# Discussion Regarding PJM's SIL Calculations

August 12, 2010


PJM Confidential

# Agenda

- Quick overview of Purpose, Concerns, and Primary Questions
- Discuss each element of Attachment E and PJM's application of this
- Review current outputs & how 2009 values differ from 2006 values
- Discuss questions and concerns raised by PJM and its members.
- Highlight next steps

# Purpose of Discussion

- Discuss relevant FERC orders to better understand FERC's intent to better derive SIL values that represent PJM's system dynamics.

- The discussion should enable PJM to better address its concerns and outstanding questions.

# Concerns

1. Current application of our interpretations of FERC directives are causing us to calculate values that are not reflective of PJM's actual import capabilities.
    1. Scaling the world artificially limits transfer capability.
    2. Internal zonal flow combined with a "world neighbor" artificially limits transfer capability.
2. In particular the Zero SIL values, in our initial calculations, are not supportable.

# Primary Questions

1. Why should we use a 70% discount on the effect of counter-flows?
2. Are we properly handling reservations or can we add them back in? At a minimum can we can demonstrate the reservation component, because the reservations are indicative of an ability to import?
3. When we reach a limit on one path are we able to pursue another path?
4. Is the intent to avoid redispatch or should we consider the ability to redispatch and address particular limits?
5. How representative is a Zero value if there are additional abilities not represented by typical operational measures? Our operational response could be – switching, redispatch, TLR's, congestion management/market to market measures.
6. Can the SIL represent Firm and Non-Firm?
7. Can the SIL assumptions work for a market of PJM's size?

**(Other questions are underlined and in BOLD)**

# Compliance to FERC Requirements

# Calculation Method

## Requirements (per FERC Order 697 and Appendix E of the April 14 FERC Order)

- Use TP's tariff as basis, and transmission reliability margins " that existed" on the applicant's flowgates "during each seasonal peak."
  - PJM's flowgate definition file detailing the specific TRM and CBM values for each flowgate was used in both the SIL study and PJM's ATC calculation process.

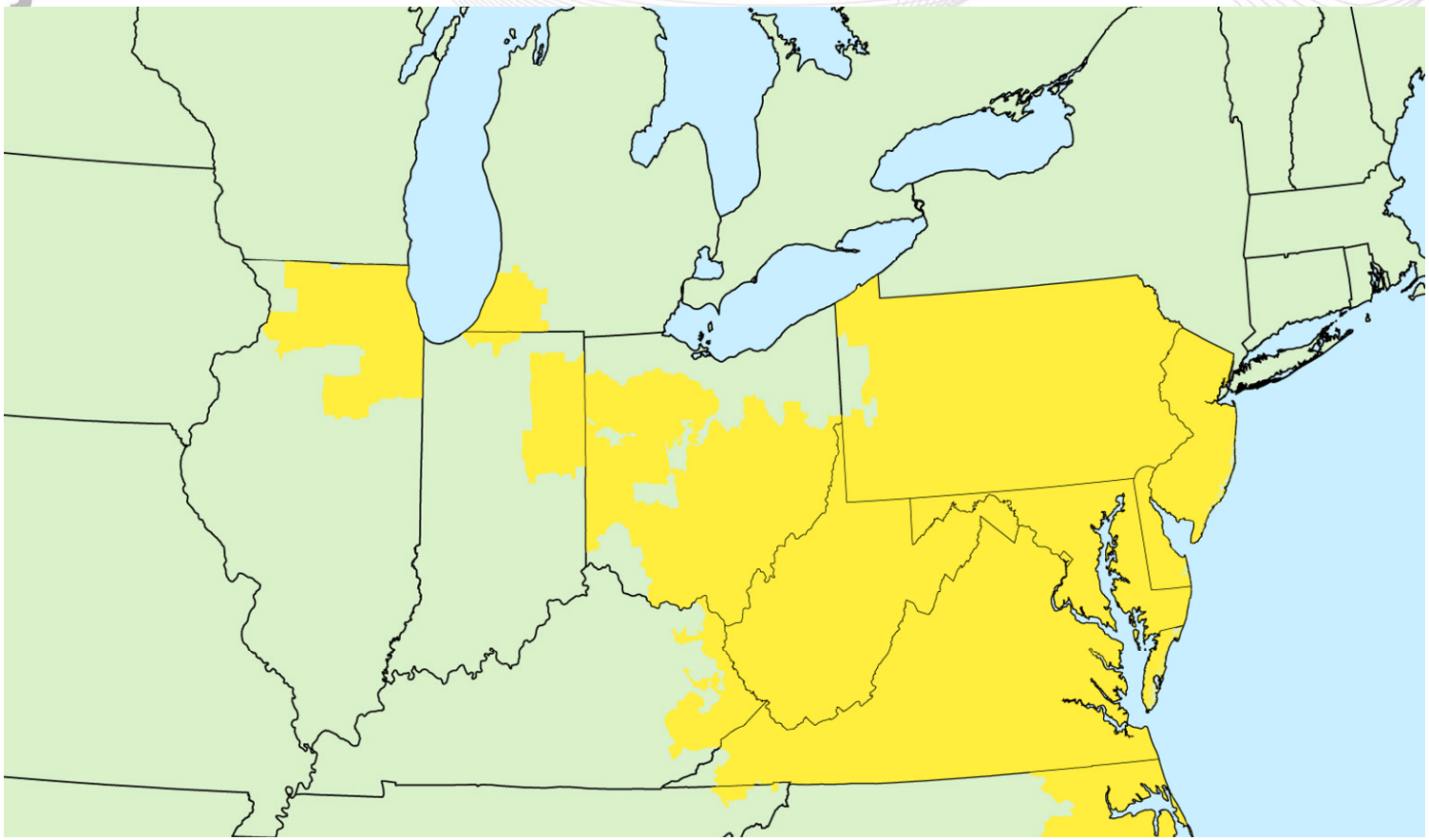
# Calculation Method (continued)

