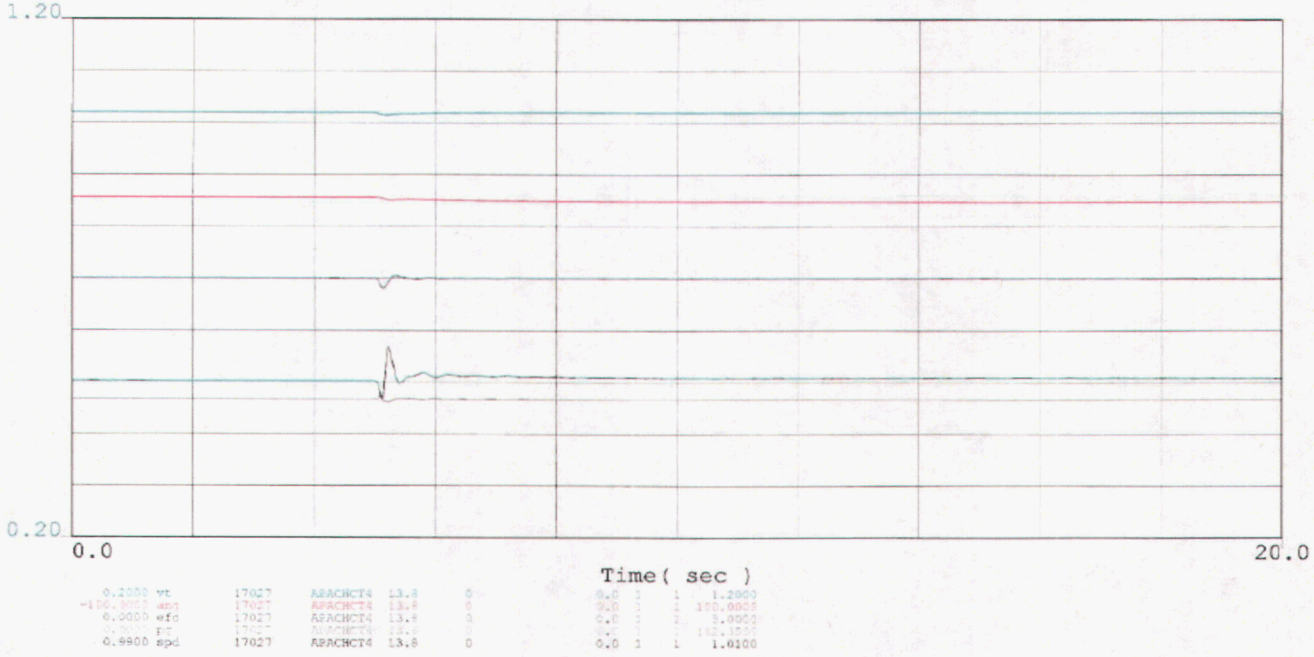
Final review - APS, TEP - 4/2/09
1) wapa/seb 12/7/2009
Clear Both Ends in 5 Cycles

Marana Tap to Marana 115 kV Outage

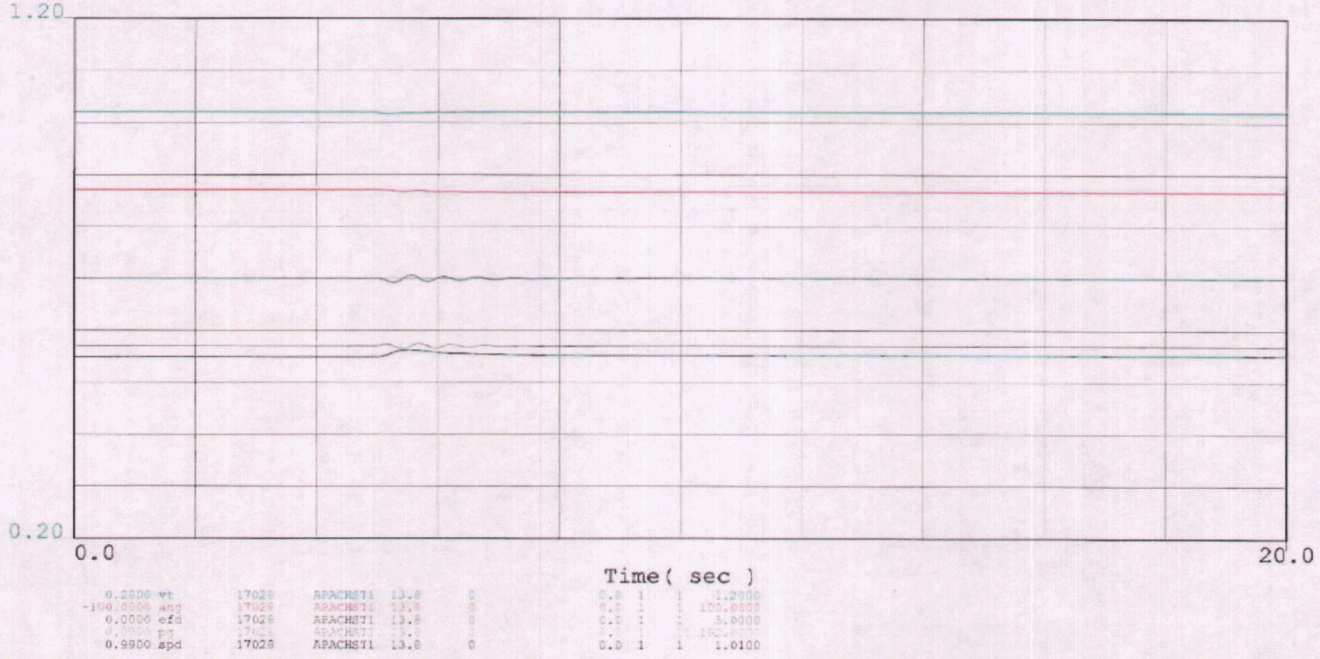


2010 SATS Heavy Summer Case
Developed from WECC 2009 HS3A APPROVED OPERATING CASE
Initial case reviewed by TEP, SWTC, and WAPA
Final review - APS, TEP - 4/2/09
1) wapa/seb 12/7/2009
Clear Both Ends in 5 Cycles

maranatap_marana.chf

Thu Oct 14 13:46:50 2010

Marana Tap to Marana 115 kV Outage



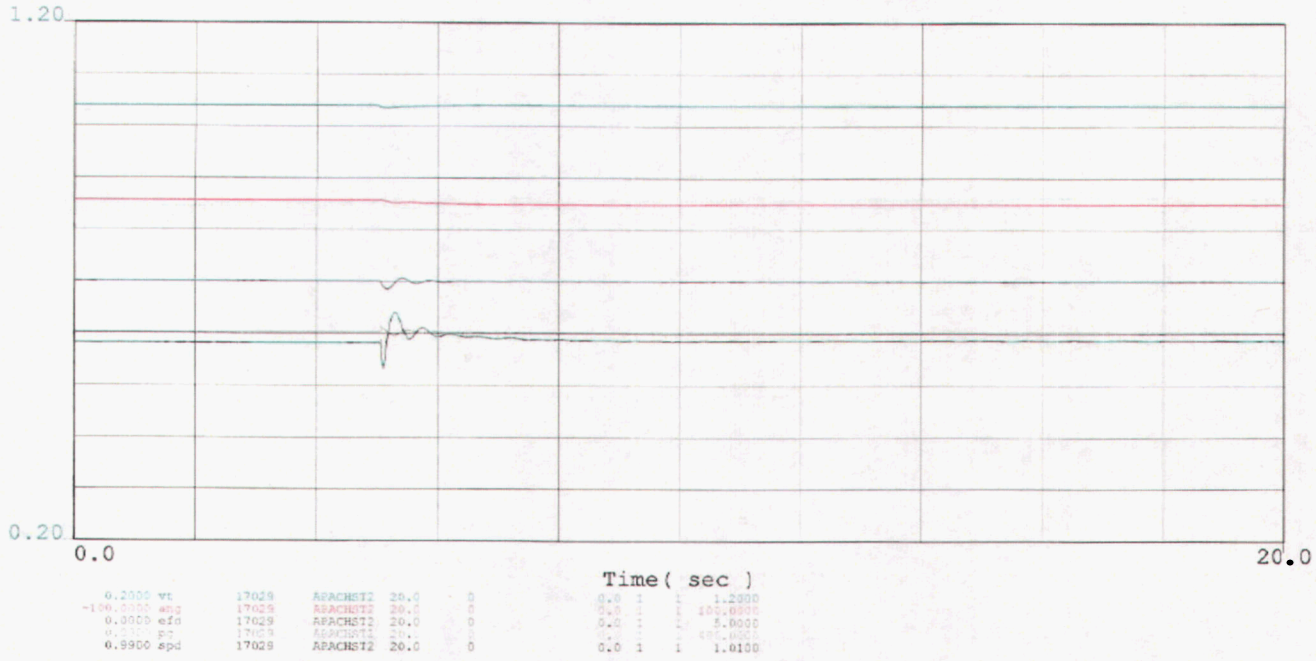
2010 SATS Heavy Summer Case
Developed from WECC 2009 HS3A APPROVED OPERATING CASE
Initial case reviewed by TEP, SWTC, and WAPA
Final review - APS, TEP - 4/2/09
1) wapa/seb 12/7/2009
Clear Both Ends in 5 Cycles

Southwest Transmission

maranatap_marana.chf

Thu Oct 14 13:46:51 2010

Marana Tap to Marana 115 kV Outage



0.2000	vt	17029	APACHST2	20.0	0	0.0	1	1	1.2000
-100.0000	ang	17029	APACHST2	20.0	0	0.0	1	1	100.0000
0.0000	efd	17029	APACHST2	20.0	0	0.0	1	1	5.0000
0.0000	p	17029	APACHST2	20.0	0	0.0	1	1	0.0000
0.9900	spd	17029	APACHST2	20.0	0	0.0	1	1	1.0100

