SWAT
Southwest Area Transmission

0000093675

RECEIVED

Robert E. Kondziolka, Manager
Transmission Planning Department
Southwest Area Transmission Planning Group
PO Box 52025, MS POB100
Phoenix, Arizona 85072-2025
Phone: (602) 236-0971
Fax: (602) 236-3896

2009 FEB 11 P 4: 00

AZ CORP COMMISSION
DOCKET CONTROL

ORIGINAL

February 11, 2009

Arizona Corporation Commission
DOCKETED

FEB 11 2009

DOCKETED BY

Docket Control
Arizona Corporation Commission
1200 West Washington
Phoenix, Arizona 85007

RE: SWAT Study to Support Ten Year Plan Submittals for 2010 Biennial Electric Transmission Assessment 2010-2019
Docket No. E-00000D-09-0020

Dear Sir/Madam:

The Southwest Area Transmission (SWAT) Sub-Regional Transmission Planning Group is comprised of transmission regulators/governmental entities, transmission users, transmission owners, transmission providers, transmission operators and environmental entities. The group was formed to promote regional planning across the entire Southwest area of the Western Electricity Coordinating Council. SWAT operates in a public forum and is open to any entity or persons interested in the development and future of the electric transmission system. SWAT encourages collaborative efforts and joint participation to address issues. A key goal of SWAT is to maximize use and benefits of the existing and future regional transmission system.

As members of SWAT, the Arizona Transmission Providers have participated in various SWAT Technical Subcommittees, Task Forces, Work Groups and the Oversight Committee. The Subcommittees, Task Forces, and Work Groups have been involved in study efforts investigating renewable energy resources such as wind energy, new base load generation, and transmission studies to meet load growth and enhance the utilization of the existing transmission system. Due to the nature of performing joint study work, Arizona Transmission Providers are dependent on the technical studies performed under the direction of SWAT for development of their Ten Year Plans. The projects shown by the Transmission Providers in their Ten Year Plan submittals reflect study work covered by SWAT during the past year. The study work and reports have been approved by the sponsoring Subcommittee or Task Force and Oversight Committee.

The 2008 study work was prepared by the SWAT sub-committee, Central Arizona Transmission System – High Voltage (CATS-HV). The attached report has been prepared for

use during the ACC's Sixth Biennial Transmission Assessment. The CATS-HV 2008 Transmission Study provides an analysis of ten-year (2018) transmission plan projects and sensitivity to regional generation additions.

SWAT strongly supports the coordinated effort between the utilities and stakeholders and supports the enclosed study report.

Sincerely,

Robert E. Kondziolka

Robert E. Kondziolka
Chairman of the SWAT Sub-Regional Transmission Planning Group

REK:JKB

Enclosure

cc: Prem Bahl (ACC)
Joseph Herrera (CATS-HV Chairman/ED3)
John Lucas (APS)
Ron Belval (TEP)
Jana Brandt (SRP)
James Rein (SWTC)
Grant Ward (Santa Cruz Water and Power Districts Association)
Dennis Delaney (ED4/SPPR)
Gary Ijams (Central Arizona Project)
Tom Martin (ED2)
Ron McEachern (ED4/ED5)
Michael Gazda (APA)
Ken Buchanan (Pinal County)
Ron Moulton (Western)

Original and 13 copies of the foregoing filed with Docket Control.

CATS HV

2008 Transmission Study

Analysis of Ten-Year (2018) Transmission Plan
Projects and Sensitivity to Regional Generation Additions

For
Central Arizona Transmission System – High Voltage
"CATS-HV"

A sub-committee of the Southwest Area Transmission
("SWAT") sub regional planning group

SWAT
Southwest Area Transmission

FINAL REPORT
January 26, 2009

PDS

(this page intentionally left blank)

Acknowledgements

This study could not have been performed without the assistance and participation of the following organizations. Their help was instrumental in the development and completion of the study:

Arizona Corporation Commission (ACC) Staff

Arizona Power Authority (APA)

Arizona Public Service Company (APS)

Central Arizona Project (CAP)

Electrical District #2 of Pinal County (ED2)

Electrical District #3 of Pinal County (ED3)

Electrical District #4 of Pinal County (ED4)

Electrical District #5 of Pinal County (ED5)

Pinal County Planning Department Staff

Salt River Project (SRP)

Southwest Transmission Cooperative (SWTCo)

Southwest Public Power Resources Group (SPPR)

Tucson Electric Power Company (TEP)

Western Area Power Administration (Western)

Executive Summary

Previous CATS-HV subcommittee reports have included a "saturated load" study to identify what the total electric load between Phoenix and Tucson could ultimately be if land development occurs according to county and municipal General Plans in the region, as well as the expected performance of the regional transmission system for the 2016 Ten-Year Plans. There have been significant changes within the CATS-HV region and a significant swing in load growth in multiple directions; however the continual review of the long term (ten years and beyond) requirements to meet the expected loads and resources for the multiple load serving entities serving this area will continually give the visibility for all of the planning jurisdictions within the CATS-HV area.

With the completion of the 2007 CATS-HV study efforts, two key issues had been identified for additional review as a component of the 2008 CATS-HV Transmission Plan. Specifically, the 2007 Transmission Plan identified the need to include additional detailed 69kV subtransmission facilities as a component of the coordinated CATS-HV 2008 Ten-Year Transmission Plan; as well as the potential impacts of the CATS-HV transmission system with new generation resources to serve local and regional loads. Therefore, the 2008 Study Plan included the following tasks:

- Task 1 – Coordinate a 2018 Ten-Year Plan detailed base case and perform a power flow assessment in accordance with WECC/NERC performance criteria.
- Task 2 – Perform a screening assessment (N-0 and N-1 only) for 500MW generation resource injections at multiple substations within the CATS-HV area.
- Task 3 – Document the findings and coordinate with the annual 2008 SWAT/WestConnect Report.

In summary for Task 1, the 2008 CATS-HV Ten-Year Plan analysis found there were no voltage or thermal issues within the CATS-HV area in the coordinated SWAT base case under pre and post outage conditions (assumes power factor correction for the Valley Farms area). The analysis identified a few new N-2 overloads that will need to be mitigated as part of the plans.

For Task 2, additional generation resource injections at Desert Basin, Saguaro, San Manuel and Sundance substations may result in new overloads that will need to be mitigated if the resources materialize. Generation additions at either Pinal Central or Pinal West did not result in any incremental or new criteria violations.
Specifically:

- **Desert Basin 500MW** – Overloads from Santa Rosa to Test Track and Test Track to Lone Butte 230kV lines for an outage of the Santa Rosa to Knox 230kV line.
- **Pinal Central 1000MW** – No new overloads identified.
- **Pinal West 500MW** – No new overloads identified.
- **Saguaro 500MW** – Marana 115kV area overloads under certain outage conditions.
- **San Manuel 500MW** – Significant overloads under normal and contingency outages on San Manuel to Hayden 115kV and overloads in the Oracle area 115kV lines under contingency outages (San Manuel-Hayden, San Manuel-Saguaro, etc.).
- **Sundance 500MW** – Minimal overloads (101%) on Coolidge-Rogers 230kV for an outage of Sundance to Pinal Central 230kV.

Table of Contents

Acknowledgements i
Executive Summary ii
Table of Contents iii
Introduction 1
Base Case Assumptions 3
Methodology 6
Task 1 – Reliability Assessment of Ten-Year Plans 7
Task 2 – Regional Incremental Generation Impacts 10
Conclusions 17

APPENDICES

Appendix A – Task 1 Summary Tables

Appendix B – Task 2 Summary Maps and Tables

Introduction

The Central Arizona Transmission Study – High Voltage (CATS-HV) technical work group is a subregional planning organization of transmission owners and interested stakeholders tasked with examining the near and long term high voltage transmission system (mostly 115kV and 230kV) requirements for the area between Phoenix and Tucson. The area is currently served by a number of Load Serving Entities (LSE's) and the work group is tasked with the coordination of transmission plans that meet the requirements of the LSE's as well as the potential for new transmission customers (generation resources, etc.) to deliver energy across the CATS-HV footprint.

With the completion of the 2007 CATS-HV study efforts, two key issues had been identified for additional review as a component of the 2008 CATS-HV Transmission Plan. Specifically, the 2007 Transmission Plan identified the need to include additional detailed 69kV subtransmission facilities as a component of the coordinated CATS-HV 2008 Ten-Year Transmission Plan; as well as the potential impacts from new generation resources on the CATS-HV transmission system. The specific tasks identified in the 2008 Study Plan are included below.

Task 1

Prepare a coordinated Ten-Year Transmission Plan (specifically 2018) for the CATS-HV study area to be included in the 2008 SWAT Transmission Plan. The coordination of the 2008 CATS-HV Transmission Plan will require (but is not limited to) the following steps:

- Coordinate 2018 base case development for the CATS-HV region; including individual stakeholders ten-year transmission plans, subtransmission facilities and the associated system representations. The 2008 WestConnect coordinated base case will be used as the source for this case development.
- In addition to incorporating the detailed system representation, each LSE will be responsible for supplying their respective load and resource information for the 2018 heavy summer season.
- Conduct an assessment of the coordinated 2018 CATS-HV Transmission Plan in accordance with NERC/WECC planning criteria.

Task 2

Review the potential impacts to the CATS-HV transmission system with the interconnection of new generation resources proposed to be located within the CATS-HV study area. This generation resource assessment will require (but is not limited to) the following steps:

- Coordinate potential generation resource "injection" locations for the CATS-HV 2018 base case; including stakeholders individual ten-year resource plans and probable resource locations identified by the CATS-HV study participants.
    - Initially, a matrix of the following substation sites will be evaluated for 500MW incremental generation injections:
        - Pinal West, Randolph, Desert Basin, Sundance, Saguaro, Pinal Central, Empire (or ED5), and San Manuel

- Conduct an assessment of the impacts of the new generation resources to the CATS-HV Ten-Year Transmission Plan.
- Compare the assessment from the Task 1 study analysis (which assumed generation resources imported to the CATS-HV study area) to that of the addition of CATS-HV area local generation resources; noting impacts in losses, incremental transmission overloads, and other observations related to the resource injection.

Task 3

The final task for the 2008 SWAT CATS-HV Transmission Plan is to document the findings of the analysis identified in this Study Plan as a component of the overall 2008 SWAT Transmission Plan assessment, specifically:

- Document the findings of the 2008 CATS-HV Transmission Plan and coordinate the final report with the overall 2008 SWAT/WestConnect Transmission Plan report.

Base Case Assumptions

The following sections identify the assumptions used in performing this study. The 2018 CATS-HV base case development was initiated using with the July 2008 Western Electricity Coordinating Council (WECC) approved 2018HS1A base case. A "round robin" approach was used to develop the CATS-HV base case among the regional CATS-HV transmission owners and load serving entities (WECC members only due to confidentiality of the power flow case information). Each entity updated the case to reflect their expected 2018 heavy summer loads and resources, as well as planned transmission additions (69kV and above). Entities included in the detailed review were ED2, ED3, ED4, ED5, SPPR, APS, SRP, Western, TEP, and SWTCo.

