Zones & study results

Zone 4 overview

Zone 4 includes the Wisconsin counties of:

- Brown
- Calumet
- Dodge (northeast corner)
- Door
- Fond du Lac (eastern portion)
- Manitowoc
- Marinette (southern portion)
- Menominee, Mich. (southern portion)
- Menominee, Wis.
- Oconto
- Outagamie
- Kewaunee
- Shawano (eastern portion)
- Sheboygan
- Winnebago (eastern portion)

The physical boundaries of Zone 4 and transmission facilities located in Zone 4 are shown in Figure ZS-20.

Zone 4 land use is a mix of agricultural, forest and urban.

Major population centers in Zone 4 include Appleton, Green Bay, Fond du Lac, Sheboygan, Marinette/Menominee and Manitowoc.

Zone 4 typically experiences peak electric demands during the summer months, though the northern portion of Zone 4 typically experiences nearly equal summer and winter peaks. Paper mills and foundries in the Green Bay and Appleton metropolitan areas are some of the largest electricity users in the zone.

Zone 4 demographics

The population of the counties in Zone 4 grew at an annual rate of 0.8 percent from 1995 to 2005. The highest growth rate occurred in Calumet County (1.6 percent), while the largest increase in population over the period occurred in Brown County, which increased by 24,300 people.

During the same period, the annual employment growth rate was 1.3 percent. The highest growth rate occurred in Calumet County, while the largest increase in employment occurred in Brown County.

Zone 4 future population and employment projections

Population in Zone 4 grew at 0.7 percent annually from 2001 through 2006 and is projected to grow at 0.7 percent from 2006 through 2011. From 2001 to 2006, Brown County realized the largest increase in population, while Calumet County had the highest growth rate.

Employment in Zone 4 grew at 0.9 percent annually between 2001 and 2006 and is projected to grow at 1.2 percent from 2006 through 2011. From 2001 to 2006, Brown County realized the largest increase in employment, while Calumet County had the highest growth rate.

Zone 4 environmental considerations

Zone 4 includes lands in the Southeast Glacial Plains, Central and Northern Lake Michigan Coastal, and Northeast Sands ecological landscape regions.

The area drains towards Lake Michigan via the Milwaukee, Sheboygan, Manitowoc, Twin-Door-Kewaunee, Wolf and Lower Fox drainage basins. Lake Winnebago and the Fox Valley are located in the central part of this zone. The eastern boundary of the zone is formed by the shorelines of Lake Michigan and Green Bay. The Niagara Escarpment runs through the center of the zone and out the Door County Peninsula.

Portions of the Kettle Moraine State Forest and the Horicon National Wildlife Refuge are found in the southern end of the zone. Navarino State Wildlife Area and a segment of the Wolf River, classified as a Federal Wild and Scenic River, are located in the northwest part of the zone. Several Indian reservations are also located in this zone.

Zone 4 electricity demand and generation

The coincident peak load forecasts for Zone 4 for 2007, 2011 and 2015 are shown in Table ZS-10. 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.

This table shows that load is projected to grow at roughly 2.4 percent annually from 2007 through 2015. Comparing load with generation (at maximum output) within the zone indicates that Zone 4 has more generation than load during peak load periods. Actual operating experience indicates that during lighter load periods, Zone 4 is a net exporter of power.

Zone 4 transmission system issues

Key transmission facilities in Zone 4 include:

- four 345-kV lines extending from the Kewaunee and Point Beach nuclear units, 138-kV network in the Fox River Valley/Green Bay area,
- two 345-kV lines extending from the Edgewater Power Plant,

- the eastern portion of the Rocky Run-North Appleton 345-kV line,
- 345-kV lines from South Fond du Lac to Columbia, Edgewater and Fitzgerald and
- a 345-kV line from Fitzgerald to North Appleton.

Key system performance issues in Zone 4 include:

- heavily loaded and aging 138- and 69-kV facilities in the Green Bay area, north of Green Bay and the Fox River Valley,
- heavily loaded 138-kV and 69-kV facilities in the Sheboygan area,
- low voltages in the northern Door County area,
- heavily loaded 138-kV lines west of Green Bay and Appleton,
- insufficient 138/69-kV transformer capability in the Marinette area,
- the stability response of the Point Beach nuclear units and
- the limited import capability of northeast Wisconsin and Michigan's Upper Peninsula, resulting in uneconomic dispatch of generating units.

Zone 4 - 2007 study results

Refer to Table ZS-1 and Figure ZS-10

Summary of key findings

- Construction of a new 345/138-kV substation at a Werner West site will avert overloads and improve 138-kV voltage profiles in the area.
- Certain generation patterns may cause heavy loading on the Ellington-Hintz-Werner West 138-kV line under single contingency conditions.
- Low voltages and heavy flows will drive the need for additional transmission reinforcements in Upper Peshtigo area.

Several potential line overloads as well as low voltages were revealed in Zone 4 based on the 2007 analysis.

As noted in the Northern Umbrella Plan discussion in the 2005 10-Year Assessment, the most chronic problem plaguing day-to-day operation of ATC's transmission system is the limited transfer capability during non-peak periods between Wisconsin and Michigan's Upper Peninsula. The resulting effects include:

- uneconomic dispatch of generation,
- interruption or curtailment of transmission service,
- operating near thermal and voltage limits for extended periods of time and
- limited ability to schedule maintenance without invoking redispatch, system reconfiguration or other measures.