2010 SATS Heavy Summer Case
Developed from WECC 2009 HS3A APPROVED OPERATING CASE
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Final review - APS, TEP - 4/2/09
1) wapa/seb 12/7/2009
Clear Both Ends in 5 Cycles

Southwest Transmission

maranatap_marana.chf

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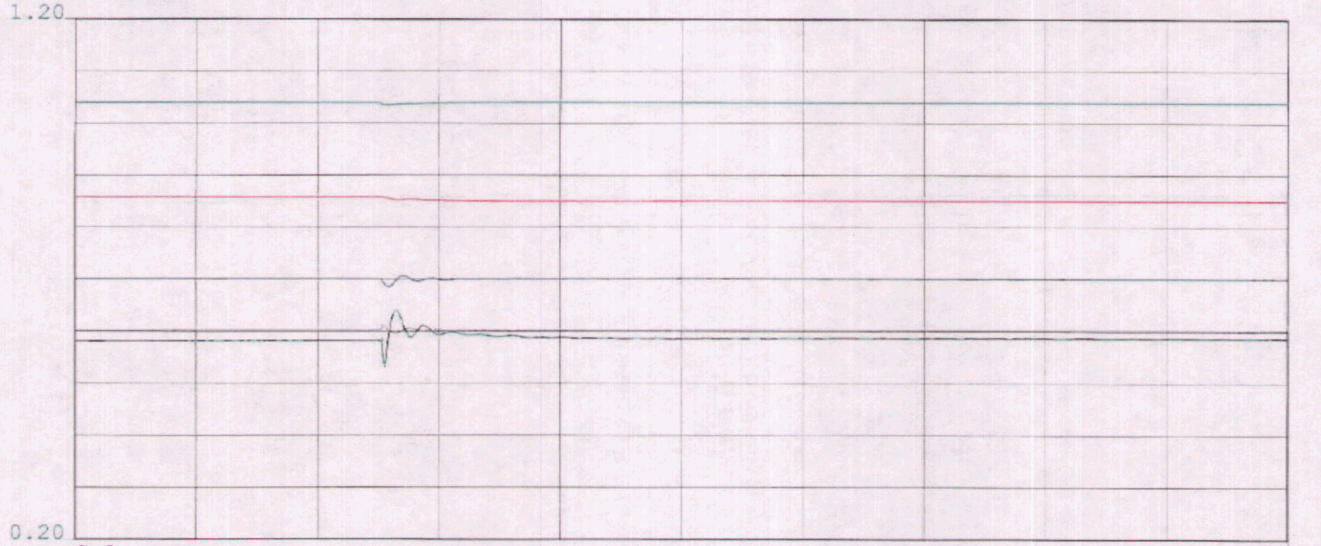
Thu Oct 14 13:46:51 2010

Marana Tap to Marana 115 kV Outage



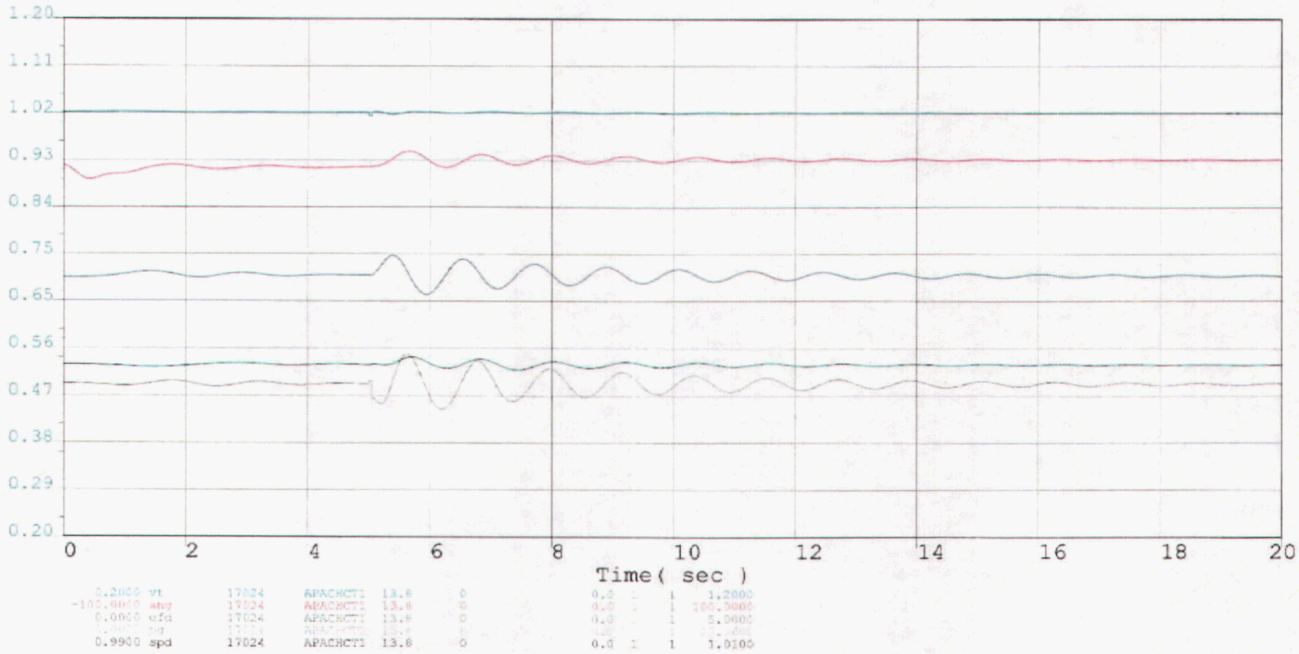
0.2000 vt	17030	APACHST3	20.0	0	0.0	1	1	1.2000
-106.8000 anq	17030	APACHST3	20.0	0	0.0	1	1	180.6000
0.0000 efd	17030	APACHST3	20.0	0	0.0	1	1	5.0000
1.0000 f7	17030	APACHST3	20.0	0	0.0	1	1	65.0000
0.9900 spd	17030	APACHST3	20.0	0	0.0	1	1	1.0100

2010 SATS Heavy Summer Case
Developed from WECC 2009 HS3A APPROVED OPERATING CASE
Initial case reviewed by TEP, SWTC, and WAPA
Final review - APS, TEP - 4/2/09
1) wapa/seb 12/7/2009
Clear Both Ends in 5 Cycles

maranatap_marana.chf

Thu Oct 14 13:46:52 2010

Apache to Butterfield 230 kV Outage



0.2000	vt	17024	APACHCT1	13.8	0	0.0	1	1.2000
-180.0000	ang	17024	APACHCT1	13.8	0	0.0	1	180.0000
0.0000	efd	17024	APACHCT1	13.8	0	0.0	1	5.0000
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0.9900	spd	17024	APACHCT1	13.8	0	0.0	1	1.0100

WESTERN ELECTRICITY COORDINATING COUNCIL
2014 HS3-SA APPROVED BASE CASE
MARCH 1, 2010
ALL COMMENTS FROM THE TSS REVIEW ARE INCLUDED.
Clear Both Ends in 5 Cycles

Southwest Transmission

Apache_Butterfield.chf

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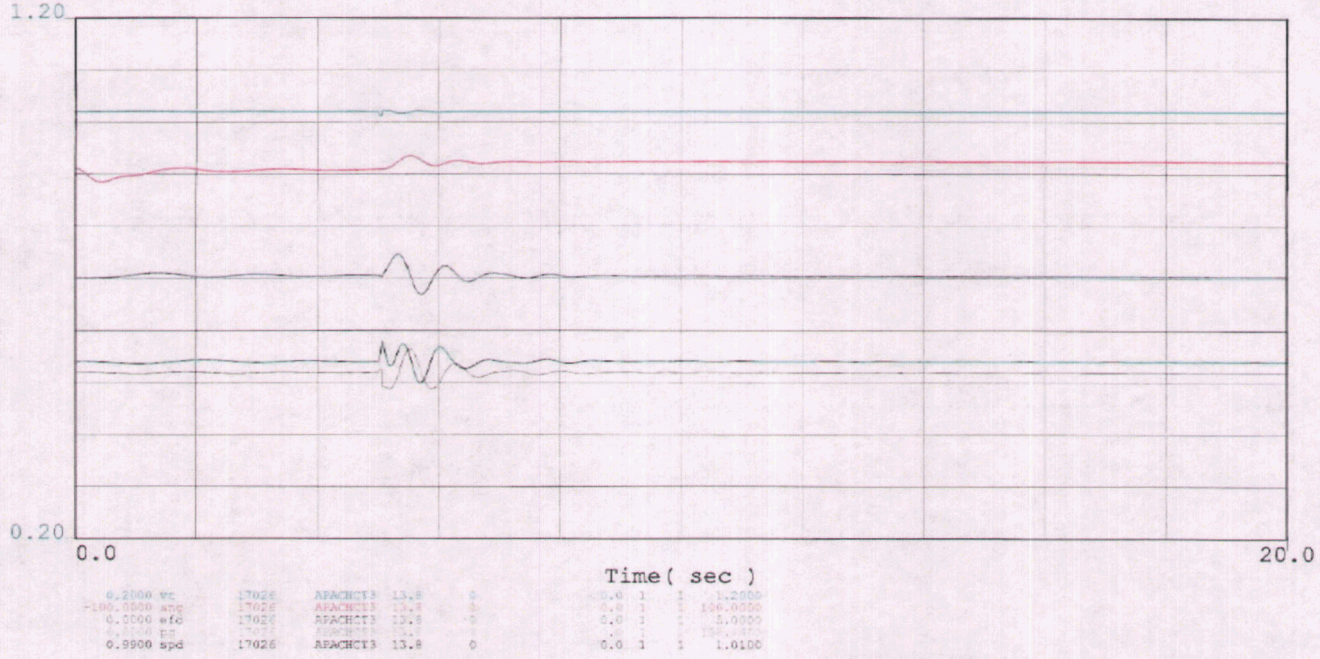
Thu Oct 14 14:27:33 2010

