



**Zone 5 overview**

Zone 5 includes the Wisconsin counties of:

- ❑ Kenosha
- ❑ Milwaukee
- ❑ Ozaukee
- ❑ Racine
- ❑ Washington
- ❑ Waukesha

The physical boundaries of Zone 5 and transmission facilities located in Zone 5 are shown in [Figure ZS-26](#). Zone 5 encompasses southeast Wisconsin. Land use in Zone 5 is largely urban, though some agricultural uses exist.

The major population center in Zone 5 is the metropolitan Milwaukee area.

Zone 5 typically experiences peak demands during the summer months. Large industrial loads in the Milwaukee metropolitan area (such as Charter Steel, Miller Brewing) are among the largest electricity users in the zone.

*Demographics*

The population of the counties in Zone 5 grew at an annual rate of 0.5 percent from 1998 to 2008. The highest growth rate occurred in Washington County, while the largest increase in population occurred in Waukesha County, which increased about 32,000 people over the period.

Population in Zone 5 is projected to grow at 0.5 percent annually for the 2008 through 2019 period. Waukesha County is projected to realize the largest increase in population, while Washington County is projected to have the highest growth rate.

During the same period, the annual employment growth rate was 0.6 percent. The highest growth rate was in Kenosha County and the highest increase in employment occurred in Waukesha County.

Employment in Zone 5 is projected to grow at 0.9 percent annually between 2008 and 2019. Waukesha County is projected to realize the largest increase in employment, while Ozaukee County the highest growth rate.

Employment			
Annual Growth Rate			
1998-2008		2008-2019	
Zone 5	0.6	Zone 5	0.9
Kenosha, WI	2.1	Ozaukee, WI	1.6

Population			
Annual Growth Rate			
1998-2008		2008-2019	
Zone 5	0.5	Zone 5	0.5
Washington, WI	1.3	Washington, WI	1.6

Total Increase			
1998-2008		2008-2019	
Zone 5	72,400	Zone 5	127,610
Waukesha, WI	39,165	Waukesha, WI	44,211

Total Increase			
1998-2008		2008-2019	
Zone 5	86,959	Zone 5	115,739
Waukesha, WI	31,634	Waukesha, WI	60,878



### *Zone 5 environmental considerations*

Zone 5 encompasses the southeastern portion of the state and is the most densely populated of the zones. The area lies in the Southern Lake Michigan Coastal and Southeast Glacial Plains ecological landscape regions. Most of the zone lies in the drainage basins of the Milwaukee, Root or Fox rivers. The Kettle Moraine State Forest lies in the western portions of the zone, and Lake Michigan forms its eastern boundary. Pre-settlement vegetation varied from prairie and oak savanna in the south, to southern mesic forest in the northern portions of the zone. Agricultural land uses are common throughout this zone.

### *Zone 5 electricity demand and generation*

The coincident peak load forecasts for Zone 5 for 2010, 2014, 2019 and 2024 are shown in [Table ZS-12](#). Existing generation, along with proposed generation based on projected in-service year, are also shown. The resultant capacity margins, with or without the proposed generation, are shown as well.

The table shows that load is projected to grow at roughly 1.7 percent annually from 2010 through 2019. Comparing load with generation (at maximum output) within the zone indicates that Zone 5 has less generation than load during peak load periods.

### *Zone 5 transmission system issues*

Key transmission facilities in Zone 5 include:

- ❑ the southern portion of 345-kV lines from Point Beach and Edgewater,
- ❑ the Saukville, Arcadian, Granville, Oak Creek, and Racine 345/138-kV substations,
- ❑ the transmission lines emanating from the Pleasant Prairie and Oak Creek power plants,
- ❑ 230 kV facilities near Milwaukee, and
- ❑ a significant 138-kV network in the Milwaukee area, a portion of which is underground.

Key system performance issues in Zone 5 include:

- ❑ heavy flows on aging facilities,
- ❑ new generation projects expected to be placed in service in 2009 and 2010 that may influence the solutions to load-serving needs in the zone,
- ❑ heavy flows from the west (Zone 3) resulting in heavily loaded 138-kV facilities in the western portion of Zone 5,
- ❑ heavy market flows from the south, resulting in high 345- and 138-kV line loadings and the need to monitor potential multiple contingency conditions, and
- ❑ sagging voltage profile in portions of Washington, Waukesha and Jefferson counties.

The proposed rebuild of the Zoo interchange will necessitate some review of the existing 138-kV lines originating from the Bluemound Substation. This review could result in new projects within the next few years.

*Oak Creek generation:* We Energies has placed in service one 615-megawatt (net) coal powered generator in 2009 and another 615-megawatt (net) plant is under construction at Oak Creek with an



in-service date of 2010. The following projects have been or will be constructed as a result of this new generation.

### **2009 - Oak Creek generation Phase 1**

The following projects were completed prior to the first Oak Creek generator being placed in service in 2009.

- Construct a new Oak Creek 345-kV switchyard to interconnect one new 615-megawatt (net) generator,
- Reconductor a segment of the Oak Creek-Ramsey 138-kV line,
- Terminate the Ramsey-Harbor line into the Kansas/Norwich substations creating a Kansas-Harbor 138-kV line and a Norwich-Ramsey 138-kV line,
- Reconductor the Oak Creek-Allerton 138-kV line,
- Replace current transformers at the Racine 345-kV Substation,
- Replace two 345-kV circuit breakers at Pleasant Prairie Substation on the Racine and Zion lines with IPO breakers and upgrade relaying, and
- Expand Oak Creek 138-kV switchyard to connect the 345/138-kV, 500 MVA transformer.

### **2010 - Oak Creek generation Phase 2**

The second phase of new generation at Oak Creek is scheduled to be placed in service in 2010. The following projects will need to be completed prior to the second unit being placed in service.

- Expand 345-kV switchyard at Oak Creek Power Plant to interconnect a second new 615-megawatt (net) generator,
- Reconductor the Oak Creek-Root River 138-kV line,
- Upgrade terminal equipment and increase line clearances on the Oak Creek-Nicholson 138-kV line to permit operation at 230 degrees, and
- Increase line rating of the Kansas – Ramsey 138-kV line.

In response to customer requests for new distribution interconnections, new 138-kV bus sections were recently constructed at the Pleasant Valley, Shorewood and Brookdale Substations.

### **Zone 5 – 2010 study results**

Refer to [Table ZS-1](#) and [Figure ZS-17](#)

#### *Summary of key findings*

- Some of the line loading and low voltage issues in Zone 5 occur as a result of opening substation bus tie breakers.
- New generation in the greater Milwaukee area will drive many system improvements in Zone 5 within the next decade.

In addition to the new Oak Creek generation, two-32.4 MVAR capacitor banks are scheduled to be placed in service at the Summit Substation by June of 2010 to improve area bus voltages. In the interim, dispatching Concord and/or Germantown generation will provide reactive support to improve area voltage.



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A project to install a second Shorewood-Humboldt underground cable in 2010 is under consideration to accommodate additional distribution load (2009) at the Shorewood Substation under contingency conditions. The Shorewood load is served by two 138-kV underground cables. An underground cable can be out of service for weeks or months for repair in the event a cable is damaged. If one cable is out of service for repair and the second cable experiences a fault, the Shorewood load would have to be bridged elsewhere while repairs are made. Due to geography constraints, the ability to bridge Shorewood load elsewhere is limited. Installing a parallel Shorewood-Humboldt underground line will reduce the likelihood of two cable failures occurring which could cause a load shedding situation at Shorewood.

Thermal and low voltage issues also are expected to occur elsewhere in Zone 5. Following are results of the 2010 contingency analysis (NERC Category B or TPL-002-0 conditions) performed on Zone 5.

Bus outages at Pleasant Prairie and Oak Creek cause transformers at Bain and Oak Creek to exceed their summer emergency ratings. Bus outages are low probability events. Loading relief can be achieved by backing down generation at Pleasant Prairie for Bain transformer relief or Oak Creek for Oak Creek transformer relief.

An outage of the Bain–Kenosha 138-kV line will cause the Bain–Albers 138-kV line to load to 96.4 percent of its summer emergency rating. Increasing line conductor clearances will alleviate this situation by permitting operation above 167 degrees.

An outage of the Arcadian 345/138-kV transformer #1 causes Arcadian transformer #3 to load to 99.0 percent of its summer emergency rating. Project development is underway to replace the Arcadian transformers #2 and #3 with a single 500 MVA transformer. Other alternatives are also being considered. The 345/138-kV windings of the existing transformers are rated at 239/239 MVA (SN/SE). The summer emergency rating of the new transformer will be 640 MVA.

An outage of either one of the Arcadian–Waukesha 138-kV lines (KK9962 and KK9942) results in the other Arcadian–Waukesha 138-kV line loading to between 98 and 99 percent of their summer emergency ratings. The limiting element is the line conductor with clearances set for operation at 200 degrees. The line conductor clearances will be increased to permit higher flows under contingency conditions. Other alternate solutions are being considered.

An outage of the Hartford – St. Lawrence 138-kV line results in Hartford bus voltage dropping to 91.6 percent of the nominal bus voltage. Running generation at Concord improves bus voltage at Hartford.

*Projects whose “Need date” precedes the “In-service date”*

- None

*Projects whose “In-service date” precedes the “Need date”*

As a result of in-service date flexibility, project cost saving and corresponding alignment with other ATC project needs, the following projects will be in service prior to the need date. Additionally, the projects listed below are asterisked in the Annual Project Tables.



- ❑ Construct second Shorewood-Humboldt 138-kV underground cable (need 2012, in service 2010). This project is being constructed in 2010 to take advantage of synergies with area road construction.

## Zone 5 – 2014 study results

Refer to [Table ZS-2](#) and Figure [ZS-18](#)

### Summary of key findings

- ❑ Additional reactive support is required in the greater Milwaukee area.
- ❑ Potential thermal violations indicate the need for facility upgrades in the Waukesha and Kenosha areas.
- ❑ Thermal, voltage, and load serving issues in Kenosha and Walworth might be resolved with a 138-kV line between Spring Valley and North Lake Geneva.

Additional reactive sources are required in the greater Milwaukee area. In addition to the Summit capacitor banks, 225 MVAR of capacitance will be installed at the Bluemound Substation in 2012.

Following are the results of the 2014 contingency analysis (NERC Category B or TPL-002-0 conditions) performed on Zone 5.

An outage of either one of the Arcadian–Waukesha 138-kV lines or Arcadian transformer #1 create overloads in 2014 compared to heavily loaded facilities as seen in the 2010 analysis. Running generation at Concord and Germantown provides relief until line clearances are increased and transformers are replaced. Other alternatives are also being investigated.

The Albers-Bain 138-kV line loads to 113 percent of its summer emergency limit for an outage of the Bain-Kenosha 138-kV line. The limiting element is line conductor clearances. Increasing line clearances is being considered.

Splitting the Pleasant Prairie 345-kV bus between bus sections 3 and 4 will cause Bain transformer #5 to exceed its summer emergency rating by 59 percent. Bus outages are low probability events. Relief can be provided by reducing the output of Pleasant Prairie generator #2 to about 350 megawatts.

An outage of the Hartford – St. Lawrence 138-kV line results in the Hartford 138-kV bus voltage dropping to 90.0 percent of the nominal bus voltage. Running generation at Concord improves bus voltage at Hartford.

The intact system bus voltage at Cooney is at 95.9 percent of nominal voltage. This is approaching the 95.0 percent limit as specified by NERC Category A requirements. An outage of Cooney – Summit results in the Cooney bus voltage dropping to 91.5 percent of the nominal bus voltage. Running generation at Concord will provide relief. In addition, 138-kV capacitors at Concord and Summit will improve the voltage in Waukesha and Jefferson Counties.





Thermal, voltage, and load serving issues in Kenosha and Walworth County might be resolved by constructing a 138-kV line from Spring Valley to Twin Lakes, continuing on to South Lake Geneva. This would entail acquiring new right-of-way between Spring Valley and Twin Lakes. The remaining segment between Twin Lake and North Lake Geneva could make use of an existing right-of-way. Studies are underway to determine the course of action to alleviate the issues in the area. This project would also coordinate with a Zone 3 project, the North Lake Geneva-South Lake Geneva 138-kV line with a 2016 in-service date. Please refer to [Zone 3 – 2014 study results](#) for details about this project.

*Projects whose “Need date” precedes the “In-service date”*

- Uprate Arcadian-Waukesha 138-kV lines KK9942/KK9962 (need 2010, in service 2013)
- Replace two existing 345/138-kV transformers at Arcadian Substation with 1-500 MVA transformer (need 2010, in service 2013)

Considering reasonable project lead times, the 2013 in-service date was chosen for these provisional projects. In the interim, dispatching area generation could be one possible mitigation strategy to address the Arcadian area constraints.

*Projects whose “In-service date” precedes the “Need date”*

- None

## **Zone 5 – 2019 study results**

Refer to [Table ZS-3](#), [Table ZS-3a](#) and [Figure ZS-19](#)

*Summary of key findings*

- Heavy load growth in Waukesha, Washington, Dodge and Jefferson counties will require voltage and load support. A new 345-kV line from Rockdale to Mill Road (formerly Lannon Junction) is one option being considered to solve these problems.
- Voltage and thermal issues remain in Zone 5 under contingency conditions.
- Thermal, voltage, and load serving issues in Kenosha and Walworth might be resolved with a 138-kV line between Spring Valley and North Lake Geneva

Three 138-kV buses in Waukesha and Washington County experience marginal bus voltages under NERC Category A or TPL-001-0 conditions (intact system) in 2019. The buses are Bark River (95.8 percent), Germantown (95.5 percent), and Maple (95.7 percent). Modeling the Bluemound and Mukwonago capacitors in service as well as running additional generation at Germantown will improve the voltage profile in Washington County.

Following are the results of the 2019 contingency analysis (NERC Category B or TPL-002-0 conditions) performed on Zone 5.

Low probability bus outages at Pleasant Prairie continue to be a problem. Relief can be provided by reducing the output of Pleasant Prairie generator #2 to about 350 megawatts.

An outage of the Bain–Kenosha 138-kV line will result in the Albers–Kenosha 138-kV line loading to 97.8 percent of its summer emergency rating.



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Loading issues on the Arcadian–Waukesha 138-kV lines and Arcadian transformers under contingency conditions get worse when compared to 2014. Increasing line clearances and replacing the two smaller transformers are potential solutions. Running generation at Concord and Germantown provides relief.

An outage of the Oak Creek–Pennsylvania 138-kV line will cause the Branch–Kansas 138-kV line (100.5 percent) to exceed its summer emergency ratings. Increasing line conductor clearances on the Branch–Kansas 138-kV line will provide relief.

A low probability bus outage at Burlington 138-kV bus will result in marginal 138-kV bus voltages at Tichigan (91.4 percent).

An outage of the Bark River – Sussex 138-kV line causes the Bark River 138-kV bus voltage to drop to 91.8 percent.

An outage of the Maple – Saukville 138-kV line causes the Germantown (88.7 percent) and Maple (88.2 percent) 138-kV bus voltages to be constrained under NERC Category B requirements. Running generation at Germantown will provide relief.

Past studies have shown low bus voltages in eastern Jefferson, western Waukesha, and southern Washington counties, all areas where load growth has been and is expected to remain high. To provide relief, a new 345-kV line connecting the Madison area with the Milwaukee area is being considered. The components of the project could include:

- ❑ Construct a new 345/138-kV Mill Road Substation (formerly known as Lannon Junction) at the intersection of the Cypress–Arcadian 345-kV line, the Arcadian–Granville 345-kV line, Germantown–Bark River 138-kV line and Sussex–Tamarack 138-kV line. This project will improve the 138-kV voltage profile in the area and facilitate expansion of the 345-kV network to the west of this substation. A 500 MVA, 345/138-kV transformer will be installed.
- ❑ Construct a Rockdale–Concord 345-kV line adjacent to the existing Rockdale–Jefferson–Concord 138-kV line on existing double-width right-of-way and install a 500 MVA, 345/138-kV transformer at Concord.
- ❑ Convert the Bark River–Mill Road 138-kV line (currently built to 345-kV standards) to 345-kV operation and install a 500 MVA, 345/138-kV transformer at Bark River.
- ❑ Construct a new 345-kV line from Concord to Bark River.

In addition to improving the voltage profiles in Jefferson, Waukesha and Washington counties, reducing loadings on parallel 138-kV circuits and reducing system losses, the above reinforcements will improve ATC’s existing east-west transfer capability in this region. Such a project is not being proposed in this Assessment, but may be justified in future Assessments for analysis beyond the current 10-year horizon. Potential economic benefits will need to be reviewed as the future develops.



Provisional projects to install 2-32 MVAR of capacitance at the Mukwonago Substation and upgrading the Oak Creek-Pennsylvania 138-kV line are being considered in the 2015-2019 timeframe in order to address remaining voltage and thermal issues.

*Projects whose "Need date" precedes the "In-service date"*

- None

*Projects whose "In-service date" precedes the "Need date"*

- None

### Zone 5 - 2019 futures study results

Two potential 2019 futures were studied as part of this Assessment:

- 20% Wind Future
- Slow Growth Future

Please refer to the [Methodology & Assumptions](#) for details about how the futures models were developed.

In the 20% Wind Future, line overloads and bus voltages generally improve in Zone 5. However, bus voltages worsen in the Germantown area. Additionally, the Arcadian transformer overload worsens. Future projects and/or increasing area generation mitigates the situation(s). These results occur because of area generation dispatch and the associated change in the flow of power associated with the 20% Wind scenario. Please refer to [Table ZS-3a](#) for the limitations and performance criteria exceeded for these futures.

In the Slow Growth Future, line overloads and bus voltages generally improve throughout Zone 5. This result is consistent with the reduced loading and associated generation redispatch throughout the zone.

### Zone 5 – 2024 study results

Refer to [Table ZS-4](#) and [Figure ZS-20](#)

#### Summary of key findings

- Heavy load growth in Waukesha, Washington, Dodge and Jefferson counties will require voltage and load support. A new 345-kV line from Rockdale to Mill Road (formerly Lannon Junction) is one option being considered but not yet proposed to solve these problems.
- Voltage and thermal issues remain in Zone 5 under contingency conditions.

Ten 138-kV buses in Waukesha and Washington County experience low or marginal bus voltage under NERC Category A or TPL-001-0 conditions (intact system) in 2024. The buses are Bark River (94.8 percent), Chinook (95.2 percent), Cooney (94.9 percent), Cottonwood (94.1 percent), Edgewood (95.2 percent), Glacier (95.9 percent), Hartford (95.5 percent), Merrill Hills (95.1 percent), Mukwonago (95.0 percent), St. Lawrence (95.9 percent), Arthur Road (95.8 percent), and





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Summit (94.6 percent). Installing capacitor banks at Summit and Mukwonago will help alleviate these voltage issues.

Following are the results of the 2024 contingency analysis (NERC Category B or TPL-002-0 conditions) performed on Zone 5.

The Oak Creek–Pennsylvania 138-kV line will load to 99.0 percent of its summer normal rating under intact system conditions. Under a number of contingencies, the line will approach or exceed its summer emergency rating.

Contingencies in eastern Jefferson and western Waukesha Counties create voltage issues at numerous locations in northern Waukesha and southern Washington Counties. Running generation at Concord and Germantown as well as capacitor additions at Summit, Concord, Mukwonago, and Bluemound should improve voltage profiles.

An outage of the Saukville–Fredonia 138-kV line will cause the bus voltage at Fredonia to drop to 91.9 percent.

Low probability bus outages at Pleasant Prairie, Oak Creek, and Burlington continue to create thermal and voltage problems as described in 2010 and 2014.

An outage of the Bain–Kenosha 138-kV line will cause the Albers–Kenosha 138-kV line to exceed its summer emergency rating by 1.3 percent.

Contingencies on 138-kV lines terminating at Oak Creek create thermal and voltage issues in southern Milwaukee County. Possible solutions are being developed.

Thermal issues in the Arcadian – Waukesha area continue. Solutions have been described above.

An outage of the Edgewood – St. Martins 138-kV line will result in low voltages at Edgewood (90.1 percent), Chinook (90.1 percent), and Mukwonago (91.6 percent).

An outage of the Pleasant Valley–Saukville 138-kV line will result in marginal voltages (91.5 percent) at the Pleasant Valley 138-kV bus.

In the previous 2019 results section, a potential Rockdale–Mill Road 345-kV line was discussed as a way improving bus voltages in Waukesha, Washington, and Jefferson Counties. Through 2019, the ATC planning models indicated there is generation available at Concord and Germantown that could provide support to the three county region. At some point between 2019 and 2024, all of the generation at Concord and Germantown will be dispatched. Dispatching generation at Concord and Germantown has been able to provide voltage and thermal relief. When all the generation has been dispatched, no additional relief will be available and it will be time to consider other system improvements to provide relief.

*Projects whose “Need date” precedes the “In-service date”*

None



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*Projects whose "In-service date" precedes the "Need date"*

None

### *Summary of Compliance with NERC Standards*

The mitigation plans, planned, proposed and provisional projects identified for Zone 5 in this Assessment will allow the ATC system in Zone 5 to meet NERC standards TPL-001, TPL-002, TPL-003 and TPL-004 in each of the four years 2010-2014, and for the 2015-2019 planning horizon.