Most of short-term solutions discussed in the 2005 10-Year Assessment are already in service. Those are:

- rebuilding the Morgan-Falls-Pioneer-Stiles 138-kV line (2005),

- ❑ rebuilding the Plains-Amberg 138-kV line (2005),
- ❑ rebuilding/converting the West Marinette-Amberg 69-kV line to 138 kV (2005)
- ❑ rebuilding the Amberg-Crivitz 138-kV line (2006) and
- ❑ rebuilding the Hiawatha-Indian Lake 69-kV line (2006).

Rebuilding the Amberg-Stiles and Crivitz-Stiles 138-kV lines is the remaining short-term work which is expected to be complete by the end of 2006. As discussed in the 2005 10-Year Assessment, the following projects have been planned in Zone 4 as long-term solutions:

- ❑ construct a new 345/138-kV substation at Werner West (Dec 2006)
- ❑ install a second Plains 345/138-kV transformer (2008)
- ❑ construct a Cranberry-Conover-Plains 115/138-kV line (2008) and
- ❑ construct a new Morgan-Werner West 345-kV line (Dec 2009).

The Werner West 345/138-kV Substation was deferred to December 2006 because the North Appleton-Ellington 138-kV line was uprated in April 2006. The Werner West 345/138-kV Substation also will provide voltage support to the area.

A capacitor bank is planned at the Canal 69-kV Substation in 2007. The addition of this capacitor bank will boost the voltages in the area and reduce the flows on the existing Canal 138/69-kV transformers under normal or single contingency conditions until long-term solutions are in place. The long-term solution may include adding a Canal-Dunn Road 138-kV line (2012) and a Dunn Road-Egg Harbor 69-kV line (2016) which have been deferred due to the planned installation of a capacitor bank at the Sister Bay 69-kV Substation (2008) (See Zone 4-2011 study results).

To accommodate a planned distribution interconnection near Plymouth in 2007, the Forest Junction/Howards Grove-Charter Steel/Saukville 138-kV line is to be looped into the proposed Plymouth #4 138-kV Substation (approximately 1.75 miles).

A project for stringing the Ellinwood-Sunset Point 138-kV line is planned for 2007 in order to address the potential overload on the Ellinwood 138/69-kV T1 transformer under single contingency conditions with certain generation patterns in the area. The project also would provide operations and maintenance flexibility for the double contingency of the Fitzgerald-Sunset Point 138-kV and the Neevin-Woodenshoe 138-kV lines which could potentially cause voltage collapse in the Oshkosh area.

Rebuilding the Crivitz-High Falls double-circuit 69-kV lines is proposed for 2008 in order to address the potential overloads on the Pioneer-Sandstone 69-kV line or the Crivitz-High Falls 69-kV line and to provide voltage support in the area under normal and single contingency conditions. The 2008 in-service date is possible because of the interim load-shifting measure from the Sandstone 69-kV to the Crivitz 138-kV Substation in 2007. Due to the non-coincident nature of the load for this area and the hydro generation patterns in

the area, the potential overloads and low voltage issues may also occur during off-peak periods.

To address system problems due to significantly lower line ratings from a recent line rating review, two new projects are proposed for 2007. Those projects are as follows.

- Uprate the First Avenue-Sawyer 69-kV line (2007). The project includes:
  - Phase 1: investigating the ratings of the submarine cable (2006),
  - Phase 2a: Uprating the line to avoid the potential thermal overload during 2006 summer peak conditions during an outage of the Canal-Dunn Road 69-kV line (2006), and
  - Phase 2b: Uprating the line to achieve higher line ratings (69 SN / 82 SE MVA) (2007).
    Depending on the results of the investigation in Phase 1, Phase 2a may not be needed and the in-service date of Phase 2b may be deferred.
- Uprate the Lakefront-Revere 69-kV line (2007).
  The project will address the line overload during an outage of the Lakefront-Dewey 69-kV line which is one of two outlets for the Lakefront generators. Until the line uprate is in place, the overload issue will significantly limit the outputs of the generators.

The Ellington-Hintz-Werner West 138-kV line may overload during single contingency conditions with certain generation patterns. Re-dispatching generators in the Weston and Appleton areas can be an interim solution until Weston generator 4 is in service (2008).

As discussed in the Update to our 2005 10-Year Assessment, four wind farms at two sites are proposed in the Fond du Lac County area.

- Forward Energy Wind Farm (2006)
- Blue Sky, Green Field, and Lake Breeze Wind Farms, connected at the new Cypress Substation (2006)

Forward Energy Center (200 MW) is scheduled to be in-service in 2006. Interconnection studies have been completed for this generation, and transmission service studies for 150 MW of the plant output have been completed; 150 MW of the requested service is approved and accepted. We will construct the following transmission facilities to support this new generation:

- a new 138-kV switchyard will be located at the wind farm site to connect the generators and to connect two 138-kV lines and a 28 MVAR 138-kV capacitor bank and
- the existing South Fond du Lac-Butternut 138-kV line will be looped into the new switchyard.

Blue Sky, Green Field and Lake Breeze (258 MW) are scheduled to be in-service in 2006. Interconnection studies have been completed and a transmission service study for 160 MW

has been completed; the requested service is approved and accepted. We will construct the following transmission facilities to support this new generation:

- ❑ a new 345-kV switchyard will be located at the wind farm site to connect the generators and two 345-kV lines and
- ❑ the existing Forest Junction-Arcadian 345-kV line will be looped into the new switchyard.