- Treat the TP control area as a single area ("study area")
  - PJM RTO is the single area defined as PJM's "study area". This single Point of Receipt area includes PJM Mid-Atlantic, Allegheny Power, American Electric Power, Duquesne, Dayton, Commonwealth Edison and Dominion Virginia Power.

# Calculation Method (continued)

- Treat first-tier (adjacent) markets as a single area
  - Our interpretation is that we scale all generators in the outside world. This causes us to quickly hit a limit on the most limiting path and flowgate. Had we imported from a subset of interfaces, our import capability would be much higher and more representative or reality.
  - PJM defined its first-tier markets. This single Point of Delivery area includes: New York ISO, Alliant Energy East, Alliant Energy West, Ameren Illinois, Cinergy, First Energy, Indianapolis Power & Light Company, MidAmerican Electric Company, Michigan Electric Coordinated System, Northern Indiana Public Service Company, Ohio Valley Electric Cooperative, Wisconsin Electric Company, Carolina Power & Light East, Carolina Power & Light West, DUKE, East Kentucky Power Cooperative, Louisville Gas & Electric and Tennessee Valley Authority.

PJM territory as of May 1, 2005



## Can the SIL assumptions work for a market of PJM's size?

# Calculation Method (continued)

- The import capability of the study area is defined to be the simultaneous transfer limit from the composite first-tier market area into the study area.
  - All available generation within the first-tier markets will be scaled in the same manner as they were scaled in the PJM ATC calculation process.

# Calculation Method (continued)

- Power flow cases should represent the TP's tariff provisions
  - PJM used winter IDC power flow cases that were the basis for PJM's 2009 ATC determination.
  - This includes assumptions for internal PJM zonal interchange. This interchange was compared with PJM most requested paths. The same zonal interchange applied to the "world" produces unrealistic results (sometimes zero import capability).