TABLE ZS-1

## PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2010 Summer Peak, Shoulder and E-W Bias Cases

Planning Zone	Criteria Exceeded/Need	2010 Summer Peak Case		2010 Shoulder Case		2010 E-W Bias Case		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
1	Petenwell, Big Pond, Necedah, Whistling Wings, ACEC Dellwood, Friendship, ACEC Friendship 69-kV buses		89.5 - 91.9%		--		90.8 - 91.6%	Necedah Tap - Big Pond 69-kV line Petenwell - Big Pond 69-kV line Petenwell 138/69-kV transformer	Redispatch generation or McKenna capacitor expansion
1	Petenwell, Council Creek 138-kV bus		90.5 - 91.4%		--		91.3%	Saratoga - Petenwell 138-kV line	Monroe County – Council Creek 161-kV line
1	Harrison 69-kV bus		--		105.0%		--	System Intact	Take Harrison 69-kV capacitor out of service
1	Whitcomb 115-kV bus		--		--		105.5%	System Intact	Take Badger 138-kV capacitor out of service
1	Caroline 115-kV bus		105.1%		105.1%		105.6%	System Intact	Take Badger 138-kV capacitor out of service
1	Coloma 69-kV bus		91.9%		--		--	Chaffee Creek - Coloma Tap 69-kV line	
1	Metomen 138/69-kV transformer #31	93.0% - 100.2%		--		--		System Intact North Randolph - Markesan Tap 69-kV line North Fond du Lac - Rosendale 69-kV line Sunset Point - Winneconne 69-kV line	Metomen transformer replacement
1	Petenwell 138/69-kV transformer #31	89.0%		--		--		System Intact	
1	Whitcomb 115/69-kV transformer #31	91.0%		--		--		System Intact	
1	Castle Rock - ACEC Quincy 69-kV Line	96.2%		--		--		Petenwell - Big Pond 69-kV line Petenwell 138/69-kV transformer #31 Necedah Tap - Big Pond 69-kV line	
2	Pine River - Straits 69-kV line Straits - Evergreen 69-kV line Straits - Evergreen 69-kV line	--		--		98.1 - 124.2%		Brevort - Lakehead 138-kV line Lakehead - Hiawatha 138-kV line Brevort - Straits 138-kV line Pine River - Evergreen 69-kV line Evergreen - Straits 69-kV line ATC_B2_9902	Rebuild Straits-Pine River 69-kV lines
2	Straits - McGulpin 138-kV line #3	--		--		100.2%		Straits - McGulpin 138-kV line #1	Uprate Straits - McGulpin 138-kV line #3
2	Straits - McGulpin 138-kV line #1	--		--		100.3%		Straits - McGulpin 138-kV line #3	Uprate Straits - McGulpin 138-kV line #1
2	Nordic - Mountain 69-kV line	--		107.9%		--		Chandler 138/69-kV transformer #1	Uprate Nordic-Mountain 69-kV line
2	Delta – Mead 69-kV line	99.0 - 157.1 %		102.0 - 108.7%		112.4 - 140.8%		System Intact Chandler-Lakehead Tap 69-kV line Lakehead Tap-Masonville 69-kV line Masonville-Gladstone 69-kV line Gladstone-North Bluff 69-kV line North Bluff-Bay Tap 69-kV line Bay Tap-Mead 69-kV line	Uprate Delta – Mead 69-kV line, Increase generation at Mead/Gladstone
2	Chandler – Delta 69-kV #1 line	106.5%		117.1%		--		Chandler-Delta 69-kV #2 line	Uprate Chandler – Delta 69-kV #1 line

TABLE ZS-1

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2010 Summer Peak, Shoulder and E-W Bias Cases

Planning Zone	Criteria Exceeded/Need	2010 Summer Peak Case		2010 Shoulder Case		2010 E-W Bias Case		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
2	Chandler – Delta 69-kV #2 line	101.7%		111.7%		--		Chandler-Delta 69-kV #1 line	Uprate Chandler – Delta 69-kV #2 line
2	Atlantic – M38 69-kV line	117.5 - 118.1%		95%		115.3 - 115.4%		Atlantic 138/69-kV transformer #1 Atlantic - M-38 138-kV line ATC_B2_ATLAN (both of the above)	Uprate Atlantic – M38 69-kV line
2	Chandler – Lakehead Tap 69-kV line Masonville – Lakehead Tap 69-kV line Masonville – Gladstone 69-kV line Gladstone – North Bluff 69-kV line North Bluff – Bay Tap 69-kV line Mead – Bay Tap 69-kV line	119.1 - 159.0%		97.3 - 107.3%		106.3 - 142.0%		Delta - Mead 69-kV line	Uprate Chandler-Masonville, Masonville-Gladstone, Gladstone-North Bluff, North Bluff-Mead 69-kV lines
2	Lakota Road 69-kV bus		--		--		105.4% - 118.5%	System Intact Conover - Lakota 69-kV line	Adjust 138/69-kV transformer taps at Lakota Road
2	Engadine, Straits, St. Ignace, Hiawatha, Manistique, Valley, Glen Jenks, Indian Lake, Evergreen 69-kV buses		--		105.2% - 105.5%		105.1% - 105.8%	System Intact	Adjust 138/69-kV transformer taps at Indian Lake, Hiawatha, and Straits
2	WE-Greenstone, Barnum Tap, Barnum Sub, Humboldt Tap, Foundry, North Lake 69-kV buses		--		105.3 - 105.5%		--	System Intact	Adjust 138/69-kV transformer taps at North Lake
2	Munising, Alger, Alger Delta Hiawatha 69-kV buses		--		105.1 - 105.5%		--	System Intact	Adjust 138/69-kV transformer taps at Munising
2	Cornell Tap, Delta, Escanaba 1, Escanaba 2, Masonville, Mead, Gladstone, West Tap, West, Lakehead Tap, Lakehead, Bay Tap, Bay View, North Bluff, Cornell, Harris, Harris Tap 69-kV buses		90.5 - 91.9%		88.3 - 91.5%		--	Chandler 138/69-kV transformer #1	Increase local generation at Gladstone/Mead/Escanaba
2	Engadine, Newberry, Newberry Hospital, Newberry Hospital Tap, Newberry Village, Louisiana Pacific, Roberts, Hulbert, Eckerman, Raco, Talentino, Talentino 6950, Goetzville, Brimley, DeTour 69-kV buses		71.8 - 91.6%		--		--	Hiawatha – Engadine 69-kV line	Increase generation at Newberry, Dafter, DeTour, US Hydro, Edison Sault
2	Straits, Brevort, Lakehead, Hiawatha 138-kV buses		89.3 - 91.1%		--		--	Livingston – Emmett 138-kV line	Increase generation at Newberry, Dafter, DeTour, US Hydro, Edison Sault
2	Atlantic 138-kV bus		88.0%		--		89.0%	Atlantic-M38 138-kV line	Adjust 138/69-kV transformer taps at Atlantic

TABLE ZS-1

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2010 Summer Peak, Shoulder and E-W Bias Cases

Planning Zone	Criteria Exceeded/Need	2010 Summer Peak Case		2010 Shoulder Case		2010 E-W Bias Case		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
3	No criteria limits exceeded or constraints	--	--	--	--	--	--	System Intact	
3	Hubbard and Hustisford 138-kV buses		84.4 – 86.9%		86.6 – 87.3%		86.7 – 87.3%	Rubicon – Hustisford 138-kV line Hustisford – Hubbard 138 kV line	Local Operating Steps
3	Crawfish River 138-kV bus		91.4%		--		--	Jefferson – Crawfish River 138-kV line	Increase Concord generation
3	Verona - Sun Valley 69-kV line	110.9%-101.3%		--		101.3%		Stoughton - Stoughton South 69-kV line Kegonsa - Stoughton North 69-kV line Kegonsa 138/69-kV transformer #31	Y119 Verona-Oregon 69-kV line rebuild
3	McCue - Harmony - Lamar 69-kV line	98%-95.4%		--		--		Kegonsa - Stoughton North 69-kV line	Y61 McCue - Lamar line uprate
3	Fitchburg - Syene 69-kV line	109.6%		--		98.8%		Royster - AGA Tap 69-kV line	Uprate Fitchburg-Nine Springs line, uprate Pflaum - Royster line, install 2-16.33 MVAR 69 kV capacitor banks at Nine Springs and move the AGA load onto Femrite - Royster line
3	Royster - AGA Tap 69-kV line	106.7%		--		96.6%		Fitchburg - Syene 69-kV line	Uprate Fitchburg-Nine Springs line, uprate Pflaum - Royster line, install 2-16.33 MVAR 69 kV capacitor banks at Nine Springs and move the AGA load onto Femrite - Royster line
3	Verona 138-kV bus		90.1%		-		90.7%	Verona - Oak Ridge 138-kV line	Adjust Verona 138/69-kV transformer setting
3	Harmony, Lamar, Fulton and Saunders Creek 69-kV buses		87.8-91.9%		--		90.1-91.3%	McCue - Harmony 69-kV line Harmony - Lamar 69-kV line	Lamar 2-16.33 MVAR 69-kV capacitor banks
3	Huiskamp – Mendota - Ruskin 69-kV line	--		101.6%-97.7%		--		North Madison - Vienna 138-kV line Vienna - Yahara River 138-kV line Yahara River - American Center 138-kV line	Bypass the Mendota line switch as a short term solution; the 2011 Mendota Substation retirement project will remove the line switch limitation
3	Paddock – Townline 138-kV line	--		97%-95.2%		--		Blackhawk – Northwest Beloit Tap 138-kV line Northwest Beloit Tap – Paddock 138-kV line	Increase Rock River generation
4	Chalk Hills and Alger Delta Nathan 69-kV buses		105.1 – 105.8%		–		106.4 – 107.1%	System Intact	Modeling Corrections
4	Bell Plaine and Badger 115-kV buses		105.4%		–		105.7%	System Intact	Local Operating Steps
5	Germantown 138-kV bus		--		95.8%		--	System Intact	Run Germantown generation
5	Bain 345/138-kV transformer #5	158.5%		131.2%		158.6%		Pleasant Prairie 345-kV 3-4 bus tie	Reduce Pleasant Prairie #2 generation



**TABLE ZS-1**

**PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2010 Summer Peak, Shoulder and E-W Bias Cases**

Planning Zone	Criteria Exceeded/Need	2010 Summer Peak Case		2010 Shoulder Case		2010 E-W Bias Case		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
5	Albers – Bain 138-kV line	96.4%		--		101.6%		Bain-Kenosha 138-kV line	Upgrade Bain – Albers 138-kV line
5	Albers – Kenosha 138-kV line			114.6%		106.3%		Albers – Bain 138-kV line	Upgrade Albers – Kenosha 138-kV line
5	Oak Creek8 – Elm Road 345/230-kV transformer #884	101.8%		--		--		Oak Creek 230-kV 6-7 bus tie	Reduce Oak Creek generation on units 7 or 8.
5	Arcadian4- Waukesha1 138-kV line	98.8%		105.1%		114.9%		Arcadian6 – Waukesha3 138-kV line	Upgrade Arcadian – Waukesha 138-kV lines or investigate other alternatives
5	Arcadian 345/138-kV transformer #3	99.0%		95.1%		103.9%		Arcadian 345/138-kV transformer #1	Replace Arcadian transformers or investigate other alternatives
5	Arcadian 345/138-kV transformer #2	--		--		95.1%		Arcadian 345/138-kV transformer #1	Replace Arcadian transformers or investigate other alternatives
5	Hartford 138-kV bus		91.6%		--		--	Hartford – St. Lawrence 138-kV line	Increase Concord generation
5	Oak Creek8 – Elm Road 345/230-kV transformer #884	95.8		--		--		Oak Creek 230-kV 6-9 bus tie	Reduce Oak Creek generation on 6, 7, or 8
5	Harbor – Kansas 138-kV line	--		95.4% 96.3% 96.5% 99.3%		--		Montana – Dewey 138-kV line Dewey 138-kV bus Dewey – Norwich 138-kV line Kansas – Norwich 138-kV line	Replace 138-kV underground segment of the Kansas – Harbor 183kV line
5	Arcadian6 – Waukesha3 138-kV line	97.9%		104.2%		114.0%		Arcadian4 - Waukesha1 138-kV line	Upgrade Arcadian – Waukesha 138-kV lines or investigate other alternatives

**Table ZS-2  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2014 Summer Peak without Nelson Dewey, with Nelson Dewey, Shoulder, E-W Bias and High Load Cases**

Planning Zone	Criteria Exceeded/Need	2014 Summer Peak Case Without Nelson Dewey		2014 Summer Peak Case With Nelson Dewey		2014 Shoulder Case		2014 E-W Bias Case		2014 High Load Case		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal Voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
1	Fountain Valley, Redgranite, ACEC Spring Lake, Silver Lake 69-kV bus		91.3 - 91.7%		90.7 - 91.7%		--		--		90.0 - 91.1%	Wautoma - Silver Lake Tap 69-kV line	No project needed at this time
1	Dartford, Northwest, Ripon Industrial Park, Ripon, Southwest Ripon 69-kV bus		--		91.9%		--		--		91.0 - 91.8%	Metomen - Ripon 69-kV line Ripon - Northwest Ripon Tap 69-kV line	No project needed at this time
1	Winneconne 69-kV bus		--		--		--		--		91.5%	Sunset Point - Winneconne 69-kV line	No project needed at this time
1	Aurora Street 115-kV bus Antigo 115-kV bus		--		--		--		--		90.4 - 90.5%	Antigo - Black Brook 115-kV line	No project needed at this time
1	Petenwell, Big Pond, Necedah, Whistling Wings, ACEC Dellwood, Friendship, ACEC Friendship, Houghton Rock 69-kV buses		88.1 - 91.7%		87.8 - 91.5%		--		89.3 - 91.9%		87.3 - 91.9%	Petenwell 138/69-kV transformer #31 Petenwell - Big Pond 69-kV line Big Pond - Necedah Tap 69-kV line Necedah Tap - Whistling Wings Tap 69-kV line	McKenna capacitor bank expansion
1	Petenwell, Council Creek 138-kV buses		90.5% - 91.6%		90.3 - 91.4%		--		91.8%		95.4 - 95.6% 90.0 - 91.9%	System Intact Saratoga - Petenwell 138-kV line	Monroe County - Council Creek 161-KV line
1	Caroline 115/69-kV transformer #61	95.5%		--		--		--		101.6%		Whitcomb 115/69-kV transformer #31	No project needed at this time
1	Castle Rock - ACEC Quincy 69-kV line	96.1%		103.0%		--		--		97.5%		Petenwell 138/69-kV transformer #31 Petenwell - Big Pond 69-kV line Big Pond - Necedah Tap 69-kV line	Uprate Castle Rock - McKenna 69-KV line
1	Council Creek - Tomah Industrial Park Tap 69-kV line	97.7%		98.1%		--		--		--		System Intact	No project needed at this time
1	Northwest Ripon - Ripon 69-kV line	--		--		--		--		98.7%		Sunset Point - Winneconne 69-kV line	No project needed at this time
1	Whitcomb 115/69-kV transformer #31	--		--		--		--		96.4%		System Intact	No project needed at this time
1	Metomen 138/69-kV transformer #31	99.0 - 104.0%		103.3% 97.6%				100.8 - 107.4%		109.0%		System Intact North Fond du Lac - Rosendale Tap 69-kV line Metomen - Rosendale Tap 69-kV line North Randolph - Markesan Tap 69-KV line Sunset Point - Winneconne 69-KV line	Metomen transformer replacement

TABLE ZS-2

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2014 Summer Peak without Nelson Dewey, with Nelson Dewey, Shoulder, E-W Bias and High Load Cases

Planning Zone	Criteria Exceeded/Need	2014 Summer Peak Case Without Nelson Dewey		2014 Summer Peak Case With Nelson Dewey		2014 Shoulder Case		2014 E-W Bias Case		2014 High Load Case		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal Voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
2	DeTour, Goetzville, Talentino, Mich Limestone, Rockview, Magazine, Pickford, Talentino, Talentino 6950 69-kV buses Straits, Brevort, Lakehead, Hiawatha 138-kV buses		86.3 - 91.8%		89.2 - 91.9%		--		Did not converge		Did not converge	Livingston – Emmett 138-kV line	
2	Straits, Brevort, Lakehead, Hiawatha 138-kV buses		90.1 - 92.0%		--		--		Did not converge		Did not converge	Keystone – Ludington 345-kV line	
2	Pine River - Straits 69-kV, Straits-Evergreen 69-kV, Pine River-Evergreen 69-kV lines	--		--		--		96.2 -135.8%		--		Brevort - Lakehead 138-kV Line Lakehead - Hiawatha 138-kV Line Brevort - Straits 138-kV Line Pine River - Evergreen 69-kV Line Evergreen - Strait 69-kV line ATC_B2_9902	Rebuild Straits-Pine River 69 kV lines
2	Straits - McGulpin 138-kV line #3	--		--		--		112.6%		--		Straits - McGulpin 138-kV line #1	Uprate Straits - McGulpin 138-kV line #3
2	Straits - McGulpin 138-kV line #1	--		--		--		112.6%		--		Straits - McGulpin 138-kV line #3	Uprate Straits - McGulpin 138-kV line #1
2	Delta – Mead 69-kV line	100.0 - 157.2%		100.0 - 158.0%		--		112.7 - 141.8%		105.8 - 165.2%		System Intact Chandler - Lakehead Tap 69-kV line Lakehead Tap - Masonville 69-kV line Masonville - Gladstone 69-kV line Gladstone - North Bluff 69-kV line North Bluff - Bay Tap 69-kV line Bay Tap - Mead 69-kV line	Uprate Delta - Mead 69-kV line, increase generation at Mead/Gladstone
2	Chandler – Delta 69-kV #1 line	108.1%		108.1%		117.9%		95.7%		97.9 - 117%		Chandler - Delta 69-kV #2 line, Chandler - Lakehead Tap 69-kV line	Uprate Chandler - Delta 69-kV line #1
2	Chandler – Delta 69-kV #2 line	102.6%		102.4%		112.6%				111.7%		Chandler - Delta 69-kV #1 line	Uprate Chandler-Delta 69-kV line #2
2	Atlantic – M38 69-kV line	117.6 - 118.2%		118.2 - 118.8%		96.3%		116.8%		119.7 - 120.0%		Atlantic - M-38 138-kV line, Atlantic 138/69-kV transformer #1, Both	Uprate Atlantic-M38 69-kV line or increase local generation at Portage
2	Chandler - Lakehead Tap, Lakehead Tap - Masonville, Masonville - Gladstone, Gladstone - North Bluff, North Bluff - Bay Tap, Bay Tap - Mead 69-kV lines	120.2 - 160.5%		120.3 - 160.7%		98.0 - 108.3%		106.8 - 142.6%		128.4 - 171.4%		Delta-Mead 69-kV line	Uprate Chandler-Masonville, Masonville-Gladstone, Gladstone-North Bluff, North Bluff-Mead 69-kV lines; increase generation at Mead/Gladstone
2	Nordic – Mountain 69-kV line	110.8%		--		106.1%		--		119.7%		Chandler 138/69-kV transformer #1	Uprate Nordic-Mountain 69-kV line
2	Ontonagon - UPPSCO Tap 69-kV line	--		--		--		--		105.9% - 106.9%		Victoria - Rockland Junction 2 69-kV, Rockland Junction 2 - Rockland 69-kV, Rockland - Mass 69-kV lines	Uprate Ontonagon - UPPSCO Tap 69-kV line Reduce generation at White Pine Mine/Victoria Hydro
2	New Quinnesec - Kingsford Tap 69-kV line	--		--		--		--		95.2 - 95.3%		Twin Falls North-Twin Falls South Twin Falls South-Bass Lake 69-kV lines	Uprate New Quinnesec -Kingsford Tap 69-kV line
2	WE-Greenstone, Barnum Tap, Barnum Sub, Humboldt Tap, Foundry, North Lake 69-kV buses		--		--		105.0 - 105.6%		--		---	System Intact	Adjust 138/69-kV transformer taps at North Lake

TABLE ZS-2

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2014 Summer Peak without Nelson Dewey, with Nelson Dewey, Shoulder, E-W Bias and High Load Cases

Planning Zone	Criteria Exceeded/Need	2014 Summer Peak Case Without Nelson Dewey		2014 Summer Peak Case With Nelson Dewey		2014 Shoulder Case		2014 E-W Bias Case		2014 High Load Case		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal Voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
2	Straits, St Ignace, Manistique, Valley, Glen Jenks, Indian Lake, Evergreen 69-kV buses		--		--		105.1 - 105.6%		104.7 - 105.4%		--	System Intact	Adjust 138/69-kV transformer taps at Indian Lake, Hiawatha, and Straits
2	Lakota Rd 115-kV bus		--		--		105.2%		105.0%		--	System Intact	Adjust 138/69-kV transformer taps at Lakota Road
2	Hiawatha, Lakehead, Brevort 138-kV buses		--		--		--		88.8 % - 92.0%		--	Morgan - Highway 22 345-kV line Morgan - Plains 345-kV line Remove Weston Unit 4, Livingston - Vanderbilt 138-kV line Riggsville - Rondo 138-kV line McGulpin - Oden 138-kV line, Remove Kewaunee unit 1, Gallagher - Gallagher Tap, Gallagher - Livingston, Gallagher - Tittabawassee 345-kV lines	Adjust 138/69-kV transformer taps at Hiawatha
2	Atlantic 138-kV bus		--		--		105.8%		--		--	System Intact	Reduce capacitor bank MVAR at Atlantic 69 kV bus
2	Centennial Mine, Centennial Tap, MTU, Osceola, Henry Sub, Henry Tap 69-kV buses		--		--		--		--		90.8 - 91.7%	Atlantic - M38 138-kV line Atlantic 138/69-kV transformer #1	Increase generation at Portage
2	Aspen, Iron Grove 138-kV buses		--		--		--		--		91.0%	Aspen - Plains 138-kV Line	Adjust 138/69-kV transformer taps at Aspen, Iron Grove
2	Iron Grove 138-kV bus		--		--		--		--		91.2 - 91.5%	Aspen - Iron Grove 138-kV Line	Adjust 138/69-kV transformer taps at Iron Grove
2	Lakehead, Strawberry Hill, Strawberry Hill Tap, Iron Grove 69-kV buses		--		--		--		--		91.7 - 91.9%	Iron Grove 138/69-kV transformer #G1	Add second Iron Grove 138/69-kV transformer
2	Land O Lakes, Conover, Lakota Road 69-kV buses		--		--		90.5 - 90.9%		--		--	Conover-Lakota 69-kV line, Lakota Road 138/69-kV transformer #G2	Utilize available capacitance at Conover
2	Lakota Road 69-kV, 115-kV buses		110.3 - 118.8%		110.1 - 118.8%		--		--		117.4%	Eagle River Muni - Lakota Road 115-kV line Eagle River Muni - Cranberry 115-kV line	Adjust 138/69-kV transformer taps, 138-kV capacitor banks at Lakota Road
2	Chandler, Delta, West Side, Escanaba 1, Escanaba 2, Masonville, Mead, Gladstone, West, Lakehead Tap, Lakehead, Bay View, North Bluff, Cornell, Harris, Harris Tap 69-kV buses		89.0 - 91.9%		89.2 - 91.2%		88.3 - 91.5%		--		87.0 - 90.4%	Chandler 138/69-kV transformer #1	Increase generation at Mead/Gladstone/Escanaba
2	Newberry Village, Louisiana Pacific, Newberry, Newberry Hospital, Roberts, Hulbert, Eckerman, Raco, Brimley, Goetzville 69-kV buses		80.0 - 91.8%		80.6 - 91.8%		80.6 - 91.9%		Did not converge 87.1 - 91.8%		80.4 - 92.0%	Hiawatha - Engadine 69-kV line, Engadine-Newberry 69-kV line, Newberry - Newberry Village 69-kV line	Increase generation at Newberry, Dafter, DeTour, US Hydro, Edison Sault

TABLE ZS-2

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2014 Summer Peak without Nelson Dewey, with Nelson Dewey, Shoulder, E-W Bias and High Load Cases