Note that the Lake Breeze wind farm was not included in this 10-Year Assessment because FERC approval of the interconnection agreement was identified after the March 1, 2006 model building cutoff date.

Zone 4 - 2011 study results

Refer to Table ZS-2 and Figure ZS-11

Summary of key findings

- ❑ Construction of a new 345-kV line from Morgan to Werner West will significantly increase transfer capability between Wisconsin and the Upper Peninsula, avert overloads in and around the Green Bay area, improve 138-kV voltage profiles in the Fox Valley and Green Bay areas and significantly lower losses.
- ❑ Load growth in Marinette and Menominee areas will drive the need for additional 138/69-kV transformer capacity.
- ❑ Additional reinforcements will be required in the Manitowoc area to reliably serve load during non-peak periods.

In the 2008 summer peak, the 138/69-kV transformers at the West Marinette and Roosevelt Substations will be either overloaded or approaching their emergency ratings under single contingency conditions and certain generation patterns. In order to address these overload issues, the West Marinette-Bay de Noc 138-kV line will need to be looped into the expanded Menominee 69-kV Substation and a new 138/69-kV transformer will need to be installed at the substation. Although the proposed in-service date of the project is 2008, it can be deferred several years by dispatching the West Marinette G31 generator.

Uprating of the North Appleton-Mason Street and the North Appleton-Lost Dauphin 138-kV lines is scheduled for 2008 to provide transmission service for the Fox Energy Center.

As discussed in the Update to our 2005 10-Year Assessment, two Northern Door County projects were deferred until 2012 and 2016. Deferring the in-service dates was possible due to the installation of an 8.2-MVAR capacitor bank at Sister Bay Substation (2008). The deferral also will provide an opportunity for better resource allocation. The two projects consist of:

- ❑ Construct a 7.7-mile Canal-Dunn Road 138-kV line and install a new 138/69-kV transformer at Dunn Road Substation by June 2012.

- ❑ Construct a second 12.7-mile Dunn Road-Egg Harbor 69-kV line by June 2016.

The rebuild of the Canal-Dunn Road 69-kV line as a 138/69-kV double-circuit line will provide the necessary additional link to northern Door County. The placement of a third 138/69-kV transformer in Door County at a different substation from the other two will provide geographic diversity for the transformation. The second 69-kV line between Dunn Road and Egg Harbor substations will provide a second source to the area and facilitate maintenance outages of the existing Dunn Road-Egg Harbor 69-kV line. The projects will provide more capacity and improve voltages to northern Door County.

As discussed in the 2005 10-Year Assessment, the rebuild of the Sunset Point-Pearl Avenue 69-kV line would address a potential line overload under single contingency conditions. The project is proposed for 2009.

The proposed Morgan-Werner West 345-kV line in 2009 would aid the transmission system by reducing the south to north loading on the 138-kV lines through the Green Bay area, thus deferring or eliminating the need for numerous 138-kV transmission line upgrades/rebuilds in and around Green Bay. The proposed project also would provide the extra transmission capacity needed to fully utilize the upgrades to the Wisconsin-Upper Peninsula transmission corridor which are scheduled to be completed before this project (i.e., Plains-Stiles and Cranberry-Conover).

The proposed Clintonville-Werner West 138-kV line will be strung primarily on Morgan-Werner West 345-kV line structures. The proposed project would provide significant system benefits. These benefits include additional reduced loading on the Highway V-Preble-Tower Drive 138-kV line, the North Appleton-Lawn Road-White Clay 138-kV line, the Badger 138/115-kV transformer, the Badger-Caroline 115-kV line and facilitating a future de-energized rebuild of the Pulliam-Stiles double-circuit 138-kV line, which would not be possible under current system conditions. In addition, the Clintonville-Werner West line will provide a second 138-kV source to the city of Clintonville.

Two capacitor bank projects are scheduled for 2011. Those projects are:

- ❑ Install 2-16.3 MVAR capacitor banks at the Mears Corners 138-kV Substation - This provisional project is to address the potential low voltage issues in the Woodenshoe, Mears Corners, and Sunset Point areas under single contingency conditions until additional reinforcements are implemented in the area.
- ❑ Install 2-16.3 MVAR capacitor banks at the Rosiere 138-kV Substation - This provisional project is to address the potential low voltage issue in the Ontario, Dyckesville, and Rosiere areas under single contingency conditions until additional reinforcements are implemented in the area. Due to the uncertainty of load demand in the area, a detailed study needs to be done for an accurate in-service date.

A new 138-kV line project is proposed to address potential heavy flows on the Shoto-Mirro-Northeast-Revere 69-kV line or the Shoto 138/69-kV transformer under single contingency conditions during non-peak periods (2012). The project includes constructing a new Shoto to Custer 138-kV line and installing a new 138/69-kV transformer at Custer Substation. This project may be able to be deferred several years with more generation running at Lakefront during non-peak periods.

A project for replacing the two existing Glenview 138/69-kV transformers is proposed for 2014. It would address the potential overload of the transformer under single contingency conditions during non-peak periods. The transformer overloads are primarily due to higher load demand at Brillion Iron Works (BIW) during non-peak periods. This project may be able to be deferred several years by swapping the loads on the Glenview 69-kV and 138-kV buses. However, there is also a potential for an early in-service date depending on the new load interconnection at BIW (2007).