Transmission and Generation Configurations

The coordinated 2018 CATS-HV base case was reviewed by Arizona entities and included the companies' ten year plan elements that would be in service by 2018. A few note-worthy transmission and generation items include:

Significant Additions or Exclusions:

- Southeast Valley (SEV) 500kV line (Pinal West-Santa Rosa-Pinal Central-Abel-Browning) was included.
- Pinal Central 230kV lines to Desert Basin, Sundance, and Randolph/Browning were included.
- The SPPR "Three-Terminal" transmission plan (Pinal Central to ED5 230kV, ED5 to Test Track 230kV, ED5 to Marana 230kV) was included.
- Planned generation at Coolidge Energy (Randolph), Pinal Central, SPPR and Bowie were included in the base case and dispatched as needed to meet load and resource requirements for the region. Specific CATS HV area generation included in the base case is shown in Table 1.
- The Frontier Project, TransWest Express, SunZia Southwest and other EHV injections (transmission) into the state of Arizona were not included in this transmission configuration as none of these projects had been classified as "Planned" projects in the WestConnect model (all were considered as "Conceptual") at the time of the base case development.
- Total Arizona Generation (dispatched): 34,932 MW
- Total Arizona Load (w/o losses): 26,324 MW

Table 1: CATS-HV Area Base Case Generation Assumptions

Generation Location	Existing or Planned	Base Case Dispatch Level (MW)	Max Generation Available (MW)
Desert Basin	Existing	630	630
Sundance	Existing	437	437
Saguaro	Existing	398	398
Randolph (Coolidge)	Planned	561.6	561.6
Pinal Central	Planned	1123	1394
SPPR Gen	Planned	350	627

Task 2 Generation Resource Injections

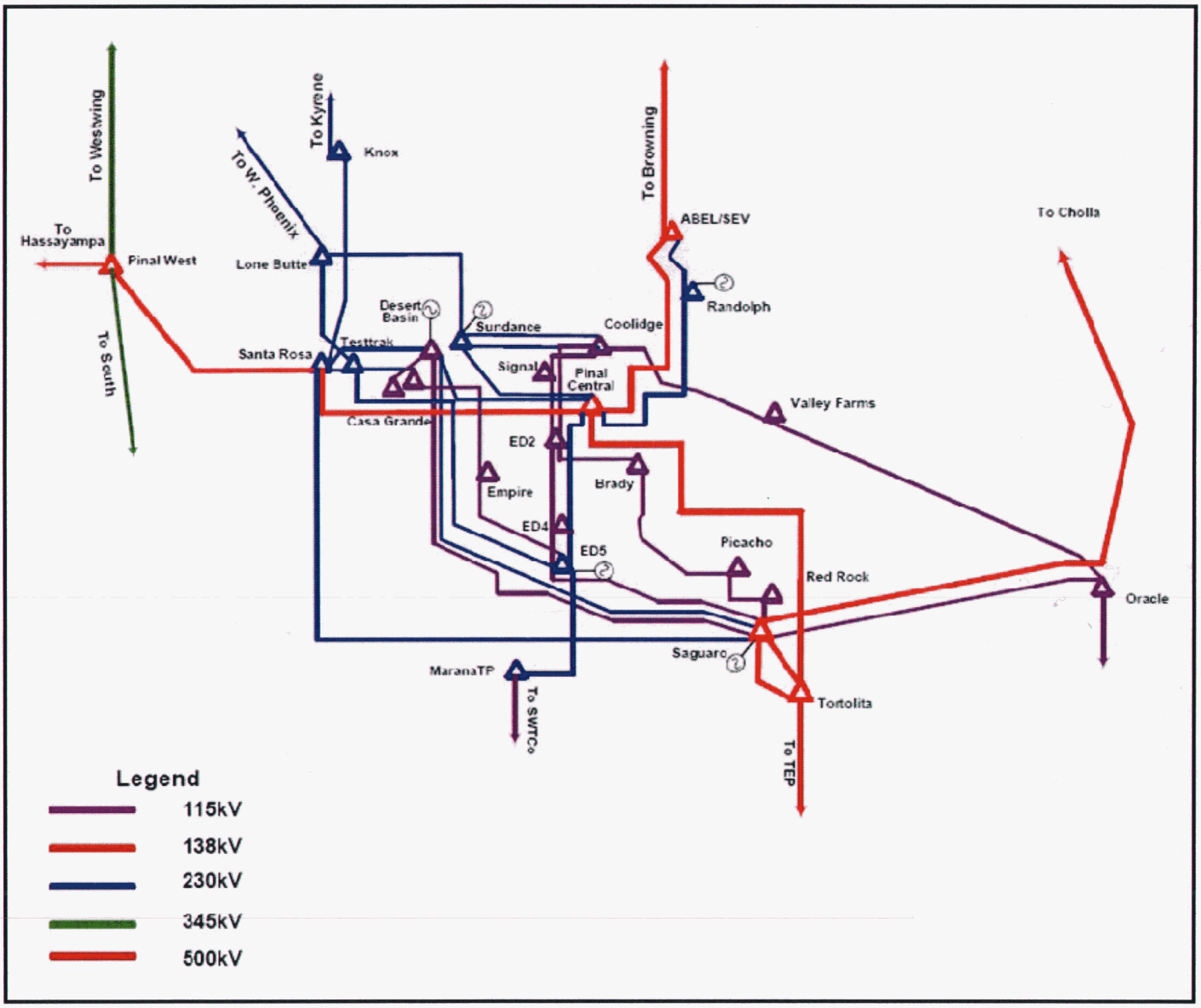
The insertion of the Task 2 resource additions was limited to incremental sites agreed to by the CATS-HV participants; specifically Desert Basin, Pinal Central, Pinal West, Saguaro, San Manuel, and Sundance were agreed upon for further injection analysis. The following table (Table 2) depicts the specific resource injection and associated generation "off-set" for this analysis.

Table 2: CATS-HV Task 2 Generation Resource Injection Assumptions

Arizona Area Summary Table					
Case Name/Generation Resource Injection and Offset	Injection (MW)	Load (MW)	Losses (MW)	Generation (MW)	Interchange (MW)
CATS-HV BASE CASE (catshv_2018_final_112408.sav)	N/A	26323.7	690.9	34931.7	7917.3
DESERT BASIN (catshv_2018_db.sav)	500	26323.7	703.9	34944.9	7917.3
Red Hawk-CT1,CT2,CT3,CT4, San Tan 5s					
PINAL CENTRAL (catshv_2018_pc.sav)	1000	26323.7	688.2	34929.3	7917.3
Red Hawk-CT1,CT2,CT3,CT4, Hgc-CT1, Mes-CT1, CT2, Arl-CT1, CT2, San Tan 5s					
PINAL WEST (catshv_2018_pw.sav)	500	26323.7	691.5	34932.3	7917.3
Red Hawk-CT1,CT2,CT3,CT4,Red-ST, San Tan 5s					
SAGUARO (catshv_2018_sa.sav)	500	26323.7	697.4	34938.7	7917.3
Red Hawk-CT1,CT2,CT3,CT4, San Tan 5s					
SUNDANCE (catshv_2018_sd.sav)	500	26323.7	698.7	34939.9	7917.3
Red Hawk-CT1,CT2,CT3,CT4, San Tan 5s					
SAN MANUEL (catshv_2018_sm.sav)	500	26323.7	718.8	34959.9	7917.3
Red Hawk-CT1,CT2,CT3,CT4, San Tan 5s					

The transmission configuration for the 2018 CATS-HV base case was reviewed by Arizona entities and included the companies' ten year plan elements that would be in service by 2018. Figure 1 depicts the CATS-HV region and associated transmission configuration.

Figure 1: 2018 CATS-HV Regional Transmission Configuration



Methodology

With the CATS-HV loads and resources incorporated into the 2018 heavy summer base case, an initial base case screening was performed to document transmission facility overloads during normal operating conditions. Following the initial screening, power flow contingency analyses were performed to review for reliability criteria violations. Specific studies conducted and their evaluation criteria are outlined below:

Contingency Analysis

The CATS-HV 2018 base case was used to perform a reliability assessment under normal operating conditions (NERC Category A, N-0), as well as, single (NERC Category B, N-1) contingencies, and double (NERC Category C/D, N-2) contingencies. These outages included:

- All single (115-500kV) transmission circuit outages within Arizona (approximately 1065 contingencies, via PSLF generated outage list).
- All single transformer outages within the Arizona area.
- All single generation unit (G-1) outages within the Arizona area.
- All double (115-500kV) transmission circuit combination outages within CATS-HV as a "brute force" run for testing the transmission system (roughly 15,620 contingencies).

The WECC/NERC planning standards were used to assess the adequacy of the study results. The power flow analysis related evaluation criteria that were used are summarized below:

- Pre-contingency bus voltage must be between 0.95 per unit and 1.05 per unit (although note that several 500kV buses operate at approximately 1.06 per unit).
- Maximum voltage deviation allowed at all buses under contingency conditions will be 5% for N-1 contingencies.
- Pre-disturbance loading to remain within continuous ratings of all equipment and line conductors; specifically referencing Rating 1 as included in the CATS-HV base case.
- Post-disturbance (N-1 and N-2 contingencies) loading to remain within emergency ratings of all equipment and line conductors; specifically referencing Rating 2 as included in the CATS-HV base case.

Task 1 – Reliability Assessment of Ten-Year Plans

The CATS-HV 2018 heavy summer base case was initially screened for any NERC Category A (N-0) thermal overloads based on the ratings contained in the base case to ensure it meets reliability criteria during normal operating conditions. NERC Category B (N-1) and limited NERC Category C/D multiple contingency outages (N-2) were also conducted; it should be noted however that a full outage listing (i.e. contingency list) is not included with this report due to the magnitude of outages taken but are available upon request. The detailed summary output tables are included in Appendix A.

Key findings from the power flow studies using the CATS-HV 2018 heavy summer base case are:

- As shown in Table 3, no CATS-HV area facilities were identified as overloaded under normal, all lines in service, conditions.

Table 3: NERC Category A Overloads within CATS-HV Area

Outage	Overloaded Facility	Recommended Mitigation
NERC Category A (N-0)		
ALL LINES IN SERVICE	None	N/A

Following the base case screening, power flow contingency simulations were conducted on the CATS-HV 2018 heavy summer base case. Power flow solutions were achieved for all N-1 outages simulated.

- As shown in Table 4, a few CATS-HV area facilities were identified as overloaded under emergency conditions for a single contingency; however the loadings have been confirmed by the facility owner to be within the acceptable 30 minute emergency rating.

Table 4: NERC Category B Overloads within CATS-HV Area

Outage	Overloaded Facility	Recommended Mitigation
NERC Category B (N-1)		
Milligan 230/69kV transformer	Casa Grande 230/69kV Transformer loaded to 113% of 100MVA Rating	Facility Owner has confirmed that this loading is within the 30-minute emergency rating.
Milligan 230/69kV Transformer	Casa Grande to SE8 69kV line loaded to 100% of 107.6MVA Rating	Facility Owner has confirmed that this loading is within the 30-minute emergency rating.

- Multiple transmission facility overloads were identified outside of the CATS-HV area (south of Marana) under emergency operating conditions for a single contingency outage. These overloads will be addressed as part of the SATS transmission plan.

- Table 5 summarizes the findings related to violations of "delta Voltages" greater than 5% voltage deviation and "Voltage Magnitude" for load buses less than 0.90 p.u. The load serving entity for these facilities has confirmed that power factor correction will be required and examined as part of the routine planning cycle.

Table 5: NERC Category B Voltage Violations within CATS-HV Area

Outage	Substation	Delta Voltage	Voltage Magnitude	Recommended Mitigation
NERC Category B (N-1)				
Coolidge to Valley Farms 115kV line	Merrill 69kV SE5 69kV Valley Farms 69kV Valley Farms 115kV	12.9 % 12.9 % 12.6 % 12.1 %	0.884 p.u. 0.884 p.u. 0.903 p.u. 0.890 p.u.	Facility Owner has confirmed that power factor correction will be required.

- A few other voltage violations were identified outside of the CATS-HV area (south of Marana) under emergency operating conditions for a single contingency outage. These violations will be addressed as part of the SATS transmission plan.

An assessment was also conducted for a "brute force" N-2 outage of approximately 15,600 outage combinations of the CATS HV area transmission facilities (excluding generators). The GE PSLF contingency processor was used to generate the list based on a limited outage list of CATS HV area single contingencies. In addition to the overloads identified in Table 3, additional overloads were identified. Table 6 summarizes the overloads identified for this analysis.