Apache to Butterfield 230 kV Outage

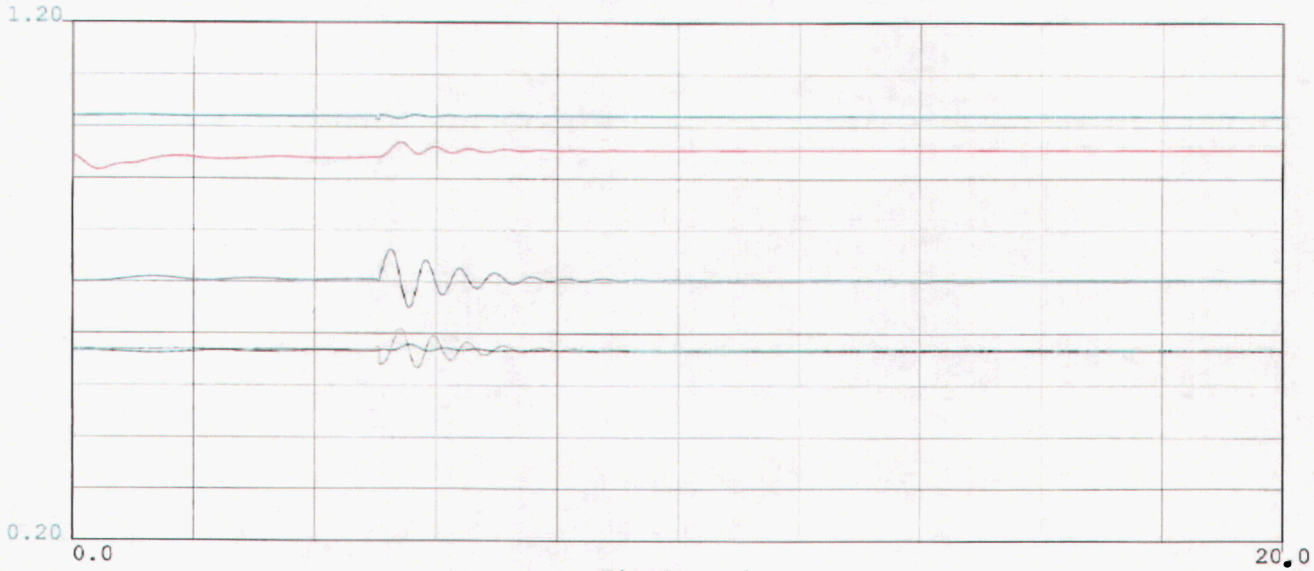


WESTERN ELECTRICITY COORDINATING COUNCIL
2014 HS3-SA APPROVED BASE CASE
MARCH 1, 2010
ALL COMMENTS FROM THE TSS REVIEW ARE INCLUDED.
Clear Both Ends in 5 Cycles

Apache_Butterfield.chf

Thu Oct 14 14:27:33 2010

Apache to Butterfield 230 kV Outage



0.2000	vt	17028	APACHET1	13.8	0	0.0	1	1	1.2000
-136.0000	ang	17028	APACHET1	13.8	0	0.0	1	1	180.0000
0.0000	efd	17028	APACHET1	13.8	0	0.0	1	1	5.0000
0.0000	pg	17028	APACHET1	13.8	0	0.0	1	1	180.0000
0.9900	spd	17028	APACHET1	13.8	0	0.0	1	1	1.0100

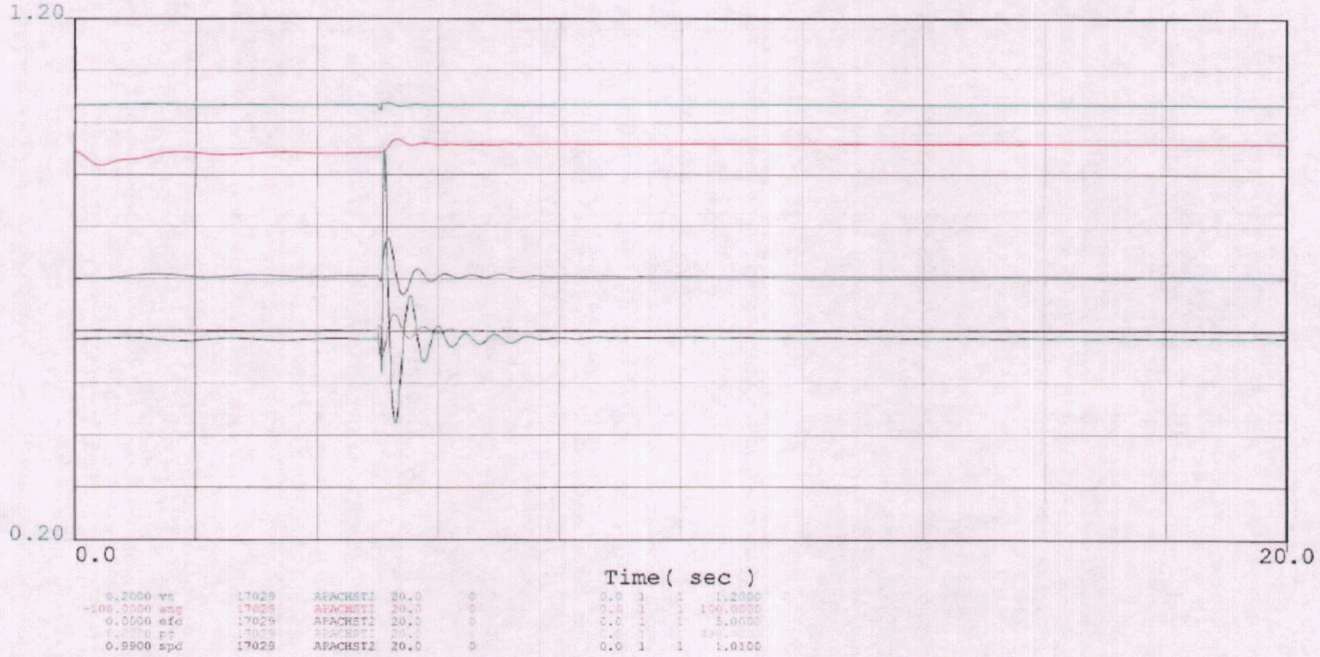
WESTERN ELECTRICITY COORDINATING COUNCIL
2014 HS3-SA APPROVED BASE CASE
MARCH 1, 2010
ALL COMMENTS FROM THE TSS REVIEW ARE INCLUDED.
Clear Both Ends in 5 Cycles

Southwest Transmission

Apache_Butterfield.chf

Thu Oct 14 14:27:33 2010

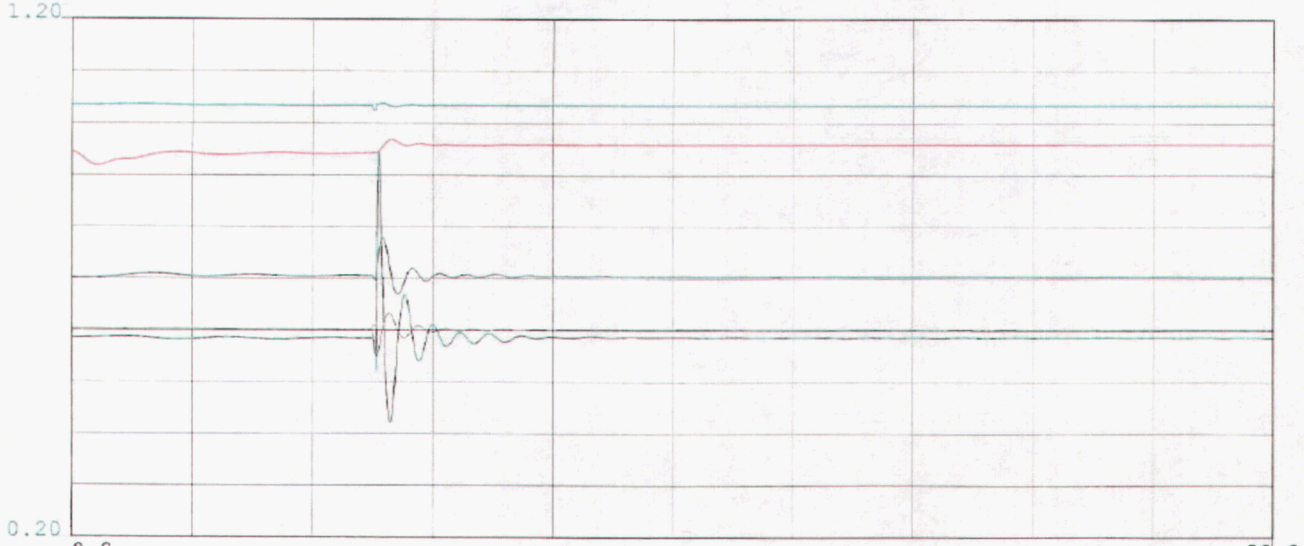
Apache to Butterfield 230 kV Outage



0.2000 vs	17029	APACHST1	20.0	0	0.0	1	1	1.2000
-108.0000 ang	17029	APACHST1	20.0	0	0.0	1	1	150.0000
0.0000 efd	17029	APACHST1	20.0	0	0.0	1	1	5.0000
0.0000 pt	17029	APACHST1	20.0	0	0.0	1	1	0.0000
0.9900 spd	17029	APACHST1	20.0	0	0.0	1	1	1.0100