Several projects are cancelled either due to higher ratings yielded from recent rating reviews or because they are already covered by other Maintenance or System Protection projects. These cancelled projects are:

- ❑ Retap the 48 MVA CT associated with the South Sheboygan Falls 138/69-kV transformer (2010).
- ❑ Retap the 400 A primary CT associated with the Edgewater-Nicolet 69-kV line (2012).
- ❑ Replace the 300A CT associated with the Sheboygan Falls-Adams St 69-kV line (2013). This project will be done as part of the existing project at Sheboygan Falls Substation (2006 or 2007) driven by Maintenance and System Protection.
- ❑ Replace the 300A metering current transformers associated with the Edgewater-Washington St-Riverside 69-kV line (2013).

Zone 4 – 2015 study results

Refer to Table ZS-3 and Figure ZS-12

Summary of key findings

- ❑ Load growth in the eastern portion of the metropolitan Green Bay area will drive the need for system reinforcements.
- ❑ Additional transformer capacity is needed due to the load growth in the Oshkosh area.

A potential load interconnection at the Bluestone 69-kV Substation (2015) may cause unacceptably low voltages under single contingency conditions. A Best Value Planning analysis needs to be performed in order to address the low voltages and determine the best location for the potential new load interconnection.

Three related reconductor projects comprised of Pulliam-Van Buren, Pulliam-Danz and the Danz-Henry Street 69-kV lines are proposed for 2015 to address potential overloads or heavy flows on the lines under single contingency conditions. The transmission system is under detailed study for a Best Value Planning solution which will accommodate a new load interconnection at the Henry Street 69-kV Substation and possible future transmission expansion in the area. Depending on the study results, the scope of the project may be adjusted and the in-service date may be changed.

In the 2015 summer peak timeframe, the two 138/69-kV transformers at the Sunset Point Substation will be overloaded under single contingency conditions. To address these overload issues, replacing the two existing transformers with larger transformers is proposed for 2015.

Unacceptable voltages may occur at the Butternut, Forward Energy Center and Hickory 138-kV substations under single contingency conditions. A project for installing 28.8 MVAR of capacitor banks at Butternut Substation is proposed for 2015.

Replacing the 1200A breaker at the Edgewater T22 345/138-kV transformer is proposed for 2014 to address potential transformer overloads under single contingency conditions. The load in the Edgewater area is currently under review. Depending on the result of the review, the in-service date of the project may be changed.

Uprating the Melissa-Tayco 138-kV line (0.16 miles) is scheduled for 2014 to address the line overload under single contingency conditions and certain generation patterns.

TABLE ZS-1
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2007 Peak and Hot Summer Case

Planning Zone	Criteria Exceeded/Need	% of Facility Rating Peak Case	% of Nominal Bus Voltage Peak Case	Cause	% of Facility Rating Hot Summer Case	% of Nominal Bus Voltage Hot Summer Case
1	Antigo, Aurora Street and Summit Lake 115-kV bus voltages		89 – 92%	Gardner Park-Blackbrook-Antigo 115-kV line outage		88 – 92%
1	Weston-Sherman Street 115-kV line	102%		Weston-Morrison 115-kV line outage	105%	
1	Weston-Morrison 115-kV line	104%		Weston-Sherman Street 115-kV line outage	107%	
1	Morrison-Sherman Street 115-kV line	112%		Weston-Sherman Street 115-kV line outage	115%	
1	Sigel, Lakehead Vesper & Port Edwards 138-kV bus voltages		87 – 91%	Arpin-Sigel 138-kV line outage Sigel-Lakehead Vesper 138-kV line outage Lkhd Vesper-Port Edwards 138-kV line outage		85 – 90%
1	Port Edwards, Hollywood, & Saratoga 138-kV bus voltages		88 – 92%	Arpin-Sigel 138-kV line outage Sigel-Lakehead Vesper 138-kV line outage Lkhd Vesper-Port Edwards 138-kV line outage		86 – 92%
1	Castle Rock – Quincy 69-kV line	95 - 102%		Various line outages	95 – 107%	
1	Council Creek 69-kV bus tie	97 – 100%		King-Eau Claire-Arpin 345-kV line outage Eau Claire-Arpin 345-kV line outage Hillsboro-Hillsboro tap 69-kV line outage	98 – 102%	
1	Council Creek and Petenwell 138-kV bus voltage		90 – 96%	Base Case Arpin-Sigel 138-kV line outage Sigel-Lakehead Vesper 138-kV line outage		91%
1	Necedah, Whistling Wings, Dellwood, Friendship, Houghton Rock 69-kV bus voltages		89 – 91%	Petenwell 138/69-kV transformer Petenwell-Big Pond 69-kV line outage Big Pond-Necedah tap 69-kV line outage		88 – 92%
1	Wautoma, Sand Lake and Roeder 138-kV bus voltages		88 – 95%	Base Case Various line outages		86 – 92%
1	Metomen 138/69-kV transformer	97 – 102%		North Fond Du Lac-Rosendale 69-kV line outage Rosendale-Metomen 69-kV line outage	96 – 107%	
1	Metomen-Ripon 69-kV line	98%		Winneconne-Sunset Point 69-kV line outage	97 – 104%	
1	NW Ripon - Ripon 69-kV line	96%		Winneconne-Sunset Point 69-kV line outage	102%	
1	Metomen-Rosendale 69-kV line	96%		Metomen 138/69-kV transformer outage	102%	
1	North Fond du Lac-Rosendale 69-kV line	105%		Metomen 138/69-kV transformer outage	112%	
1	Berlin area 69-kV bus voltages		88 – 92%	Various line outages		85 – 92%
1	Deer Trail-Polar Tap 69-kV line	98%		Gardner Pk-Blackbrook-Antigo 115 kV outage	96 – 102%	
1	Portage – Lakehead Portage 69-kV line	95 – 101%		Various line outages	95 – 107%	
1	Roslin, Endeavor and Lakehead Portage 69-kV bus voltages		84 – 91%	Portage-Lakehead Portage 69-kV line outage		84 – 92%
1	Coloma (ACEC) 69-kV bus voltage		91%	Chaffee Creek-Coloma tap 69-kV line outage		90%
1	Roslin – Lakehead Portage 69-kV line	-		Various line outages	98 – 100%	
1	Mckenna – Quincy 69-kV line	-		Winnebago-Quincy 69-kV line outage	98%	
1	Bunker Hill – Blackbrook 115-kV line	-		Gardner Park-Blackbrook 115-kV line outage	95%	
1	Wild Rose and Wild Rose (ACEC) 69-kV bus voltages		-	Harrison 138/69-kV transformer outage		91 – 92%
1	Hancock, Hancock (ACEC), Plainfield, Plainfield (ACEC), Coloma 69-kV bus voltages		-	Sand Lake 138/69-kV transformer outage		89 – 90%
1	Wisconsin Dells #2, Lyndon Station 69-kV bus voltages		-	Kilbourn-Wisc Dells #2 69-kV line outage		91 – 92%
1	Winnebago, Glen 69-kV bus voltages		-	Kilbourn-Winnebago 69-kV line outage		91 – 92%
2	Atlantic-Elevation Tap #1 69-kV	113%		Atlantic-Elevation Tap #1 69-kV line outage	119%	
2	Sawyer, Gwinn 69-kV bus voltages		89-91%	Forsyth-Gwinn 69-kV line outage		88-90%
2	Bruce Crossing, Watersmeet 69-kV bus voltages		90-91%	Mass-Bruce Crossing 69-kV line outage		88-89%
2	L'Anse, Baraga, M-38 69-kV bus voltages		89-91%	M-38 138/69-kV transformer outage		89-91%
2	Munising 69-kV bus voltage		91%	Munising 138/69-kV transformer, Munising-Forsyth 138-kV line outage		91%