Table 6: NERC Category C/D Overloads within CATS-HV Area

Outage	Overloaded Facility	Recommended Mitigation
NERC Category C/D (N-1-1/N-2)		
Casa Grande-SE8 69kV and Milligan-Toltec 69kV (multiple outages)	Santa Rosa-Vista 69kV line (worst loading 147% of 107.6MVA)	Upgrade to achieve a minimum of 160MVA by 2018.
Santa Rosa-Asarco/Vista 69kV and Eastgate-SE8 69kV (multiple outages)	Milligan-Toltec 69kV line (worst loading 123% of 107.6MVA)	Upgrade to achieve a minimum of 160MVA by 2018.
Santa Rosa-Knox 230kV and Test Track-ED5 230kV	Santa Rosa- Test Track 230kV line (loaded to 112% plus of 174.9MVA)	Facility owner has confirmed that the loading is well within new emergency rating.
Santa Rosa-Desert Basin 230kV and Milligan 230/69 230kV	SE8 - Eastgate 69kV line (loaded to 104.5% of 107.6MVA)	Facility Owner has confirmed that this loading is within the 30-minute emergency rating.
Santa Rosa 230/69 #1 xfmr Santa Rosa 230/69 #2 xfmr	Test Track 230/69kV xfmr (loaded to 100% of 167MVA)	Facility owner has confirmed that the loading is within emergency rating.

- Multiple transmission facility overloads were identified outside of the CATS-HV area (south of Marana) under emergency operating conditions for multiple contingency outages. These overloads will be addressed as part of the SATS transmission plan.
- Voltage Violations were not assessed as part of the N-2 analysis.
- It should also be noted that a significant amount of transmission and generation additions were included in the CATS-HV base case. The primary reason for these additions was to meet the 2018 heavy summer load serving requirements within the CATS-HV area from local generation resources versus importing from remote resources (as was done in earlier CATS-HV studies).

Task 2 –Regional Incremental Generation Resource Impacts

The addition of additional generation resources within the CATS-HV area during the Ten-Year planning time frame is highly probable. The generation resource additions will likely be a mix of renewable resources (primarily solar thermal and photovoltaic) and gas fired resources. As such, the 2008 Study Plan was developed to determine transmission limitation that may develop from the addition of additional generation resources. Specifically, the review the potential impacts to the CATS-HV transmission system with the interconnection of new generation resources proposed to be located within the CATS-HV study area. These generation resource assessment tasks were to include the following:

- Coordinate potential generation resource "injection" locations for the CATS HV 2018 base case; including individual stakeholder ten-year resource plans and the potential for opportunistic locations based on reliability needs.
    - Initially, a matrix of the following substation sites will be evaluated for 500MW incremental generation injections:
        - Pinal West, Randolph, Desert Basin, Sundance, Saguaro, Pinal Central, Empire, and San Manuel
- Conduct an assessment of the impacts of the new generation resources to the CATS HV Ten-Year Transmission Plan.
- Compare the assessment from the Task 1 study scope (which assumed generation resources imported to the CATS HV study area) to that of this local generation resource assessment; noting impacts in losses, transmission overloads, etc. as required.

However during the initial development for the 2018 CATS-HV base case, additional planned resources at Randolph (by TransCanada and SRP) and the SPPR generation at ED5 substation was announced and modeled along with the associated transmission systems additions to accommodate the generation. Therefore the analysis was limited to incremental sites for only six sites; specifically Desert Basin, Pinal Central, Pinal West, Saguaro, San Manuel, and Sundance were agreed upon for further injection analysis by the CATS-HV Participants. The detailed results for each of the specific resource injections are included in Appendix B.

Desert Basin (500MW)

As shown in Table 7, the addition of an incremental 500MW at the existing Desert Basin 230kV substation did not cause any overloads compared to the CATS-HV base case under continuous (N-0) conditions.

Table 7: Desert Basin Incremental 500MW Overloads within CATS-HV Area

Outage	Overloaded Facility	Incremental Loading
NERC Category A (N-0)		
ALL LINES IN SERVICE	None	N/A

However under contingency conditions, additional overloads were identified with the addition of the incremental 500MW at the Desert Basin 230kV substation; Table 8 summarizes the overloads and incremental loading compared to the CATS-HV base case.

Table 8: Desert Basin Incremental 500MW Overloads within CATS-HV Area

Outage	Overloaded Facility	Incremental Loading
NERC Category B (N-1)		
Knox – Santa Rosa 230kV	**Santa Rosa-Test Track 230kV** (loads to 101% of 175MVA) **Test Track-Lone Butte 230kV** (loads to 100% of 175MVA)	**33%** **26%**
Desert Basin-Santa Rosa 230kV	**Casa Grande 230/69kV xfmr** (loads to109% of 100MVA) **Casa Grande-SE8 69kV line** (loads to 102% of 107.6MVA)	**23%** **22%**
Milligan 230/69 xfmr	**Various Casa Grande 69kV lines**	**Approx. 10%**

Pinal Central (1000MW)

As shown in Table 9, the addition of an incremental 1000MW at the proposed Pinal Central 500kV substation (note that this is in addition to the 1000MW proposed at the Pinal Central 230kV substation) did not cause any overloads compared to the CATS-HV base case under continuous (N-0) conditions.

Table 9: Pinal Central 500kV Incremental 1000MW Overloads within CATS-HV

Outage	Overloaded Facility	Incremental Loading
NERC Category A (N-0)		
ALL LINES IN SERVICE	None	N/A

In addition, under contingency conditions, no additional overloads were identified; Table 10 summarizes the overloads and incremental loading compared to the CATS-HV base case.

Table 10: Pinal Central 500kV Incremental 1000MW Overloads within CATS-HV

Outage	Overloaded Facility	Incremental Loading
NERC Category B (N-1)		
N/A	**No additional overloads compared to CATS-HV base case**	**Less than 2.5% for most**

Pinal West (500MW)

As shown in Table 11, the addition of an incremental 500MW at the Pinal West 500kV substation did not cause any overloads compared to the CATS-HV base case under continuous (N-0) conditions.

Table 11: Pinal West 500kV Incremental 500MW Overloads within CATS-HV

Outage	Overloaded Facility	Incremental Loading
NERC Category A (N-0)		
ALL LINES IN SERVICE	None	N/A

In addition, under contingency conditions, no additional overloads were identified; Table 12 summarizes the overloads and incremental loading compared to the CATS-HV base case.

Table 12: Pinal West 500kV Incremental 500MW Overloads within CATS-HV

Outage	Overloaded Facility	Incremental Loading
NERC Category B (N-1)		
N/A	**No additional overloads compared to CATS-HV base case**	**Less than 0.5% for most**

Saguaro (500MW)

As shown in Table 13, the addition of an incremental 500MW at the existing Saguaro 230kV substation did not cause any overloads compared to the CATS-HV base case under continuous (N-0) conditions.

Table 13: Saguaro Incremental 500MW Overloads within CATS-HV Area

Outage	Overloaded Facility	Incremental Loading
NERC Category A (N-0)		
ALL LINES IN SERVICE	None	N/A

However under contingency conditions, additional overloads were identified with the addition of the incremental 500MW at the Saguaro 230kV substation; Table 14 summarizes the overloads and incremental loading compared to the CATS-HV base case.

Table 14: Saguaro Incremental 500MW Overloads within CATS-HV Area

Outage	Overloaded Facility	Incremental Loading
NERC Category B (N-1)		
Marana-Marana Tap 115kV line	**Rattlesnake-Twin Peak 115kV line** (loads to 100% of 132MVA)	**15%**
Avra-Marana 115kV	**Rattlesnake-Twin Peak 115kV line** (loads to 124% of 132MVA) **Various SATS area lines**	**Approx. 8%**
Milligan 230/69 xfmr	**Various Casa Grande 69kV lines**	**Approx. 3%**

San Manuel (500MW)

The addition of an incremental 500MW at the existing San Manuel 115kV substation was found to cause two overloads compared to the CATS-HV base case under continuous (N-0) conditions. Table 15 summarizes the overloads and incremental loading compared to the CATS-HV base case.

Table 15: San Manuel Incremental 500MW Overloads within CATS-HV Area

Outage	Overloaded Facility	Incremental Loading
NERC Category A (N-0)		
ALL LINES IN SERVICE	**San Manuel-Saddlebrook 115kV** (loaded to 120% of 146MVA)	**114%**
ALL LINES IN SERVICE	**San Manuel-Hayden 115kV** (loaded to 113% of 167MVA)	**92%**

Under contingency conditions, multiple overloads were identified with the addition of the incremental 500MW at the San Manuel 115kV substation; Table 16 summarizes the overloads and incremental loading compared to the CATS-HV base case.

Table 16: San Manuel Incremental 500MW Overloads within CATS-HV Area

Outage	Overloaded Facility	Incremental Loading
NERC Category B (N-1)		
Multiple Outages Worst outage: San Manuel- Hayden 115kV line	**Oracle-Saddlebrook 115kV** (loads to 141% of 146MVA)	**Worst approx. 120%**
San Manuel-Saddlebrook 115kV line	**San Manuel-Saguaro 115kV** (loads to 111% of 159MVA)	**90%**
Various SATS outages	**Various SATS lines**	**Approx. 5%**

Sundance (500MW)

As shown in Table 17, the addition of an incremental 500MW at the existing Sundance 230kV substation did not cause any overloads compared to the CATS-HV base case under continuous (N-0) conditions.

Table 17: Sundance Incremental 500MW Overloads within CATS-HV Area

Outage	Overloaded Facility	Incremental Loading
NERC Category A (N-0)		
ALL LINES IN SERVICE	None	N/A

However under contingency conditions, additional overloads were identified with the addition of the incremental 500MW at the Sundance 230kV substation; Table 18 summarizes the overloads and incremental loading compared to the CATS-HV base case.

Table 18: Sundance Incremental 500MW Overloads within CATS-HV Area

Outage	Overloaded Facility	Incremental Loading
NERC Category B (N-1)		
Sundance – Pinal Central 230kV line	**Coolidge-Spookhill-Rogers 230kV line** (loads to 101% of 391MVA)	**40%**
Sundance-Coolidge 230kV #1 or #2 line	**Sundance-Coolidge 230kV remaining line**	**23%**
Milligan 230/69 xfmr	**Various Casa Grande 69kV lines**	**Approx. 2%**

Conclusions

In summary for Task 1, the 2008 CATS-HV Ten-Year Plan analysis found there were no voltage or thermal issues within the CATS-HV area in the coordinated SWAT base case under pre and post outage conditions (assumes power factor correction for the Valley Farms area). The analysis identified a few new N-2 overloads that will need to be mitigated as part of the ongoing transmission owner plans.

Additional generation resource injections at Desert Basin, Saguaro, San Manuel and Sundance substations may result in new system overloads that will need to be mitigated (or the generation resource scaled back to prevent system overloads) if the resources materialize. Generation additions at either Pinal Central or Pinal West did not result in any incremental or new criteria violations.