# Calculation Method (continued)

- Operational practices are used historically
  - PJM used its OASIS and ATC practices for this SIL study.
  - PJM's real-time operating procedures for mitigating operating limit violations were not applied.
    - Overly Conservative
    - Not representative of capabilities
    - Magnified by PJM's size
    - May 20 ,2010 – Order – SPP SIL – **Should not a Day 2 Market have the ability to consider operating procedures?**

# Calculation Method (continued)

- Use historic Reliability margins (*TRM, CBM, counter flow, generating operating limits operating reserves*)
  - PJM used its flowgate definitions file containing TRM, CBM and counter-flow values.
    - **In the SIL should not counter-flow be calculated at 100% of effect?**
  - PJM adhered to operating limits (Pmax and Pmin) used in PJM's ATC calculation process.
  - Operating Reserves are not used in PJM's ATC calculation process and therefore were not included.

# Calculation Method (continued)

- All Firm/Network reservations held by applicant/affiliate resources during the most recent seasonal peaks
  - PJM included all accepted and confirmed Firm Point to Point and Network reservations that contain PJM, MISO or TVA as a POR/POD for the respective study period.
  - **Reservations vs. Schedules make it appear as though PJM is a net exporter for each season and this is not reflective of actual operations. How can we address this?**

# Calculation Method (continued)

- Aggregation of all internal/external contingency facilities
  - PJM used its monitored flowgate files containing its internal/external contingency files.
    - The facilities were the same used in PJM's ATC calculation process.

# Calculation Method (continued)

- All monitored/limiting facilities that were used historically to approximate area-area transmission availability
  - PJM used its monitored flowgate files containing its internal/external contingency files.
    - The facilities were the same used in PJM's ATC calculation process.

# Calculation Method (continued)

- Scale up available generation in the exporting (aggregated first-tier areas per their proportion) and scale down the study area resources according to the same methods used historically in assessing available transmission for non-affiliate resources
  - PJM scaled all for export for the aggregated first-tier areas.
    - The PJM software respect generation minimum and maximum capabilities.
  - PJM scaled all for import for the PJM RTO area.
    - Certain “non –reducible” units consistent with ATC calculation methods were excluded.
    - Used block dispatch method to approximate economics.
  - Used direct dispatch for pumped storage units
  - **Should PJM scale down evenly across its footprint rather than largely seeing generation shifts in the West of PJM – which create greater West to East flows and reduce SIL?**

# RESULTS

# Results

| | WORLD to PJM RTO | | |
|---|---|---|---|
| **2009** | **Import MW*** | **Load** | **Limit** |
| Winter | 432 | 120313 | Pruntytown-Mt. Storm 500 kV for loss of Black Oak-Bedington 500 kV |
| Spring | 0 | 105933 | Person-Halifax 230 kV for loss of Wake-Carson 500 kV |
| Summer | 0 | 134105 | Pruntytown-Mt. Storm 500 kV for loss of Black Oak-Bedington 500 kV |
| Fall | 2293 | 97963 | Mt. Storm-Doubs 500 kV for loss of Black Oak-Bedington 500 kV |

* Import MW amount represented a snapshot in time during the peak season, calculated based on the same method as the ATC calculation. It should not be looked at as an indication that PJM had no import capability throughout the season. The method of calculation does not consider off-cost redispatch and/or switching procedures.

# Results (continued)

| | PJM to Eastern PJM Submarket | | |
|---|---|---|---|
| **2009** | **Import MW**** | **Load** | **Limit** |
| Winter | 9944 | 24284 | Graceton-Manor 230 kV for loss of Conastone-Peach Bottom 500 kV |
| Spring | 9477 | 23558 | Graceton-Manor 230 kV for loss of Conastone-Peach Bottom 500 kV |
| Summer | 11543 | 31353 | Mt. Storm-Doubs 500 kV for loss of Mt. Storm-Greenland Gap 500 kV |
| Fall | 6927 | 20539 | Cedar Grove_F-Clifton_K 230 kV for loss of Cedar Grove_B-Roseland 230 kV |

** Import MW amount were based on the load level and generation availability to balance the load at a snapshot in time during the peak season. Off-cost redispatch and/or switching procedures were not included as part the study.