TABLE ZS-1
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2007 Peak and Hot Summer Case (continued)

Planning Zone	Criteria Exceeded/Need	% of Facility Rating Peak Case	% of Nominal Bus Voltage Peak Case	Cause	% of Facility Rating Hot Summer Case	% of Nominal Bus Voltage Hot Summer Case
2	L'Anse and Baraga 69-kV bus voltages, M-38 and Atlantic 138-kV bus voltages		90-91%	M38-Perch Lake 138-kV line outage		
2	Hiawatha, Lakehead, Brevort 138-kV bus voltages		90%	Hiawatha-Lakehead 138-kV line outage, Lakehead-Brevort 138-kV line outage, Brevort-Straits 138-kV line outage		89%
2	Engadine, Newberry Village, Newberry Hospital, Louisiana Pacific and Roberts 69-kV bus voltages		89-91%	Engadine-Hiawatha 69-kV line outage		87-88%
2	St. Ignace and Straits 69-kV bus voltages		91%	Straits 138-69-kV transformer		89-90%
3	Rock River 138/69-kV transformer	109%		Colley Road-Brick Church 138-kV line outage Op Guide, Colley Road-Brick Church 138-kV line outage, Black Hawk-Colt Industries 69-kV line outage.	111%	
3	Rock River-Turtle 69-kV line	128%		Colley Road-Brick Church 138-kV line outage Op Guide, Colley Road-Brick Church 138-kV line outage	131%	
3	Colley Road-Brick Church 69-kV line	111%		Colley Road-Brick Church 138-kV line outage	115%	
3	Paddock-Shirland Ave 69-kV line	104%		Colley Road 138/69-kV transformer outage	108%	
3	Colley Road-Park Ave Tap 69-kV line	110%		Paddock 138/69-kV transformer outage	116%	
3	Colley Road 138/69-kV transformer	96%		Paddock 138/69-kV transformer outage	100%	
3	North Lake Geneva-Lake Geneva 69-kV line	109%		Brick Church-Cobblestone 69-kV line outage	114%	
3	Brick Church-Cobblestone 69-kV line	114%		North Lake Geneva-Lake Geneva 69-kV line outage	119%	
3	Janesville-Parkview 69-kV line	113%		McCue 138/69-kV transformer outage	120%	
3	Royster-Pflaum 69-kV line	104%		Fitchburg-Syene 69-kV line outage	109%	
3	Blount-Ruskin 69-kV line	106%		Second Blount-Ruskin 69-kV line outage	119%	
3	Fitchburg-Syene 69-kV line	111%		Royster-Pflaum Tap 69-kV line outage	117%	
3	Stage Coach-Black Earth 69-kV line	102%		Spring Green 138/69-kV transformer outage	109%	
3	Verona-Oregon 69-kV line	121%		Stoughton-Aaker Road 69-kV line outage, Stoughton-Sheepskin 69-kV line outage	131%	
3	North Monroe-Monticello 69-kV line	95%		Stoughton-Aaker Road 69-kV line outage	99%	
3	Brodhead-Blacksmith 69-kV line	111%		North Monroe 138/69-kV transformer outage, Town line Road-Albany 138-kV line outage, Albany-North Monroe 138-kV line outage	116%	
3	Hillman-Belmont 69-kV line	97%		Nelson Dewey-Lancaster 138-kV line outage	97%	
3	Hillman 138/69-kV transformer	115%		Various DPC 69-kV line outages	121%	
3	Darlington-Rock Branch 69-kV line	97%		Nelson Dewey-Lancaster 138-kV line outage	98%	
3	Kilbourn 47 MVA 138/69-kV transformer	144%		Kilbourn 93 MVA 138/69-kV transformer outage	152%	
3	Portage-Columbia 69-kV line	113%		Portage 138/69-kV transformer outage	118%	
3	Columbia 138/69-kV transformer	105%		Portage 138/69-kV transformer outage, North Madison 138/69-kV transformer outage	109%	
3	Portage-Trienda 138-kV line	98%		Second Portage-Trienda 138-kV line outage	104%	
3	Columbia 345/138-kV transformer #2	98%		Columbia 345/138-kV transformer #1 and #3 outage	103%	
3	Academy-Columbus 69-kV line	110%		North Randolph-Fox Lake 138-kV line outage, Fox Lake-North Beaver Dam 138-kV line outage,	117%	
3	Concord-Cooney 138-kV line	102%		Concord 138-kV bus 4-5 outage	111%	
3	Cobblestone-Zenda Tap 69-kV line			North Lake Geneva-Lake Geneva 69-kV line outage	98%	
3	North Monroe-Monticello 69-kV line			Stoughton-Sheepskin 69-kV line outage	95%	
3	Black Hawk 138/69-kV transformer			Rock River 138/69-kV transformer outage	96%	