APPENDIX A
TASK 1

CATS-HV N-0 Violations
CATS-HV N-1 Flow Violations
CATS-HV N-1 Delta Voltage Flow Violations
CATS-HV N-1 Voltage Magnitude Violations
CATS-HV N-2 Flow Violations

CATS-HV N-0 VIOLATIONS

NONE

CATS-HV N-1 FLOW VIOLATIONS

(MVA)

NO.	FROM	KV	TO	NAME	KV2	CONTINGENCY DESCRIPTION	RATING	OVLD %
17019	RIVIERA	69	17087	RIVIERA	230	"tran_812"Tran RIVIERA 69.00 to RIVIERA 230.00 Circuit 1	112.0	154.76%
17019	RIVIERA	69	17087	RIVIERA	230	"tran_813"Tran RIVIERA 69.00 to RIVIERA 230.00 Circuit 2	112.0	154.17%
19210	RATTLSNK	115	19216	TWINPEAK	115	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	134.14%
19216	TWINPEAK	115	17670	PICTROCK	115	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	133.01%
17670	PICTROCK	115	19212	SANDARIO	115	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	122.59%
17089	SNDARIO	115	19212	SANDARIO	115	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	121.43%
19210	RATTLSNK	115	19216	TWINPEAK	115	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	116.27%
19216	TWINPEAK	115	17670	PICTROCK	115	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	115.15%
14203	CASGRAPS	230	84848	CASGRAPS	69	"tran_914"Tran MILLIGAN 230.00 to MILLIGAN 69.00 Circuit 1	100.0	113.06%
17013	MARANATP	115	19210	RATTLSNK	115	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	120.0	110.63%
17670	PICTROCK	115	19212	SANDARIO	115	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	105.14%
17089	SNDARIO	115	19212	SANDARIO	115	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	103.98%
17013	MARANATP	115	19210	RATTLSNK	115	"line_94"Line SAG.EAST 115.0 to NAVISKA 115.0 Circuit 1	120.0	100.57%
84848	CASGRAPS	69	84747	SE8	69	"tran_914"Tran MILLIGAN 230.00 to MILLIGAN 69.00 Circuit 1	107.6	100.24%

CATS-HV N-1 DELTA VOLTAGE VIOLATIONS

BUS	NAME	KV	AREA	CONTINGENCY DESCRIPTION	DELTA V
84875	MERRIL	69	14	"line_264"Line COOLIDGE 115.0 to VLYFARMS 115.0 Circuit 1	-12.92%
84904	SE5	69	14	"line_264"Line COOLIDGE 115.0 to VLYFARMS 115.0 Circuit 1	-12.90%
84908	VLYFARMS	69	14	"line_264"Line COOLIDGE 115.0 to VLYFARMS 115.0 Circuit 1	-12.61%
14359	VLYFARMS	115	14	"line_264"Line COOLIDGE 115.0 to VLYFARMS 115.0 Circuit 1	-12.11%
17045	HACKBERY	69	14	"line_211"Line HACKBERY 230.0 to MORENCI 230.0 Circuit 1	-9.39%
17019	RIVIERA	69	14	"tran_812"Tran RIVIERA 69.00 to RIVIERA 230.00 Circuit 1	-7.47%
17019	RIVIERA	69	14	"tran_813"Tran RIVIERA 69.00 to RIVIERA 230.00 Circuit 2	-7.09%

CATS-HV N-1 VOLTAGE MAGNITUDE VIOLATIONS

NUMBER	NAME	KV	AREA	OTG DESCRIPTION	VMAG
84904	SE5	69	14	"line_264"Line COOLIDGE 115.0 to VLYFARMS 115.0 Circuit 1	88.42%
84875	MERRIL	69	14	"line_264"Line COOLIDGE 115.0 to VLYFARMS 115.0 Circuit 1	88.44%
84926	MERRILTP	69	14	"line_264"Line COOLIDGE 115.0 to VLYFARMS 115.0 Circuit 1	88.68%
84908	VLYFARMS	69	14	"line_264"Line COOLIDGE 115.0 to VLYFARMS 115.0 Circuit 1	90.29%
17019	RIVIERA	69	14	"tran_812"Tran RIVIERA 69.00 to RIVIERA 230.00 Circuit 1	94.04%
17019	RIVIERA	69	14	"tran_813"Tran RIVIERA 69.00 to RIVIERA 230.00 Circuit 2	94.42%

CATS-HV N-2 FLOW VIOLATIONS (in addition to those identified in N-1) (MVA)

FROM	NAME	KV	TO	NAME2	KV2	CONTINGENCY DESCRIPTION	RATING	% OVLD
14226	SNTAROSA	230	19068	TESTTRAK	230	"line_40_line_173"Line KNOX 230.0 to SNTAROSA _Line TESTTRAK 230.0 to ED5-230	174.9	112.39%
84747	SE8	69	84861	EGTAP W	69	"line_6_tran_280"Line SNTAROSA 230.0 to DBG _Tran MILLIGAN 230.00 to MILLIGAN	107.6	104.50%
84911	EASTGATS	69	84861	EGTAP W	69	"line_6_tran_280"Line SNTAROSA 230.0 to DBG _Tran MILLIGAN 230.00 to MILLIGAN	107.6	104.49%

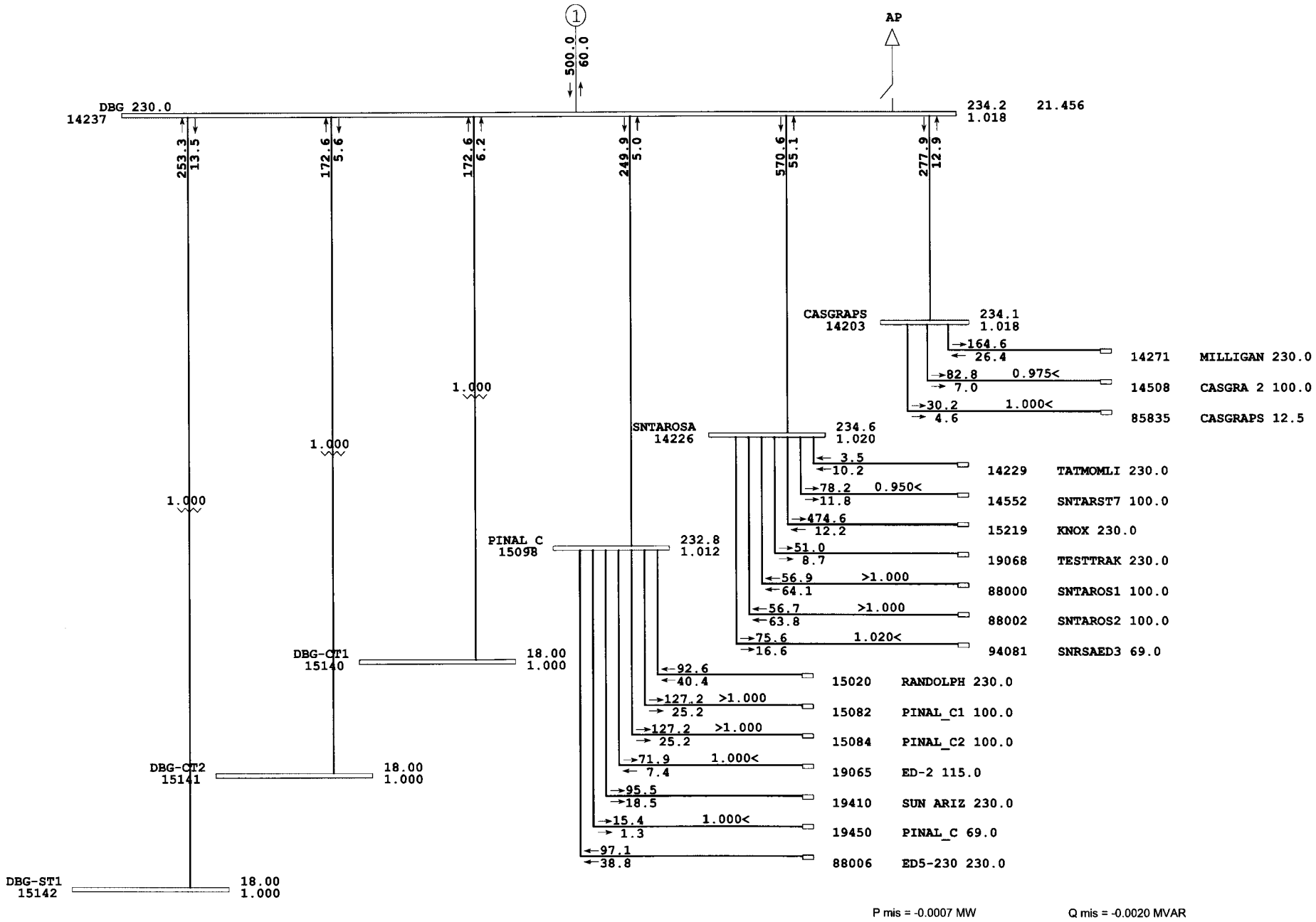
(MVA)

FROM	NAME	KV	TO	NAME2	KV2	CONTINGENCY DESCRIPTION	RATE	% OVLD
19210	RATTLSNK	115	19216	TWINPEAK	115	"line_172_line_18"Line ED5-230 230.0 to MARANATP _Line MARANATP 115.0 to MARANA	132.0	151.82%
19210	RATTLSNK	115	19216	TWINPEAK	115	"line_186_tran_26"Line MARANATP 115.0 to MARANA _Tran MARANATP 230.00 to MARANA	132.0	151.82%
19216	TWINPEAK	115	17670	PICTROCK	115	"line_172_line_18"Line ED5-230 230.0 to MARANATP _Line MARANATP 115.0 to MARANA	132.0	150.69%
19216	TWINPEAK	115	17670	PICTROCK	115	"line_186_tran_26"Line MARANATP 115.0 to MARANA _Tran MARANATP 230.00 to MARANA	132.0	150.68%
84859	SNTAROSA	69	84880	ASARCOTP	69	"line_195_line_20"Line CASGRAPS 69.0 to SE8 _Line TOLTEC 69.0 to MILLIGAN	107.6	147.59%
84880	ASARCOTP	69	84910	VISTA W	69	"line_195_line_20"Line CASGRAPS 69.0 to SE8 _Line TOLTEC 69.0 to MILLIGAN	107.6	147.53%
84859	SNTAROSA	69	84880	ASARCOTP	69	"line_200_tran_27"Line TOLTEC 69.0 to MILLIGAN _Tran CASGRAPS 230.00 to CASGRAPS	107.6	147.49%
84880	ASARCOTP	69	84910	VISTA W	69	"line_200_tran_27"Line TOLTEC 69.0 to MILLIGAN _Tran CASGRAPS 230.00 to CASGRAPS	107.6	147.43%
17670	PICTROCK	115	19212	SANDARIO	115	"line_172_line_18"Line ED5-230 230.0 to MARANATP _Line MARANATP 115.0 to MARANA	132.0	139.83%
17670	PICTROCK	115	19212	SANDARIO	115	"line_186_tran_26"Line MARANATP 115.0 to MARANA _Tran MARANATP 230.00 to MARANA	132.0	139.83%
17089	SNDARIO	115	19212	SANDARIO	115	"line_172_line_18"Line ED5-230 230.0 to MARANATP _Line MARANATP 115.0 to MARANA	132.0	138.67%
17089	SNDARIO	115	19212	SANDARIO	115	"line_186_tran_26"Line MARANATP 115.0 to MARANA _Tran MARANATP 230.00 to MARANA	132.0	138.67%
84860	TOLTEC	69	84901	MILLIGAN	69	"line_199_line_20"Line SNTAROSA 69.0 to ASARCOTP _Line EASTGATS 69.0 to EGTAP W	107.6	123.34%
84860	TOLTEC	69	84901	MILLIGAN	69	"line_196_line_19"Line SE8 69.0 to EGTAP W _Line SNTAROSA 69.0 to ASARCOTP	107.6	123.31%
84860	TOLTEC	69	84901	MILLIGAN	69	"line_205_line_21"Line EASTGATS 69.0 to EGTAP W _Line ASARCOTP 69.0 to VISTA W	107.6	123.28%
84860	TOLTEC	69	84901	MILLIGAN	69	"line_196_line_21"Line SE8 69.0 to EGTAP W _Line ASARCOTP 69.0 to VISTA W	107.6	123.26%
84859	SNTAROSA	69	84880	ASARCOTP	69	"line_200_line_20"Line TOLTEC 69.0 to MILLIGAN _Line EASTGATS 69.0 to EGTAP W	107.6	119.43%
84859	SNTAROSA	69	84880	ASARCOTP	69	"line_196_line_20"Line SE8 69.0 to EGTAP W _Line TOLTEC 69.0 to MILLIGAN	107.6	119.41%
84880	ASARCOTP	69	84910	VISTA W	69	"line_200_line_20"Line TOLTEC 69.0 to MILLIGAN _Line EASTGATS 69.0 to EGTAP W	107.6	119.36%
84880	ASARCOTP	69	84910	VISTA W	69	"line_196_line_20"Line SE8 69.0 to EGTAP W _Line TOLTEC 69.0 to MILLIGAN	107.6	119.34%
94025	MARTAP2	69	94011	FARRELL	69	"line_143_tran_25"Line REDRIVER 69.0 to PETENALL _Tran PINAL_W 500.00 to PINALW69	40.0	112.54%
17013	MARANATP	115	19210	RATTLSNK	115	"line_172_line_18"Line ED5-230 230.0 to MARANATP _Line MARANATP 115.0 to MARANA	120.0	110.20%
17013	MARANATP	115	19210	RATTLSNK	115	"line_186_tran_26"Line MARANATP 115.0 to MARANA _Tran MARANATP 230.00 to MARANA	120.0	110.20%
19068	TESTTRAK	230	19217	TESTTRAK	69	"tran_251_tran_27"Tran SNTAROSA 230.00 to SNRSAED3 _Tran SNTAROSA 230.00 to SNTAROSA	167.0	100.35%