# Output format/Sensitivity

- Supplementing the SIL results with additional component information will enable the members to better understand the results
- The next slide describes these components
  - Transfer Distribution Factor (TDF) - The amount of the transfer that flows on the monitored element (on a first contingency basis)
  - Reservation impact – The impact of reservations from the OASIS mined as part of the ATC process (PJM/MISO/TVA/MAPP)
  - Transmission Reliability Margin (TRM) – Reflects the uncertainty of generation, load, and transmission availability forecasts.
  - Capacity Benefit Margin (CBM) – The amount of transmission set aside to ensure that PJM has the ability to import external generation for the purpose of serving native load.
  - Initial AFC – Available Flowgate Capability after generation to load and interchange are met but before reservation impacts, TRM and CBM are applied
  - Final AFC – Available Flowgate Capability after reservation impacts, TRM and CBM are applied

# Output format/Sensitivity (continued)

## ATC compares to FCITC

| ATC | | | | Base Case Flow Initial | | Base Case Flow Final | | | MW Rating | FCITC |
|---|---|---|---|---|---|---|---|---|---|---|
| ATC With TRM CBM Reser-vations applied | Season | Flowgate Limit monitored facility with contingency | TDF (with outage) | Initial AFC | Impact of Reser-vations. | Final AFC | Impact of TRM | Impact of CBM | Flow gate Rating | ATC without TRM CBM without rese -rvations |
| **3513.16** | **Winter** | Pruntytown-Mt. Storm 500 for loss of Black Oak-Bedington 500 | 0.0828 | 849 | 310 | 290.8 | 194.3 | 53.9 | 3886 | **10253.62** |
| **1990.04** | **Spring** | Person-Halifax 230 for loss of Wake-Carson 500 | 0.0486 | 269.6 | 105.1 | 96.8 | 12.1 | 55.6 | 607 | **5547.33** |
| **-1038.34** | **Summer** | Pruntytown-Mt. Storm 500 for loss of Black Oak-Bedington 500 | 0.0597 | 341.4 | 180.8 | -61.9 | 168.6 | 53.9 | 3372 | **5718.59** |
| **5485.54** | **Fall** | Mt. Storm-Doubs 500 for loss of Black Oak-Bedington 500 | 0.0468 | 450.3 | 58.2 | 257 | 135.2 | 0 | 2704 | **9621.79** |

# Differences Between 2009 vs. 2006

- Software used and power flow cases
- Higher west to east flow
- Outages
- Transmission Service Requests (TSRs)
- PJM base case net interchange

# Differences Between 2009 vs. 2006 (continued)

- Software used and power flow cases
  - Using Historic – Yet Economic Flow Patterns
  - PJM is concerned this is artificially limiting actual import capability.
- Most Significant Variable in Differences

| | **2006** | **2009** |
|---|---|---|
| Software | MUST AFC | TARA AMB |
| Power flow cases | PSS/E version 29 | PSS/E version 30 |

# Differences Between 2009 vs. 2006 (continued)

- Base case net interchange

| | 2009[1] | 2006[2] |
|---|---|---|
| Summer | 3024[3] | 2796[3] |
| Spring | 3040[3] | 2131[3] |
| Fall | 3193[3] | 2638[3] |
| Winter | 3081[3] | 3088[3] |

[1]MW was included as part of the SIL equation

[2]MW was *not* included as part of the SIL equation

[3]PJM RTO was exporting

# 2009 PJM RTO Real Time Net Interchange

| | 2009 |
|---|---|
| Summer | -381[1] |
| Spring | 1080 |
| Fall | -2788[1] |
| Winter | 2196 |

[1]PJM RTO was exporting

# Re-Cap of Primary Questions

1. Why should we use a 70% discount on the effect of counter-flows?
2. Are we properly handling reservations or can we add them back in? At a minimum can we can demonstrate the reservation component, because the reservations are indicative of an ability to import?
3. When we reach a limit on one path are we able to pursue another path?
4. Is the intent to avoid redispatch or should we consider the ability to redispatch and address particular limits?
5. How representative is a Zero value if there are additional abilities not represented by typical operational measures? Our operational response could be – switching, redispatch, TLR's, congestion management/market to market measures.
6. Can the SIL represent Firm and Non-Firm?
7. Can the SIL assumptions work for a market of PJM's size?