TABLE ZS-1
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2007 Peak and Hot Summer Case (continued)

Planning Zone	Criteria Exceeded/Need	% of Facility Rating Peak Case	% of Nominal Bus Voltage Peak Case	Cause	% of Facility Rating Hot Summer Case	% of Nominal Bus Voltage Hot Summer Case
3	Janesville 138/69-kV transformer			McCue 138/69-kV transformer outage	96%	
3	McCue-Harmony 69-kV line			Sheepskin-Sheepskin Peak Unit 69-kV line outage, Paddock-Newark 69-kV line outage, Brodhead Switching Station-Brodhead Muni 3 69-kV line outage	98%	
3	Columbia 138/69-kV transformer			Deforest-North Madison 69-kV line outage	96%	
3	Pheasant Branch-Westport 69-kV line			West Middleton-Pheasant Branch 69-kV line outage	98%	
3	Town Line-Albany 138-kV line			Nelson Dewey-Potosi 138-kV line outage, Potosi-Hillman 138-kV line outage	97%	
3	Portage-Columbia 138-kV line			Second Portage-Columbia 138-kV line outage	95%	
3	Both of the Blount-Ruskin 69-kV lines			North Madison 138/69-kV transformer outage, North Madison-Dane 69-kV line outage	98%	
3	Concord-Cooney 138-kV line			Concord-Rubicon 138-kV line outage	97%	
3	Syene-Nine Springs 69-kV line			Royster-Pflaum Tap 69-kV line outage	99%	
3	Koch Oil Tap-South Fond Du Lac 69-kV line			North Randolph-Fox Lake 138-kV line outage	98%	
3	Lake Geneva, South Lake Geneva, Twin Lake, Katzenberg 69-kV bus voltages		88-90%	North Lake Geneva-Lake Geneva 69-kV line outage		88-91%
3	Brodhead Muni 3, Brodhead Muni 2, Brodhead, Brodhead Muni 1, RCEC Orfordville 69-kV bus voltages			Brodhead Switching Station-Brodhead Muni 3 69-kV line outage, Brodhead Muni 3-Brodhead Muni 2 69-kV line outage		92%
3	Evansville, RCEC center 69-kV bus voltages		90-92%	Evansville-Sheepskin 69-kV line outage		89-91%
3	North Monroe, Idle Hour, Monroe, Monroe Tap, South Monroe, Monticello, Monticello Tap, New Glarus, Belleville, Blacksmith, Browntown, Verona, Oregon, Green Wind 69-kV bus voltages		85-92%	North Monroe 138/69-kV transformer, North Monroe-Idle Hour 69-kV line outage, Idle Hour-Monroe 69-kV line outage		83-90%
3	Monticello, Monticello Tap, New Glarus, Belleville, Verona, Oregon, Brooklyn 69-kV bus voltages		83-91%	North Monroe-Monticello Tap 69-kV line outage, Monticello Tap-New Glarus 69-kV line outage, New Glarus-Belleville 69-kV line outage		81-90%
3	Pine River, Richland Center, Richland, Lone Rock 69-kV bus voltages		91-92%	Pine River-Richland 69-kV line outage, Lone Rock-Richland 69-kV line outage, Lone Rock 69 kV phase shifter outage		90-91%
3	Spring Green 69-kV bus voltage		92%	Spring Green 138/69-kV transformer outage		91%
3	Brooklyn, Oregon, Aaker Road, Verona, Belleville 69-kV bus voltages		83-90%	Stoughton-Aaker Road 69-kV line outage		80-90%
3	Brooklyn, Oregon 69-kV bus voltages		90%	Oregon-Aaker Road 69-kV line outage		88%
3	North Beaver Dam, Beaver Dam East 138-kV bus voltages		93%	Base case, various line outages		92%
3	North Beaver Dam, Beaver Dam East, Fox Lake, Cambridge, Cambridge Tap, London, Boxelder, Lakehead Waterloo, Stony Brook 138-kV bus voltages		89-91%	Boxelder to London 138-kV line outage, Rockdale to Cambridge Tap 138-kV line outage, Cambridge Tap to London 138-kV line outage		88-89%
3	Pflaum, Pflaum Tap , AGA Gas 69-kV bus voltages		91%	Royster-Pflaum Tap 69-kV line outage		90%
3	Concord 5 138-kV bus voltage		92%	Concord 138-kV bus 4-5 outage		89%
3	Dickinson, Brick Church, Williams Bay, Elkhorn 138-kV bus voltages		90-92%	Colley Road-Brick Church 138-kV line outage		89-91%
3	North Lake Geneva 138-kV bus voltage		92%	North Lake Geneva-North Lake Geneva Tap 138-kV line outage		91%
3	Lewiston, Kilbourn, Loch Mirror, Birchwood, Dell Creek, Zobel, Nishan 138-kV bus voltages		90-92%	Trienda-Lewiston 138-kV line outage		88-90%
3	Kilbourn, Loch Mirror, Birchwood, Dell Creek, Zobel, Nishan 138-kV bus voltages		90-92%	Lewiston-Kilbourn 138-kV line outage		88-90%