APPENDIX B
TASK 2

BUS SCANS
OUTAGE SUMMARY

INCREMENTAL RESOURCE INJECTIONS:
Desert Basin 230kV: 500MW
Pinal Central 500kV: 1000MW
Pinal West 500kV: 500MW
Saguaro 500kV: 500MW
San Manuel 230kV: 500MW
Sundance 230kV: 500MW



General Electric International, Inc. PSLF Program Mon Dec 15 13:33:11 2008 c:\data\cats hv\catshv_2018_db.sav

PDS	CATSHV_2018HS_final_112408.sav from CATSHV_2018HS_final_aps.sav MLE/PDS 1124 CATS HV BASE CASE for 2018 HS ACC TEN-YEAR PLANS FILED Jan 31 2008	B - 1	MW/MVAR Rating = 1

CATS-HV 2008 Study: TASK 2

DESERT BASIN 500MW INJECTION

N-0 Summary

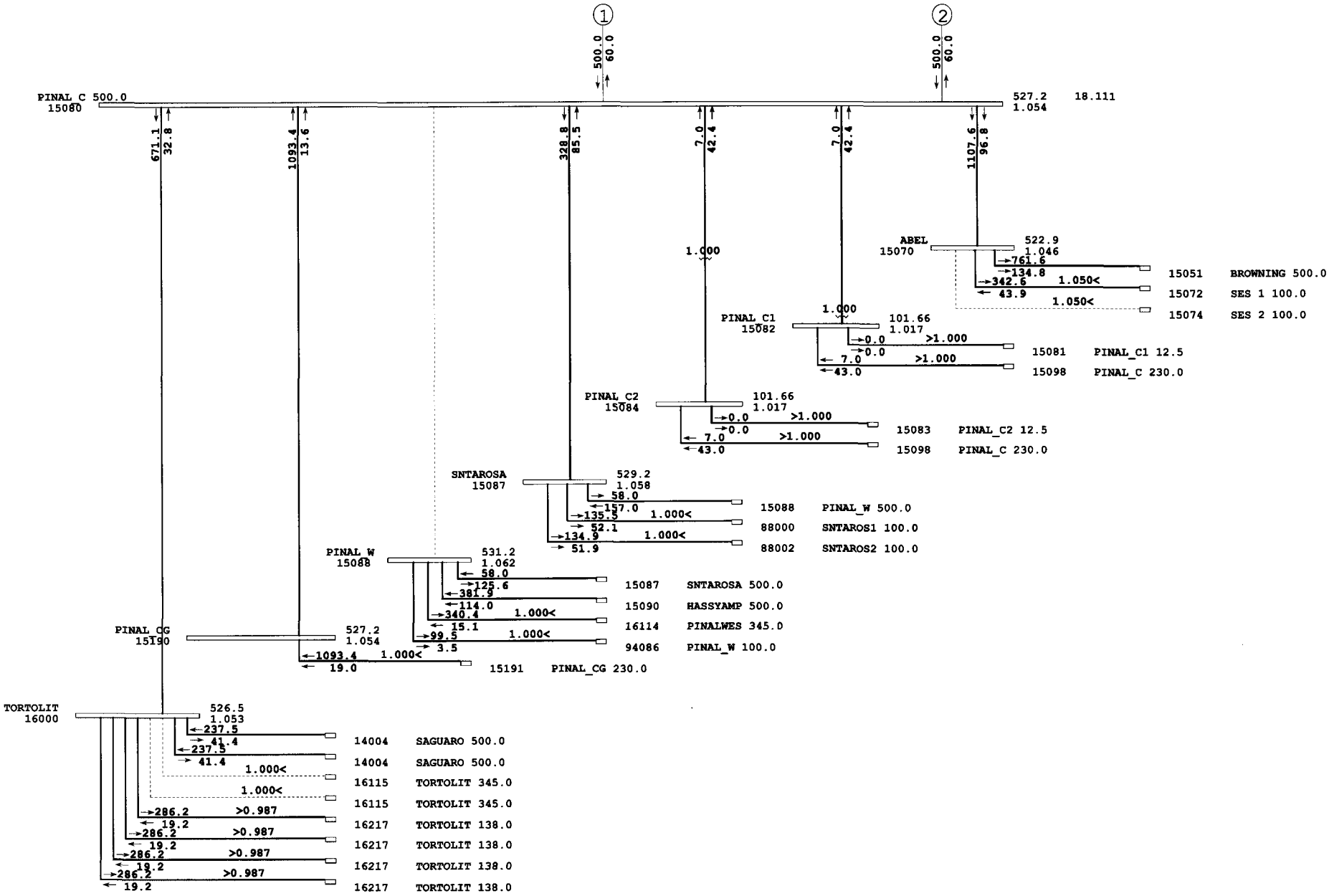
(MVA)

NO.	NAME	KV	NO.2	NAME3	KV4	OTG	CONTINGENCY DESCRIPTION	RATING	BASE CASE	DESERT BASIN	INCREMENTAL
14206	CTRYCLUB	230	14216	LINCSTRT	230	1	"base"Base system (n-0)	557.0	99.93%	100.54%	0.60%

N-1 Summary

(MVA)

NO.	NAME	KV	NO.2	NAME3	KV4	OTG	CONTINGENCY DESCRIPTION	RATING	BASE CASE	DESERT BASIN	INCREMENTAL
14226	SNTAROSA	230	19068	TESTTRAK	230	181	"line_180"Line KNOX 230.0 to SNTAROSA 230.0 Circuit 1	174.9	67.76%	100.72%	32.96%
19055	LONE BUT	230	19068	TESTTRAK	230	181	"line_180"Line KNOX 230.0 to SNTAROSA 230.0 Circuit 1	174.9	73.84%	100.09%	26.25%
14203	CASGRAPS	230	84848	CASGRAPS	69	58	"line_57"Line SNTAROSA 230.0 to DBG 230.0 Circuit 1	100.0	89.86%	113.10%	23.25%
84848	CASGRAPS	69	84747	SE8	69	58	"line_57"Line SNTAROSA 230.0 to DBG 230.0 Circuit 1	107.6	79.88%	102.00%	22.12%
19055	LONE BUT	230	19068	TESTTRAK	230	107	"line_106"Line PALOVRDE 500.0 to RUDD 500.0 Circuit 1	174.9	82.07%	100.96%	18.90%
14203	CASGRAPS	230	84848	CASGRAPS	69	665	"line_664"Line TOLTEC 69.0 to MILLIGAN 69.0 Circuit 1	100.0	99.00%	108.84%	9.83%
14203	CASGRAPS	230	84848	CASGRAPS	69	915	"tran_914"Tran MILLIGAN 230.00 to MILLIGAN 69.00 Circuit 1	100.0	113.06%	122.81%	9.75%
84848	CASGRAPS	69	84747	SE8	69	915	"tran_914"Tran MILLIGAN 230.00 to MILLIGAN 69.00 Circuit 1	107.6	100.24%	109.50%	9.25%
17013	MARANATP	115	19210	RATTLSNK	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	120.0	110.63%	113.94%	3.31%
19210	RATTLSNK	115	19216	TWINPEAK	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	134.14%	137.20%	3.06%
19216	TWINPEAK	115	17670	PICTROCK	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	133.01%	136.07%	3.06%
19210	RATTLSNK	115	19216	TWINPEAK	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	116.27%	119.32%	3.04%
19216	TWINPEAK	115	17670	PICTROCK	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	115.15%	118.19%	3.04%
17670	PICTROCK	115	19212	SANDARIO	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	122.59%	125.62%	3.04%
17089	SNDARIO	115	19212	SANDARIO	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	121.43%	124.46%	3.03%
17670	PICTROCK	115	19212	SANDARIO	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	105.14%	108.16%	3.02%
17089	SNDARIO	115	19212	SANDARIO	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	103.98%	106.99%	3.01%
17013	MARANATP	115	19210	RATTLSNK	115	95	"line_94"Line SAG.EAST 115.0 to NAVISKA 115.0 Circuit 1	120.0	100.57%	103.58%	3.01%
14217	LONEPEAK	230	14221	PNPKAPS	230	50	"line_49"Line REACH 230.0 to PNPKAPS 230.0 Circuit 1	545.4	108.64%	109.03%	0.39%
17019	RIVIERA	69	17087	RIVIERA	230	813	"tran_812"Tran RIVIERA 69.00 to RIVIERA 230.00 Circuit 1	112.0	154.76%	154.76%	0.00%
17019	RIVIERA	69	17087	RIVIERA	230	814	"tran_813"Tran RIVIERA 69.00 to RIVIERA 230.00 Circuit 2	112.0	154.17%	154.17%	0.00%
84826	ARABY S	69	84895	AR FH TP	69	401	"line_400"Line N.GILA 69.0 to SW1 69.0 Circuit 1	78.6	102.46%	102.37%	-0.09%



p mis = 0.004 q mis = 0.008

General Electric International, Inc. PSLF Program Thu Dec 18 13:09:21 2008 c:\data\cats hv\report\catshv_2018_pc_r1.sav

CATSHV_2018HS_final_112408.sav from CATSHV_2018HS_final_aps.sav MLE/PDS 1124 CATS HV BASE CASE for 2018 HS ACC TEN-YEAR PLANS FILED Jan 31 2008	B - 3	MW/MVAR Rating = 1