**(Other questions are underlined and in BOLD)**

# Next Steps

- PJM will reassess its approach based upon today's guidance
- Re-run SIL Calculations
- Potentially set up a conference call between FERC Staff and interested PJM members to discuss new findings.

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# ADDITIONAL SLIDES

# Differences Between 2009 vs. 2006 (continued)

- Outages

| | 2009 | | 2006 | |
|---|---|---|---|---|
| | No. of PJM transmission outages[1] | No. of PJM generation outages[1] | No. of PJM transmission outages[1] | No. of PJM generation outages[1] |
| Summer | 1691 | 1323 | 797 | 928 |
| Spring | 1692 | 1596 | 1090 | 1007 |
| Fall | 1522 | 1556 | 761 | 996 |
| Winter | 1409 | 1163 | 717 | 1042 |

[1]Total number of PJM outages retrieved for use in the AFC/ATC process. The outage information was a snapshot of outages that cross the time frame, not all of the outages were applied to the SIL cases. Also note that external outages that were retrieved via NERC SDX and applied to the SIL cases are not included in the numbers above.

# Conclusion

- The PJM SIL analysis was conducted in accordance with FERC Order 697 and FERC's April 4, 2008 Letter
  - Required modification to the representation of PJM and the adjoining BA's.
  - Considering all first tier areas as a single POR and the PJM as a single POD limits the granularity of the PJM market in the SIL analysis.
  - No attempt was made to modify the SIL analysis to represent PJM zones.
  - The calculated SIL's should be considered conservative estimates.
  - PJM real time data includes the impact of economics in PJM operations.

# Differences Between 2009 vs. 2006 (continued)

- Higher west to east flow*

RTO SIL

| | 2006 flow | 2006 rating | 2009 flow | 2009 rating | 2006 limit |
|---|---|---|---|---|---|
| **Summer** | -80.8 | 608 | 247.2 | 607 | Person-Halifax 230 kV for loss of Wake-Carson 500 kV |
| **Spring** | -30.4 | 608 | 203.5 | 607 | Person-Halifax 230 kV for loss of Wake-Carson 500 kV |
| **Fall** | -172.7 | 492 | 0** | 485 | Mitchell-Elrama 138 kV |
| **Winter** | 380.4 | 840 | 431.6 | 596*** | Waldwick-Hawthorne 230 kV for loss of Waldwick-Hillsdale 230 kV |
| | | | | | |

| | 2006 flow | 2006 rating | 2009 flow | 2009 rating | 2009 limit |
|---|---|---|---|---|---|
| **Summer** | 1676.3 | 3326 | 3001 | 3372 | Pruntytown-Mt. Storm 500 kV for loss of Black Oak-Bedington 500 kV |
| **Spring** | -30.4 | 608 | 203.5 | 607 | Person-Halifax 230 kV for loss of Wake-Carson 500 kV |
| **Fall** | 1566.2 | 2704 | 2145.6 | 2704 | Mt. Storm-Doubs 500 kV for loss of Black Oak-Bedington 500 kV |
| **Winter** | 1832.8 | 3886 | 2767.6 | 3886 | Pruntytown-Mt. Storm 500 kV for loss of Black Oak-Bedington 500 kV |
| | | | | | |

*Flow on the line before SIL analysis begins
**PJM operating procedure detailed in Manual 03
*** Rating at that time, actual line rating was 840