TABLE ZS-1
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2007 Peak and Hot Summer Case (continued)

Planning Zone	Criteria Exceeded/Need	% of Facility Rating Peak Case	% of Nominal Bus Voltage Peak Case	Cause	% of Facility Rating Hot Summer Case	% of Nominal Bus Voltage Hot Summer Case
3	North Beaver Dam, Beaver Dam East, Fox Lake 138-kV bus voltages		80%	North Randolph-Fox Lake 138-kV line outage, Fox Lake-North Beaver Dam 138-kV line outage		78%
3	Avoca, Muscoda, Lone Rock, Arena, Mazomanie, Mazomanie Industrial 69-kV bus voltages			Spring Green 138/69-kV transformer outage		92%
3	Burke 69-kV bus voltage			Reiner Road-Burke Tap 69-kV line outage, Reiner Road 138/69-kV transformer outage		91%
3	North Lake Geneva Tap, North Lake Geneva 138-kV bus voltages			Burlington 138-kV bus 1-2 outage		92%
3	Albany 138-kV bus voltage			Town Line-Albany 138-kV line outage		92%
3	Hustiford, Spring Brook, Mayville, Oakfield, Horicon Industrial Park 69-kV bus voltages			Oakfield-South Fond Du Lac 69-kV line outage		91-92%
3	Fox Lake 138-kV bus voltage			Base case		94%
3	Footville, Bass Creek 69-kV bus voltages			Evansville-Sheepskin 69-kV line outage		91-92%
3	Nine Springs 69-kV bus voltage			Royster-Pflaum Tap 69-kV line outage		92%
3	Third Street, Center Street, Alto 69-kV bus voltages			North Randolph-Fox Lake 138-kV line outage		91-92%
4	Pioneer-Sandstone 69-kV line	95.3%		Crivitz-High Falls 69-kV line outage	100%	
4	High Falls-Crivitz 69-kV line	<95%		Pioneer-Sandstone 69-kV line outage	95%	
4	Goodman 69-kV bus		92.6%	Base Case		93%
4	Mountain 69-kV bus		91%	Crivitz-High Falls 69-kV line outage		89%
4	Thunder, High Falls, Caldron Falls 69-kV buses		>92%	Crivitz-High Falls 69-kV line outage		91-92%
4	Woodenshoe, Mears Corners 138-kV buses		>92%	Neevin-Woodenshoe 138-kV line outage		91%
4	Ellington-Hintz 138-kV line	107.6%		North Appleton-Werner West 345-kV line outage	115%	
4	Hintz-Werner 138-kV line	105.9%		North Appleton-Werner West 345-kV line outage	113%	
4	Werner-Werner West 138-kV line	<95%		North Appleton-Werner West 345-kV line outage	99%	
5	Bain 345/138-kV transformer #5	161%		Splitting Pleasant Prairie 345-kV bus sections 3 & 4	164%	
5	Oak Creek 345/230-kV transformer T884	101-108%		Various Oak Creek 230-kV bus outages	106–111%	
5	Pleasant Valley – Saukville 138-kV line	123%		Various outages	98–133%	
5	Pleasant Valley – Arthur Road 138-kV line			Various outages	98%	
5	Cooney – Concord 138-kV line	102%		Splitting Concord 345-kV bus sections 3 & 4	107%	
5	St. Martins – Raymond 138-kV line			Pleasant Prairie – Racine 345-kV line	98%	
5	Germantown – Maple 138-kV line			Bark River - Germantown	101%	

TABLE ZS-2
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2011 Peak, Hot Summer and Shoulder Cases