Planning Zone	Criteria Exceeded/Need	2014 Summer Peak Case Without Nelson Dewey		2014 Summer Peak Case With Nelson Dewey		2014 Shoulder Case		2014 E-W Bias Case		2014 High Load Case		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal Voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
2	DeTour, Goetzville, Talentino 6906, Mich Limestone, Rockview 69-kV buses Brevort, Lakehead, Hiawatha 138-kV buses		--						89.4 - 92.0%		--	Brevort - Straits 138-kV line Brevort - Lakehead 138-kV line Hiawatha - Lakehead 138-kV line, Remove US Hydro Unit 1	Increase generation at Newberry, Dafter, DeTour, US Hydro, Edison Sault
2	Atlantic 138-kV bus		87.2%		87.0%		--		88.4%		84.8%	Atlantic-M-38 138-kV line	Adjust taps at Atlantic 138/69-kV transformer #1
3	Kirkwood - Rock Springs 138-kV line	--		--		--		--		95.1%		Trienda – Lewiston ACEC 138-kV line	No project needed at this time
3	Kilbourn 138/69-kV transformer #1	--		--		--		100.3%		--		Kilbourn 138/69-kV transformer #2	
3	Fitchburg –Syene - Ninesprings 69-kV line	114.9 - 96%		115 - 96.1%		--		103.2%		120.8 - 100.8%		Royster - AGA Tap 69-kV line; AGA Tap - Pflaum 69-kV line	Uprate Fitchburg-Nine Springs line, uprate Pflaum - Royster line, install 2-16.33 MVAR 69 kV capacitor banks at Nine Springs and move the AGA load onto Femrite - Royster line
3	Royster-AGA Tap-Pflaum 69-kV line	112.6 - 98.2%		112.6 - 98.3%		--		101.1 - 96.9%		118.3 - 96.8%		Fitchburg - Syene 69-kV line	Uprate Fitchburg-Nine Springs line, uprate Pflaum - Royster line, install 2-16.33 MVAR 69 kV capacitor banks at Nine Springs and move the AGA load onto Femrite - Royster line
3	Dana – Sheepskin 69-kV line	104.7 - 100%		104.7 - 100%		--		--		111.3 - 107.2%		McCue - Harmony 69-kV line; Harmony - Lamar 69-kV line	Sheepskin substation project which will uprate Y-61 Sheepskin-Dana 69-kV line to 95 MVA SE
3	McCue – Harmony - Lamar 69-kV line	104.0 - 95.4%		103.0 - 96.4%		--		--		112.2 - 97.6%		Kegonsa - Stoughton North 69-kV line ; Kegonsa 138/69-kV transformer; Stoughton North - Stoughton East 69-kV line	Y61 McCue-Lamar line uprate
3	Harmony, Lamar, Fulton, Saunders Creek, Dana, Sheepskin, Evansville 69-kV buses		84.2 -91.9%		84.3 -91.9%		--		88 -91.7%		83.1 -91.3%	McCue - Harmony 69-kV line; Harmony - Lamar 69-kV line	Lamar 2-16.33 Mvar 69-kV capacitor banks
3	Verona 138-kV bus		89.1%		89.0%		--		90.1%		88.5%	Verona - Oak Ridge 138-kV line	Lock the Verona 138/69-kV transformer setting at 1.0 to achieve 98%
3	Brodhead Muni 3, Brodhead Muni 2, Brodhead Muni 1, Brodhead and REC Orfordville 69-kV buses		91 - 91.8%		91 - 91.8%		--		--		89.4 - 91.7%	Brodhead Switching Station- Brodhead Muni 3 69-kV line; Brodhead Muni 3-Brodhead Muni 2 69-kV line	Install a 138/69-kV transformer at Bass Creek Substation
3	Muscoda 69-kV bus		--		91.9%		--		--		91.8%	Lone Rock-Spring Green 69-kV line	Install 1-8.16 MVAR capacitor bank at Boscobel 69-kV Substation and upgrade existing 5.4 MVAR bank with an 8.16 MVAR bank
3	AGA, Pflaum 69-kV buses		91.9%		91.8 - 91.9%		--		--		91.4 - 91.5%	Royster-AGA Tap 69-kV line	Loop Ninesprings-Pflaum line in and out of Femrite
3	Paddock-Townline 138-kV line	--		--		97.8 – 96.0%		--		--		Paddock-Northwest Beloit Tap 138-kV line; Northwest Beloit Tap-Black Hawk 138-kV line	Possible mitigation is to dispatch Riverside generation



**TABLE ZS-2**  
**PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2014 Summer Peak without Nelson Dewey, with Nelson Dewey, Shoulder, E-W Bias and High Load Cases**

Planning Zone	Criteria Exceeded/Need	2014 Summer Peak Case Without Nelson Dewey		2014 Summer Peak Case With Nelson Dewey		2014 Shoulder Case		2014 E-W Bias Case		2014 High Load Case		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal Voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
3	Rockdale - Wempletown 345-kV line	--		--		98.0%		--		--		Wempletown - Paddock 345-kV line	Possible mitigation is to dispatch Riverside generation
3	McCue – Harmony - Lamar 69-kV line	--		--		--		--		95.8%		System Intact	Construct double-circuit line between McCue and Lamar substations
3	North Monroe - Idle Hour 69-kV line	--		--		--		--		97.1%		Paddock - Newark 69-kV line	Install a 138/69-kV transformer at Bass Creek Substation
3	Stoughton - Sheepskin 69-kV line	--		--		--		--		99.2%-95.6%		McCue - Harmony 69-kV line; Harmony - Lamar 69-kV line	Construct double-circuit line between McCue and Lamar substations
3	Gran Grae – Wauzeka - Boscobel 69-kV line	--		--		--		--		95.7%-95.4%		Spring Green - Lone Rock 69-kV line	Uprate Y-40 Gran Grae-Boscobel 69-kV line to achieve a 99 MVA summer emergency rating
3	West Middleton - Timberlane 69-kV line	--		--		--		--		98.3%		Spring Green 138/69-kV transformer #31	Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating
3	Waunakee Switching Station - Waunakee 2 69-kV line	--		--		--		--		96.3%		West Middleton - Pheasant Branch 69-kV line	Potential Waunakee Switching Station-Waunakee 2 69-kV 0.58 miles of line (Y-131) and terminal uprate to achieve 115 MVA SE
3	Academy – Columbus Muni #3 Tap 69-kV line	95.0 – 99.7%		98.4 – 102.8%		--		98.3%	--	98.6%		North Randolph – Fox Lake 138-kV line Fox Lake – North Beaver Dam 138-kV line	Model corrections
3	Columbus Muni #3 Tap – Columbus 69-kV line	98.1%		96.8 – 101.2%		--		96.8%	--	96.9%		North Randolph – Fox Lake 138-kV line Fox Lake – North Beaver Dam 138-kV line	Model corrections
3	Koch Oil Tap – Waupun 69 kV line	--		--		--		--		99.3%		North Randolph – Fox Lake 138-kV line	Horicon – East Beaver Dam 138 kV line project
3	Koch Oil Tap – South Fond du Lac 69 kV line	--		--		--		--		98.5%		North Randolph – Fox Lake 138-kV line	Horicon – East Beaver Dam 138 kV line project
3	Hubbard and Hustisford 138-kV buses		86.4 – 90.8%		86.0 – 90.2%		86.6 – 86.9%		86.4 – 87.1%		85.8 – 86.3%	Rubicon – Hustisford 138-kV line Hustisford – Hubbard 138-kV line Hartford – St. Lawrence 138-kV line	Local operating steps
3	Fox Lake, North Beaver Dam and East Beaver Dam 138-kV buses		--		88.9 – 90.0%		--		--		--	North Randolph – Fox Lake 138-kV line	Local operating steps
3	Fort Atkinson 138-kV bus		91.9%		91.6%		--		--		--	Jefferson – Lakehead – Rockdale 138-kV line	Increase generation at Concord
3	Concord 138-kV bus		95.5% 91.6%		95.3% 91.2% 91.9%		--		--		--	System Intact Jefferson – Crawfish River 138-kV line Hartford – St. Lawrence 138-kV line	Increase Concord generation Install Concord capacitors
3	Rubicon 138-kV bus		91.0%		90.4%		--		--		--	Hartford – St. Lawrence 138-kV line	Increase Concord generation Install Concord capacitors
3	Lake Geneva 69-kV bus		91.9%		91.9%		--		--		90.9%	North Lake Geneva – Lake Geneva 69-kV line	Spring Valley – Twin Lakes line
3	Twin Lakes 69-kV bus		--		--		--		--		91.4%	North Lake Geneva – Lake Geneva 69-kV line	Spring Valley – Twin Lakes line
3	Dickinson 138-kV bus		91.5%		91.6%		--		91.3%		91.1%	Colley Road – Dickinson 138-kV line	Brick Church capacitors
3	Brick Church 138-kV bus		--		--		--		91.9%		91.8%	Colley Road – Dickinson 138-kV line	Brick Church capacitors
3	Crawfish River 138-kV bus		90.2%		89.8%		--		91.7%		--	Jefferson – Crawfish River 138-kV line	Increase Concord generation
3	South Lake Geneva 69-kV bus		--		--		--		--		91.5%	North Lake Geneva – Lake Geneva 69-kV line	Spring Valley – Twin Lakes line

**TABLE ZS-2**  
**PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2014 Summer Peak without Nelson Dewey, with Nelson Dewey, Shoulder, E-W Bias and High Load Cases**

Planning Zone	Criteria Exceeded/Need	2014 Summer Peak Case Without Nelson Dewey		2014 Summer Peak Case With Nelson Dewey		2014 Shoulder Case		2014 E-W Bias Case		2014 High Load Case		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal Voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
3	Lake Geneva – South Lake Geneva 69-kV line	99.0%		98.9%		--		--		104.3%		Cobblestone – Brick Church 69-kV line	Spring Valley – Twin Lakes line
3	Cobblestone – Zenda Tap 69-kV line	--		--		--		--		98.7%		North Lake Geneva – Lake Geneva 69-kV line	Spring Valley – Twin Lakes line
3	Williams Bay, Bristol, Delavan, North Shore, Rock River, Blackhawk, Paddock, Colley Road, Dickinson, Brick Church, Elkhorn 69-kV buses		--		--		92.0 – 91.0%		--		--	Paddock 345/138-kV transformer #21	
3	Colley Road 138/69-kV transformer #31	--		--		--		--		95.7%		Paddock 138/69-kV transformer #31	Install Bass Creek transformer
4	Chalk Hills and Alger Delta Nathan 69-kV buses		--		--		105.8 – 106.3%		--		--	System Intact	Model corrections
4	Bell Plaine 115-kV bus		--		--		105.3%		--		--	System Intact	Local operating steps
5	Harbor – Kansas 138-kV line	--		--		107.3% 107.1% 106.1% 103.3% 102.3% 99.2%		--		--		Dewey – Norwich 138-kV line Split Dewey 138-kV bus Montana – Dewey 138-kV line Kansas – Norwich 138-kV line Montana – Valley 138-kV line Harbor – Norwich 138-kV line	increase Valley generation
5	Arcadian4-Waukesha1 138-kV line	113.8%		115.7%		118.5%		131.1%		112.9%		Arcadian 6–Waukesha3 138-kV line	Upgrade Arcadian – Waukesha 138-kV lines or investigate other alternatives
5	Arcadian transformer #3 Arcadian transformer #2	106.9% 96.9%		108.1% 97.4%		99.8%		111.7% 102.8%		109.5% 98.2%		Arcadian transformer #1	Replace Arcadian transformers or investigate other alternatives
5	Pleasant Valley 138-kV bus		--		91.8%		--		--		--	Pleasant Valley – Saukville 138-kV line	Increase Concord generation
5	Arcadian6 – Waukesha3 138-kV line	112.9%		114.8% 96.7%		117.6% 105.6%		130.1% 114.2%		111.9%		Arcadian4- Waukesha1 138-kV line Waukesha 138-kV 1-2 bus tie	Upgrade Arcadian – Waukesha 138-kV lines or investigate other alternatives
5	Bain 345/138-kV transformer #5	158.9% 100.5%		158.9% 98.9% 95.3%		147.0%		158.8%		159.2% 99.8% 96.8%		Pleasant Prairie 345-kV 3-4 bus tie Pleasant Prairie 345-kV 2-3 bus tie Bain 345/138-kV transformer #4	Reduce Pleasant Prairie generation
5	Bain 345/138-kV transformer #4	--		--		--		--		96.0%		Bain 345/138-kV transformer #5	Reduce Pleasant Prairie generation
5	Albers – Bain 138-kV line	112.5%		114.0%		102.9% 96.2%		116.6%		115.4%		Bain - Kenosha 138-kV line Albers – Kenosha 138-kV line	Upgrade Bain – Albers 138-kV line
5	Albers – Kenosha 138-kV line	--		--		124.9%		112.8%		--		Albers – Bain 138-kV line	Increase Paris generation
5	Edgewood – St. Martins 138-kV line	--		--		102.0% 95.5% 97.2%		--		--		Merrill Hills - Waukesha 138-kV line Paris – Air Liquide - Burlington 138-kV line Paddock – Wempletown 345kV line	Increase Concord generation
5	Tichigan 138-kV bus		--		--		91.3%		--		--	Burlington 138-kV 1-2 bus tie	Increase University generation
5	Burlington 138-kV bus		--		--		91.6%		--		--	Burlington 138-kV 1-2 bus tie	Increase University generation
5	Germantown 138-kV bus		--		--		--		89.8%		--	Maple – Saukville 138-kV line	Increase Germantown generation
5	Maple 138-kV bus		--		--		--		89.4%		--	Maple – Saukville 138-kV line	Increase Germantown generation
5	Nicholson – Ramsey 138-kV line	--		--		--		95.0%		--		Oak Creek – Pennsylvania 138-kV line	Increase Germantown generation
5	Hartford 138-kV bus		90.0%		89.5%		--		--		--	Hartford – St. Lawrence 138-kV line	Increase Concord generation Install Concord capacitors
5	Butler Ridge 138-kV bus		90.5%		89.9%		--		--		--	Hartford – St. Lawrence 138-kV line	Increase Concord generation Install Concord capacitors
5	Cooney 138-kV bus		95.9% 91.5%		95.7% 91.0%		--		--		--	System Intact Cooney – Summit 138-kV line	Increase Concord generation Install Concord capacitors

**TABLE ZS-3  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2019 Summer Peak with Nelson Dewey and without Nelson Dewey**

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case without Nelson Dewey		2019 Summer Peak Case with Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
1	Berlin, River Run, Fountain Valley, Redgranite, ACEC Spring Lake, Silver Lake, Fox River 69-kV buses		86.8 - 91.9%		86.6 - 91.9%	Wautoma - Silver Lake Tap 69-kV line Silver Lake - ACEC Spring Lake 69-kV line ACEC Spring Lake - Redgranite 69-kV line Ripon - Northwest Ripon Tap 69-kV line Metomen - Ripon 69-kV line	Ripon capacitor bank expansion & Metomen transformer replacement
1	Dartford, Northwest Ripon, Industrial Park, Ripon, Southwest Ripon 69-kV buses		86.6 - 91.6%		86.5 - 91.8%	Ripon - Northwest Ripon Tap 69-kV line Metomen - Ripon 69-kV line Sunset Point - Winneconne 69-kV line Wautoma - Silver Lake Tap 69-kV line	Ripon capacitor bank expansion
1	Winneconne, Omro Industrial Park 69-kV buses		86.3 - 91.9%		85.7 - 91.9%	Sunset Point - Winneconne 69-kV line Ripon - Northwest Ripon Tap 69-kV line Metomen - Ripon 69-kV line Winneconne - Omro Tap 69-kV line	Ripon capacitor bank expansion, Metomen transformer replacement and Wautoma 2 <sup>nd</sup> transformer
1	Lincoln Pumping Station, Grand Marsh (PP&L), ACEC Brooks 69-kV buses		91.1 - 91.9%		90.7 - 91.8%	Necedah Tap - Big Pond 69-kV line Petenwell - Big Pond 69-kV line Petenwell 138/69 kV transformer	No project needed at this time
1	Sigel 138-kV bus		91.8%		91.8%	Sigel - Arpin 138-kV line	No project needed at this time
1	Petenwell, Council Creek 138-kV buses		94.6 - 95.0% 88.4 - 91.6%		94.5 - 94.8% 88.0 - 91.7%	System Intact Saratoga - Petenwell 138-kV line Sigel - Arpin 138-kV line	Monroe County – Council Creek 161-kV line
1	Baker, Saratoga 115-kV buses		91.6%		91.4%	Baker - Coyne 115-kV line	No project needed at this time
1	Petenwell, Big Pond, Necedah, Whistling Wings, ACEC Dellwood, Friendship, ACEC Friendship, Houghton Rock, McKenna 69-kV buses		84.0 - 91.1%		83.6 - 91.7%	Necedah Tap - Big Pond 69-kV line Petenwell - Big Pond 69-kV line Petenwell 138/69-kV transformer Necedah Tap – Whistling Wings Tap 69-kV line	McKenna capacitor expansion
1	ACEC Coloma 69-kV bus		--		91.9%	Chaffee Creek - Coloma Tap 69-kV line	No project needed at this time
1	Fairwater 69-kV bus		91.9%		91.8%	Metomen 138/69-kV transformer	No project needed at this time
1	Antigo, Aurora Street 115-kV buses		90.0 - 90.1%		90.0 - 90.2%	Antigo - Black Brook 115-kV line	No project needed at this time
1	Petenwell 138/69-kV transformer #31	98.1% 95.7%		99.8% 95.7%		System Intact McKenna - Houghton Rock 69-kV line	No project needed at this time
1	McKenna - ACEC Quincy 69-kV line Castle Rock - ACEC Quincy 69-kV line	97.8 - 113.8%		97.0 - 120.7%		Necedah Tap - Big Pond 69-kV line Petenwell - Big Pond 69-kV line Petenwell 138/69 kV transformer Necedah - Whistling Wings Tap 69-kV line Kilbourn - Winnebago ACEC 69-KV line	Uprate Castle Rock - McKenna 69-KV line
1	Caroline 115/69-kV transformer #61	109.0%		108.6%		Whitcomb 115/69-kV transformer #31	Reduce area capacitor banks and redispach area generation.

**TABLE ZS-3  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2019 Summer Peak with Nelson Dewey and without Nelson Dewey**

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case without Nelson Dewey		2019 Summer Peak Case with Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal Bus voltage		
1	Council Creek - Tomah Industrial Park Tap 69-kV line	103.5%		103.8%		System Intact	Monroe County – Council Creek 161-kV line
1	Harrison 138/69-kV transformer	--		99.9%		System Intact	No project needed at this time
1	Metomen - Ripon 69-kV line	98.4% 98.1 - 105.8%		93.0% 97.3 - 101.9%		System Intact Sunset Point - Winneconne 69-kV line North Randolph - Markesan Tap 69-kV line Winneconne - Omro Tap 69-kV line	Reconfigure the North Randolph-Ripon 69-kV line to form a second Ripon-Metomen 69-kV line and retire the circuit between Metomen and the Mackford Prairie tap
1	Metomen 138/69-kV transformer #31	113.6% 108.7 - 130.9%		111.7% 107.7 - 126.5%		System Intact Ripon - Southwest Ripon Tap 69-kV line Southwest Ripon - Mackford Prairie 69-kV line North Randolph - Markesan Tap 69-kV line North Fond du Lac - Rosendale 69-kV line	Metomen transformer replacement
1	Northwest Ripon - Ripon 69-kV line	101.3 - 113.4%		98.2 - 110.5%		Sunset Point - Winneconne 69-kV line Winneconne - Omro Tap 69-kV line	SW Ripon T-D interconnection
1	Omro - Winneconne 69-kV line Winneconne - Sunset Point 69-kV line	97.0 - 103.3%		95.4 - 107.5%		Ripon - Northwest Ripon Tap 69-kV line Metomen - Ripon 69-kV line	Load forecast variations
1	Rocky Run 345/115-kV transformer #4	95.9 - 97.1%		96.3 - 97.5%		Rocky Run 345/115-kV transformer #1 Rocky Run 345/115-kV transformer #2	No project needed at this time
1	Whitcomb 115/69-kV transformer #31	101.1%		101.6%		System Intact	Reduce area capacitor banks and redispach area generation
1	Wautoma 138/69-kV transformer #31	112.0% 95.6 - 99.8%		108.2% 95.2 - 99.2%		System Intact Portage - Lakehead Pipeline Portage 69-kV line Sand Lake Tap - Sand Lake 69-kV line Sand Lake 138/69-kV transformer #31 Endeavor - Lakehead Pipeline 69-kV line Ripon - Northwest Ripon Tap 69-kV line	Install a second 138/69-kV transformer at Wautoma Substation
2	Delta – Mead 69-kV line	101.0 – 158.1%		100.9 – 158.1%		System Intact Chandler-Lakehead Tap 69-kV line Lakehead Tap-Masonville 69-kV line Masonville-Gladstone 69-kV line Gladstone-North Bluff 69-kV line North Bluff-Bay Tap 69-kV line Bay Tap-Mead 69-kV line	Uprate Delta-Mead-North Bluff 69-kV line
2	Chandler-Delta 69-kV #1 line	109.5%		109.6%		Chandler-Delta 69-kV #2 line	Uprate Chandler-Delta 69-kV line #1
2	Chandler – Delta 69-kV #2 line	103.4%		103.4%		Chandler - Delta 69-kV #1 line	Uprate Chandler-Delta 69-kV line #2
2	Atlantic - M38 69-kV line	121.3 - 122.4%		121.9 - 122.0%		Atlantic - M-38 138-kV line Atlantic 138/69-kV transformer #1	Uprate Atlantic - M38 69-kV line

**TABLE ZS-3  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2019 Summer Peak with Nelson Dewey and without Nelson Dewey**