CATS-HV 2008 Study: TASK 2

PINAL CENTRAL 1000MW INJECTION

N-0 Summary

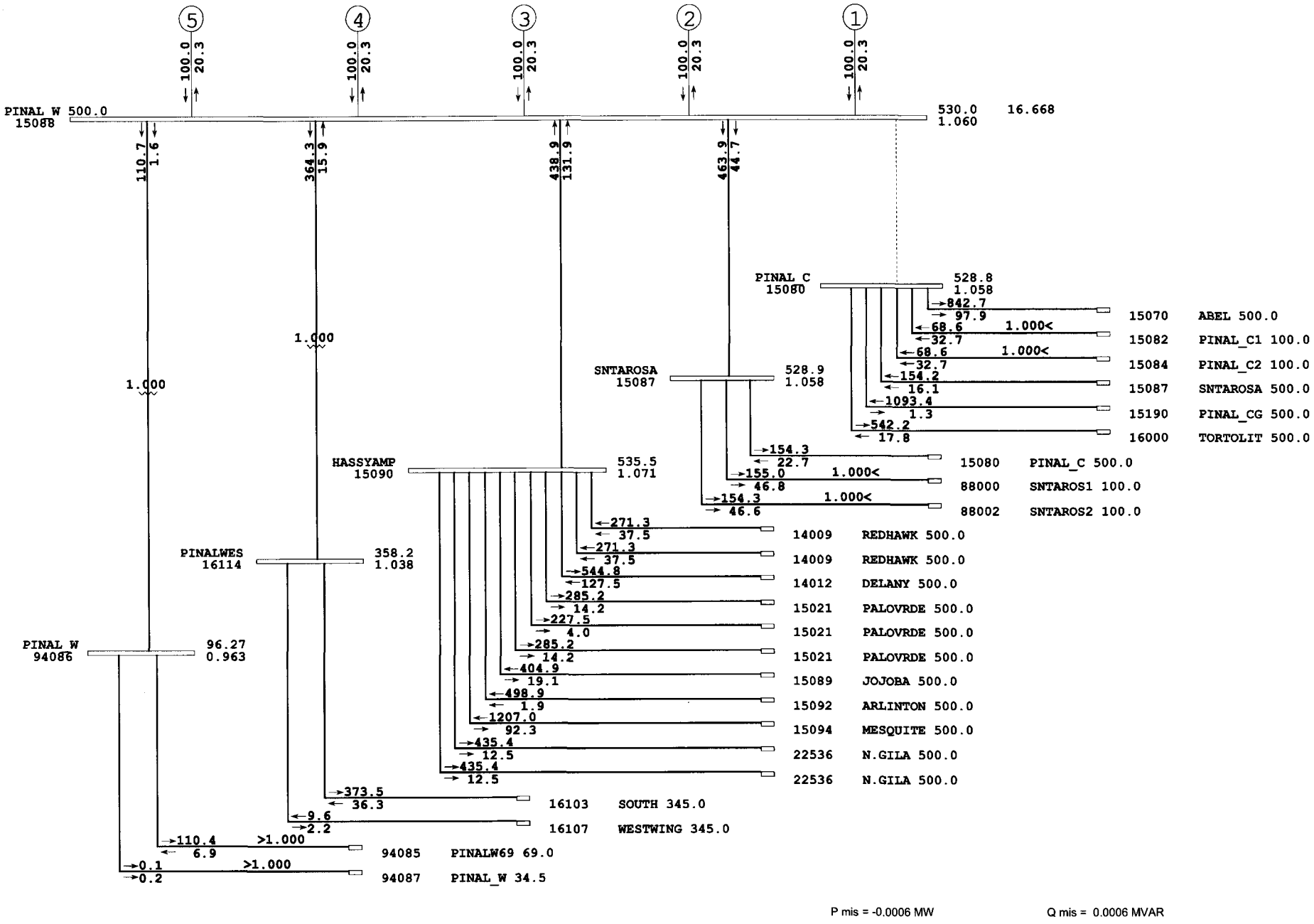
(MVA)

NO.	NAME	KV	NO.2	NAME3	KV4	OTG	CONTINGENCY DESCRIPTION	RATING	BASE CASE	PINAL CENTRAL	INCREMENTAL
14206	CTRYCLUB	230	14216	LINCSTRT	230	1	"base"Base system (n-0)	557.0	99.93%	100.20%	0.26%

N-1 Summary

(MVA)

NO.	NAME	KV	NO.2	NAME3	KV4	OTG	CONTINGENCY DESCRIPTION	RATING	BASE CASE	PINAL CENTRAL	INCREMENTAL
17019	RIVIERA	69	17087	RIVIERA	230	813	"tran_812"Tran RIVIERA 69.00 to RIVIERA 230.00 Circuit 1	112.0	154.76%	154.76%	0.00%
17019	RIVIERA	69	17087	RIVIERA	230	814	"tran_813"Tran RIVIERA 69.00 to RIVIERA 230.00 Circuit 2	112.0	154.17%	154.17%	0.00%
19210	RATTLSNK	115	19216	TWINPEAK	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	134.14%	136.60%	2.46%
15222	BROWNING	230	15050	BROWNING	69	795	"tran_794"Tran BROWNING 230.00 to BROWNING 69.00 Circuit 2	300.0	133.27%	133.33%	0.06%
15222	BROWNING	230	15050	BROWNING	69	794	"tran_793"Tran BROWNING 230.00 to BROWNING 69.00 Circuit 1	300.0	133.27%	133.33%	0.06%
17670	PICTROCK	115	19212	SANDARIO	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	122.59%	125.03%	2.45%
17089	SNDARIO	115	19212	SANDARIO	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	121.43%	123.87%	2.44%
19210	RATTLSNK	115	19216	TWINPEAK	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	116.27%	118.73%	2.46%
14203	CASGRAPS	230	84848	CASGRAPS	69	915	"tran_914"Tran MILLIGAN 230.00 to MILLIGAN 69.00 Circuit 1	100.0	113.06%	114.49%	1.43%
17013	MARANATP	115	19210	RATTLSNK	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	120.0	110.63%	112.97%	2.34%
17670	PICTROCK	115	19212	SANDARIO	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	105.14%	107.58%	2.44%
17089	SNDARIO	115	19212	SANDARIO	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	103.98%	106.42%	2.44%
17013	MARANATP	115	19210	RATTLSNK	115	95	"line_94"Line SAG.EAST 115.0 to NAVISKA 115.0 Circuit 1	120.0	100.57%	102.93%	2.36%
84848	CASGRAPS	69	84747	SE8	69	915	"tran_914"Tran MILLIGAN 230.00 to MILLIGAN 69.00 Circuit 1	107.6	100.24%	101.67%	1.43%
14203	CASGRAPS	230	84848	CASGRAPS	69	665	"line_664"Line TOLTEC 69.0 to MILLIGAN 69.0 Circuit 1	100.0	99.00%	100.43%	1.43%



General Electric International, Inc. PSLF Program Mon Dec 15 13:30:04 2008 c:\data\cats hv\catshv_2018_pw.sav

PDS	CATSHV_2018HS_final_112408.sav from CATSHV_2018HS_final_aps.sav MLE/PDS 1124 CATS HV BASE CASE for 2018 HS ACC TEN-YEAR PLANS FILED Jan 31 2008	B - 5	MW/MVAR Rating = 1

CATS-HV 2008 Study: TASK 2

PINAL WEST 500MW INJECTION

N-0 Summary

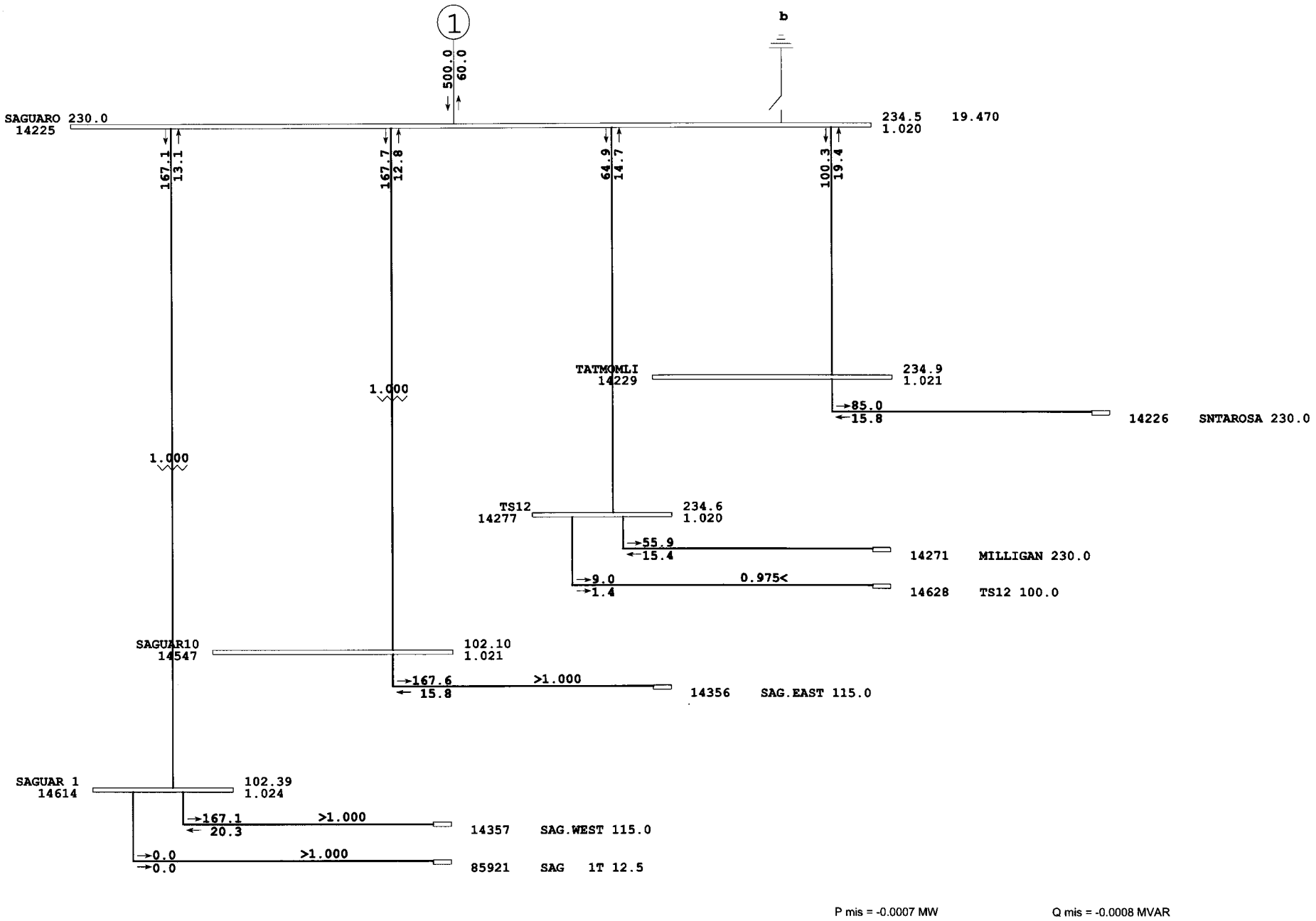
(MVA)

NO.	NAME	KV	NO.2	NAME3	KV4	OTG	CONTINGENCY DESCRIPTION	RATING	BASE CASE	PINAL WEST	INCREMENTAL
14206	CTRYCLUB	230	14216	LINCSTRT	230	1	"base"Base system (n-0)	557.0	99.93%	100.15%	0.22%

N-1 Summary

(MVA)

NO.	NAME	KV	NO.2	NAME3	KV4	OTG	CONTINGENCY DESCRIPTION	RATING	BASE CASE	PINAL WEST	INCREMENTAL
17013	MARANATP	115	19210	RATTLSNK	115	95	"line_94"Line SAG.EAST 115.0 to NAVISKA 115.0 Circuit 1	120.0	100.57%	100.83%	0.26%
17013	MARANATP	115	19210	RATTLSNK	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	120.0	110.63%	110.88%	0.26%
19210	RATTLSNK	115	19216	TWINPEAK	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	134.14%	134.25%	0.11%
14217	LONEPEAK	230	14221	PNPKAPS	230	50	"line_49"Line REACH 230.0 to PNPKAPS 230.0 Circuit 1	545.4	108.64%	108.75%	0.10%
19210	RATTLSNK	115	19216	TWINPEAK	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	116.27%	116.38%	0.10%
17670	PICTROCK	115	19212	SANDARIO	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	122.59%	122.69%	0.10%
17089	SNDARIO	115	19212	SANDARIO	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	121.43%	121.53%	0.10%
17670	PICTROCK	115	19212	SANDARIO	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	105.14%	105.24%	0.10%
17089	SNDARIO	115	19212	SANDARIO	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	103.98%	104.08%	0.10%
15222	BROWNING	230	15050	BROWNING	69	795	"tran_794"Tran BROWNING 230.00 to BROWNING 69.00 Circuit 2	300.0	133.27%	133.27%	0.00%
15222	BROWNING	230	15050	BROWNING	69	794	"tran_793"Tran BROWNING 230.00 to BROWNING 69.00 Circuit 1	300.0	133.27%	133.27%	0.00%
17019	RIVIERA	69	17087	RIVIERA	230	814	"tran_813"Tran RIVIERA 69.00 to RIVIERA 230.00 Circuit 2	112.0	154.17%	154.17%	0.00%
17019	RIVIERA	69	17087	RIVIERA	230	813	"tran_812"Tran RIVIERA 69.00 to RIVIERA 230.00 Circuit 1	112.0	154.76%	154.76%	0.00%
84826	ARABY S	69	84895	AR FH TP	69	401	"line_400"Line N.GILA 69.0 to SW1 69.0 Circuit 1	78.6	102.46%	102.41%	-0.05%
19060	ADAMS TP	115	17001	APACHE	115	196	"line_195"Line APACHE 230.0 to BUTERFLD 230.0 Circuit 1	110.0	105.09%	104.94%	-0.15%
84848	CASGRAPS	69	84747	SE8	69	915	"tran_914"Tran MILLIGAN 230.00 to MILLIGAN 69.00 Circuit 1	107.6	100.24%	99.89%	-0.35%
14203	CASGRAPS	230	84848	CASGRAPS	69	915	"tran_914"Tran MILLIGAN 230.00 to MILLIGAN 69.00 Circuit 1	100.0	113.06%	112.57%	-0.48%