WESTERN ELECTRICITY COORDINATING COUNCIL
2014 HS3-SA APPROVED BASE CASE
MARCH 1, 2010
ALL COMMENTS FROM THE TSS REVIEW ARE INCLUDED.
Clear Both Ends in 5 Cycles

Apache to Butterfield 230 kV Outage



WESTERN ELECTRICITY COORDINATING COUNCIL
2014 HS3-SA APPROVED BASE CASE
MARCH 1, 2010
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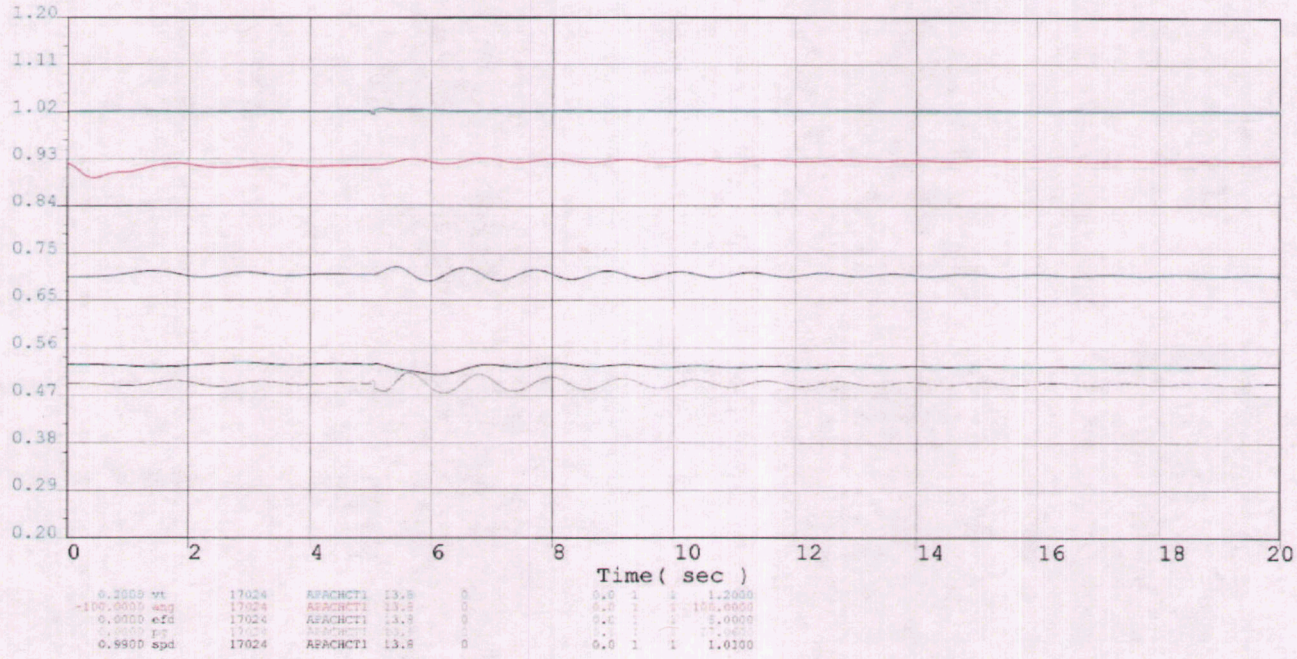
Clear Both Ends in 5 Cycles

Apache_Butterfield.chf

Thu Oct 14 14:27:34 2010

Apache to Red Tail 230 kV Outage

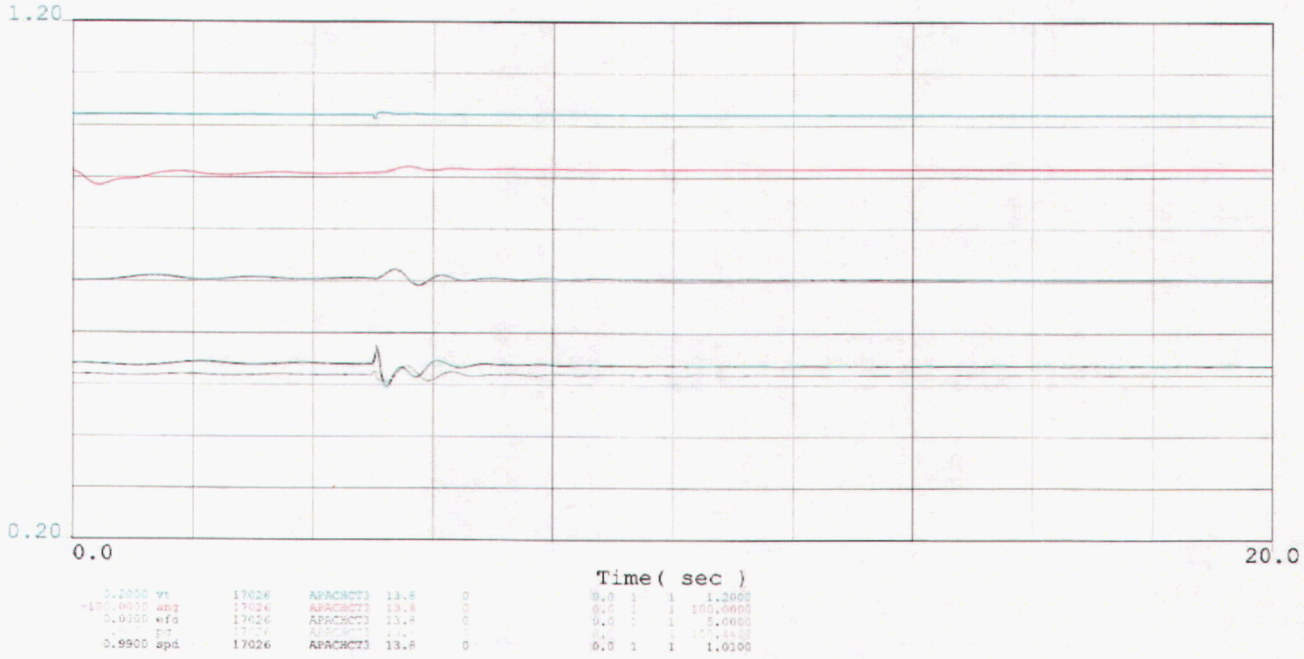


WESTERN ELECTRICITY COORDINATING COUNCIL
2014 HS3-SA APPROVED BASE CASE
MARCH 1, 2010
ALL COMMENTS FROM THE TSS REVIEW ARE INCLUDED.
Clear Both Ends in 5 Cycles

2014apa-rdtl.chf

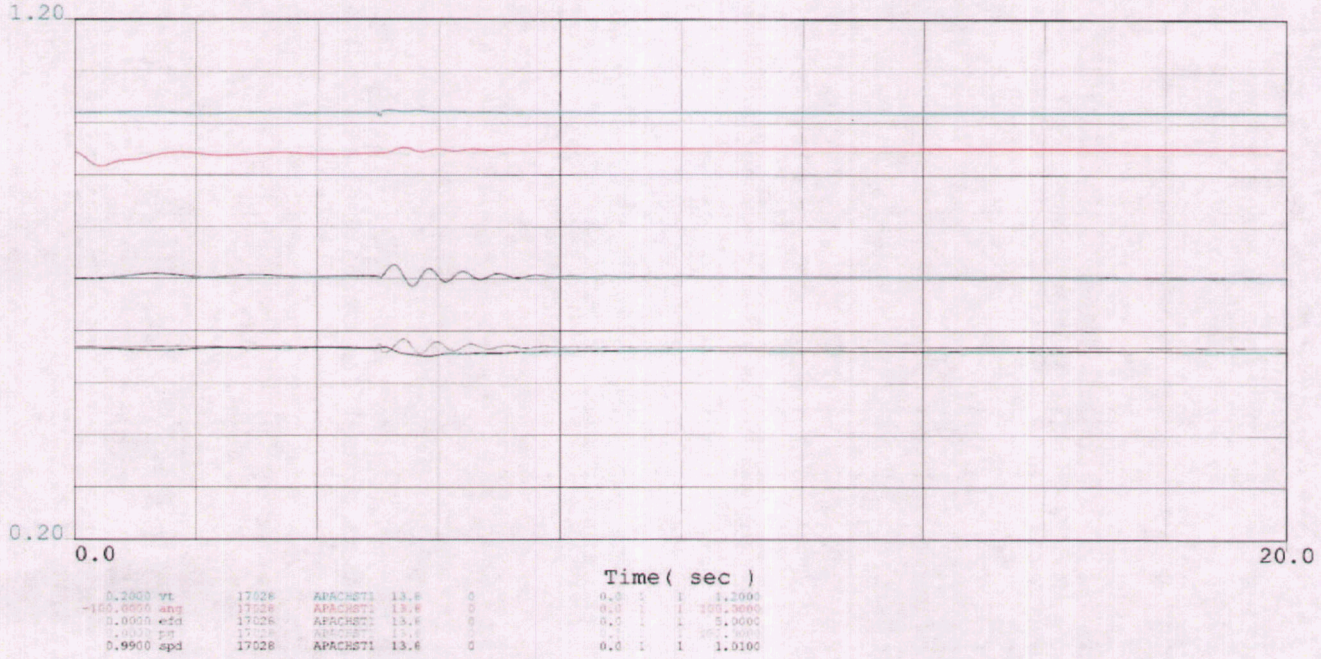
Thu Oct 14 14:34:19 2010

Apache to Red Tail 230 kV Outage



WESTERN ELECTRICITY COORDINATING COUNCIL
2014 HS3-SA APPROVED BASE CASE
MARCH 1, 2010
ALL COMMENTS FROM THE TSS REVIEW ARE INCLUDED.
Clear Both Ends in 5 Cycles