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case without Nelson Dewey		2019 Summer Peak Case with Nelson Dewey		Facility Outage(s)	Project or Mitigation
2	Chandler-Lakehead Tap 69-kV line Lakehead Tap-Masonville 69-kV line Masonville-Gladstone 69-kV line Gladstone-North Bluff 69-kV line North Bluff-Bay Tap 69-kV line Bay Tap-Mead 69-kV line	121.6 - 162.2%		121.4 - 162.0%		Delta - Mead 69-kV line	Uprate Chandler-Masonville, Masonville-Gladstone, Gladstone-North Bluff, Delta-Mead-North Bluff 69-kV lines
2	Pine River - Straits 69-kV line Straits-Evergreen 69-kV line Pine River-Evergreen 69-kV line	98.0 - 109.2%		96.1 - 106.5%		Brevort - Straits 138-kV line Brevort - Lakehead 138-kV line Hiawatha - Lakehead 139-kV line Straits - Evergreen 69-kV line	Rebuild Straits-Pine River 69 kV lines
2	Pine River-Rudyard 69-kV line Rudyard-Tone 69-kV line	97.3%		99.8% - 103.9%		Hiawatha - Engadine 69-kV line, Pine River - 9 Mile 69-kV line	Uprate or rebuild Pine River - Rudyard - Tone 69-kV line
2	Nordic - Mountain 69-kV line	111.4%		--		Chandler 138/69-kV transformer #1	Uprate Nordic-Mountain 69-kV line
2	New Quinnesec – Kingsford Tap 69-kV line	100.0% - 100.3%		99.7% - 99.9%		Twin Falls North -Twin Falls South 69-kV line Twin Falls South - Bass Lake 69-kV line	Uprate New Quinnesec - Kingsford Tap 69-kV line
2	Lakota 69-kV bus		117.1%		117.2%	Conover - Lakota 69-kV line	Adjust 138/69-kV transformer taps at Lakota Road
2	Chandler, Cornell Tap, Delta, Escanaba 1, Escanaba 2, Masonville, Mead, Gladstone, West, Lakehead, Bay View, North Bluff, Cornell, Harris 69-kV buses		88.4% - 91.4%		88.2% - 91.2%	Chandler 138/69-kV transformer #1	Increase generation at Escanaba/Mead/Gladstone
2	Hulbert, Eckerman, Newberry Village, Louisiana Pacific, Newberry, Newberry Hospital, Roberts, Raco 69-kV buses		78.9% - 91.9%		76.0% - 92.0%	Hiawatha-Engadine, Engadine-Newberry, Newberry-Newberry Hospital Tap, Newberry Hospital Tap-Roberts 69-kV lines	Increase generation at Newberry, Dafter, DeTour, US Hydro, Edison Sault
2	Atlantic 138-kV bus Keweenaw 69-kV bus		86.1 - 91.8%		86.0%	Atlantic-M-38 138-kV line ATC_B2_ATLAN	increase generation at Portage
2	Munising 138-kV bus		91.8%		91.8%	Forsyth-Munising 138-kV line	Adjust 138/69-kV transformer taps at Munising
2	Aspen, Iron Grove 138-kV buses		91.1% - 91.5%		91.0% - 91.3%	Aspen-Plains 138-kV line	Adjust 138/69-kV transformer taps at Aspen, Iron Grove
2	Iron Grove 138-kV bus		91.0%		91.3%	Aspen-Iron Grove 138-kV line	Adjust 138/69-kV transformer taps at Iron Grove
2	Lakehead 69-kV bus		91.9%		--	Iron Grove 138/69-kV transformer	Add second Iron Grove 138/69-kV transformer
3	Artesian - Rock Springs 138-kV line Rock Springs - Kirkwood 138-kV line	100.3 - 104.4%		99.0 - 103.4%		Trienda - Lewiston ACEC 138-kV line Lewiston - Kilbourn ACEC 138-KV line	Construct a Lake Delton-Birchwood 138-kV line
3	Dane - Lodi Tap 69-kV line	100.6%		100.9%		Island Street - Kirkwood 69-kV line	Rebuild Dane-Dam Heights 69-KV line
3	Portage – Trienda 138-kV line	96.1%		--		Portage – Trienda1 138-kV line	No project needed at this time.
3	Lake Geneva – South Lake Geneva 69-kV line	126.3% 104.7%		126.3% 104.8%		Cobblestone–Brick Church 69-kV line Cobblestone–Zenda Tap 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Katzenberg - South Lake Geneva 69-kV line	96.7%		96.7%		Cobblestone–Brick Church 69-kV line	Spring Valley – Twin Lakes line
3	Colley Road 138/69-kV transformer #31	103.6%		103.2%		Paddock 138/69-kV transformer #31	Install Bass Creek transformer
3	Enzyme – RC3 69-kV line	95.4%		--		Brick Church 138/69-kV transformer #31	Rebuild Y-32 Colley Road-Brick Church 69-kV line
3	Colley Road – Marine 138-kV line			99.6%		Paddock-Northwest Beloit 138-kV line	Upgrade Colley Road – Marine 138-kV line
3	Cobblestone – Brick Church 69-kV line	102.2%		102.2%		North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138kV line



**TABLE ZS-3  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2019 Summer Peak with Nelson Dewey and without Nelson Dewey**

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case without Nelson Dewey		2019 Summer Peak Case with Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
3	Cobblestone – Zenda Tap 69-kV line	123.3%		123.4%	95.0%	North Lake Geneva – Lake Geneva 69-kV line Lake Geneva – South Lake Geneva 69kV line	Spring Valley – Twin Lakes line
3	Katzenberg – Zenda Tap 69-kV line	109.5%		109.5%		North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Cobblestone 69-kV bus		89.9%		89.8%	Cobblestone–Brick Church 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Zenda 69-kV bus		91.4%		91.3%	North Lake Geneva-Lake Geneva 69-kV line Cobblestone–Brick Church 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
			90.9%		90.8%		
3	Brick Church 138-kV bus		91.2%		91.2%	Beloit Gateway–Dickinson 138-kV line Colley Road–Dickinson 138-kV line	Brick Church capacitors or Spring Valley – Twin Lakes line
			90.4%		90.5%		
3	Williams Bay 138-kV bus		91.9%		91.9%	Colley Road–Dickinson 138-kV line	Brick Church caps or Spring Valley – Twin Lakes line
3	Lake Geneva 69-kV bus		83.5%		83.5%	North Lake Geneva–Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Katzenberg 69-kV bus		85.1%		85.1%	North Lake Geneva–Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Twin Lakes 69-kV bus		84.4%		84.3%	North Lake Geneva–Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	South Lake Geneva 69-kV bus		84.2%		84.2%	North Lake Geneva–Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Dickinson 138-kV bus		89.4%		89.4%	Colley Road–Dickinson 138-kV line	Brick Church caps or Spring Valley – Twin Lakes line
3	Concord 138-kV bus		90.2%		89.7%	Concord 138-kV 4-5 bus tie	Install Concord capacitors
3	Butler Ridge 138-kV bus		--		91.7%	Concord 138-kV 4-5 bus tie	Install Concord capacitors
3	Rubicon 138-kV bus		91.9%		91.4%	Concord 138-kV 4-5 bus tie	Install Concord capacitors
3	Academy – Columbus Muni #3 Tap 69-kV line	--		106.7 – 112.2%		North Randolph – Fox Lake 138-kV line Fox Lake – North Beaver Dam 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	Columbus Muni #3 Tap – Columbus 69-kV line	--		104.9 – 100.4%		North Randolph – Fox Lake 138-kV line Fox Lake – North Beaver Dam 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	South Beaver Dam – Center Street 69-kV line	--		98.3%		North Randolph – Fox Lake 138-kV line	
3	South Fond du Lac – Koch Oil Tap 69-kV line	--		97.3 – 102.2%		North Randolph – Fox Lake 138-kV line Fox Lake – North Beaver Dam 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	Koch Oil Tap – Waupun 69-kV line	--		97.9 – 103.1%		North Randolph – Fox Lake 138-kV line Fox Lake – North Beaver Dam 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	Hubbard and Hustisford 138-kV buses		--		96.0 – 96.2%	System Intact Rubicon – Hustisford 138-kV line Hustisford – Hubbard 138-kV line	Horicon – East Beaver Dam 138-kV line project
					85.0 – 90.6%	Concord 138-kV 4-5 bus tie	
3	Fox Lake, North Beaver Dam and East Beaver Dam 138-kV buses		--		90.2 – 90.4%	North Randolph – Fox Lake 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	Koch Oil 69-kV bus		--		92.0%	South Fond du Lac – Koch Oil Tap 69-kV line	No project identified. Additional study needed.
3	Horicon Industrial Park 69-kV bus		--		91.9%	Hubbard – Horicon Ind. Park 69-kV line	No project identified. Additional study needed.
3	McCue – Harmony - Lamar 69-kV line	--		104.1 - 101%		System Intact	Construct double-circuit line between McCue and Lamar substations
3	Hillman 138/69-kV transformer #31	101.3 - 98.5%		105.5 - 96.7%		DPC Galena - Pilot 69-kV line Pilot -Terr Tap 69-kV line Terr Tap-LNGHLLW8 69-kV line	Replace the existing 46 MVA Hillman 138/69-kV transformer with a 100 MVA transformer
3	McCue – Harmony - Lamar 69-kV line	102.5 - 95.0%		123.0 - 96.0%		Various outages	Y61 McCue-Lamar line uprate and 2017 Construct double-circuit line between McCue and Lamar substations

**TABLE ZS-3  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2019 Summer Peak with Nelson Dewey and without Nelson Dewey**

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case without Nelson Dewey		2019 Summer Peak Case with Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
3	North Monroe – Idle Hour 69-kV line	103.1 - 95.8%		107.2 - 97.4%		Darlington- Gratiot 69-kV line; Darlington 138/69-kV transformer; Browntown -Jennings Rd 69-kV line; Gratiot - Wiota 69-kV line; Wiota – Jennings Road 69-kV line; Brodhead - Newark 69-kV line; Paddock -Newark 69-kV line; Paddock 138/69-kV transformer #31	Install a 138/69-kV transformer at Bass Creek Substation
3	Dana – Sheepskin 69-kV line	115.2 - 110.8%		133.4 - 127.4%		McCue - Harmony 69-kV line Harmony -Lamar 69-kV line	Sheepskin substation project which will uprate Y-61 Sheepskin-Dana 69-kV line to 95 MVA and 2017 Construct double-circuit line between McCue and Lamar substations
3	Stoughton - Sheepskin 69-kV line	--		114.9 - 110.1%		McCue - Harmony 69-kV line Harmony-Lamar 69-kV line	Construct double-circuit line between McCue and Lamar substations
3	Spring Green 138/69-kV transformer #31	--		95.2%		Gran Grae-Wauzeka 69-kV line	Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating
3	Gran Grae – Wauzeka - Boscobel 69-kV line	100 - 96.2%		105.6 - 100.4%		Spring Green 138/69-kV transformer #31; Lone Rock-Spring Green 69-kV line; Nelson Dewey-Lancaster 138-kV line; Lancaster-Eden 138-kV line; Eden-Wyoming Valley 138-kV line; Spring Green-Wyoming Valley 138-kV line	Uprate Y-40 Gran Grae-Boscobel 69-kV line to achieve a 99 MVA summer emergency rating
3	Boscobel - Blue River 69-kV line	--		96.3 - 95.2%		Spring Green 138/69-kV transformer #31 Nelson Dewey-Lancaster 138-kV line	No project identified
3	West Middleton - Timberlane 69-kV line	106.5%		97.9%		Spring Green 138/69-kV transformer #31	Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating
3	Waunakee Industrial Park - Huiskamp 69-kV line	95.3%		94.0%		North Madison 138/69-kV transformer #31	Potential Y132 line switch replacement project at Waunakee Industrial Park to achieve 170 MVA SE out of ten years
3	Waunakee Switching Station - Waunakee 2 69-kV line	101.3%		101.5%		West Middleton - Pheasant Branch 69-kV line	Potential Waunakee Switching Station-Waunakee 2 69-kV 0.58 miles of line (Y-131) and terminal uprate to achieve 115 MVA SE
3	Fitchburg-Syene - Ninesprings 69-kV line	126.2 - 107.9%		129.2 - 107.7%		Royster - AGA Tap 69-kV line AGA Tap - Pflaum 69-kV line	Uprate Fitchburg-Nine Springs line, uprate Pflaum - Royster line, install 2-16.33 MVAR 69 kV capacitor banks at Nine Springs and move the AGA load onto Femrite - Royster line
3	Royster - AGA Tap - Pflaum 69-kV line	126.5 - 102.8%		126.5 - 103%		Fitchburg - Syene 69-kV line Ninesprings - Syene 69-kV line	Uprate Fitchburg-Nine Springs line, uprate Pflaum - Royster line, install 2-16.33 MVAR 69 kV capacitor banks at Nine Springs and move the AGA load onto Femrite - Royster line
3	West Middleton - West Town 69-kV line	--		95%		West Middleton - Pleasant View 138-kV line	Potential 1.98 miles West Middleton-West Town 69-kV line (6997) uprate and terminal uprate to achieve 106 MVA SE out of ten years
3	Royster - Sycamore 69-kV line	96.5%		96.8%		Femrite 138/69-kV transformer #31	Uprate the 6986 Royster to Sycamore 69-kV line to 115 MVA
3	Verona, Oak Ridge, Fitchburg and Cross Country 138-kV buses		95 - 95.7%		94.6 - 95.9%	System intact	Verona 1-16.33 Mvar 69-kV cap bank and potential 2-49 Mvar 138kV cap banks at Oak Ridge
3	Harmony, Lamar, Fulton, Saunders Creek , Dana, Sheepskin, Bass Creek, Footville, Center, Union Townline, Orfordville and Evansville 69-kV buses		88.9 - 90.6%		76.2 - 91.3%	McCue-Harmony 69-kV line Harmony-Lamar 69-kV line	Lamar 2-16.33 Mvar 69-kV cap banks; 2017 Construct double-circuit line between McCue and Lamar substations
3	Verona 138-kV bus		86.3%		85.5%	Verona-Oak Ridge 138-kV line	Verona 1-16.33 Mvar 69-kV cap bank / Adjust Verona 138/69-kV transformer setting
3	Verona 138-kV bus		--		91.9%	Rockdale-West Middleton 345-kV line	Verona 1-16.33 Mvar 69-kV cap bank and potential 2-49 Mvar 138kV capacitor banks at Oak Ridge
3	Southwest Verona 69-kV bus		90.4%		90%	Verona-Southwest Verona 69-kV line	Potential Mount Horeb capacitor bank upgrade or addition
3	Brodhead Muni 3, Brodhead Muni 2, Brodhead Muni 1, Brodhead, RCEC Orfordville, Bass Creek, Footville, Center, Union Townline and Evansville 69-kV buses		--		87 - 91.8%	Brodhead Switching Station-Brodhead Muni 3 69-kV line; Brodhead Muni 3-Brodhead Muni 2 69-kV line	Install a 138/69-kV transformer at Bass Creek Substation
3	Muscoda, Lone Rock, Avoca, and Blue River 69-kV buses		90.3 - 91.8%		90 - 91.8%	Lone Rock-Spring Green 69-kV line Spring Green 138/69-kV transformer #31	Install 1-8.16 MVAR capacitor bank at Boscobel 69-kV Substation and upgrade existing 5.4 MVAR bank with an 8.16 MVAR bank

**TABLE ZS-3  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2019 Summer Peak with Nelson Dewey and without Nelson Dewey**

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case without Nelson Dewey		2019 Summer Peak Case with Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
3	Burke, Reiner and Colorado 69-kV buses		91.9%		91.5 - 91.6%	Reiner 138/69-kV transformer #31 Reiner-Burke Tap 69-kV line	Install 2-16.33 Mvar 69-kV capacitor banks at Sun Prairie
3	AGA, Pflaum 69-kV buses		90.5 - 90.7%		90.6 - 90.8%	Royster-AGA Tap 69-kV line	Uprate Fitchburg-Nine Springs line, uprate Pflaum - Royster line, install 2-16.33 MVAR 69 kV capacitor banks at Nine Springs and move the AGA load onto Femrite - Royster line
3	Lancaster, Wyoming Valley and Eden 138-kV buses		90.9 - 91.9%		89.8 - 90.8%	Nelson Dewey-Lancaster 138-kV line Lancaster-Eden 138-kV line	Install 2-16.33 Mvar 69-kV capacitor banks at Eden Substation
3	Pleasant View, Hawk, Fitchburg and Cross Country 138-kV buses		91.5 - 91.9%		91.2 - 91.6%	West Middleton-Pleasant View 138-kV line	Verona 1-16.33 Mvar 69-kV cap bank and potential 2018 2-49 Mvar 138kV cap banks at Oak Ridge
4	Bluestone 69-kV bus		--		91.4%	Finger Road – Bluestone 69-kV line	???
4	Sister Bay 69-kV bus		--		95.9%	System Intact	Canal – Dunn Road 138-kV line project
5	Bain 345/138-kV transformer #5	159.1%		159.1%		Pleasant Prairie 345-kV 3-4 bus tie	Reduce Pleasant Prairie generation
5	Albers – Kenosha 138-kV line	97.8%		95.9%		Bain – Kenosha 138-kV line	Increase Paris generation
5	Arcadian4- Waukesha1 138-kV line	113.6%		115.2%		Arcadian 6 – Waukesha3 138-kV line	Upgrade Arcadian – Waukesha 138-kV lines or investigate other alternatives
5	Arcadian 345/138-kV transformer #3 Arcadian 345/138-kV transformer #2	108.7% 97.6%		109.7% 98.8%		Arcadian 345/138-kV transformer #1	Replace Arcadian transformers or investigate other alternatives
5	Branch – Kansas 138-kV line	100.5%		100.5%		Oak Creek – Pennsylvania 138-kV line	Load shift – investigate future projects to resolve loading on the Branch – Kansas 138kV line.
5	Arcadian 6 – Waukesha3 138-kV line	112.6%		114.3%		Arcadian 4- Waukesha1 138-kV line	Upgrade Arcadian – Waukesha 138-kV lines or investigate other alternatives
5	Bark River 138-kV bus		95.8% 91.8%		95.7% 91.7%	System Intact Bark River–Sussex 138-kV line	Increase Germantown generation
5	Hartford 138-kV bus		--		91.9%	Concord 138-kV 3-4 bus tie	Install Concord capacitors
5	Tichigan 138-kV bus		91.4%		91.3%	Split Burlington 138-kV bus	Load shift – Investigate future projects for voltage support at Tichigan
5	Cottonwood 138-kV bus		--		95.3% 91.9%	System Intact Bark River–Sussex 138-kV line	Install Summit & Concord capacitors
5	Germantown 138-kV bus		95.5% 88.7%		95.4% 88.6%	System Intact Maple – Saukville 138-kV line	Increase Germantown generation
5	Maple 138-kV bus		95.7% 88.2%		95.6% 88.1%	System Intact Maple – Saukville 138-kV line	Increase Germantown generation

Table ZS-3a  
2009 10-Year Assessment - 2019 Futures Constraints

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case		2019 DOE 20% Wind Future		2019 Slow Growth Future		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
1	Berlin, River Run, Fountain Valley, Redgranite, ACEC Spring Lake, Silver Lake, Fox River 69-kV buses		86.8 - 91.9%		88.3% - 91.9%		--	Wautoma - Silver Lake Tap 69-kV line Silver Lake - ACEC Spring Lake 69-kV line ACEC Spring Lake - Redgranite 69-kV line Ripon - Northwest Ripon Tap 69-kV line Metomen - Ripon 69-kV line	
1	Dartford, Northwest Ripon, Industrial Park, Ripon, Southwest Ripon 69-kV buses		86.6 - 91.6%		88.2% - 91.6%		--	Ripon - Northwest Ripon Tap 69-kV line Metomen - Ripon 69-kV line Sunset Point - Winneconne 69-kV line Wautoma - Silver Lake Tap 69-kV line	
1	Winneconne, Omro Industrial Park 69-kV buses		86.3 - 91.9%		89.4% - 90.0%		--	Sunset Point - Winneconne 69-kV line Ripon - Northwest Ripon Tap 69-kV line Metomen - Ripon 69-kV line Winneconne - Omro Tap 69-kV line	
1	Lincoln Pumping Station, Grand Marsh (PP&L), ACEC Brooks 69-kV buses		91.1 - 91.9%		--		--	Necedah Tap - Big Pond 69-kV line Petenwell - Big Pond 69-kV line Petenwell 138/69-kV transformer	No project needed at this time
1	Sigel 138-kV bus		91.8%		--		--	Sigel - Arpin 138-kV line	No project needed at this time
1	Petenwell, Council Creek 138-kV buses		94.6 - 95.0% -- 88.4 - 91.6%		95.4% 90.6 - 91.9%		96.9% --	System Intact Saratoga - Petenwell 138-kV line Sigel - Arpin 138-kV line	Monroe County – Council Creek 161-kV line
1	Baker, Saratoga 115-kV buses		91.6%		91.0%		--	Baker - Coyne 115-kV line	No project needed at this time
1	Petenwell, Big Pond, Necedah, Whistling Wings, ACEC Dellwood, Friendship, ACEC Friendship, Houghton Rock, McKenna 69-kV buses		84.0 - 91.1%		88.5 - 91.8%		89.4% - 91.9%	Necedah Tap - Big Pond 69-kV line Petenwell - Big Pond 69-kV line Petenwell 138/69-kV transformer #31 Necedah Tap - Whistling Wings Tap 69-kV line	McKenna capacitor expansion
1	Fairwater 69-kV bus		91.9%		--		--	Metomen 138/69-kV transformer #31	No project needed at this time
1	Antigo, Aurora Street 115-kV buses		90.0 - 90.1%		89.0 - 91.9%		--	Antigo - Black Brook 115-kV line	No project needed at this time
1	Petenwell 138/69-kV transformer #31	98.1% 95.7%		112.9% --		97.0% --		System Intact McKenna - Houghton Rock 69-kV line	No project needed at this time
1	McKenna - ACEC Quincy 69-kV line Castle Rock - ACEC Quincy 69-kV line	97.8 - 113.8%		99.2 - 100.0%		97.6%		Necedah Tap - Big Pond 69-kV line Petenwell - Big Pond 69-kV line Petenwell 138/69-kV transformer #31 Necedah - Whistling Wings Tap 69-kV line Kilbourn - Winnebago ACEC 69-kV line	Uprate Castle Rock - McKenna 69-KV line
1	Arnott 138/69-kV transformer #31	--		102.0%		--		Harrison 138/69-kV transformer #31	
1	Caroline 115/69-kV transformer #61	109.0%		95.9%		--		Whitcomb 115/69-kV transformer #31	
1	Council Creek - Tomah Industrial Park Tap 69-kV line	103.5%		99.3%		91.0%		System Intact	
1	Harrison 138/69-kV transformer	--		113.3%		90.0%		System Intact	
1	Hartman Creek - Harrison 138-kV line	--		101.7 - 96.6%		--		Port Edwards - Sand Lake 138-kV line Wautoma 138/69-kV transformer #31 Sigel - Arpin 138-KV line	