# Differences Between 2009 vs. 2006 (continued)

- Higher west to east flow*

Submarket SIL

| | 2006 flow | 2006 rating** | 2009 flow | 2009 rating*** | 2006 limit |
|---|---|---|---|---|---|
| **Summer** | 2721.6 | 3661 | 394.1 | 7949 | AP South Transfer Interface |
| **Spring** | 1295 | 3061 | 2243.7 | 7962 | Central Transfer Interface |
| **Fall** | 762 | 3061 | 2874.2 | 7962 | Central Transfer Interface |
| **Winter** | 468.5 | 2974 | 1554.9 | 8770 | Central Transfer Interface |
| | | | | | |

| | 2006 flow | 2006 rating | 2009 flow | 2009 rating | 2009 limit |
|---|---|---|---|---|---|
| **Summer** | 1893.8 | 2704 | 2439.1 | 2704 | Mt. Storm-Doubs 500 kV for loss of Mt. Storm-Greenland Gap 500 kV |
| **Spring** | -76.4 | 531 | 103.3 | 485 | Graceton-Manor 230 kV for loss of Conastone-Peach Bottom 500 kV |
| **Fall** | -93 | 873 | 737.9 | 831 | Cedar Grove_F-Clifton_K 230 kV for loss of Cedar Grove_B-Roseland 230 kV |
| **Winter** | -181.5 | 594 | 26.2 | 553 | Graceton-Manor 230 kV for loss of Conastone-Peach Bottom 500 kV |
| | | | | | |

*Flow on the line before SIL analysis begins
**Reactive ratings
***Thermal ratings

# Differences Between 2009 vs. 2006 (continued)

## 2006 SIL vs. 2009 SIL

| | 2006 Import MW | 2006 Limiting Facility | 2009 Import MW | 2009 Limiting Facility |
|---|---|---|---|---|
| **Winter** | 13600 | Waldwick-Hawthorne 230 kV for loss of Waldwick-Hillsdale 230 kV | 432 | Pruntytown-Mt. Storm 500 kV for loss of Black Oak-Bedington 500 kV |
| **Spring** | 8300 | Person-Halifax 230 kV for loss of Wake-Carson 500 kV | 0 | Person-Halifax 230 kV for loss of Wake-Carson 500 kV |
| **Summer** | 9200 | Person-Halifax 230 kV for loss of Wake-Carson 500 kV | 0 | Pruntytown-Mt. Storm 500 kV for loss of Black Oak-Bedington 500 kV |
| **Fall** | 3300 | Mitchell-Elrama 138 kV | 2293 | Mt. Storm-Doubs 500 kV for loss of Black Oak-Bedington 500 kV |

# Differences Between 2009 vs. 2006 (continued)

2006 SIL vs. 2009 SIL

Direct comparison between 2006 and 2009 is “apple to orange” because

- Power flow case is different
  - Interchange to the external areas accounted for differently between 2006 and 2009
  - Historical real-time data was built into the initial starting case for PJM zones for 2009
- Limiting facilities are different
- Attributes of flowgates (CBM, TRM) are different
- Impact of PJM and external reservations

# Differences Between 2009 vs. 2006 (continued)

***Directly comparing the limiting facility attributes for***

Summer

- The impact of higher west to east flow is 83%
- The impact of TRM is 12.5%
- The impact of CBM is -0.5%
- The impact of reservation is -23.9%
- The impact of interchange is 28.9%

Spring

- The impact of higher west to east flow is 75.3%
- The impact of TRM is -0.5%
- The impact of CBM is 10.2%
- The impact of reservation is -31.4%
- The impact of interchange is 46.3%

Fall

- The impact of higher west to east flow is 72.5%
- The impact of TRM is 29.1%
- The impact of CBM is 0%
- The impact of reservation is -67.4%
- The impact of interchange is 65.7%

Winter

- The impact of higher west to east flow is -5.1%
- The impact of TRM is 17.5%
- The impact of CBM is 5.6%
- The impact of reservation is 29.1%
- The impact of interchange is 53%

# Differences Between 2009 vs. 2006 (continued)

## Why 2009 SIL limiting facilities did not showing up in 2006 SIL analysis?

– Tables below show 2009 SIL limiting facilities and their flow for 2006 and 2009. The result shows 2009 had more flow on the facilities than in 2006 and thus reduced their available capability, resulted in them showing up as the *most* constraints in the 2009 SIL analysis. Table 1 shows the flow comparison between 2006 and 2009 for 2009 RTO SIL. Table 2 shows the flow comparison between 2006 and 2009 for 2009 Submarket SIL.