Apache to Red Tail 230 kV Outage



0.2003	vt	17028	APACHS71	13.8	0	0.0	1	1	1.2000
-180.0000	ang	17028	APACHS71	13.8	0	0.0	1	1	300.3000
0.0000	efd	17028	APACHS71	13.8	0	0.0	1	1	5.0000
0.0000	pm	17028	APACHS71	13.8	0	0.0	1	1	99.9000
0.9900	spd	17028	APACHS71	13.8	0	0.0	1	1	1.0100

WESTERN ELECTRICITY COORDINATING COUNCIL
2014 HS3-SA APPROVED BASE CASE
MARCH 1, 2010
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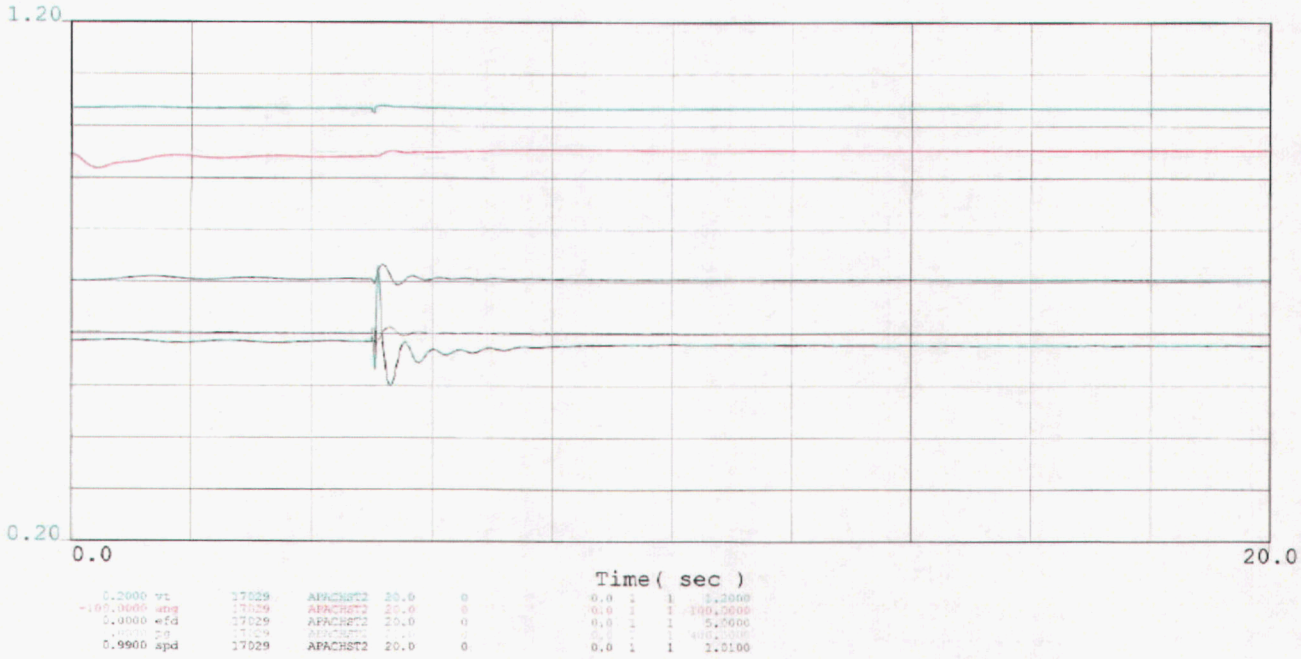
Clear Both Ends in 5 Cycles

Apache to Red Tail 230 kV Outage



WESTERN ELECTRICITY COORDINATING COUNCIL
2014 HS3-SA APPROVED BASE CASE
MARCH 1, 2010
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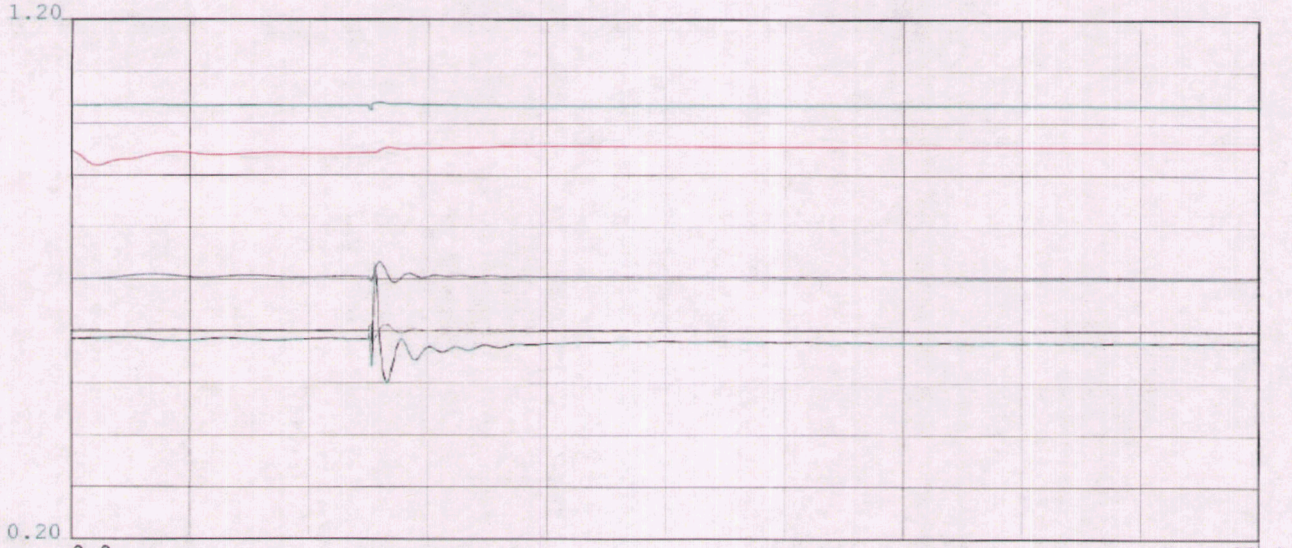
Clear Both Ends in 5 Cycles

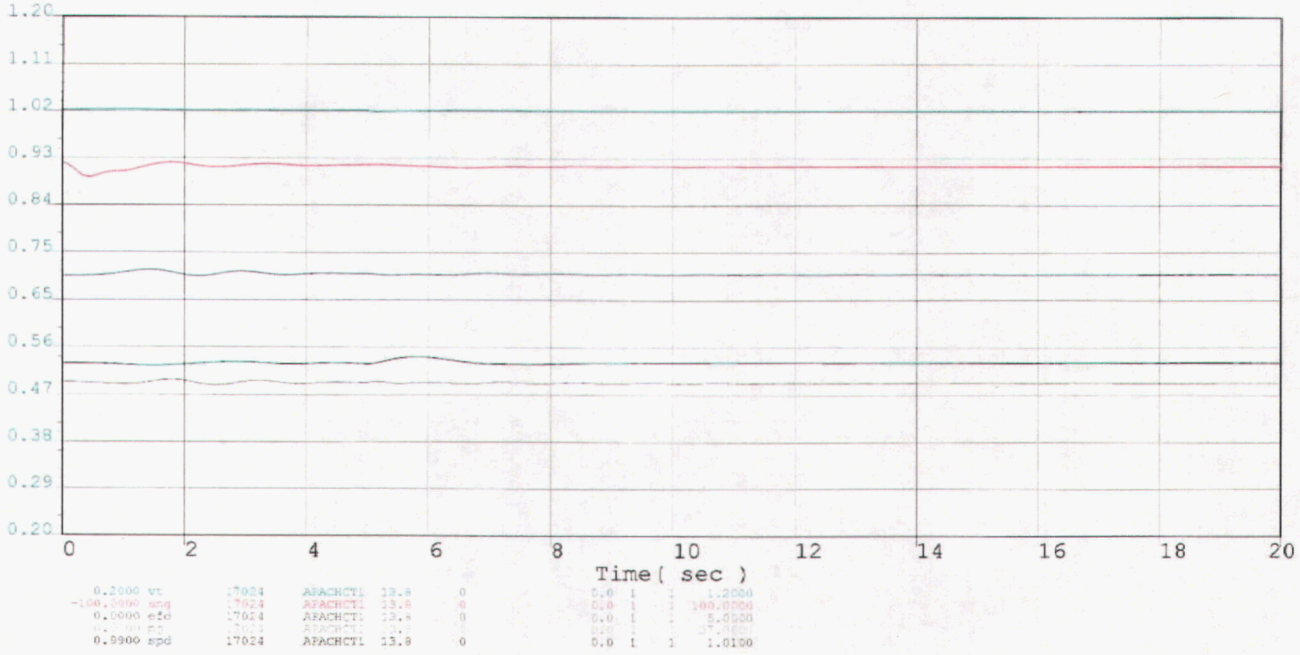
Apache to Red Tail 230 kV Outage



0.2000 vt	17030	APACHST3	20.0	6	0.0	1	1	1.2000
-100.0000 ang	17030	APACHST3	20.0	6	0.0	1	1	100.0000
5.0000 efd	17030	APACHST3	20.0	6	0.0	1	1	5.0000
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0.9900 spd	17030	APACHST3	20.0	6	0.0	1	1	1.0100

WESTERN ELECTRICITY COORDINATING COUNCIL
2014 HS3-SA APPROVED BASE CASE
MARCH 1, 2010
ALL COMMENTS FROM THE TSS REVIEW ARE INCLUDED.
Clear Both Ends in 5 Cycles

Bicknell to Vail 345 kV Outage



0.2000 vt	17024	APACHCT1	13.8	0	0.0	1	1	1.2000
-100.0000 anq	17024	APACHCT1	13.8	0	0.0	1	1	100.0000
0.0000 efd	17024	APACHCT1	13.8	0	0.0	1	1	5.0000
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0.9900 spd	17024	APACHCT1	13.8	0	0.0	1	1	1.0100