Table ZS-3a  
2009 10-Year Assessment - 2019 Futures Constraints

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case		2019 DOE 20% Wind Future		2019 Slow Growth Future		Facility Outage(s)	Project/Mitigation	
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage			
1	Metomen - Ripon 69-kV line	98.4%		--		--		System Intact		
		98.1 - 105.8%						Sunset Point - Winneconne 69-kV line		
		--						North Randolph - Markesan Tap 69-kV line		
		--						Winniconne - Omro Tap 69-kV line		
1	Metomen 138/69-kV transformer #31	113.6%		100.4%		--		System Intact	Metomen Transformer Replacement	
		--		--				Ripon - Southwest Ripon Tap 69-kV line		
		108.7 - 130.9%		99.1%				Southwest Ripon - Mackford Prairie 69-kV line		
		--		--				North Randolph - Markesan Tap 69-kV line		
		--		--				North Fond du Lac - Rosendale 69-kV line		
		--		--				Rocky Run - Whiting Avenue 115-kV line		
1	Rocky Run - Plover 115-kV line		96.9%		--		--	Rocky Run - Whiting Avenue 115-kV line		
	Rocky Run - Whiting Avenue 115-kV line		97.4%					Rocky Run - Plover 115-kV line		
1	Northwest Ripon - Ripon 69-kV line	101.3 - 113.4%		--		--		Sunset Point - Winneconne 69-kV line		
								Winniconne - Omro Tap 69-kV line		
1	Omro - Winneconne 69-kV line	97.0 - 103.3%		--		--		Ripon - Northwest Ripon Tap 69-kV line		
	Winneconne - Sunset Point 69-kV line								Metomen - Ripon 69-kV line	
1	Rocky Run 345/115-kV transformer #4	95.9 - 97.1%		112.6 - 96.0%		--		Rocky Run 345/115-kV Transformer #2		
								Rocky Run 345/115-kV Transformer #1		
								Sigel - Arpin 138-kV line		
								Arpin 345/138-kV transformer		
								Werner West - Rocky Run 345 KV line		
1	Sand Lake - Sand Lake Tap 69-kV line	--		96.3%		--		Wautoma 138/69-kV transformer #31		
1	Sigel - Arpin 138-kV line	--		97.1%		95.5%		Baker - Coyne 115-kV line		
1	Whitcomb 115/69-kV transformer	101.1%		105.5%		95.3%		System Intact		
1	Wautoma 138/69-kV transformer	112.0%		112.8%		--		System Intact		
		95.6 - 99.8%		104.7% - 95.5%				Portage - Lakehead Pipeline Portage 69-kV line		
									Sand Lake Tap - Sand Lake 69-kV line	
									Sand Lake 138/69-kV transformer #31	
									Endeavor - Lakehead Pipeline 69-kV line	
									Ripon - Northwest Ripon Tap 69-kV line	
									System Intact	
2	Delta - Mead 69-kV line	101 - 158.1%		--		--		Chandler - Lakehead Tap 69-kV line	Uprate Delta-Mead-North Bluff 69-kV line, or increase generation at Mead/Gladstone	
								Lakehead Tap - Masonville 69-kV line		
								Masonville - Gladstone 69-kV line		
								Gladstone - North Bluff 69-kV line		
								North Bluff - Bay Tap 69-kV line		
								Bay Tap - Mead 69-kV line		
2	Chandler - Delta 69-kV #1 line	109.5%		--		--		Chandler - Delta 69-kV #2 line	Uprate Chandler-Delta 69-kV line #1, or increase generation at Escanaba/Mead/Gladstone	
2	Chandler - Delta 69-kV #2 line	103.4%		--		--		Chandler - Delta 69-kV #1 line	Uprate Chandler-Delta 69-kV line #2, or increase generation at Escanaba/Mead/Gladstone	
2	Atlantic - M38 69-kV line	121.3 - 122.4%		--		--		Atlantic - M-38 138-kV line	Uprate Atlantic - M38 69-kV line	
								Atlantic 138/69-kV transformer #1	or increase generation at Portage	
								Both		



Table ZS-3a  
2009 10-Year Assessment - 2019 Futures Constraints

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case		2019 DOE 20% Wind Future		2019 Slow Growth Future		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
2	Chandler-Lakehead Tap 69-kV line	121.6 - 162.2%		--		--		Delta - Mead 69-kV line	Uprate Chandler-Masonville, Masonville-Gladstone, Gladstone-North Bluff, Delta-Mead-North Bluff 69-kV lines; or increase generation at Mead/Gladstone
	Lakehead Tap-Masonville 69-kV line								
	Masonville-Gladstone 69-kV line								
	Gladstone-North Bluff 69-kV line								
	North Bluff-Bay Tap 69-kV line								
Bay Tap-Mead 69-kV line									
2	Pine River-Straits 69-kV line	98 - 109.2%		--		--		Brevort - Straits 138-kV line	Rebuild Pine River-Straits 69-kV lines
	Straits-Evergreen 69-kV line								
	Pine River-Evergreen 69-kV line								
2	Rudyard - Tone 69-kV line	97.3%		--		--		Hiawatha - Engadine 69-kV line	Uprate Rudyard - Tone 69-kV line, Increase generation at Newberry, Dafter, DeTour, US Hydro, Edison Sault
2	Nordic - Mountain 69-kV line	111.4%		--		--		Chandler 138/69-kV transformer #1	Uprate Nordic - Mountain 69-kV line, Increase generation
2	New Quinnesec - Kingsford Tap 69-kV line	100.0%		--		--		Twin Falls North - Twin Falls South 69-kV line	Uprate New Quinnesec - KFM Tap 69-kV line
		100.3%						Twin Falls South - Bass Lake 69-kV line	
2	Lakota 69-kV bus		117.1%		--	--		Conover - Lakota 69-kV line	Change controlled bus for Lakota 138/69-kV tcul transformer to Lakota 69-kV bus instead of Conover 69-kV bus
2	Chandler, Delta, Escanaba 1, Escanaba 2, Masonville, Mead, Gladstone, West, Lakehead, Bay View, North Bluff, Cornell,		88.4-91.4%		--	--		Chandler 138/69-kV transformer #1	Increase generation at Escanaba/Mead/Gladstone
2	Hulbert, Eckerman, Newberry Village, Louisiana Pacific, Newberry, Newberry Hospital, Roberts, Raco 69-kV buses		87.2 - 90.3%		--	--		Engadine - Newberry 69-kV line	Increase generation at Newberry, Dafter, DeTour, US Hydro, Edison Sault
2	Newberry Village, Louisiana Pacific, Newberry Hospital, Roberts, Hulbert, Eckerman 69-kV buses		78.9 - 91.9%		--	--		Newberry - Newberry Hospital Tap 69-kV line Hiawatha - Engadine 69-kV line Newberry Hospital Tap-Roberts 69-kV lines	Increase generation at Dafter, DeTour, US Hydro, Edison Sault
2	Atlantic 138-kV bus		86.1 - 91.8%		--	--		Atlantic - M-38 138-kV line	Adjust taps at Atlantic 138/69-kV transformer
	Keweenaw Tap, Keweenaw 69-kV buses							ATC_B2_ATLAN	
2	Munising 138-kV bus		91.8%		--	--		Forsyth - Munising 138-kV line	Adjust taps at Munising 138/69-kV transformer
2	Aspen, Iron Grove 138-kV buses		91.1 - 91.5%		--	--		Aspen - Plains 138-kV line	Adjust taps at Iron Grove, Aspen 138/69-kV
2	Iron Grove 138-kV bus		91.0%		--	--		Aspen - Iron Grove 138-kV line	Adjust taps at Iron Grove 138/69-kV transformers
2	Lakehead 69-kV bus		91.9%		--	--		Iron Grove 138/69-kV transformer #G1	Add second Iron Grove 138/69-kV transformer
3	Artesian - Rock Springs 138-kV line	100.3 - 104.4%		--		--		Trienda - Lewiston ACEC 138-kV line	
	Rock Springs - Kirkwood 138-kV line							Lewiston - Kilbourn ACEC 138-KV line	
3	Dane - Lodi Tap 69-kV line	100.6%		--		--		Island Street - Kirkwood 69-kV line	Rebuild Dane-Dam Heights 69-KV line
3	Portage - Trienda 138-kV line	96.1%		--		--		Portage - Trienda1 138-kV line	No project needed at this time
3	Artesian - Rock Springs 138-kV line	100.3 - 104.4%		--		--		Trienda - Lewiston ACEC 138-kV line	
	Rock Springs - Kirkwood 138-kV line							Lewiston - Kilbourn ACEC 138-KV line	

Table ZS-3a  
2009 10-Year Assessment - 2019 Futures Constraints

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case		2019 DOE 20% Wind Future		2019 Slow Growth Future		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
3	Dane - Lodi Tap 69-kV line	100.6%		--		--		Island Street - Kirkwood 69-kV line	Rebuild Dane-Dam Heights 69-KV line
3	Portage - Trienda 138-kV line	96.1%		--		--		Portage - Trienda 138-kV line	No project needed at this time
3	Academy – Columbus Muni #3 tap 69-kV line	112.2%		108.6%		--		North Randolph – Fox Lake 138-kV line	
		107.1%		102.9%		--		North Randolph–Fox Lake–North Beaver Dam 138-kV line	
		106.7%		102.5%		--		Fox Lake – North Beaver Dam 138-kV line	
3	Columbus Muni #3 Tap – Columbus 69-kV line	110.4%		106.8%		--		North Randolph – Fox Lake 138-kV line	
		105.4%		101.1%		--		North Randolph – Fox Lake – North Beaver Dam 138-kV line	
		104.9%		100.7%		--		Fox Lake – North Beaver Dam 138-kV line	
3	South Beaver Dam – Center Street 69-kV line	98.3%		--		--		North Randolph – Fox Lake 138-kV line	
3	South Fond du Lac – Koch Oil Tap 69-kV line	102.2%		104.1%		--		North Randolph – Fox Lake 138-kV line	
		97.5%		99.0%		--		Fox Lake – North Beaver Dam 138-kV line	
		97.3%		98.8%		--		North Randolph – Fox Lake – North Beaver Dam 138-kV line	
3	Koch Oil Tap – Waupun 69-kV line	103.1%		105.0%		--		North Randolph – Fox Lake 138-kV line	
		98.1%		99.7%		--		Fox Lake – North Beaver Dam 138-kV line	
		97.9%		99.5%		--		North Randolph – Fox Lake – North Beaver Dam 138-kV line	
3	Hubbard and Hustisford 138-kV buses		96.0 – 96.2%		96.8%		95.7 - 96.1%	System Intact	
			85.0 – 85.1%		84.9 - 85.0%		86.7 - 86.8%	Rubicon – Hustisford 138-kV line	
			85.7%		85.6%		87.2%	Hustisford – Hubbard 138-kV line	
			85.7%		85.6%		87.4%	North Randolph–Fox Lake–North Beaver Dam 138-kV line	
			90.6 – 90.9%		91.0 - 91.3%		--	Concord 138-kV 4-5 bus tie	
3	Fox Lake, North Beaver Dam and East Beaver Dam 138-kV buses		90.2 – 90.4%		90.5 - 90.6%		--	North Randolph – Fox Lake 138-kV line	
3	Koch Oil 69-kV bus		92.0%		--		--	South Fond du Lac – Koch Oil Tap 69-kV line	
3	Horicon Industrial Park 69-kV bus		91.9%		--		--	Hubbard – Horicon Ind. Park 69-kV line	
3	Artesian - Rock Springs 138-kV line	100.3 - 104.4%						Trienda - Lewiston ACEC 138-kV line	
	Rock Springs - Kirkwood 138-kV line			--		--		Lewiston - Kilbourn ACEC 138-KV line	
3	Dane - Lodi Tap 69-kV line	100.6%		--		--		Island Street - Kirkwood 69-kV line	Rebuild Dane-Dam Heights 69-KV line
3	Portage - Trienda 138 kV line	96.1%		--		--		Portage - Trienda1 138 kV line	No project needed at this time
3	Lake Geneva – South Lake Geneva 69-kV line	126.3%		122.5%		101.4%		Cobblestone – Brick Church 69-kV line	North Lake Geneva – South Lake Geneva 138kV line
		104.7%		101.8%		--		Cobblestone – Zenda Tap 69-kV line	
3	Katzenberg-South Lake Geneva 69-kV line	96.7%		--		--		Cobblestone – Brick Church 69-kV line	Spring Valley – Twin Lakes line
3	Colley Road 138/69-kV transformer #31	103.6%		98.0%		--		Paddock 138/69-kV transformer #31	Install Bass Creek transformer
3	Enzyme – RC3 69-kV line	95.4%		--		--		Brick Church 138/69-kV transformer #31	Line Y-32 rebuild
3	Cobblestone – Brick Church 69-kV line	102.2%		96.3%		--		North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138kV line
3	Cobblestone – Zenda Tap 69-kV line	123.3%		116.0%		--		North Lake Geneva – Lake Geneva 69-kV line	Spring Valley – Twin Lakes line
3	Katzenberg – Zenda Tap 69-kV line	109.5%		102.7%		--		North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Cobblestone 69-kV bus		89..9%		90.4%		--	Cobblestone – Brick Church 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Zenda 69-kV bus		91.4%		--		--	North Lake Geneva - Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
			90.9%		91.5%		--	Cobblestone – Brick Church 69-kV line	

Table ZS-3a  
2009 10-Year Assessment - 2019 Futures Constraints

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case		2019 DOE 20% Wind Future		2019 Slow Growth Future		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
3	Brick Church 138-kV bus		91.2%		--		--	Beloit Gateway – Dickinson 138-kV line	Brick Church capacitors or Spring Valley – Twin Lakes
			90.4%		91.1%			Colley Road – Dickinson 138-kV line	
3	Williams Bay 138-kV bus		91.9%		--		--	Colley Road – Dickinson 138-kV line	Brick Church capacitors or Spring Valley – Twin Lakes line
3	Lake Geneva 69-kV bus		83.5%		86.8%		--	North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Katzenberg 69-kV bus		85.1%		88.2%		--	North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Twin Lakes 69-kV bus		84.4%		87.5%		--	North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	South Lake Geneva 69-kV bus		84.2%		87.4%		--	North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Dickinson 138-kV bus		89.4%		89.9%		--	Colley Road – Dickinson 138-kV line	Brick Church caps or Spring Valley – Twin Lakes line
3	Concord 138-kV bus		90.2%		90.0%		--	Concord 138-kV 4-5 bus tie	Install Concord capacitors
3	Crawfish River 138-kV bus		--		--		91.0%	Jefferson - Crawfish River 138-kV line	
3	Butler Ridge 138-kV bus		--		91.8%		--	Concord 138-kV 4-5 bus tie	Install Concord capacitors
3	Rubicon 138-kV bus		91.9%		91.6%		--	Concord 138-kV 4-5 bus tie	Install Concord capacitors
3	McCue - Harmony - Lamar 69-kV line	102.5 - 95%		116.4 - 97.2%		96.9%		Kegonsa - Stoughton North 69-kV line Kegonsa 138/69-kV transformer #31 Stoughton North - Stoughton East 69-kV line	Construct double-circuit line between McCue and Lamar substations
3	Hillman 138/69-kV transformer #31	101.3%-98.5%		96.7%		--		DPC Galena - Pilot 69-kV line Pilot - Terr Tap 69-kV line	Replace the existing 46 MVA Hillman 138/69-kV transformer with a 100 MVA transformer
3	North Monroe - Idle Hour 69-kV line	103.1 - 95.8%		114.7 - 98.1%		101%-96.2%		Darlington- Gratiot 69-kV line Darlington 138/69-kV transformer #31 Browntown-Jennings Rd 69-kV line Gratiot-Wiota 69-kV line Wiota-Jennings Rd 69-kV line Brodhead-Newark 69-kV line Paddock-Newark 69-kV line Paddock 138/69-kV transformer #31 Whistling Wind-Black Smith 69-kV line	Install a 138/69-kV transformer at Bass Creek Substation
3	Dana – Sheepskin 69-kV line	115.2 - 110.8%		126.4 - 121%		97.4%		McCue-Harmony 69-kV line Harmony-Lamar 69-kV line	Sheepskin substation project which will uprate Y-61 Sheepskin-Dana 69-kV line to 95 MVA and 2017 Construct double-circuit line between McCue and Lamar substations
3	Gran Grae-Wauzeka-Boscobel 69-kV line	100%-96.2%		--		--		Spring Green 138/69-kV transformer #31 Lone Rock-Spring Green 69-kV line	Uprate Y-40 Gran Grae-Boscobel 69-kV line to achieve a 99 MVA summer emergency rating
3	West Middleton - Timberlane 69-kV line	106.5%		--		--		Spring Green 138/69-kV transformer #31	Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating

Table ZS-3a  
2009 10-Year Assessment - 2019 Futures Constraints

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case		2019 DOE 20% Wind Future		2019 Slow Growth Future		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
3	Waunakee Industrial Park - Huiskamp 69-kV line	95.3%		--		--		North Madison 138/69-kV transformer #31	Potential Y132 line switch replacement project at Waunakee Industrial Park to achieve 170 MVA SE out of ten years
3	Waunakee Switching Station - Waunakee 2 69-kV line	101.3%		99.6%		--		West Middleton-Pheasant Branch 69-kV line	Potential Waunakee Switching Station-Waunakee 2 69-kV 0.58 miles of line (Y-131) and terminal uprate to achieve 115 MVA SE
3	Fitchburg - Syene - Ninesprings 69-kV line	126.2 - 107.9%		106.5%		106.0%		Royster-AGA Tap 69-kV line AGA Tap-Pflaum 69-kV line	Uprate Fitchburg-Nine Springs line, uprate Pflaum - Royster line, install 2-16.33 MVAR 69 kV cap banks at Nine Springs and move the AGA load onto Femrite - Royster line
3	Royster - AGA Tap - Pflaum 69-kV line	126.5 - 102.8%		104.8%		104.6 - 101.8%		Fitchburg-Syene 69-kV line Ninesprings-Syene 69-kV line	Uprate Fitchburg-Nine Springs line, uprate Pflaum - Royster line, install 2-16.33 MVAR 69 kV capacitor banks at Nine Springs and move the AGA load onto Femrite - Royster line
3	Royster - Sycamore 69-kV line	96.5%		--		--		Femrite 138/69-kV transformer #31	Uprate the 6986 Royster to Sycamore 69-kV line to 115 MVA
3	Verona, Oak Ridge, Fitchburg and Cross Country 138-kV buses		95.0 - 95.7%		95.2%		--	System intact	Verona 1-16.33 Mvar 69-kV capacitor bank and potential 2-49 Mvar 138-kV capacitor banks at Oak Ridge
3	Harmony, Lamar, Fulton 69-kV buses		88.9 - 90.6%		78.6 - 91.8%		86.4 - 91.8%	McCue-Harmony 69-kV line Harmony-Lamar 69-kV line	Lamar 2-16.33 Mvar 69-kV cap banks; Construct double-circuit line between McCue and Lamar substations
3	Verona 138-kV bus		86.3%		86.2%		88.5%	Verona-Oak Ridge 138-kV line	Verona 1-16.33 Mvar 69-kV cap bank / Adjust Verona 138/69-kV transformer setting
3	Southwest Verona 69-kV bus		90.4%		90.6%		--	Verona-Southwest Verona 69-kV line	Potential Mount Horeb capacitor bank upgrade or addition
3	Muscoda, Lone Rock, Avoca, and Blue River 69-kV buses		90.3 - 91.8%		--		--	Lone Rock - Spring Green 69-kV line Spring Green 138/69-kV transformer #31	Install 1-8.16 MVAR capacitor bank at Boscobel 69-kV Substation and upgrade existing 5.4 MVAR bank with an 8.16 MVAR bank
3	Reiner, Burke 69-kV buses		91.9%		91.8 - 91.9%		--	Reiner 138/69-kV transformer #31 Reiner - Burke Tap 69-kV line	Install 2-16.33 Mvar 69-kV capacitor banks at Sun Prairie

Table ZS-3a  
2009 10-Year Assessment - 2019 Futures Constraints

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case		2019 DOE 20% Wind Future		2019 Slow Growth Future		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
3	AGA and Pflaum 69-kV buses		90.5 - 90.7%		--		--	Royster - AGA Tap 69-kV line	Uprate Fitchburg-Nine Springs line, uprate Pflaum - Royster line, install 2-16.33 MVAR 69 kV capacitor banks at Nine Springs and move the AGA load onto Femrite - Royster line
3	Lancaster and Eden 138-kV buses		90.9 - 91.9%		90.2 - 90.8%		--	Nelson Dewey - Lancaster 138-kV line Lancaster - Eden 138-kV line	Install 2-16.33 Mvar 69-kV capacitor banks at Eden Substation
3	Pleasant View and Hawk 138-kV buses		91.5 - 91.9%		91.8%		--	West Middleton - Pleasant View 138-kV line	Verona 1-16.33 Mvar 69-kV cap bank and potential 2-49 Mvar 138-kV capacitor banks at Oak Ridge
3	Lone Rock - Pine River - Brewer - Richland Center 69-kV line and Lone Rock phase shifter	--		121.0 -193.0%		177.9 - 113.7%		System intact	Adjust Lone Rock phase shifter to 0 deg
3	Gran Grae - Hillside 69-kV line	--		103.4%		95.3%		Seneca - Bell Center 161-kV line	Adjust Lone Rock phase shifter to 0 deg
3	Sun Valley - Oregon 69-kV line	--		97.0%		--		Kegonsa - Stoughton North 69-kV line	Potential Oregon substation uprate
3	Stoughton - Sheepskin 69-kV line	--		113.6 - 109.5%		--		McCue - Harmony 69-kV line Harmony - Lamar 69-kV line	2017 Construct double-circuit line between McCue and Lamar substations
3	West Middleton - West Towne 69-kV line	--		101.1%		--		West Middleton - Pleasant View 138-kV line	Potential ~2 mile line uprate from 83 MVA to 106 MVA
3	Lone Rock - Pine River - Brewer - Richland Center 69-kV line and Lone Rock phase shifter	--		224.6 -103.4%		203.5 - 95.2%		Gran Grae - Wauzeka 69-kV line Wauzeka - Boscobel 69-kV line Boscobel - Blue River 69-kV line Blue River - Muscoda 69-kV line Muscoda - Avoca 69-kV line	Adjust Lone Rock phase shifter to -10 deg
3	Lone Rock, Pine River, Brewer, Richland Center 69-kV buses		--		84.1 - 87%		87.2 - 89.5%	System intact	Adjust Lone Rock phase shifter to 0 deg
3	Eden 138-kV bus		--		95.8%		--	System intact	Install 2-16.33 Mvar 69-kV capacitor banks at Eden Substation
3	Miner, Shullsburg and Benton 69-kV buses		--		89.4 - 91.6%		--	DPC Galena - Pilot 69-kV line Pilot -Terr Tap 69-kV line	DPC outage. Potential capacitor bank on Y130
3	Brodhead Muni 3, Brodhead Muni 2, Brodhead Muni 1, Brodhead, RCEC Orfordville, Bass Creek, Footville, Center, Union Townline and Evansville 69-kV buses		--		87.4 - 91.9%		--	Brodhead Switching Station - Brodhead Muni 3 69-kV line Brodhead Muni 3 - Brodhead Muni 2 69-kV line	Install a 138/69-kV transformer at Bass Creek Substation
3	Wauzeka, Boscobel, Blue River, Muscoda, Avoca 69-kV buses		--		88.2 - 91.8%		91.3 - 91.7%	Gran Grae - Wauzeka 69-kV line Wauzeka - Boscobel 69-kV line Spring Green 138/69-kV transformer #31	Install 1-8.16 MVAR capacitor bank at Boscobel 69-kV Substation and upgrade existing 5.4 MVAR bank with an 8.16 MVAR bank
3	Spring Green, Wyoming Valley and Eden 138-kV buses		--		91.5 - 91.7%		--	Lake Delton - Trienda 138-kV	Install 2-16.33 Mvar 69-kV capacitor banks at Eden Substation
3	Gays Mills 69-kV bus		--		90.9%		--	Seneca - Bell Center 161-kV line	Adjust Lone Rock phase shifter to 0 deg
3	Lone Rock Phase shifter	--		--		120.4 - 119.3%		Nelson Dewey - Lancaster 138-kV line Lancaster - Eden 138-kV line	Adjust Lone Rock phase shifter to 0 deg
5	Arcadian 345/138-kV transformer #3	108.7%		111.4%		98.2%		Arcadian 345/138-kV transformer #1	Replace Arcadian