P mis = -0.0007 MW Q mis = -0.0008 MVAR

General Electric International, Inc. PSLF Program Mon Dec 15 13:31:24 2008 c:\data\cats hv\catshv_2018_sa.sav

PDS	CATSHV_2018HS_final_112408.sav from CATSHV_2018HS_final_aps.sav MLE/PDS 1124 CATS HV BASE CASE for 2018 HS ACC TEN-YEAR PLANS FILED Jan 31 2008	B - 7	MW/MVAR Rating = 1

CATS-HV 2008 Study: TASK 2

SAGUARO 500MW INJECTION

N-0 Summary

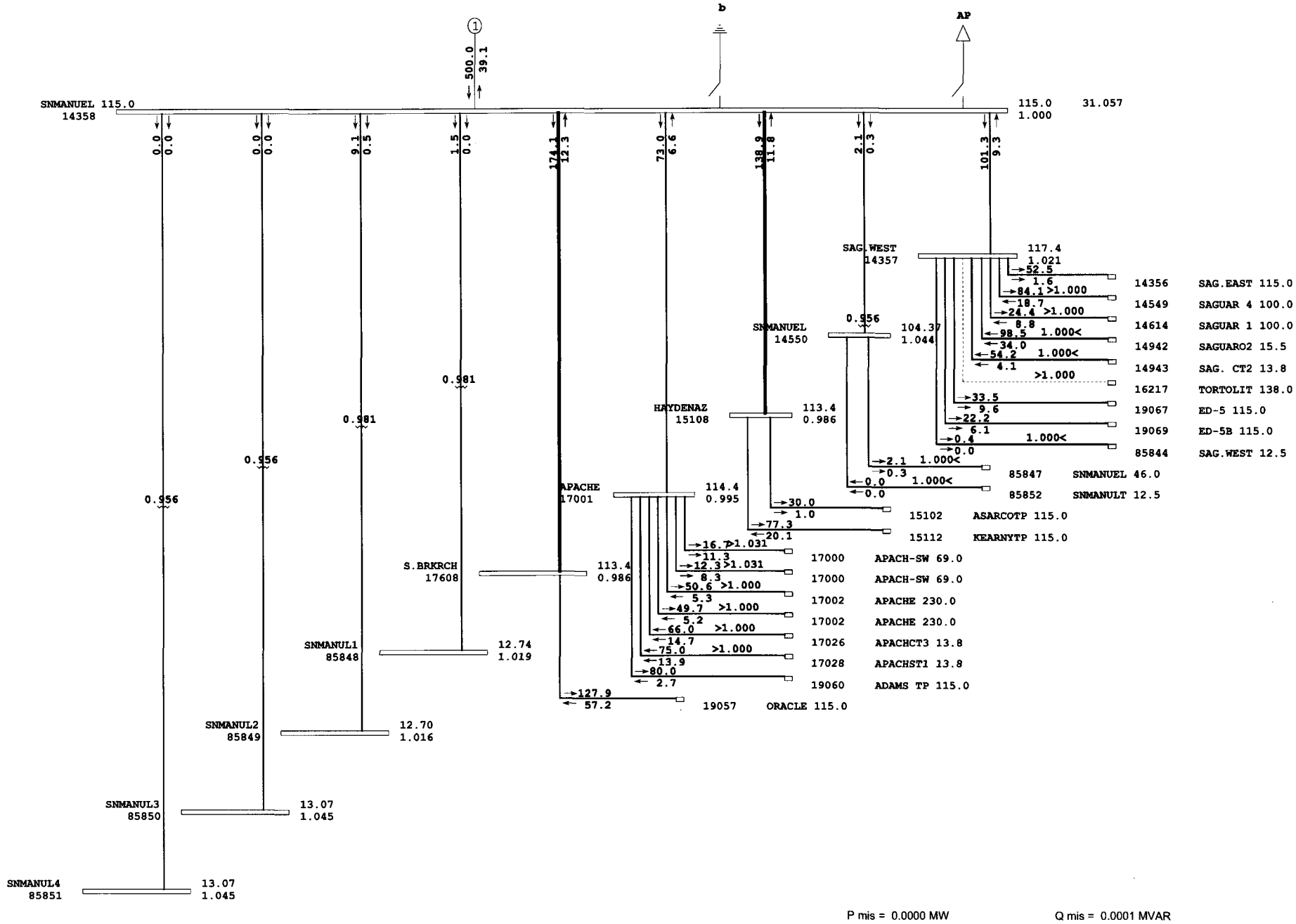
(MVA)

NO.	NAME	KV	NO.2	NAME3	KV4	OTG	CONTINGENCY DESCRIPTION	RATING	BASE CASE	SAGUARO	INCREMENTAL
14206	CTRYCLUB	230	14216	LINCSTRT	230	1	"base"Base system (n-0)	557.0	99.93%	100.36%	0.43%

N-1 Summary

(MVA)

NO.	NAME	KV	NO.2	NAME3	KV4	OTG	CONTINGENCY DESCRIPTION	RATING	BASE CASE	SAGUARO	INCREMENTAL
19210	RATTLSNK	115	19216	TWINPEAK	115	648	"line_647"Line MARANATP 115.0 to MARANA 115.0 Circuit 1	132.0	84.90%	100.03%	15.13%
19210	RATTLSNK	115	19216	TWINPEAK	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	134.14%	142.35%	8.21%
19216	TWINPEAK	115	17670	PICTROCK	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	133.01%	141.21%	8.20%
19210	RATTLSNK	115	19216	TWINPEAK	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	116.27%	124.44%	8.17%
19216	TWINPEAK	115	17670	PICTROCK	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	115.15%	123.31%	8.16%
17670	PICTROCK	115	19212	SANDARIO	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	122.59%	130.74%	8.15%
17089	SNDARIO	115	19212	SANDARIO	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	121.43%	129.57%	8.14%
17670	PICTROCK	115	19212	SANDARIO	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	105.14%	113.23%	8.09%
17089	SNDARIO	115	19212	SANDARIO	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	103.98%	112.07%	8.09%
17013	MARANATP	115	19210	RATTLSNK	115	95	"line_94"Line SAG.EAST 115.0 to NAVISKA 115.0 Circuit 1	120.0	100.57%	107.62%	7.05%
17013	MARANATP	115	19210	RATTLSNK	115	218	"line_217"Line NAVISKA 115.0 to ADONIS 115.0 Circuit 1	120.0	94.32%	101.36%	7.04%
17013	MARANATP	115	19210	RATTLSNK	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	120.0	110.63%	114.77%	4.15%
17013	MARANATP	115	19210	RATTLSNK	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	120.0	95.95%	100.06%	4.11%
14203	CASGRAPS	230	84848	CASGRAPS	69	665	"line_664"Line TOLTEC 69.0 to MILLIGAN 69.0 Circuit 1	100.0	99.00%	101.94%	2.93%
14203	CASGRAPS	230	84848	CASGRAPS	69	915	"tran_914"Tran MILLIGAN 230.00 to MILLIGAN 69.00 Circuit 1	100.0	113.06%	115.97%	2.92%
84848	CASGRAPS	69	84747	SE8	69	915	"tran_914"Tran MILLIGAN 230.00 to MILLIGAN 69.00 Circuit 1	107.6	100.24%	103.08%	2.83%
14217	LONEPEAK	230	14221	PNPKAPS	230	50	"line_49"Line REACH 230.0 to PNPKAPS 230.0 Circuit 1	545.4	108.64%	109.21%	0.57%
17019	RIVIERA	69	17087	RIVIERA	230	813	"tran_812"Tran RIVIERA 69.00 to RIVIERA 230.00 Circuit 1	112.0	154.76%	154.76%	0.00%
17019	RIVIERA	69	17087	RIVIERA	230	814	"tran_813"Tran RIVIERA 69.00 to RIVIERA 230.00 Circuit 2	112.0	154.17%	154.17%	0.00%
84826	ARABY S	69	84895	AR FH TP	69	401	"line_400"Line N.GILA 69.0 to SW1 69.0 Circuit 1	78.6	102.46%	102.38%	-0.09%



General Electric International, Inc. PSLF Program Mon Dec 15 13:42:55 2008 c:\data\cats hv\catshv_2018_sm.sav

CATSHV_2018HS_final_112408.sav from CATSHV_2018HS_final_aps.sav MLE/PDS 1124

CATS HV BASE CASE for 2018 HS

ACC TEN-YEAR PLANS FILED Jan 31 2008

B - 9

MW/MVAR

Rating = 1

CATS-HV 2008 Study: TASK 2

SAN MANUEL 500MW INJECTION

N-0 Summary

(MVA)

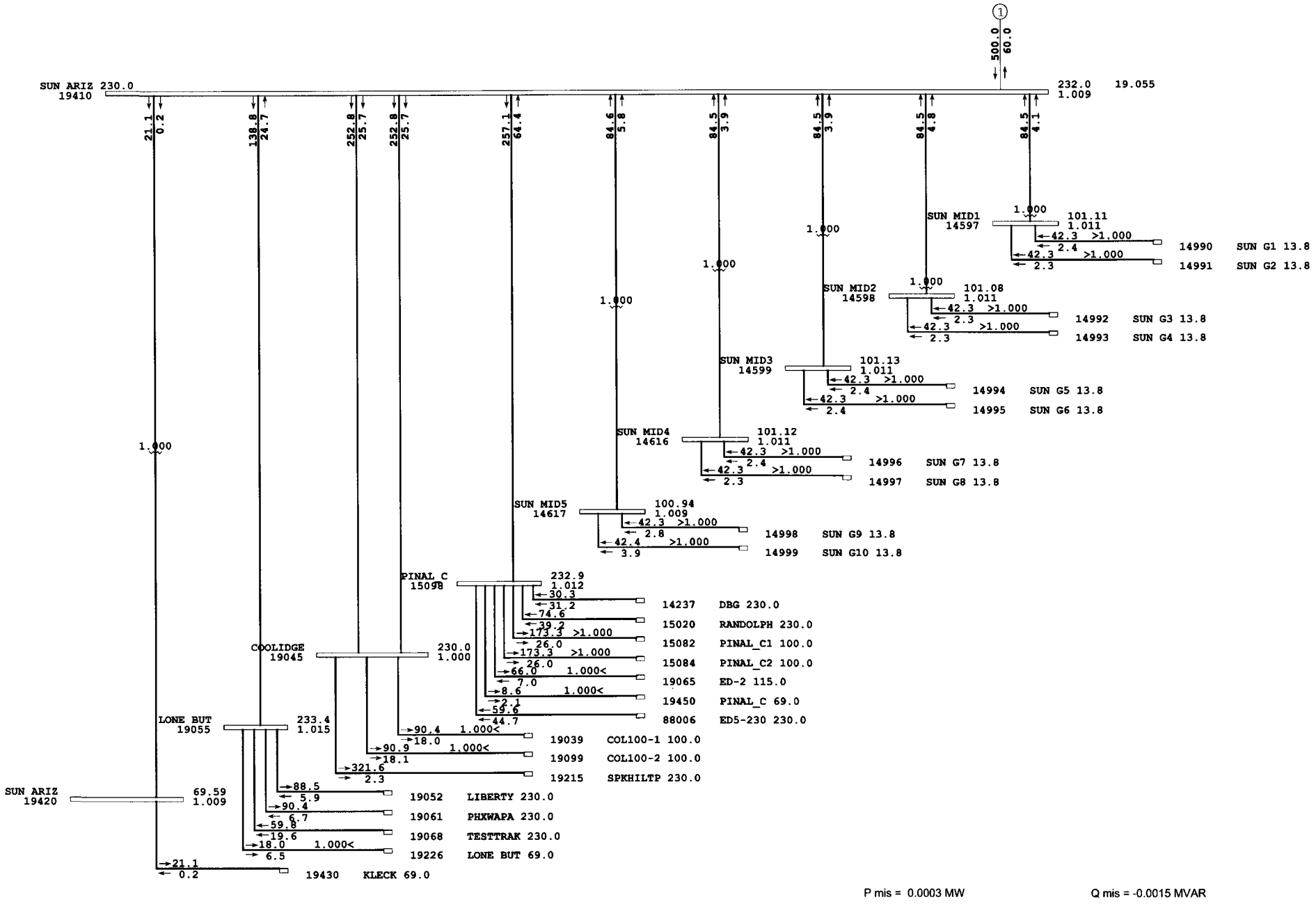
NO.	NAME	KV	NO.2	NAME3	KV4	OTG	CONTINGENCY DESCRIPTION	RATING	BASE CASE	SAN MANUEL	INCREMENTAL
17608	S.BRKRCH	115	14358	SNMANUEL	115	1	"base"Base system (n-0)	145.9	5.73%	119.62%	113.89%
14358	SNMANUEL	115	15108	HAYDENAZ	115	1	"base"Base system (n-0)	167.3	21.28%	112.88%	91.60%