WESTERN ELECTRICITY COORDINATING COUNCIL
2014 HS3-SA APPROVED BASE CASE
MARCH 1, 2010
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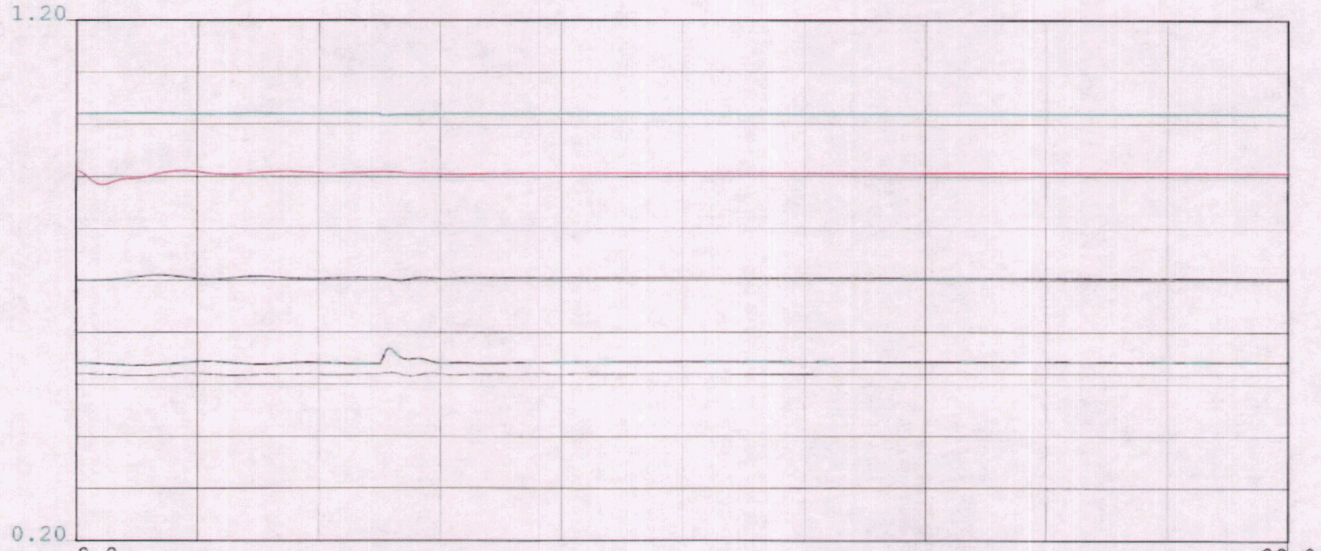
Clear Both Ends in 5 Cycles

Southwest Transmission

2014bick-vail.chf

Thu Oct 14 14:43:25 2010

Bicknell to Vail 345 kV Outage



0.2000 vt	17026	APACHCT3	13.8	0	0.0	1	1	1.2000
-100.0000 afq	17026	APACHCT3	13.8	0	0.0	1	1	100.0000
0.0000 efd	17026	APACHCT3	13.8	0	0.0	1	1	5.0000
0.0000 pa	17026	APACHCT3	13.		0.	1	1	15.0000
0.9900 spd	17026	APACHCT3	13.8	0	0.0	1	1	1.0100

WESTERN ELECTRICITY COORDINATING COUNCIL
2014 HS3-SA APPROVED BASE CASE
MARCH 1, 2010
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Southwest Transmission

2014bick-vail.chf

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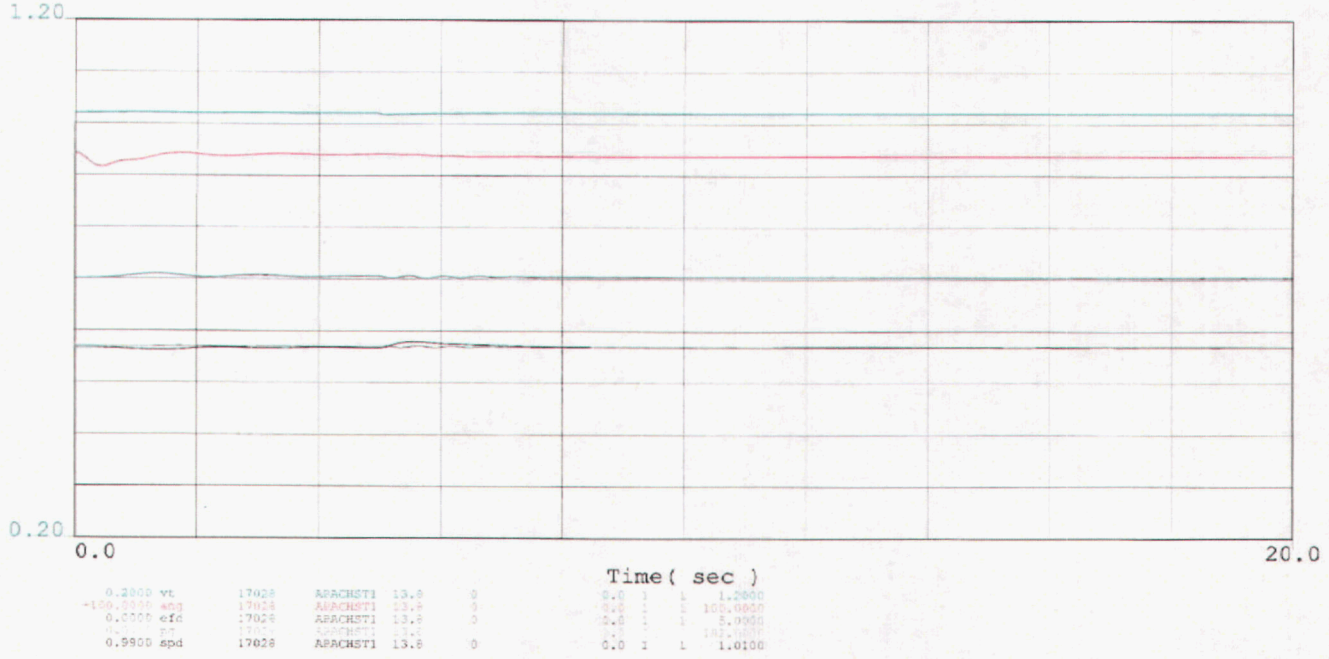
Thu Oct 14 14:43:25 2010

Bicknell to Vail 345 kV Outage

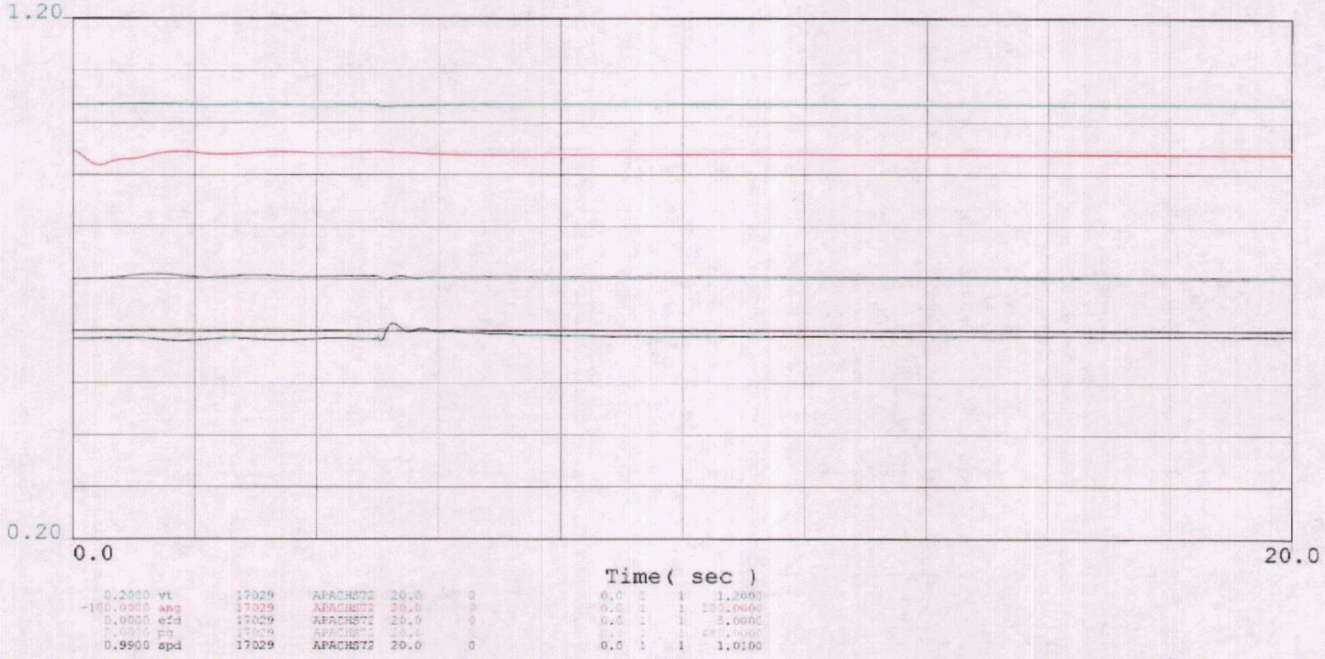


WESTERN ELECTRICITY COORDINATING COUNCIL
2014 HS3-SA APPROVED BASE CASE
MARCH 1, 2010
ALL COMMENTS FROM THE TSS REVIEW ARE INCLUDED.
Clear Both Ends in 5 Cycles