Table ZS-3a  
2009 10-Year Assessment - 2019 Futures Constraints

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case		2019 DOE 20% Wind Future		2019 Slow Growth Future		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
	Arcadian 345/138-kV transformer #2	97.6%		100.7%		95.2%			transformers or investigate
5	Branch – Kansas 138-kV line	100.5%		--		--		Oak Creek – Pennsylvania 138-kV line	Load shift – investigate future projects to resolve loading on the Branch - Kansas 138kV line.
5	Arcadian 6 – Waukesha3 138-kV line	112.6%		111.9%		103.1%		Arcadian4- Waukesha1 138-kV line	Upgrade Arcadian – Waukesha 138-kV lines or investigate other alternatives
5	Oak Creek - Elm Road 345/138-kV transformer #844	--		99.5%		98.4%		Bain - Kenosha 138-kV line	
5	Granville 345/138-kV transformer #3	--		97.5%		--		Granville 345-kV 1-2 bus tie	
5	Maple - Sauville 138-kV line	--		100.7%		--		Bark River – Sussex 138-kV line	
5	Kenosha - Lakeview 138-kV line	--		--		95.2%		Pleasant Prairie - Zion 345-kV line	
5	Bark River 138-kV bus		95.8%		95.6%		--	System Intact	Increase Germantown generation
			91.8%		90.3%			Bark River – Sussex 138-kV line	
			--		89.2%			Maple – Sauville 138-kV line	
5	Hartford 138-kV bus		--		--		91.6%	Hartford - St. Lawrence 138-kV line	
5	Tichigan 138-kV bus		91.4%		--		--	Burlington 138-kV 1-2 bus tie	Load shift – Investigate future projects for voltage support at Tichigan
5	Germantown 138-kV bus		95.5%		93.3%		95.5%	System Intact	Increase Germantown generation
			88.7%		--		88.7%	Maple – Sauville 138-kV line	
			--		89.8%		--	Bark River -Germantown 138-kV line	
			--		89.6%		--	Bark River -Sussex 138-kV line	
			--		88.8%		--	Germantown - Maple 138-kV line	
			--		80.0%		--	Maple – Sauville 138-kV line	
5	Maple 138-kV bus		95.7%		93.7%		95.7%	System Intact	Increase Germantown generation
			--		90.5%		--	Bark River - Sussex 138-kV line	
			--		90.8%		--	Bark River - Germantown 138-kV line	
			88.2%		79.3%		88.3%	Maple – Sauville 138-kV line	
5	Cottonwood 138-kV bus		95.3%		95.3%		--	System Intact	
					91.1%		--	Bark River - Sussex 138-kV line	

**TABLE ZS-4  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case**

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
1	Berlin, River Run, Fountain Valley, Redgranite, ACEC Spring Lake, Silver Lake, Fox River 69-kV bus		93.9% - 95.4% 80.1% - 91.9%	Intact System Wautoma - Silver Lake Tap 69-kV line Sunset Point - Winneconne 69-kV line Ripon - Northwest Ripon Tap 69-kV line Silver Lake - ACEC Spring Lake 69-kV line	
1	Dartford, Northwest Ripon, Ripon Industrial Park, Ripon, Southwest Ripon 69-kV bus		92.6% - 95.9% 77.5% - 91.8%	Intact System Ripon - Northwest Ripon Tap 69-kV line Metomen - Ripon 69-kV line Sunset Point - Winneconne 69-kV line Wautoma - Silver Lake Tap 69-kV line	
1	Winneconne, Omro, Omro Industrial Park 69-kV bus		94.3% - 94.7% 75.4% - 91.9%	Intact System Sunset Point - Winneconne 69-kV line Winneconne - Omro Tap 69-kV line Ripon - Northwest Ripon Tap 69-kV line Metomen - Ripon 69-kV line	
1	Grand Marsh (PP&L), ACEC Brooks, Lincoln Pumping Station, ACEC Quincy 69-kV bus		87.5% - 91.7%	Necedah Tap - Big Pond 69-kV line Necedah Tap - Whistling Wings Tap 69-kV line Chaffee Creek - Coloma Tap 69-kV line Lincoln Pumping Station - Coloma Tap 69-kV line	
1	Sigel, Lakehead Pipeline, Vulcan, Port Edwards, Hollywood, Saratoga 138-kV bus		90.6% - 91.9%	Sigel - Arpin 138-kV line	No project needed at this time
1	Petenwell, Council Creek 138-kV bus		93.9% - 94.2% 91.1% - 91.9%	Intact System Saratoga - Petenwell 138-kV line Sigel - Arpin 138-kV line Council Creek - Council Creek DPC 69-kV line Baker - Coyne 115-kV line	Monroe County – Council Creek 161-kv line
1	Baker, Saratoga 115-kV bus		95.8% - 95.9% 90.1% - 91.2%	Intact System Baker - Coyne 115-kV line	No project needed at this time



**TABLE ZS-4  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case**

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
1	Necedah, Whistling Wings, ACEC Dellwood, Friendship, ACEC Friendship, Houghton Rock, McKenna 69-kV bus		78.8% - 91.9%	Necedah Tap - Big Pond 69-kV line Big Pond – Petenwell 69-kV line Necedah Tap - Whistling Wings Tap 69-kV line Whistling Wings Tap - Dellwood ACEC 69-kV line	McKenna Capacitor Expansion
1	Lakehead Pipeline, Endeavor, Roslin ACEC, Montello ACEC 69-kV bus		88.2% - 90.9%	Portage - Lakehead Pipeline 69-kV line Lakehead Pipeline - Endeavor 69-kV line Endeavor - Roslin ACEC - 69-kV line	
1	Sand Lake, Wautoma 138-kV bus		94.7% - 94.9% 91.4% - 91.7%	Intact System Sigel - Arpin 138-kV line Port Edwards - Sand Lake 138-kV line	
1	Green Lake , Roeder 138-kV bus		95.6% - 95.9%	Intact System	No project needed at this time
1	ACEC Winnebago, ACEC Glen, Neenah Creek, ACEC Chateau 69-kV bus		90.1% - 91.7%	Kilbourn - Winnebago ACEC 69-kV line	
1	Plainfield, Sand Lake, ACEC Hancock, Hancock, Coloma, Chaffee Creek, ACEC Coloma 69-kV bus		88.9% - 91.9%	Sand Lake 138/69-kV transformer Sand Lake Tap - Sand Lake 69-kV line Necedah Tap - Big Pond 69-kV line	
1	Castle Rock 69-kV bus		90.9%	Necedah Tap - Big Pond 69-kV line	No project needed at this time
1	Fairwater, Brandon, Metomen 69-kV bus		88.4% - 91.4%	Metomen 138/69-kV transformer Sunset Point - Winneconne 69-kV line	
1	Antigo, Aurora Street 115-kV bus		90.6% - 90.7%	Antigo - Black Brook 115-kV line	No project needed at this time

**TABLE ZS-4  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case**

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
1	Harrison, Manawa 69-kV bus		91.8% - 91.9%	Harrison 138/69-kV transformer	No project needed at this time
1	Wittenburg 69-kV bus		91.3%	Whitcomb - Wittenberg CWEC 69-kV line	No project needed at this time
1	Arnott 69-kV bus		91.5%	Arnott 138/69-kV transformer	No project needed at this time
1	Metomen 138-kV bus		95.1% 91.6%	Intact System North Fond du Lac - Metomen 138-kV line	No project needed at this time
1	Turtle ACEC 69-kV bus		91.9%	Portage - Lakehead Pipeline Portage 69-kV line	No project needed at this time
1	Council Creek - Tunnel City Tap 69-kV line Petenwell 138/69-kV transformer	94.0% - 96.0%		Intact System	
1	North Randolph - Markesan - Mackford Prairie - Ripon 69-kV line	97.3% - 113.9%		Metomen - Ripon 69-kV line	
1	Arnott 138/69-kV transformer	107.1%		Harrison 138/69-kV transformer	
1	Berlin - Dartford 69-kV line	105.8% - 108.5%		Sunset Point - Winneconne 69-kV line Ripon - Northwest Ripon Tap 69-kV line	
1	Caroline 115/69-kV transformer	123.0%		Whitcomb 115/69-kV transformer	
1	Chaffee Creek - Coloma Tap 69-kV line	101.2%		Necedah Tap - Big Pond 69-kV line	
1	Council Creek - Tomah Industrial Park Tap 69-kV line	108.0%		Intact System	

**TABLE ZS-4  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case**

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
1	Harrison 138/69-kV transformer	116.0% 95.9% - 100.2%		Intact System Arnott 138/69-kV transformer Whitcomb - Rosholt Tap 69-kV line Iola - Iola CW Tap 69-kV line Wautoma 138/69-kV transformer	
1	McKenna - ACEC Quincy - Castle Rock 69-kV line	102.9% - 130.6%		Necedah Tap - Big Pond 69-kV line Necedah Tap - Whistling Wings Tap 69-kV line Dellwood ACEC - Whistling Wings Tap 69-kV line Petenwell - Big Pond 69-kV line Petenwell 138/69-kV transformer	Uprate Castle Rock - McKenna 69- kV line
1	Metomen - Ripon 69-kV line	112.1% 95.1% - 128.7%		Intact System Sunset Point - Winneconne 69-kV line North Randolph - Markesan Tap 69- kV line Winniconne - Omro Tap 69-kV line Mackford Praire - Markesan Tap 69- kV line	
1	Metomen 138/69-kV transformer	106.0% 101.6% - 125.4%		Intact System North Fond du Lac - Rosendale Tap 69-kV line Metomen - Rosendale Tap 69-kV line Sunset Point - Winneconne 69-kV line North Randolph - Markesan Tap 69- kV line	Metomen Transformer Replacement
1	Northwest Ripon - Ripon 69-kV line	96.1% - 138.5%		Sunset Point - Winneconne 69-kV line Winniconne - Omro Tap 69-kV line Omro - Omro Industrial Tap 69-kV line Wautoma - Silver Lake Tap 69-kV line Silver Lake - ACEC Spring Lake 69- kV line	
1	Northwest Ripon - Dartford 69-kV line	107.5%		Sunset Point - Winneconne 69-kV line	

**TABLE ZS-4  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case**

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
1	Omro - Omro Industrial 69-kV line	101.1%		Ripon - Northwest Ripon Tap 69-kV line	
1	Omro - Winneconne 69-kV line Winneconne - Sunset Point 69-kV line	105.7% 96.8% - 134.5%		Intact System Ripon - Northwest Ripon Tap 69-kV line Metomen - Ripon 69-kV line Northwest Ripon Tap - Dartford Tap 69-kV line Wautoma - Silver Lake Tap 69-kV line	
1	Plover - Coyne 115-kV line	96.1%		Rocky Run - Coyne 115-kV line	No project needed at this time
1	Rocky Run 345/115-kV transformer T4	96.2% - 104.5%		Rocky Run 345/115 kV Transformer T2 Rocky Run 345/115 kV Transformer T1 Sigel - Arpin 138-kV line Werner West - White Lake 138-kV line Arpin 345/138-kV transformer	
1	Rosendale - North Fond du Lac 69-kV line	101.4%		Metomen 138/69-kV transformer	
1	Sand Lake - Sand Lake Tap 69-kV line	96.2% - 99.2%		Wautoma 138/69-kV transformer Necedah Tap - Big Pond 69-kV line	No project needed at this time
1	Wautoma 138/69-kV transformer	120.0% 96.0% - 110.5%		Intact System Sand Lake Tap - Sand Lake 69-kV line Sand Lake 138/69-kV transformer Portage - Lakehead Pipeline Portage 69-kV line Ripon - Northwest Ripon Tap 69-kV line	
1	Whitcomb 115/69-kV transformer	112.2% 101.4%		Intact System Caroline 115/69-kV transformer	
3	North Monroe 138/69-kV transformer	100%		System intact	Bass Creek transformer project

**TABLE ZS-4  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case**

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	McCue-Harmony-Lamar 69-kV line	102%-99%		System Intact	Construct double-circuit line between McCue and Lamar substations
3	Hillman 138/69-kV transformer	111.4%-100.4%		DPC Galena-Pilot 69-kV line; Pilot-Terr TP 69-kV line; Terr Tap-LNGHLLW8 69-kV line; LNGHLLW8-Galna T8 69-kV line	Replace the existing 46 MVA Hillman 138/69-kV transformer with a 100 MVA transformer
3	McCue-Harmony-Lamar 69-kV line	119.8%-96.1%		Several single contingency outages	McCue-Lamar line uprate and construct double-circuit line between McCue and Lamar substations
3	North Monroe-Idle Hour 69-kV line	118.5%-95.8%		Paddock-Newark 69-kV line; Brodhead Switching-Spring Grove 69-kV; Spring Grove-Whistling Wind 69-kV line; Whistling Wind-Black Smith 69-kV line; North Monroe-Monticello 69-kV; Monticello-New Glarus 69-kV; Darlington- Gratiot 69-kV line; Darlington 138/69-kV transformer; Browntown-Jennings Road 69-kV line; South Monroe-Browntown 69-kV line; Gratiot-Wiota 69-kV line; Wiota-Jennings Rd 69-kV line; Brodhead-Newark 69-kV line; Paddock 138/69-kV transformer	Bass Creek transformer project
3	Stoughton South-Stoughton 69-kV line	103.3%		Oak Ridge-Verona 138-kV line; Verona 138/69-kV transformer	Potential Y-127 line uprate
3	Sun Valley-Oregon 69-kV line	100.9%		Stoughton South-Stoughton 69-kV line	Potential Oregon terminal uprate
3	North Monroe 138/69-kV transformer	97.1%-96.6%		Darlington 138/69-kV transformer; Paddock-Newark 69-kV line	Bass Creek transformer project
3	Paddock-Newark 69-kV line	96.8%		North Monroe-Idle Hour 69-kV line	Bass Creek transformer project
3	Dana – Sheepskin 69-kV line	144.2%-139.1%		McCue-Harmony 69-kV line; Harmony-Lamar 69-kV line	Sheepskin substation project which will uprate Y-61 Sheepskin-Dana 69-kV line to 95 MVA
3	Spring Green 138/69-kV transformer	96.3%		Gran Grae-Wauzeka 69-kV line	2 <sup>nd</sup> Spring Green transformer project

**TABLE ZS-4  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case**

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	Gran Grae-Wauzeka-Boscobel 69-kV line	107.3%-99.4%		Spring Green 138/69-kV transformer; Lone Rock-Spring Green 69-kV line; Nelson Dewey-Lancaster 138-kV line; Lancaster-Eden 138-kV line; Eden-Wyoming Valley 138-kV line; Spring Green-Wyoming Valley 138-kV line	Uprate Y-40 Gran Grae-Boscobel 69-kV line to achieve a 99 MVA summer emergency rating
3	West Middleton-Timberlane-Stage Coach 69-kV line	121.4%-96.2%		Spring Green 138/69-kV transformer; Nelson Dewey-Lancaster 138-kV line; Lancaster-Eden 138-kV line; Verona-Oak Ridge 138-kV line; Verona 138/69-kV transformer; Verona-SW Verona 69-kV line; Gran Grae-Wauzeka 69-kV line; Wauzeka-Boscobel 69-kV line; Trienda-Lake Delton 138-kV line	Short term: uprate the West Middleton-Timberlane section from 83 MVA to 106 MVA (need check the underground cable ratings) and uprate the Timberlane-Stage Coach section from 95 MVA to 115 MVA SE. Long term: potential 2 <sup>nd</sup> 69-kV line between West Middleton-Stage Coach (built for future 138 kV) ; Potential new 138-kV line from West Middleton-Stage Coach and install a 138/69-kV transformer at Stage Coach
3	Stage Coach-Black Earth 69-kV line	104.4%		Spring Green 138/69-kV transformer;	2 <sup>nd</sup> Spring Green transformer project
3	Waunakee Industrial Park-Huiskamp 69-kV line	108.7%-98.7%		North Madison 138/69-kV transformer ; West Middleton-Pheasant Branch 69-kV line	Potential Y132 line switch replacement project at Waunakee Industrial Park to achieve 170 MVA SE
3	West Middleton-Pheasant Branch 69-kV line	96.9%		Waunakee Switching Station-Waunakee 2 69-kV line	A potential new 69-kV line between West port and Huiskamp or a potential voltage conversion from West Middleton-Huiskamp or a new 138-kV line from West Middleton-Huiskamp and step down transformer at West Port or Pheasant Branch

**TABLE ZS-4  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case**

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	Waunakee Switching Station-Waunakee 2-West Port 69-kV line	113.9%-102.2%		West Middleton-Pheasant Branch 69-kV line	Short term: potential 2017 Waunakee Switching Station-Waunakee 2-West Port 69-kV 3.73 miles of line (Y-131) and terminal uprate to achieve 115 MVA SE Long term: A potential new 69-kV line between West port and Huiskamp or a potential voltage conversion from West Middleton-Huiskamp or a new 138-kV line from West Middleton-Huiskamp and step down transformer at West Port or Pheasant Branch
3	West Middleton 138/69-kV transformer	97%		2 <sup>nd</sup> West Middleton 138/69-kV transformer	Potential project to remove the CT, relay and RTU limitations for the transformer T3 to improve the SE rating from 191 MVA to 239 MVA
3	Fitchburg-Syene-Ninesprings 69-kV line	125.7%-102.3%		Royster-AGA tap 69-kV line; AGA tap-Pflaum 69-kV line	Loop Ninesprings-Pflaum line in and out of Femrite
3	Royster-AGA tap-Pflaum 69-kV line	122.7%-97.8%		Fitchburg-Syene 69-kV line; Ninesprings-Syene 69-kV line	Loop Ninesprings-Pflaum line in and out of Femrite
3	West Middleton-West Town 69-kV line	97.7%		West Middleton-Pleasant View 138-kV line	Potential ~2 mile line uprate from 83 MVA to 106 MVA
3	Royster-Sycamore 69-kV line	99.5%		Femrite 138/69-kV transformer	Uprate the 6986 Royster to Sycamore 69-kV line to 115 MVA or potential 2 <sup>nd</sup> Femrite transformer
3	Verona, Oak Ridge, Fitchburg, Pleasant View, McFarland, Sprecher, Kegonsa, Reiner, West Middleton, Femrite, Sycamore and Cross Country 138-kV buses, Gaston Rd 69-kV bus		92.5%-95.8%	System intact	Dane County voltage support project which potentially include capacitor banks at Verona, Oak Ridge, Femrite, Reiner Road
3	Eden, Wyoming, Spring Green, and Troy 138-kV buses		93.8%-94.4%	System intact	Eden capacitor banks; Mazomanie capacitor banks; Boscobel capacitor banks; or Potential 138-kV line from West Middleton-Spring Green substation
3	Miner, Benton and Shullsburg 69-kV buses		89.8%-91.9%	DPC Galena-Pilot 69-kV line; Pilot-Terr TP 69-kV line;	Need to discuss with DPC
3	Spring Green and Wyoming Valley 138-kV buses		91.7%	Gran Grae 138/69-kV transformer	Eden capacitor bank project
3	Harmony, Lamar, Fulton, Saunders Creek, Dana, Sheepskin, Bass Creek, Footville, Center, Union Townline, Orfordville and Evansville 69-kV buses		80.3%-91.8%	McCue-Harmony 69-kV line; Harmony-Lamar 69-kV line	Lamar 2-16.33 Mvar 69-kV capacitor banks;

**TABLE ZS-4  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case**

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	Verona 138-kV bus		83.2%	Verona-Oak Ridge 138-kV line;	Verona 1-16.33 Mvar 69-kV capacitor bank / Adjust Verona 138/69-kV transformer setting
3	Verona, Sun Valley and SW Verona 69-kV buses		91.1%-91.7%	Verona-Oak Ridge 138-kV line; Verona 138/69-kV transformer	Verona capacitor bank project
3	Oak Ridge 138-kV bus		91.6%	Kegonsa-Oak Ridge 138-kV line	Dane County capacitor bank support project
3	SW Verona, Mount Horeb 69-kV buses		87.1%-91.1%	Verona-SW Verona 69-kV line	Potential Mount Horeb capacitor bank upgrade or addition
3	Hillman, Elmo, McGregor, Platteville and Cuba City 69-kV buses		91 %-91.7%	Hillman 138/69-kV transformer	Potential 2 <sup>nd</sup> Hillman transformer instead of the existing Hillman transformer replacement project
3	Hooterville 69-kV bus		91.8%	Eden 138/69-kV transformer	Eden capacitor bank project
3	Idle Hour, Monroe, South Monroe 69-kV buses		91.3%-91.8%	North Monroe-Idle Hour 69-kV line	Bass Creek transformer project
3	Brodhead Muni 3, Brodhead Muni 2, Brodhead Muni 1, Brodhead, RCEC Orfordville, Bass Creek, Footville, Center, Union Townline and Evansville 69-kV buses		88.6%-91.4%	Brodhead Switching Station- Brodhead Muni 3 69-kV line; Brodhead Muni 3-Brodhead Muni 2 69-kV line	Install a 138/69-kV transformer at Bass Creek Substation
3	Evansville and Union Townline 69-kV buses		91.1%-91.5%	Sheepskin-Evansville 69-kV line	Bass Creek transformer project
3	Wauzeka, Boscobel, Blue River, Muscoda 69-kV buses, Spring Green, Eden, Wyoming Valley and Troy 138-kV buses		88.8%-91.8%	Gran Grae-Wauzeka 69-kV line; Wauzeka-Boscobel 69-kV line	Boscobel capacitor bank project
3	Muscoda 69-kV bus		91.9%	Muscoda-Avoca 69-kV line	Boscobel capacitor bank project
3	Avoca, Muscoda 69-kV buses		90.4%-90.7%	Lone Rock-Avoca 69-kV line	Boscobel capacitor bank project
3	Muscoda, Lone Rock, Avoca, Boscobel, Blue River 69-kV buses		88.4%-91.8%	Lone Rock-Spring Green 69-kV line	Install 1-8.16 MVAR capacitor bank at Boscobel 69-kV Substation and upgrade existing 5.4 MVAR bank with an 8.16 MVAR bank
3	Muscoda, Lone Rock, Avoca, Boscobel, Blue River, Spring Green, Arena, Mazomanie, Black Earth 69-kV buses		87.3%-91.7%	Spring Green 138/69-kV transformer	2 <sup>nd</sup> Spring Green transformer
3	Arena 69-kV bus		91.7%	Spring Green-Arena 69-kV line	Mazomanie capacitor banks
3	Spring Green and Wyoming Valley 138-kV buses		91.6%	West Middleton-Timberlane 69-kV line	Eden capacitor banks; Mazomanie capacitor banks; Boscobel capacitor banks; or Potential 138-kV line from West Middleton-Spring Green substation
3	Gaston Road and Cottage Grove 69-kV buses		90.6%-91.4%	Kegonsa-Cottage Grove 69-kV line	Sun Prairie capacitor banks
3	McFarland, Femrite and Sprecher 138-kV buses		91%-91.9%	Kegonsa-McFarland 138-kV line; McFarland-Femrite 138-kV line	Femrite capacitor banks