RTO SIL

| | 2006 flow | 2006 rating | 2009 flow | 2009 rating | 2009 limiting facility |
|---|---|---|---|---|---|
| **Summer** | 2318.6 | 3326 | 3030.6 | 3372 | Pruntytown-Mt. Storm 500 kV for loss of Black Oak-Bedington 500 kV |
| **Spring** | 62 | 608 | 337.4 | 607 | Person-Halifax 230 kV for loss of Wake-Carson 500 kV |
| **Fall** | 1802.6 | 2704 | 2253.7 | 2704 | Mt. Storm-Doubs 500 kV for loss of Black Oak-Bedington 500 kV |
| **Winter** | 2173.4 | 3886 | 3037 | 3886 | Pruntytown-Mt. Storm 500 kV for loss of Black Oak-Bedington 500 kV |
| | | | | | |

Table 1

Submarket SIL

| | 2006 flow | 2006 rating | 2009 flow | 2009 rating | 2009 limiting facility |
|---|---|---|---|---|---|
| **Summer** | 2433 | 2704 | 2529.2 | 2704 | Mt. Storm-Doubs 500 kV for loss of Mt. Storm-Greenland Gap 500 kV |
| **Spring** | -103.8 | 531 | -89 | 485 | Graceton-Manor 230 kV for loss of Conastone-Peach Bottom 500 kV |
| **Fall** | 569.8 | 873 | 1169.1 | 831 | Cedar Grove_F-Clifton_K 230 kV for loss of Cedar Grove_B-Roseland 230 kV |
| **Winter** | -60.6 | 594 | 121.4 | 553 | Graceton-Manor 230 kV for loss of Conastone-Peach Bottom 500 kV |
| | | | | | |

Table 2

# Differences Between 2009 vs. 2006 (continued)

## Why 2006 SIL limiting facilities did not showing up in 2009 SIL analysis?

– Tables below show 2006 SIL limiting facilities and their flow for 2006 and 2009. The result shows that either 2009 had less flow on the facilities than in 2006 and thus had more available capability or distribution factor for 2006 limiting facilities did not meet the threshold in 2009 or did not showing up as *the most limiting* facilities. Table 1 shows the flow comparison between 2006 and 2009 for 2006 RTO SIL. Table 2 shows the flow comparison between 2006 and 2009 for 2006 Submarket SIL.

RTO SIL

| | 2006 flow | 2006 rating | 2009 flow | 2009 rating | 2006 limiting facility |
|---|---|---|---|---|---|
| **Summer** | 53.8 | 608 | 319.8 | 607 | Person-Halifax 230 kV for loss of Wake-Carson 500 kV |
| **Spring** | 62 | 608 | 337.4 | 607 | Person-Halifax 230 kV for loss of Wake-Carson 500 kV |
| **Fall** | 99.6 | 492 | 0 | 485 | Mitchell-Elrama 138 kV |
| **Winter** | 334.7 | 840 | 64.13 | 596 | Waldwick-Hawthorne 230 kV for loss of Waldwick-Hillsdale 230 kV |
| | | | | | |

Table 1

Submarket SIL

| | 2006 flow | 2006 rating* | 2009 flow | 2009 rating** | 2006 limiting facility |
|---|---|---|---|---|---|
| **Summer** | 3534.6 | 3661 | 276.83 | 7949 | AP South Transfer Interface |
| **Spring** | 1274.2 | 3061 | 1229.2 | 7962 | Central Transfer Interface |
| **Fall** | 2500.1 | 3061 | 3137.7 | 7962 | Central Transfer Interface |
| **Winter** | 2485.5 | 2974 | 2625 | 8770 | Central Transfer Interface |
| | | | | | |

Table 2

*Reactive rating
**Thermal rating