N-1 Summary

(IN ADDITION TO THOSE LISTED ABOVE)

(MVA)

NO.	NAME	KV	NO.2	NAME3	KV4	OTG	CONTINGENCY DESCRIPTION	RATING	BASE CASE	SAN MANUEL	INCREMENTAL
19057	ORACLE	115	17608	S.BRKRCH	115	99	"line_98"Line SNMANUEL 115.0 to HAYDENAZ 115.0 Circuit 1	145.9	21.12%	141.48%	120.36%
19057	ORACLE	115	17608	S.BRKRCH	115	97	"line_96"Line SAG.WEST 115.0 to SNMANUEL 115.0 Circuit 1	145.9	40.51%	132.81%	92.31%
14357	SAG.WEST	115	14358	SNMANUEL	115	217	"line_216"Line S.BRKRCH 115.0 to SNMANUEL 115.0 Circuit 1	159.3	21.18%	110.85%	89.67%
19057	ORACLE	115	17608	S.BRKRCH	115	195	"line_194"Line APACHE 115.0 to SNMANUEL 115.0 Circuit 1	145.9	29.86%	118.80%	88.94%
19057	ORACLE	115	17608	S.BRKRCH	115	134	"line_133"Line HAYDENAZ 115.0 to KEARNYTP 115.0 Circuit 1	145.9	26.50%	110.08%	83.58%
19057	ORACLE	115	17608	S.BRKRCH	115	138	"line_137"Line KEARNYTP 115.0 to MORRISAZ 115.0 Circuit 1	145.9	27.99%	108.68%	80.68%
19057	ORACLE	115	17608	S.BRKRCH	115	139	"line_138"Line KNOLL 115.0 to MORRISAZ 115.0 Circuit 1	145.9	30.50%	107.02%	76.52%
19057	ORACLE	115	17608	S.BRKRCH	115	198	"line_197"Line APACHE 230.0 to WINCHSTR 230.0 Circuit 1	145.9	25.77%	101.91%	76.14%
19057	ORACLE	115	17608	S.BRKRCH	115	897	"tran_896"Tran WINCHSTR 345.00 to WINCHSTR 230.00 Circuit 1	145.9	25.76%	101.90%	76.13%
19057	ORACLE	115	17608	S.BRKRCH	115	91	"line_90"Line ADAMS TP 115.0 to APACHE 115.0 Circuit 1	145.9	25.43%	101.49%	76.06%
19057	ORACLE	115	17608	S.BRKRCH	115	110	"line_109"Line SILVERKG 500.0 to BROWNING 500.0 Circuit 1	145.9	25.48%	100.92%	75.44%
19057	ORACLE	115	17608	S.BRKRCH	115	196	"line_195"Line APACHE 230.0 to BUTERFLD 230.0 Circuit 1	145.9	25.44%	100.56%	75.11%
19057	ORACLE	115	17608	S.BRKRCH	115	133	"line_132"Line HAYDENAZ 115.0 to ASARCOTP 115.0 Circuit 1	145.9	30.47%	101.77%	71.30%
14357	SAG.WEST	115	14358	SNMANUEL	115	289	"line_288"Line ORACLE 115.0 to S.BRKRCH 115.0 Circuit 1	159.3	31.72%	100.43%	68.71%
19057	ORACLE	115	17608	S.BRKRCH	115	145	"line_144"Line RAY 115.0 to KNOLL 115.0 Circuit 1	145.9	37.21%	101.62%	64.42%
19210	RATTLSNK	115	19216	TWINPEAK	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	134.14%	139.39%	5.25%
19216	TWINPEAK	115	17670	PICTROCK	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	133.01%	138.26%	5.25%
19210	RATTLSNK	115	19216	TWINPEAK	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	116.27%	121.44%	5.17%
17670	PICTROCK	115	19212	SANDARIO	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	122.59%	127.75%	5.17%
19216	TWINPEAK	115	17670	PICTROCK	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	115.15%	120.31%	5.16%
17089	SNDARIO	115	19212	SANDARIO	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	121.43%	126.58%	5.16%
17670	PICTROCK	115	19212	SANDARIO	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	105.14%	110.22%	5.08%
17089	SNDARIO	115	19212	SANDARIO	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	103.98%	109.05%	5.07%
14203	CASGRAPS	230	84848	CASGRAPS	69	665	"line_664"Line TOLTEC 69.0 to MILLIGAN 69.0 Circuit 1	100.0	99.00%	100.46%	1.46%
14203	CASGRAPS	230	84848	CASGRAPS	69	915	"tran_914"Tran MILLIGAN 230.00 to MILLIGAN 69.00 Circuit 1	100.0	113.06%	114.51%	1.45%
84848	CASGRAPS	69	84747	SE8	69	915	"tran_914"Tran MILLIGAN 230.00 to MILLIGAN 69.00 Circuit 1	107.6	100.24%	101.70%	1.45%
17019	RIVIERA	69	17087	RIVIERA	230	813	"tran_812"Tran RIVIERA 69.00 to RIVIERA 230.00 Circuit 1	112.0	154.76%	154.76%	0.00%
17019	RIVIERA	69	17087	RIVIERA	230	814	"tran_813"Tran RIVIERA 69.00 to RIVIERA 230.00 Circuit 2	112.0	154.17%	154.17%	0.00%
17013	MARANATP	115	19210	RATTLSNK	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	120.0	110.63%	95.28%	-15.35%
17013	MARANATP	115	19210	RATTLSNK	115	95	"line_94"Line SAG.EAST 115.0 to NAVISKA 115.0 Circuit 1	120.0	100.57%	84.70%	-15.87%



General Electric International, Inc. PSLF Program Mon Dec 15 13:32:18 2008 c:\data\cats hv\catshv_2018_sd.sav

CATSHV_2018HS_final_112408.sav from CATSHV_2018HS_final_aps.sav MLE/PDS 1124

CATS HV BASE CASE for 2018 HS

ACC TEN-YEAR PLANS FILED Jan 31 2008

B - 11

MW/MVAR

Rating = 1

CATS-HV 2008 Study: TASK 2

SUNDANCE 500MW INJECTION

N-0 Summary

(MVA)

NO.	NAME	KV	NO.2	NAME3	KV4	OTG	CONTINGENCY DESCRIPTION	RATING	BASE CASE	SUNDANCE	INCREMENTAL
14206	CTRYCLUB	230	14216	LINCSTRT	230	1	"base"Base system (n-0)	557.0	99.93%	100.24%	0.31%

N-1 Summary

(MVA)

NO.	NAME	KV	NO.2	NAME3	KV4	OTG	CONTINGENCY DESCRIPTION	RATING	BASE CASE	SUNDANCE	INCREMENTAL
19215	SPKHILTP	230	19045	COOLIDGE	230	461	"line_460"Line SUN ARIZ 230.0 to PINAL_C 230.0 Circuit 1	390.5	60.31%	100.73%	40.42%
19502	ROGSWAPA	230	19215	SPKHILTP	230	461	"line_460"Line SUN ARIZ 230.0 to PINAL_C 230.0 Circuit 1	390.5	60.20%	100.52%	40.32%
19045	COOLIDGE	230	19410	SUN ARIZ	230	270	"line_269"Line COOLIDGE 230.0 to SUN ARIZ 230.0 Circuit 2	414.7	83.20%	106.35%	23.15%
19045	COOLIDGE	230	19410	SUN ARIZ	230	269	"line_268"Line COOLIDGE 230.0 to SUN ARIZ 230.0 Circuit 1	414.7	83.20%	106.35%	23.15%
17013	MARANATP	115	19210	RATTLSNK	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	120.0	110.63%	113.50%	2.87%
19210	RATTLSNK	115	19216	TWINPEAK	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	134.14%	136.70%	2.56%
19216	TWINPEAK	115	17670	PICTROCK	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	133.01%	135.57%	2.56%
19210	RATTLSNK	115	19216	TWINPEAK	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	116.27%	118.82%	2.55%
19216	TWINPEAK	115	17670	PICTROCK	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	115.15%	117.70%	2.55%
17670	PICTROCK	115	19212	SANDARIO	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	122.59%	125.13%	2.54%
17089	SNDARIO	115	19212	SANDARIO	115	199	"line_198"Line AVRA 115.0 to MARANA 115.0 Circuit 1	132.0	121.43%	123.97%	2.54%
17670	PICTROCK	115	19212	SANDARIO	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	105.14%	107.67%	2.53%
17089	SNDARIO	115	19212	SANDARIO	115	200	"line_199"Line AVRA 115.0 to SNDARIO 115.0 Circuit 1	132.0	103.98%	106.50%	2.52%
17013	MARANATP	115	19210	RATTLSNK	115	95	"line_94"Line SAG.EAST 115.0 to NAVISKA 115.0 Circuit 1	120.0	100.57%	102.43%	1.86%
14203	CASGRAPS	230	84848	CASGRAPS	69	665	"line_664"Line TOLTEC 69.0 to MILLIGAN 69.0 Circuit 1	100.0	99.00%	100.74%	1.73%
14203	CASGRAPS	230	84848	CASGRAPS	69	915	"tran_914"Tran MILLIGAN 230.00 to MILLIGAN 69.00 Circuit 1	100.0	113.06%	114.78%	1.73%
84848	CASGRAPS	69	84747	SE8	69	915	"tran_914"Tran MILLIGAN 230.00 to MILLIGAN 69.00 Circuit 1	107.6	100.24%	101.95%	1.71%
14217	LONEPEAK	230	14221	PNPKAPS	230	50	"line_49"Line REACH 230.0 to PNPKAPS 230.0 Circuit 1	545.4	108.64%	109.41%	0.77%
17019	RIVIERA	69	17087	RIVIERA	230	813	"tran_812"Tran RIVIERA 69.00 to RIVIERA 230.00 Circuit 1	112.0	154.76%	154.76%	0.00%
17019	RIVIERA	69	17087	RIVIERA	230	814	"tran_813"Tran RIVIERA 69.00 to RIVIERA 230.00 Circuit 2	112.0	154.17%	154.17%	0.00%