**TABLE ZS-4  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case**

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	Burke, Reiner, Sun Prairie, Bird St and Colorado 69-kV buses		89.1%-91.9%	Reiner 138/69-kV transformer; Reiner-Burke Tap 69-kV line; Colorado-Burke Tap 69-kV line	Sun Prairie capacitor banks
3	Spring Green and Wyoming Valley 138-kV buses		91.7%	Birchwood-Loch Mirror 138-kV line	Eden capacitor banks
3	Spring Green 138-kV bus		91.9%	Necedah Tap-Big Pond 69-kV line	Eden capacitor banks
3	Pheasant Branch 69-kV bus		90.8%	West Middleton-Pheasant Branch 69-kV line	Short term: potential capacitor banks at Pheasant Branch. Long term: A potential new 69-kV line between West port and Huiskamp or a potential voltage conversion from West Middleton-Huiskamp or a new 138-kV line from West Middleton-Huiskamp and step down transformer at West Port or Pheasant Branch
3	AGA tap, AGA, Pflaum, Ninesprings and Pflaum tap 69-kV buses		90%-91.9%	Royster-AGA tap 69-kV line; AGA tap-Pflaum 69-kV line	Loop Ninesprings-Pflaum line in and out of Femrite
3	Lancaster, Wyoming Valley, Spring Green, Troy and Eden 138-kV buses		86.4%-91.7%	Nelson Dewey-Lancaster 138-kV line; Lancaster-Eden 138-kV line; Eden-Wyoming Valley 138-kV line; Wyoming Valley-Spring Green 138-kV line	Eden capacitor banks
3	Potosi, Hillman, Lafayette Wind, Darlington, Eden, North Monroe 138-kV buses		87.5%-91.9%	Nelson Dewey-Potosi 138-kV line; Potosi-Hillman 138-kV line; Hillman-Lafayette Wind 138-kV line; Lafayette Wind-Darlington 138-kV line	North Monroe capacitor banks
3	Albany, North Monroe and Darlington 138-kV buses		87.9%-91.8%	Townline-Albany 138-kV line; North Monroe-Albany 138-kV line	North Monroe capacitor banks
3	Spring Green 138-kV bus		91.3%-91.7%	Spring Green-Troy 138-kV line; Spring Green-Wyoming Valley 138-kV line	Eden capacitor banks; Boscobel capacitor banks; Mazomanie capacitor banks
3	Troy, Spring Green, Eden and Wyoming Valley 138-kV buses		89.2%-91.5%	Troy-Kirkwood 138-kV line	Eden capacitor banks
3	Verona, Oak Ridge, Fitchburg, Hawk, Pleasant View, West Middleton and Cross Country, Spring Green, Troy and Wyoming Valley 138-kV buses, West Middleton 345-kV bus		90%-91.6%	Rockdale-West Middleton 345-kV line	Dane County voltage support project

**TABLE ZS-4  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case**

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	Lewiston, East Dells, Kilbourn, Loch Mirror, Birchwood, Zobel, Nishan, Artesian, Rock Springs, Kirkwood, City View , Kirkwood, Lake Delton, Spring Green, Wyoming Valley and Troy 138-kV bus voltages		86.0%-91.9%	Lake Delton-Kirkwood 138-kV line, Lake Delton-Trienda 138-kV line, Trienda-Lewiston 138-kV line, Lewiston-Kilbourn 138-kV line and Trienda-Kilbourn 138-kV line (ATC_B2_X-68 outage)	Potential Lake Delton-Birchwood 138-kV line or a new 138-kV line source into the Reedsburg loop
3	Spring Green and Wyoming Valley 138-kV buses		91.9%	Portage-Columbia 138-kV line	Eden capacitor banks
3	Spring Green and Wyoming Valley 138-kV buses		91.6%-91.7%	Columbia 345/138-kV transformer 2	Eden capacitor banks
3	Reiner 138-kV bus		91.8%	Reiner –Sycamore 138-kV line	Sun Prairie capacitor banks
3	Verona, Oak Ridge, Fitchburg, Hawk, Pleasant View, West Middleton and Cross Country 138-kV buses		88.8%-91.3%	West Middleton-Pleasant View 138-kV line	Dane County voltage support project
3	Verona, Oak Ridge, Fitchburg, Hawk, Pleasant View, West Middleton and Cross Country , Spring Green and Wyoming Valley 138-kV buses		90.2%-91.9%	West Middleton 345/138-kV transformer	Dane County voltage support project
3	Spring Green, Eden, Wyoming Valley and Troy 138-kV buses		89.5%-91.9%	Columbia Unit 1 outage; Columbia Unit 2 outage; King-Eau Claire-Arpin 345-kV line; King-Eau Claire-Arpin 345-kV Operating guide; Eau Claire-Arpin 345-kV line; Eau Claire-Arpin 345-kV Operating guide; Columbia 345/138-kV transformer 1 and 3 outage	Eden capacitor banks
3	Eden 138-kV bus		91.9%	Outage of DPC Genoa-Seneca 161-kV line plus Genoa-Lansing 136 kV line plus Genoa 161/69-kV transformer plus Genoa-Lac Tap 161-kV line	Eden capacitor banks
3	Colley Road 138/69-kV transformer	99.1% 97.5% 104.3% 117.9% 101.4% 99.4% 100.9%		Intact System Beloit Gateway-Dickinson 138-kV line Paddock-Shirland 69-kV line Paddock 138/69-kV transformer Shaw - Shirland 69-kV line Brick Church 138/69-kV transformer Colley Road - Dickinson 138-kV line	
3	Brick Church 138/69-kV transformer	111.8%		North Lake Geneva 138/69-kV transformer	

**TABLE ZS-4  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case**

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	Enzyme Bio-RC3 69-kV line	98.5% 106.4% 105.3%		Beloit Gateway – Dickinson 138-kV line Brick Church 138/69-kV transformer Colley Road – Dickinson 138-kV line	Y-32 Line Rebuild
3	RC3-Clinton Tap 69-kV line	95.4% 103.0% 102.1%		Beloit Gateway – Dickinson 138-kV line Brick Church 138/69-kV transformer Colley Road – Dickinson 138-kV line	Y-32 Line Rebuild
3	North Lake Geneva – Lake Geneva 69-kV line	113.1% 95.7%		Cobblestone – Brick Church 69-kV line Cobblestone – Zenda Tap 69-kV line	North Lake Geneva – South Lake Geneva 138kV line
3	Paddock 138/69-kV transformer	105.2% 103.7%		Intact System Colley Road 138/69-kV transformer	Bass Creek transformer project
3	Lake Geneva - South Lake Geneva 69-kV line	156.0% 129.2% 102.5% 108.2%		Cobblestone – Brick Church 69-kV line Cobblestone – Zenda Tap 69-kV line Brick Church 138/69-kV transformer Katzenberg-Zenda Tap 69-kV line	North Lake Geneva – South Lake Geneva 138kV line
3	Katzenberg-South Lake Geneva 69-kV line	117.4		Cobblestone – Brick Church 69-kV line	Uprate / Rebuild Brick Church – South Lake Geneva 69kV line
3	Shaw – East Rockton 69-kV line	108.7%		Paddock 138/69-kV transformer	
3	Colley Road – Park Street Tap 69-kV line	98.7%		Paddock 138/69-kV transformer	
3	Paddock - Shirland 69-kV line	102.1%		Colley Road 138/69-kV transformer	
3	North Lake Geneva 138/69-kV transformer	97.7%		Brick Church 138/69-kV transformer	
3	Brick Church - Walworth 69-kV line	113.8%		North Lake Geneva 138/69 transformer	
3	Cobblestone-Brick Church 69-kV line	106.5%		Lake Geneva - South Lake Geneva 69-kV line	Uprate / Rebuild Brick Church – South Lake Geneva 69kV line
3	Williams Bay 138-kV bus		89.0% 90.0% 91.6%	Colley Road - Dickinson 138-kV line Beloit Gateway – Dickinson 138-kV line Beloit Gateway – Brick Church 138-kV line	

**TABLE ZS-4  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case**

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	Brick Church 138-kV bus		88.7% 90.5%	Beloit Gateway – Dickinson 138-kV line Beloit Gateway – Brick Church 138-kV line	
3	Fort Atkinson 138-kV bus		95.7% 91.9%	Intact System Split Concord 138-kV bus between buses G and 4	
3	Crawfish River 138-kV bus		91.9%	Split Concord 138-kV bus between buses G and 4	
3	Butler Ridge 138-kV bus		95.8% 89.3% 90.8%	Intact System Split Concord 138-kV bus between buses 4 and 5 Split Concord 138-kV bus between buses G and 4	
3	Katzenberg 69-kV bus		84.3% 90.8%	Lake Geneva - South Lake Geneva 69-kV line Cobblestone – Brick Church 69-kV line North Lake Geneva 138/69-kV transformer	
3	Twin Lakes 69-kV bus		83.4% 91.5% 89.9%	Lake Geneva - South Lake Geneva 69-kV line Katzenberg-South Lake Geneva 69-kV line North Lake Geneva 138/69-kV transformer Cobblestone – Brick Church 69-kV line	
3	Cobblestone - Zenda tap 69-kV line	126.6%		Lake Geneva - South Lake Geneva 69-kV line	
3	Katzenberg – Zenda tap 69-kV line	109.1%		Lake Geneva - South Lake Geneva 69-kV line	
3	Zenda 69-kV bus		90.5% 88.1%	Lake Geneva - South Lake Geneva 69-kV line Cobblestone – Brick Church 69-kV line	
3	South Lake Geneva 69-kV bus		83.7%	Lake Geneva - South Lake Geneva 69-kV line North Lake Geneva 138/69-kV transformer	
3	North Lake Geneva 138-kV bus		91.8% 91.6%	Split Burlington 138-kV bus Colley Road - Dickinson 138-kV line	

**TABLE ZS-4  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case**

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	Concord 138-kV bus		86.8% 89.3%	Split Concord 138-kV bus between buses 4 and 5 Split Concord 138-kV bus between buses G and 4	
3	Rubicon 138-kV bus		88.9% 90.6%	Split Concord 138-kV bus between buses 4 and 5 Split Concord 138-kV bus between buses G and 4	
3	Bristol 138-kV bus		91.3%	Colley Road - Dickinson 138-kV line	
3	Delavan 138-kV bus		91.2%	Colley Road - Dickinson 138-kV line	
3	Dickinson 138-kV bus		86.2%	Colley Road - Dickinson 138-kV line	
3	Elkhorn 138-kV bus		90.6% 91.5%	Colley Road - Dickinson 138-kV line Beloit Gateway – Dickinson 138-kV line	
3	Cobblestone 69-kV bus		86.8%	Cobblestone – Brick Church 69-kV line	
3	West Darien 138-kV bus		91.9% 91.9%	REC LaPrairie – REC Bradford 138-kV line RCEC LaPrairie – Rock River 13-8kV line	
3	RC2 (RCEC Bradford) 138-kV bus		91.9% 91.9%	REC LaPrairie – REC Bradford 138kV line REC LaPrairie – Rock River 138-kV line	
3	RC9 (RCEC LaPrairie) 138-kV bus		91.9%	REC LaPrairie – Rock River 138-kV line	
3	Southwest Delavan 138-kV bus		91.9%	REC LaPrairie – Rock River 138-kV line	
3	Lake Geneva 69-kV bus		91.7%	North Lake Geneva 138/69-kV transformer	
3	Okee, Lodi Industrial Park, Lodi 69-kV bus		95.5% - 95.9% 90.3% - 91.5%	Intact System Dane - Lodi Tap 69-kV line	No project needed at this time

**TABLE ZS-4  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case**

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	Lake Delton, Kirkwood 138-kV bus		88.3% - 91.7%	Trienda - Lake Delton 138-kV line Lake Delton - Kirkwood 138-kV line Trienda - Lewiston ACEC 138-kV line Lewiston ACEC – Kilbourn 138-kV line	
3	Mackford Prairie, Markesan 69-kV bus		87.9% - 91.8%	North Randolph - Markesan Tap 69-kV line Markesan Tap - Mackford Prairie 69-kV line Metomen - Ripon 69-kV line	
3	Eagle View 69-kV bus		90.5%	Eagle View - Dam Height 69-kV line	No project needed at this time
3	Kilbourn, Loch Mirror, Birchwood, Dell Creek, Zobel, Nishan, Artesian, Rock Springs 138-kV bus		87.6% - 91.9%	Lake Delton - Trienda 138-kV line Trienda - Lewiston ACEC 138-kV line Lewiston ACEC - Kilbourn 138-kV line Kilbourn - Loch Mirror 138-kV line	Lake Delton – Birchwood 138-kV line
3	Lewiston 138-kV bus		87.6%	Trienda - Lewiston ACEC 138-kV line	
3	Artesian - Rock Springs - Kirkwood 138-kV line	95.9% - 115.2%		Trienda - Lewiston ACEC 138-kV line Trienda - Kilbourn 138-kV line Kilbourn - Lewiston ACEC 138-kV line Loch Mirror - Kilbourn 138-kV line	Lake Delton – Birchwood 138-kV line
3	Columbia 345/138-kV transformer T21	95.7%		Columbia 345/138-kV transformer T22	No project needed at this time
3	Columbia 345/138-kV transformer T23	95.7%		Columbia 345/138-kV transformer T22	No project needed at this time
3	Kilbourn - Lewiston 138-kV line	101.4%		Lake Delton - Trienda 138-kV line	
3	Kilbourn 138/69-kV transformer T32	96.3%		Kilbourn 139/69 kV transformer T31	No project needed at this time
3	Portage - Columbia 138-kV line	102.3%		Portage - Columbia 1 138-kV line Portage - Columbia 2 138-kV line	

**TABLE ZS-4  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case**

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	Portage - Columbia 69-kV line	95.7%		Portage 138/69-kV transformer	No project needed at this time
3	Portage - Trienda 1 138-kV line	96.4%		Portage - Trienda 2 138-kV line	No project needed at this time
3	Portage - Trienda 2 138-kV line	107.8%		Portage - Trienda 1 138-kV line	Upgrade Portage to Trienda 2
3	Trienda - Lewiston 138-kV line	96.0% - 103.4%		Lake Delton - Trienda 138-kV line Rock Springs Tap - Kirkwood 138-kV line Lake Delton - Kirkwood 138-kV line	
3	Academy – Columbus Muni #3 tap 69-kV line	108.4 – 117.9%		N. Randolph – Fox Lake 138-kV line Fox Lake – N Beaver Dam 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	Columbus Muni #3 tap – Columbus 69-kV line	106.5 – 116.1%		N. Randolph – Fox Lake 138-kV line Fox Lake – N Beaver Dam 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	Acedemy 138/69-kV transformer	95.8%		N. Randolph – Fox Lake 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	South Beaver Dam – Center Street 69-kV line	99.3 – 113.9%		N. Randolph – Fox Lake 138-kV line Fox Lake – N Beaver Dam 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	South Fond du Lac – Koch Oil tap 69-kV line	110.9 – 117.9%		N. Randolph – Fox Lake 138-kV line Fox Lake – N Beaver Dam 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	Koch Oil tap – Waupun 69-kV line	112.1 – 119.9%		N. Randolph – Fox Lake 138-kV line Fox Lake – N Beaver Dam 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	Hubbard – Horicon Industrial Park 69-kV line	98.1 – 105.6%		N. Randolph – Fox Lake 138-kV line Fox Lake – N Beaver Dam 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	Hubbard and Hustisford 138-kV buses		95.3 – 95.7%  84.2 – 90.6%	Base Case  Rubicon – Hustisford 138-kV line Hustisford – Hubbard 138-kV line Concord 138 kV bus tie 4 – 5	Horicon – East Beaver Dam 138-kV line project
3	Dane - Lodi Tap 69-kV line	95.1% - 113.8%		Island Street - Kirkwood 69-kV line Lake Delton - Trienda 138-kV line Lake Delton - Kirkwood 138-kV line Baraboo Tap - Moore Street Tap 69-kV line Island Street - Moore Street Tap 69-kV line	Rebuild Dane-Dam Heights 69-kV line

**TABLE ZS-4  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case**

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
4	Edgewater – Washington Street 69-kV line	95.2%		Edgewater – Nicolet 69-kV line	No project identified. Additional study needed.
4	Canal 138/69-kV transformer #1	97.7%		Canal 138/69-kV Transformer #2	No project identified. Additional study needed.
4	Canal 138/69-kV transformer #2	97.2%		Canal 138/69-kV Transformer #1	No project identified. Additional study needed.
4	Sunset Point 138/69-kV transformer #1	96.7%		Sunset Point 138/69-kV Transformer #2	No project identified. Additional study needed.
4	Bluestone 69-kV bus		91.1%	Finger Road – Bluestone 69-kV line	No project identified. Additional study needed.
4	Sister Bay 69-kV bus		94.8%	Base case	Canal – Dunn Road 138-kV line project
4	Egg Harbor 69-kV bus		95.6%	Base case	Canal – Dunn Road 138-kV line project
4	East Krok and Beardsley 69-kV bus		91.4 – 91.9%	East Krok 138/69-kV Transformer	No project identified. Additional study needed.
4	Holland 138-kV bus		90.0%	Charter–Holland–Cedersauk 138 kV Charter–Holland 138 kV	No project identified. Additional study needed.
5	Bain 345/138-kV transformer #5	159.7%		Splitting Pleasant Prairie 345-kV bus between buses 3 and 4.	Reduce Pleasant Prairie generation
5	Albers – Kenosha 138-kV line	101.3%		Bain – Kenosha 138-kV line	
5	Oak Creek-Elm Road 345/230-kV transformer	95.1%		Split Oak Creek 230-kV bus between 7&8	Reduce generator #8 output
5	Arcadian4- Waukesha1 138-kV line	116.3%		Arcadian 6 – Waukesha3 138-kV line	Arcadian – Waukesha line uprate. Run generation at Concord / Germantown
5	Arcadian Transformer #3	114.0%		Arcadian transformer #1	Replace Arcadian transformers. Run generation at Concord and Germantown
5	Arcadian Transformer #2	102.6%		Arcadian transformer #1	Replace Arcadian transformers. Run generation at Concord and Germantown
5	Branch – Kansas 138-kV line	119.0%		Oak Creek – Pennsylvania 138-kV line	
5	Arcadian6 – Waukesha3 138-kV line	115.3%		Arcadian 4- Waukesha1 138-kV line	Arcadian – Waukesha line uprate. Run generation at Concord / Germantown

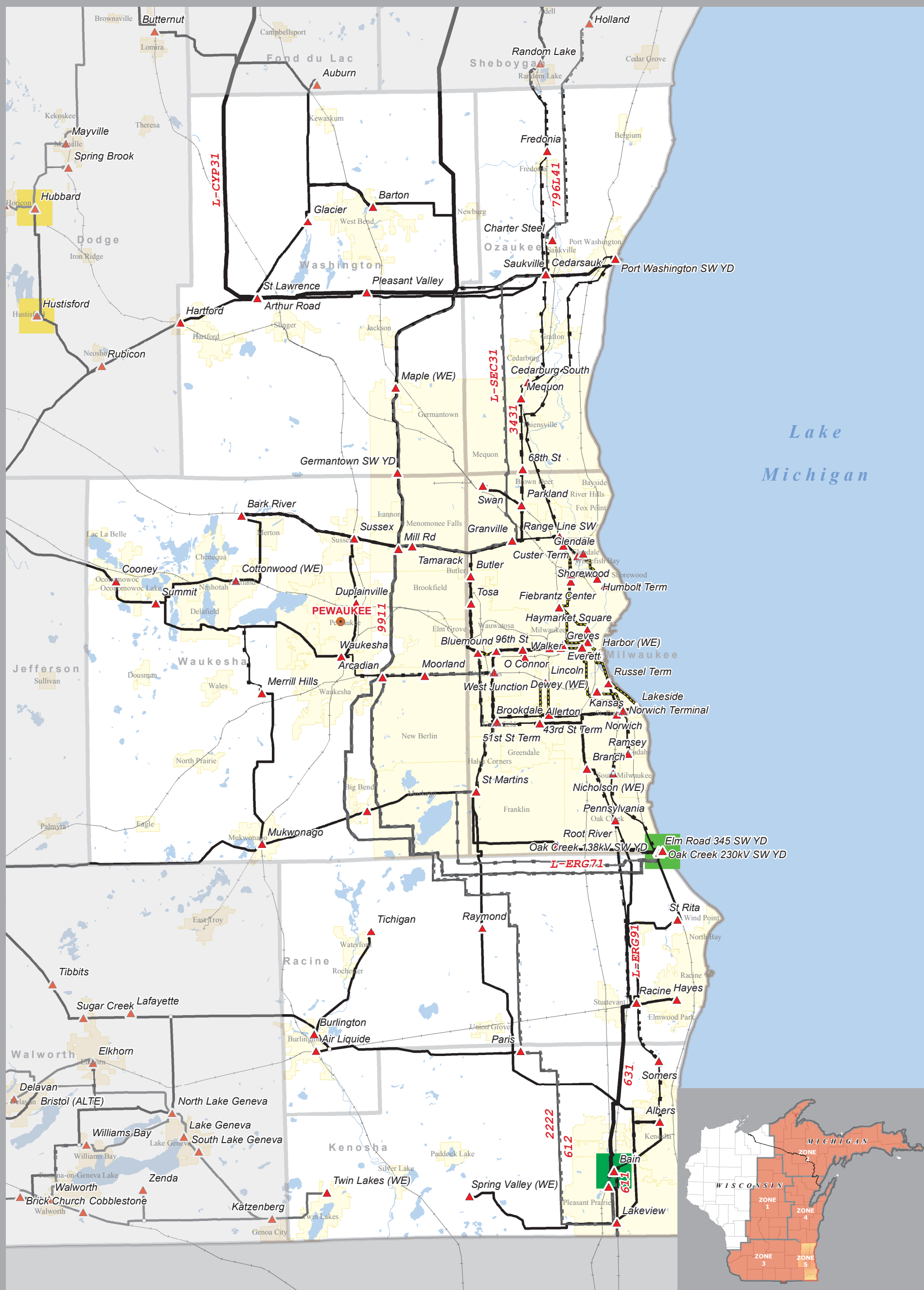


**TABLE ZS-4  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case**

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
5	Oak Creek - Pennsylvania 138-kV line	99.0% 100.4% 100.2% 99.5% 98.6% 98.3% 95.4%		Intact System Ok Creek-Nicholson 138-kV line Oak Creek-Ramsey 138-kV line Nicholson-Ramsey 138-kV line Kansas-Ramsey 138-kV line Norwich – Ramsey 138-kV line Bluemound3 – OC6 230-kV line Plus other less severe outages	Upgrade Oak Creek-Pennsylvania 138-kV line
5	Merrill Hills 138-kV bus		95.1%	Intact System	
5	Glacier 138-kV bus		95.9%	Intact System	
5	Fredonia 138-kV bus		91.9%	Cedarsauk-Fredonia 138-kV line	
5	Cooney 138-kV bus		94.9% 90.9% 89.9%	Intact System Concord-Cooney 138-kV line Split Concord 138-kV bus between buses 4 & 5	Install Summit capacitor banks
5	Cottonwood 138-kV bus		94.1% 91.6% 91.0%  90.6%	Intact System Concord-Cooney 138-kV line Split Concord 138-kV bus between buses 4 & 5 Bark River – Cottonwood 138-kV line	Install Summit capacitor banks
5	Summit 138-kV bus		94.6% 91.4% 90.6%	Intact System Concord-Cooney 138-kV line Split Concord 138-kV between bus 4 & the generator bus	Install Summit capacitor banks
5	Tichigan 138-kV bus		87.1% 90.8%	Split Burlington 138-kV bus Burlington-Air Liquide-Paris 138-kV line	
5	Burlington 138-kV bus		87.9% 91.7%	Split Burlington 138-kV bus Burlington-Air Liquide-Paris 138-kV line	
5	Hartford 138-kV bus		95.5% 89.7%  91.0%	Intact System Split Concord 138-kV bus between buses 4 & 5 Split Concord 138-kV bus between bus 4 & 5	Install Summit capacitor banks
5	St. Lawrence 138-kV bus		95.9% 91.6%	Intact System Split Concord 138-kV bus between buses 4 & 5	
5	Arthur Road 138-kV bus		95.8% 91.6%	Intact System Split Concord 138-kV bus between buses 4 & 5	