2014bick-vail.chf

Thu Oct 14 14:43:26 2010

Bicknell to Vail 345 kV Outage



0.2000	vt	17029	APACHS72	20.0	0	0.0	1	1	1.2000
-180.0000	ang	17029	APACHS72	20.0	0	0.0	1	1	180.0000
0.0000	efd	17029	APACHS72	20.0	0	0.0	1	1	5.0000
.0000	pg	17029	APACHS72	20.0	0	.0	1	1	685.0000
0.9900	spd	17029	APACHS72	20.0	0	0.0	1	1	1.0100

WESTERN ELECTRICITY COORDINATING COUNCIL
2014 HS3-SA APPROVED BASE CASE
MARCH 1, 2010
ALL COMMENTS FROM THE TSS REVIEW ARE INCLUDED.
Clear Both Ends in 5 Cycles

Southwest Transmission

2014bick-vail.chf

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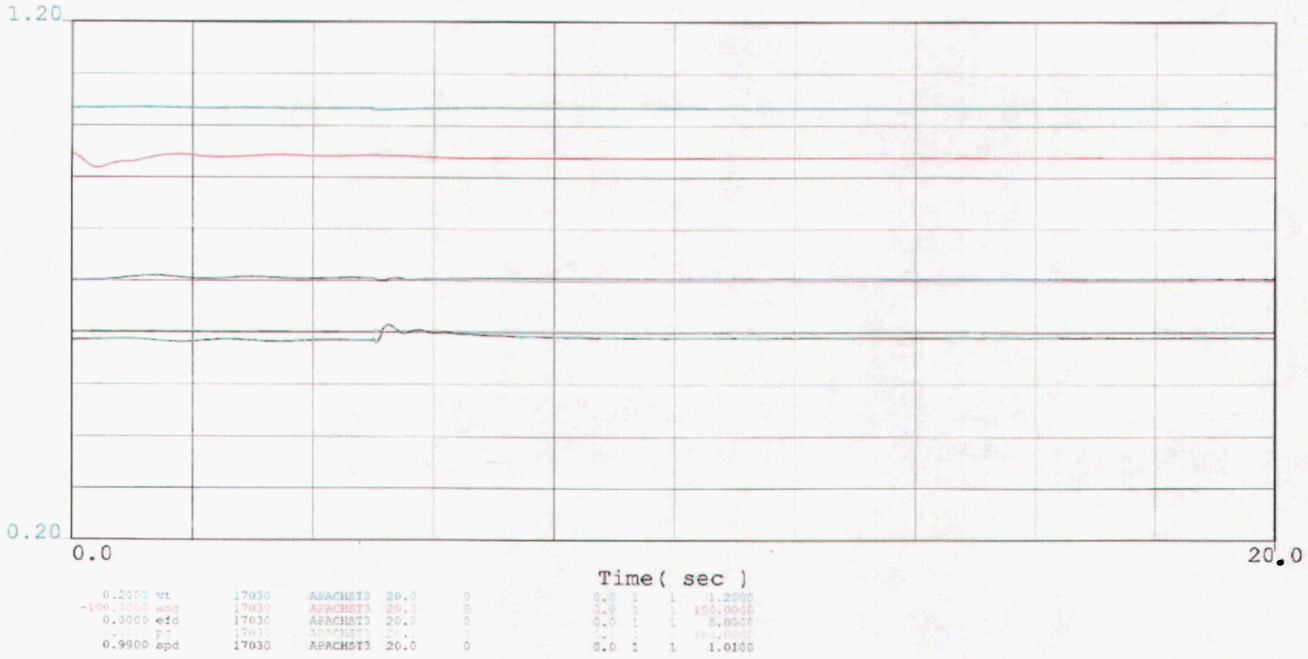
Thu Oct 14 14:43:26 2010

Bicknell to Vail 345 kV Outage

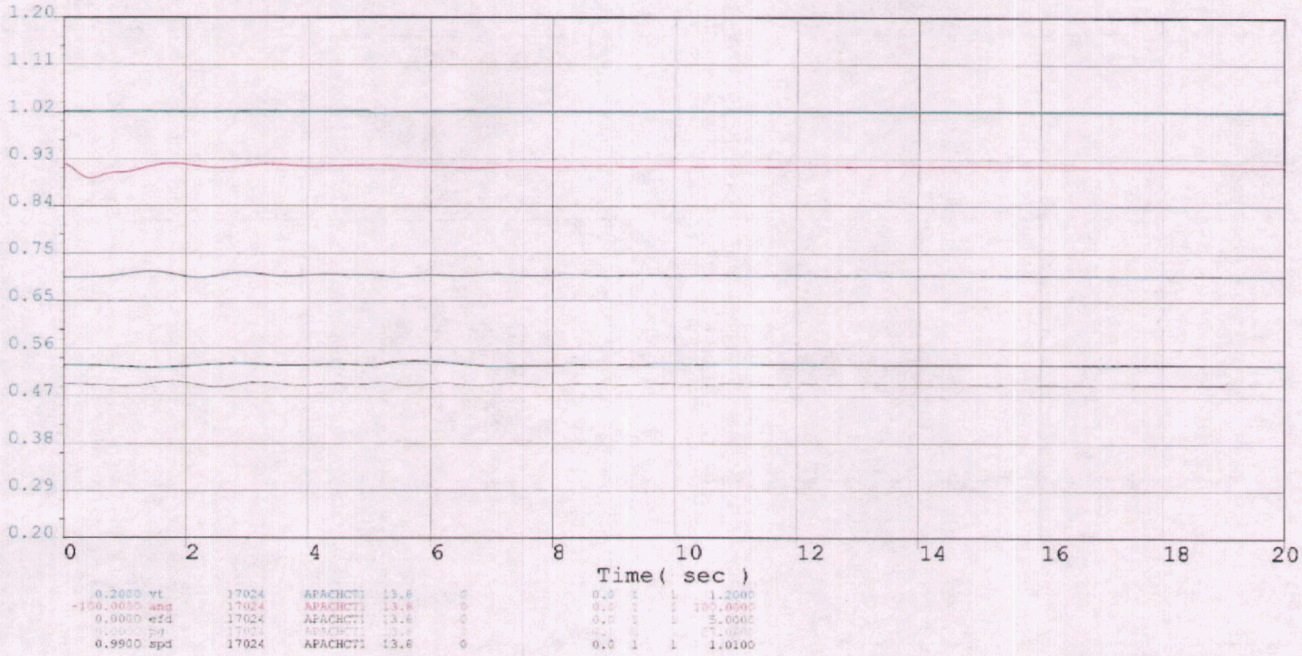


WESTERN ELECTRICITY COORDINATING COUNCIL
2014 HS3-SA APPROVED BASE CASE
MARCH 1, 2010
ALL COMMENTS FROM THE TSS REVIEW ARE INCLUDED.
Clear Both Ends in 5 Cycles

2014bick-vail.chf

Thu Oct 14 14:43:27 2010

Marana Tap to Marana 115 kV Outage



0.2000	vt	17024	APACHCT1	13.8	0	0.0	1	1	1.2000
-150.0000	ang	17024	APACHCT1	13.8	0	0.0	1	1	150.0000
0.0000	efd	17024	APACHCT1	13.8	0	0.0	1	1	5.0000
0.0000	pq	17024	APACHCT1	13.8	0	0.0	1	1	-27.0000
0.9900	spd	17024	APACHCT1	13.8	0	0.0	1	1	1.0100

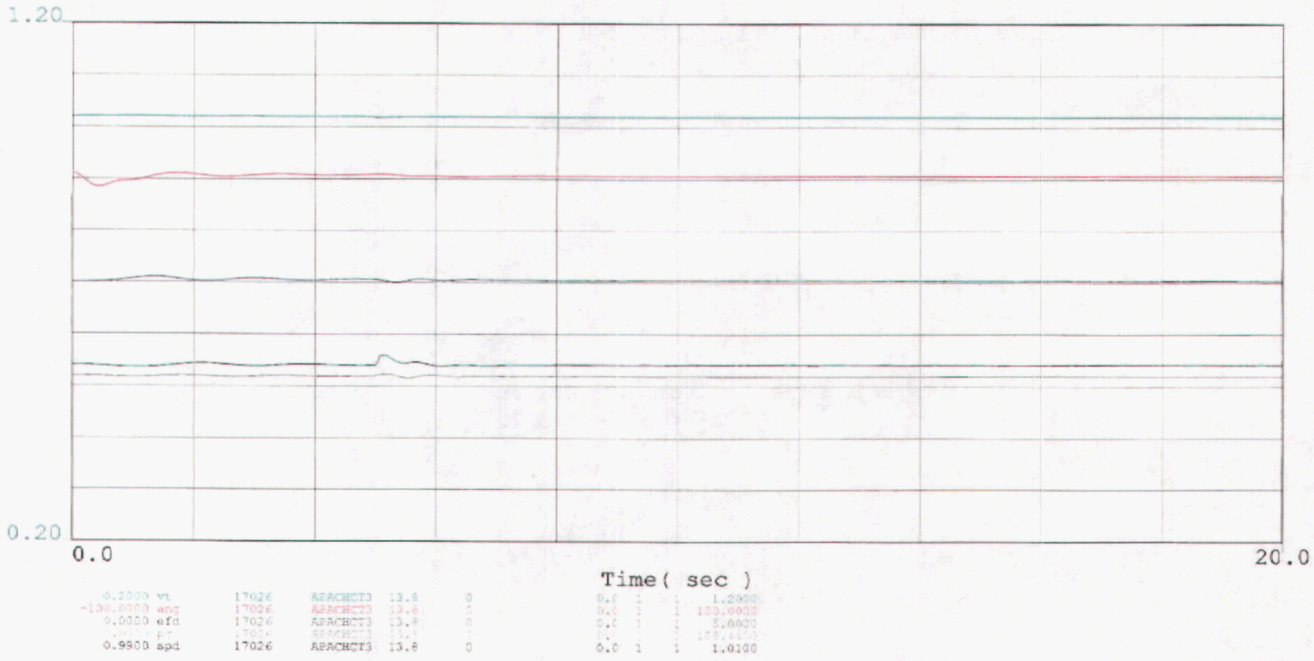
WESTERN ELECTRICITY COORDINATING COUNCIL
2014 HS3-SA APPROVED BASE CASE
MARCH 1, 2010
ALL COMMENTS FROM THE TSS REVIEW ARE INCLUDED.
Clear Both Ends in 5 Cycles

Southwest Transmission

2014MrnaTp-Mrna.chf

Thu Oct 14 14:51:55 2010

Marana Tap to Marana 115 kV Outage



WESTERN ELECTRICITY COORDINATING COUNCIL
2014 HS3-SA APPROVED BASE CASE
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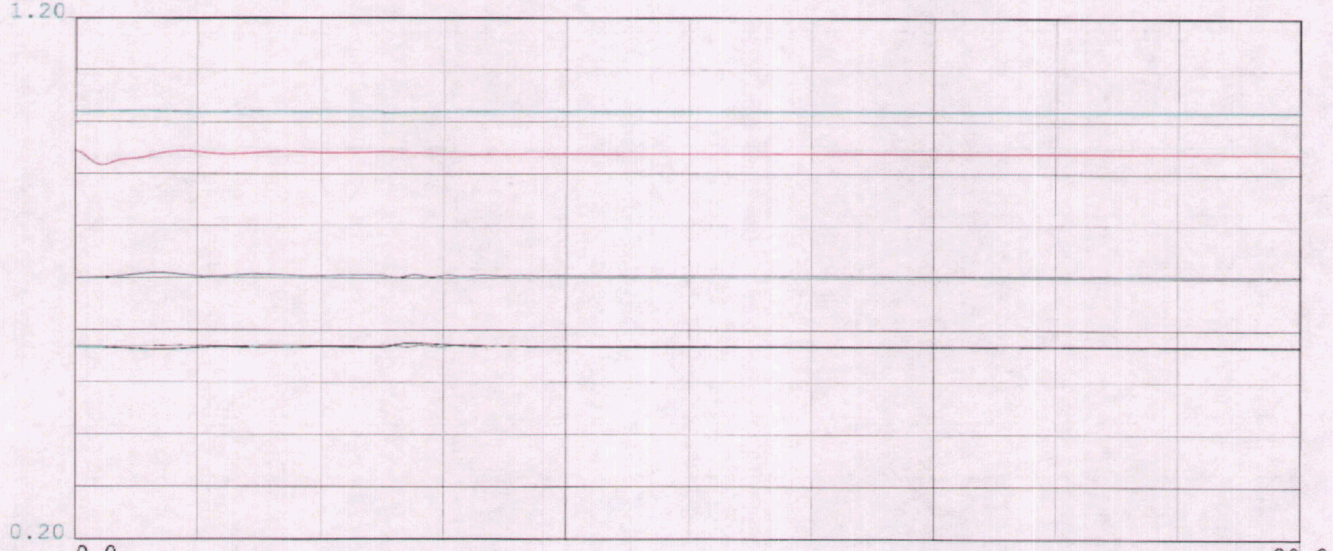
2014MrnaTp-Mrna.chf

Thu Oct 14 14:51:56 2010

Marana Tap to Marana 115 kV Outage



0.2000	vt	17028	APACHST1	13.8	0	0.0	1	1	1.2000
-160.0000	ang	17028	APACHST1	13.8	0	0.0	1	1	160.0000
0.0000	efd	17028	APACHST1	13.8	0	0.0	1	1	5.0000
0.0000	pq	17028	APACHST1	13.8	0	0.0	1	1	-95.0000
0.9900	spd	17028	APACHST1	13.8	0	0.0	1	1	1.0100

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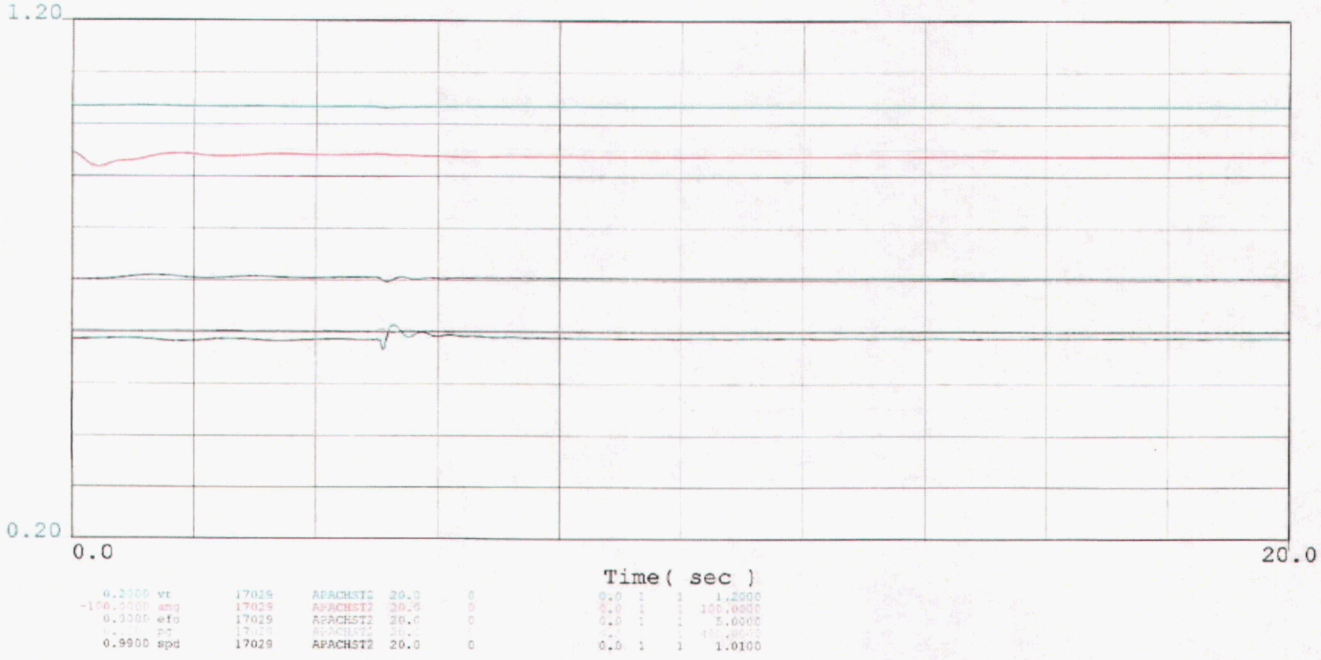
Marana Tap to Marana 115 kV Outage



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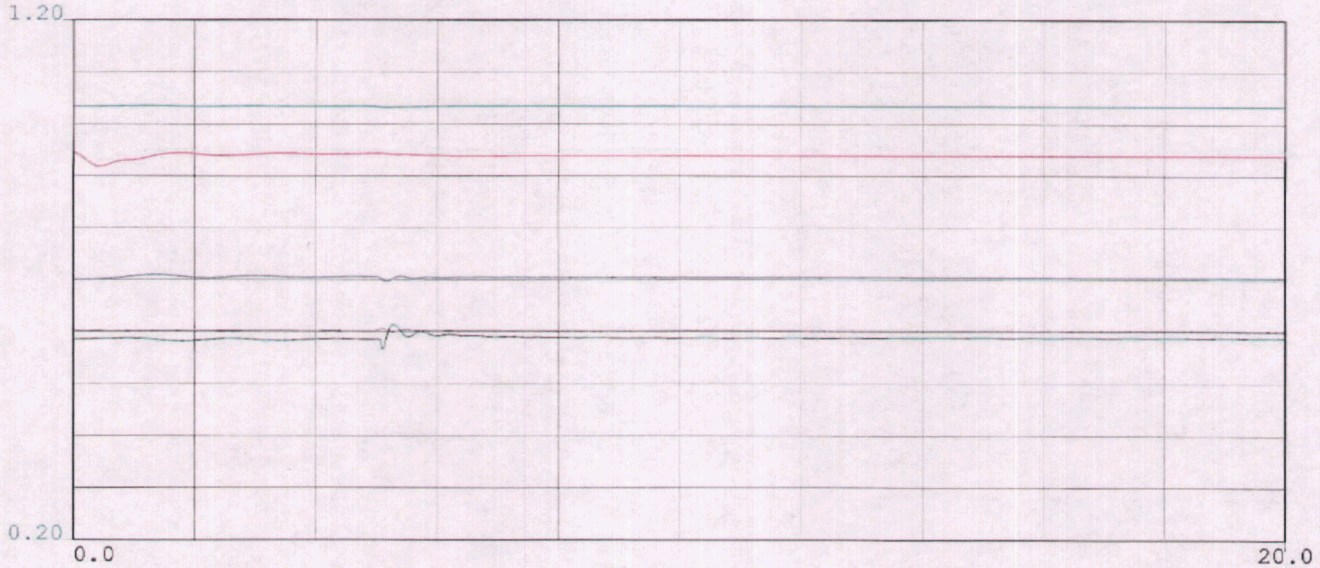
Marana Tap to Marana 115 kV Outage



0.2000 vt	17030	ARACHST3	20.0	0	0.0	1	1	1.2000	
-100.0000 ang	17030	ARACHST3	20.0	0	0.0	1	1	180.0000	
0.0000 efd	17030	ARACHST3	20.0	0	0.0	1	1	5.0000	
0.0000 rf	17030	ARACHST3	20.0	0	0.0	1	1	1.0000	
0.9900 spd	17030	ARACHST3	20.0	0	0.0	1	1	1.0100	

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2014MrnaTp-Mrna.chf

Thu Oct 14 14:51:57 2010