**TABLE ZS-4  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case**

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
5	Bark River 138-kV bus		94.8%	Intact System	
5	Root River 138-kV bus		91.9%	Oak Creek-Root River 138-kV line	
5	Edgewood 138-kV bus		95.2% 90.1%	Intact System Edgewood – St. Martin 138-kV line	Install Mukwonago capacitor banks
5	Chinook 138-kV bus		95.2% 90.1%	Intact System Edgewood – St. Martin 138-kV line	
5	Mukwonago 138-kV bus		95.0% 91.6%	Intact System Edgewood – St. Martins 138-kV line	Install Mukwonago capacitor banks
5	Pleasant Valley 138-kV bus		91.5%	Pleasant Valley – Saukville 138-kV line	
5	Pennsylvania 138-kV bus		90.6%	Oak Creek – Pennsylvania 138-kV line	



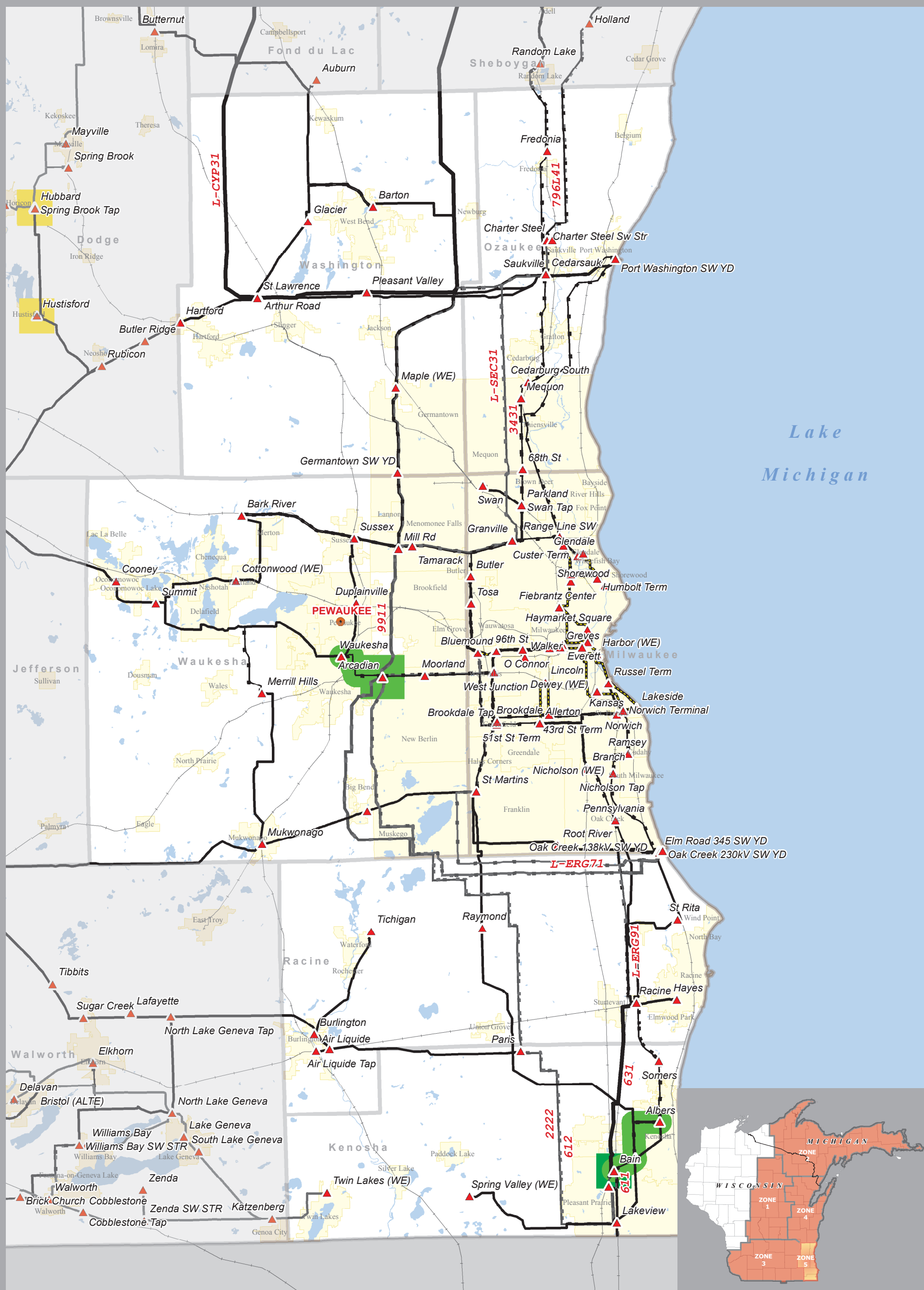
Performance Criteria Limits Exceeded and Other Constraints 2009-2010  
**PLANNING ZONE 5**

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties.  
 Facilities include:  
 \* Approximately 9350 miles of transmission lines  
 \* 96 wholly owned substations  
 \* 410 jointly owned substations  
 \* ATC offices in Madison, Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI

- Low/High Voltages
- Overloaded Facility
- New Generation/Stability
- Transmission Needed for Load Growth
- Transmission Service Limiter

- Transmission Related Facilities**
- Substation, Switchyard or Terminal
  - Proposed/Design/Construction
  - ATC Office Location
  - Generation
  - Other Facility

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Performance Criteria Limits Exceeded and Other Constraints 2011-2014  
**PLANNING ZONE 5**

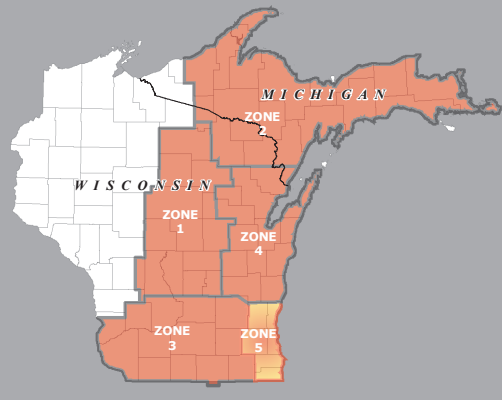
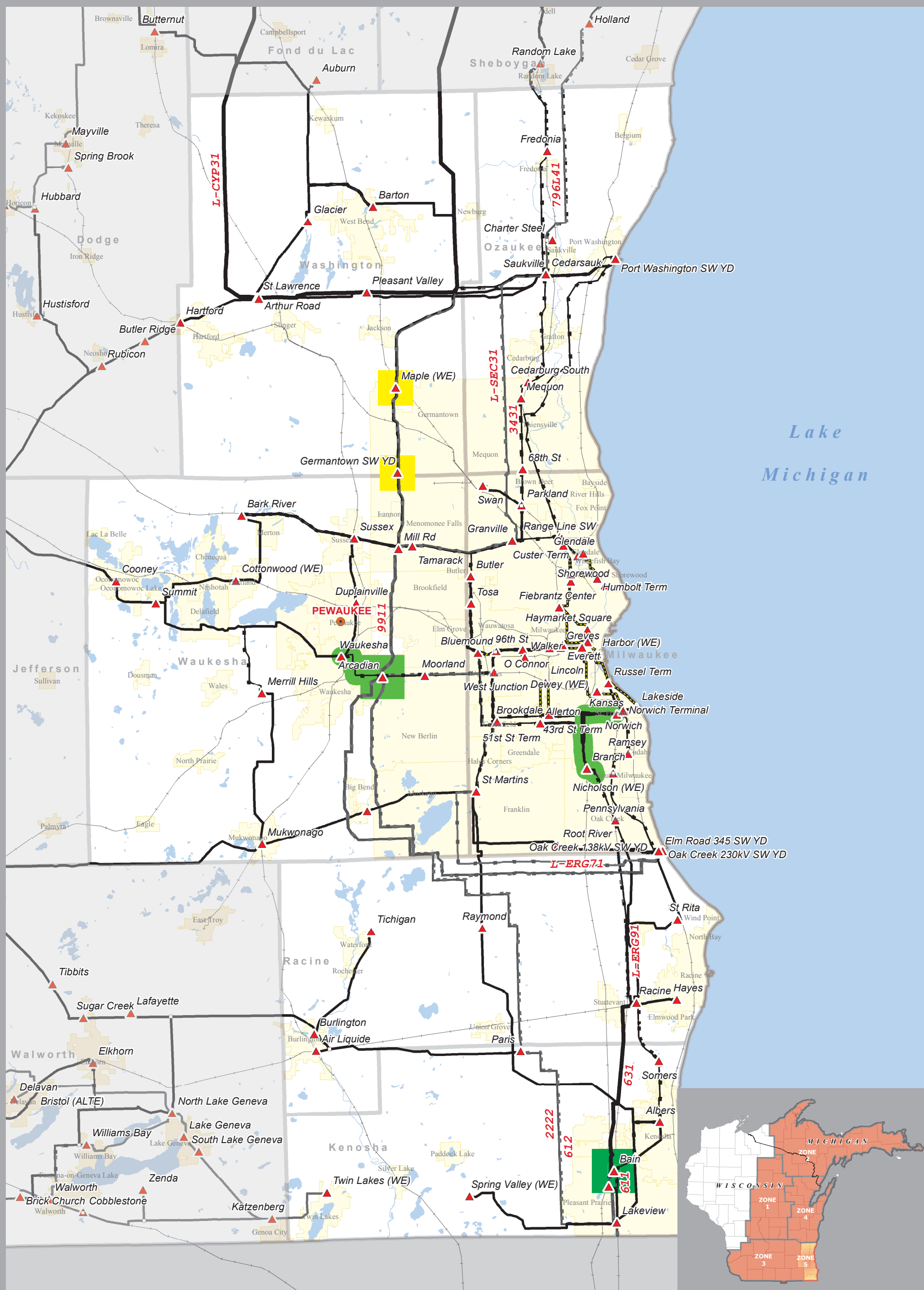
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 Facilities include:  
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- Low/High Voltages
- Overloaded Facility
- New Generation/Stability
- Transmission Needed for Load Growth
- Transmission Service Limiter

- Transmission Related Facilities**
- Substation, Switchyard or Terminal
  - Proposed/Design/Construction
  - ATC Office Location
  - Generation
  - Other Facility

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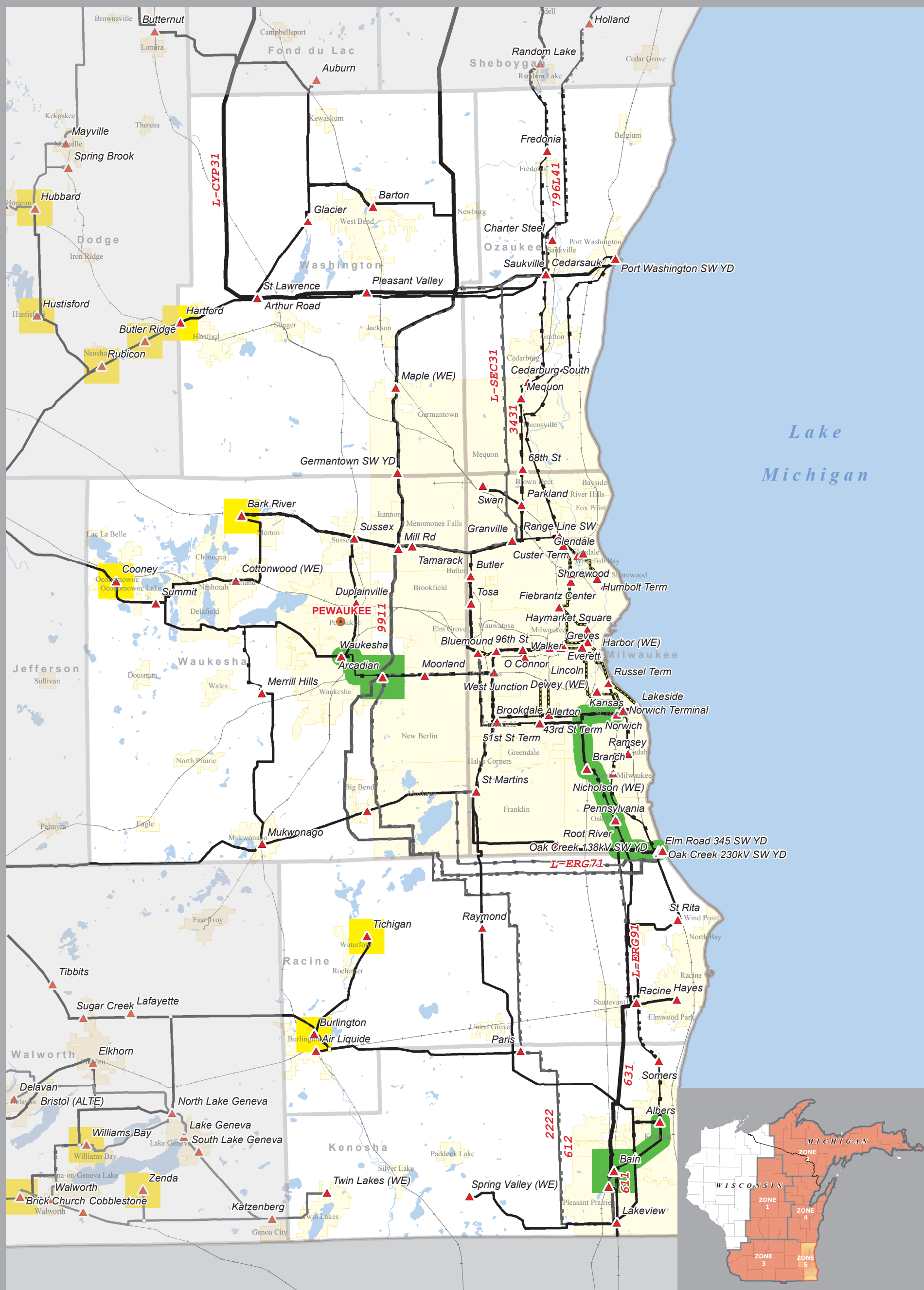
Performance Criteria Limits Exceeded and Other Constraints 2015-2019  
**PLANNING ZONE 5**

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties.  
 Facilities include:  
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 \* 410 jointly owned substations  
 \* ATC offices in Madison, Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI

- Low/High Voltages
- Overloaded Facility
- New Generation/Stability
- Transmission Needed for Load Growth
- Transmission Service Limiter

- Transmission Related Facilities**
- Substation, Switchyard or Terminal
  - Proposed/Design/Construction
  - ATC Office Location
  - Generation
  - Other Facility

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Performance Criteria Limits Exceeded and Other Constraints 2020-2024  
**PLANNING ZONE 5**

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 Facilities include:  
 \* Approximately 9350 miles of transmission lines  
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 \* ATC offices in Madison, Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI

- Low/High Voltages
- Overloaded Facility
- New Generation/Stability
- Transmission Needed for Load Growth
- Transmission Service Limiter

- Transmission Related Facilities**
- ▲ Substation, Switchyard or Terminal
  - ▲ Proposed/Design/Construction
  - ATC Office Location
  - Generation
  - Other Facility

The information presented in this map document is advisory and is intended for reference purposes only. American Transmission Company owned and operated facility locations are approximate.

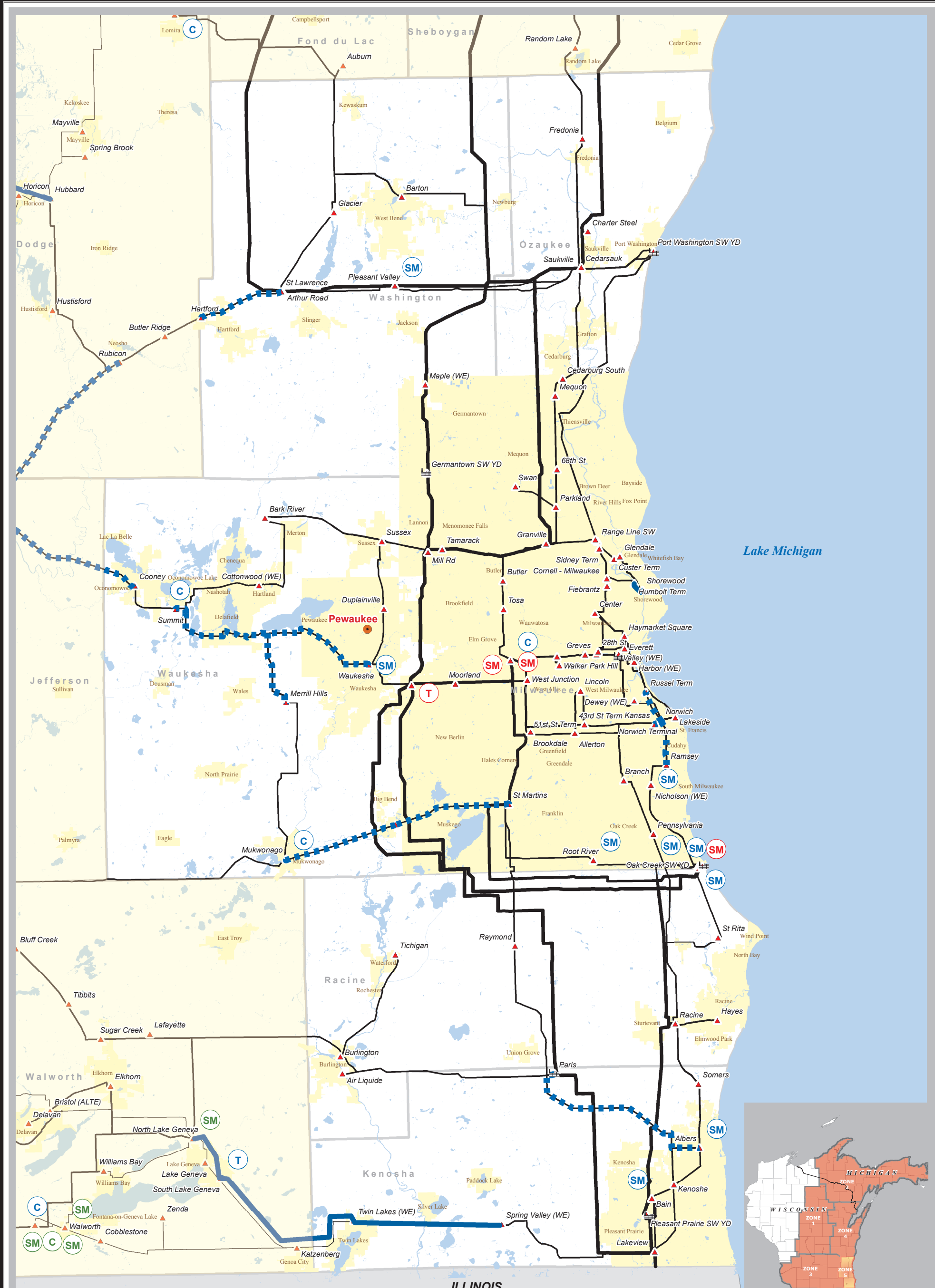
Table PR-18  
Zone 5 Transmission System Additions

<b>System Additions</b>	<b>System Need Year</b>	<b>Projected In-Service Year</b>	<b>Planning Zone</b>	<b>Need Category</b>	<b>Planned, Proposed or Provisional</b>
Construct a 138-kV bus at Pleasant Valley Substation to permit second distribution transformer interconnection	2010	2010	5	T-D interconnection	Planned
Install 2-32 MVAR capacitor banks at Summit 138-kV Substation	2010	2010	5	reliability	Proposed
Expand 345-kV switchyard at Oak Creek to interconnect one new generator	2010	2010	5	new generation	Planned
Uprate Oak Creek-Root River 138-kV line	2010	2010	5	new generation	Planned
Uprate Oak Creek-Nicholson 138-kV line	2010	2010	5	new generation	Planned
Upgrade Bain-Albers 138-kV line	2010	2010	5	reliability	Proposed
Construct second Shorewood-Humboldt 138-kV underground cable	2012	2010	5	reliability	Proposed
Install 3-75 MVAR capacitor banks at Bluemound Substation	2012	2012	5	reliability	Proposed
Uprate Arcadian-Waukesha 138-kV lines KK9942/KK9962	2010	2013	5	reliability	Provisional
Replace two existing 345/138-kV transformers at Arcadian Substation with 1-500 MVA transformer	2010	2013	5	reliability	Provisional

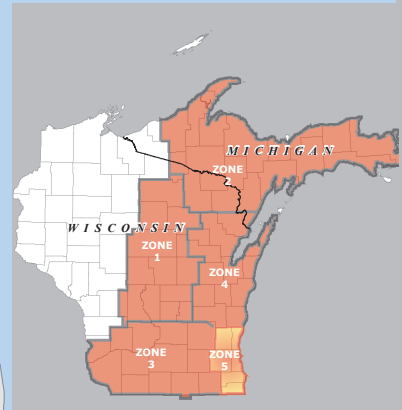
Table PR-18 (continued)  
Zone 5 Transmission System Additions

<b>System Additions</b>	<b>System Need Year</b>	<b>Projected In-Service Year</b>	<b>Planning Zone</b>	<b>Need Category</b>	<b>Planned, Proposed or Provisional</b>
Upgrade Oak Creek-Pennsylvania 138-kV line	2015	2015	5	reliability	Provisional
Install 2-32 MVAR capacitor banks at Mukwonago 138-kV Substation	2019	2019	5	reliability	Provisional
Reconductor Ramsey-Harbor 138-kV line	TBD	TBD	5	reliability	Provisional





ILLINOIS



## 2009 10-Year Assessment Projects PLANNING ZONE 5

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties. Facilities include:

- \* Approximately 9425 miles of transmission lines
- \* 96 wholly owned substations
- \* 410 jointly owned substations
- \* ATC offices in Madison, Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI

- New 69kV Transmission Line
- New 115, 138 or 161 kV Transmission Line
- New 345 kV Transmission Line
- - - Rebuilt 69 kV Transmission Line
- - - Rebuilt 115, 138 or 161 kV Transmission Line
- - - Rebuilt 345 kV Transmission Line
- Transmission Line Voltage Conversion
- SS New Substation
- SM Substation Modifications
- T-D T-D Interconnection
- C Capacitor Bank
- T Transformer

- Existing Transmission Facilities**
- ATC Office Location
  - ▲ ATC Substation, Switchyard or Terminal
  - ⚡ Generation
  - ATC Transmission Line (width = voltage)

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