Planning Zone	Criteria Exceeded/Need	% of Facility Rating Peak Case	% of Nominal Bus Voltage Peak Case	Cause	% of Facility Rating Hot Summer Case	% of Nominal Bus Voltage Hot Summer Case	% of Facility Rating Shoulder Case	% of Nominal Bus Voltage Shoulder Case
1	Antigo, Aurora Street, Summit Lake, Venus, Three Lakes, Cranberry, St. Germain, Clear Lake, Highway 8, Hodag, Eastom, Tomahawk and Pine 115-kV bus voltages		82 – 92%	Maine-Pine 115-kV line outage Blackbrook-Antigo 115-kV line outage Antigo-Aurora Street 115-kV line outage Gardner Park-Blackbrook-Antigo 115 kV outage		80 – 92%		--
1	Bunker Hill – Blackbrook 115-kV line	108%		Gardner Park-Blackbrook 115-kV line outage	113%		--	
1	Gardner Park – Blackbrook 115-kV line	97 – 108%		Maine-Pine 115-kV line outage Maine-Hilltop 115-kV line outage	99 – 113%		--	
1	Kelly – Bunker Hill 115-kV line	95%		Maine-Pine 115-kV line outage	105%		--	
1	Highway 8 – Clear Lake 115-kV line	--		Three Lakes-Venus 115-kV line outage	98%		--	
1	Sigel, Lakehead Vesper and Port Edwards 138-kV bus voltages		89 – 90%	Arpin-Sigel 138-kV line outage		89 – 90%		91 – 92%
1	Port Edwards, Hollywood, and Saratoga 138-kV bus voltages		90 – 91%	Arpin-Sigel 138-kV line outage		90 – 91%		91 – 92%
1	Castle Rock – Quincy 69-kV line	98%		Petenwell 138/69-kV transformer outages Petenwell-Big Pond 69-kV line outage Necedah tap-Big Pond 69-kV line outage	101%		96 – 107%	
1	Council Creek 69-kV bus tie	--		Hillsboro-Hillsboro tap 69-kV line outage	96%		95 – 113%	
1	Council Creek and Petenwell 138-kV bus voltage		90 – 95%	Base Case Arpin-Sigel 138-kV line outage Sigel-Lakehead Vesper 138-kV line outage Council Creek-Petenwell 138-kV line outage Petenwell-Saratoga 138-kV line outage		90 – 95%		--
1	Necedah, Whistling Wings, Dellwood, Friendship, Houghton Rock 69-kV bus voltages		89 – 92%	Petenwell 138/69-kV transformer Petenwell-Big Pond 69-kV line outage Big Pond-Necedah tap 69-kV line outage Necedah tap-Whistling Wings tap 69 kV outage		87 – 92%		91 – 92%
1	Hilltop, Lyndon Station, Wisconsin Dells 69-kV bus voltages		90 – 92%	Kilbourn-Wisc. Dells 69-kV line outage		89 – 91%		--
1	Wautoma, Sand Lake and Roeder 138-kV bus voltages		91 – 96%	Base Case Sigel-Arpin 138-kV line outage		90 – 95%		--
1	Sand Lake 138/69-kV transformer	95 – 101%		Wautoma 138/69-kV transformer outage Winnebago-Kilbourn 69-kV line outage Trienda-Lewiston 138-kV line outage E. Dells-Lewiston 138-kV line outage	95 – 107%		--	
1	Hancock, Hancock (ACEC), Plainfield and Plainfield (ACEC) 69-kV bus voltages		91 – 92%	Sand Lake 138/69-kV transformer outage		89 – 92%		--
1	Metomen 138/69-kV transformer	95 – 111%		Base Case Various line outages	95 – 117%		--	
1	Metomen – Ripon 69-kV line	96 – 103%		Winneconne-Sunset Point 69-kV line outage Omro-Winneconne 69-kV line outage Markesan tap-North Randolph 69-kV line outage	97 – 112%		--	
1	NW Ripon – Ripon 69-kV line	102%		Winneconne-Sunset Point 69-kV line outage	98 – 109%		--	
1	Winneconne – Sunset Point 69-kV line	95%		NW Ripon - Ripon 69-kV line outage	102%		--	
1	Omro – Winneconne 69-kV line	--		NW Ripon - Ripon 69-kV line outage	98%		--	
1	Berlin area 69-kV bus voltages		88 – 92%	Various line outages		85 – 92%		--
1	Roslin, Endeavor and Lakehead Portage 69-kV bus voltages		87 – 92%	Portage-Lakehead Portage 69-kV line outage Endeavor tap-Lkhd Portage 69-kV line outage		84 – 90%		--
1	Whitcomb 115/69-kV transformer	99%		Antigo-Blackbrook 115-kV line outage	97 – 112%		--	
1	Caroline 115/69-kV transformer	--		Whitcomb 115/69-kV transformer	96%		--	
1	Deer Trail – Polar tap 69-kV line	98 - 105%		Gardner Park-Blackbrook-Antigo 115 kV outage Gardner Park-Blackbrook 115-kV line outage Blackbrook-Antigo 115-kV line outage	99 – 113%		--	

TABLE ZS-2
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2011 Peak, Hot Summer and Shoulder Cases (continued)

Planning Zone	Criteria Exceeded/Need	% of Facility Rating Peak Case	% of Nominal Bus Voltage Peak Case	Cause	% of Facility Rating Hot Summer Case	% of Nominal Bus Voltage Hot Summer Case	% of Facility Rating Shoulder Case	% of Nominal Bus Voltage Shoulder Case
1	Brooks Corners – Deer Trail 69-kV line	--		Gardner Park-Blackbrook-Antigo 115 kV outage Gardner Park-Blackbrook 115-kV line outage Blackbrook-Antigo 115-kV line outage	95 –97%		--	
1	Coloma (ACEC), Lincoln Pumping Station, Brooks (ACEC) and Grand Marsh 69-kV bus voltages		90 – 92%	Chaffee Creek-Coloma tap 69-kV line outage		89 – 91%		90 – 91%
1	White Lake 138-kV bus voltage		91%	Werner West-White Lake 138-kV line outage		91%		--
1	Plover – Coyne 115-kV line	--		Rocky Run-Coyne 115 kV line outage	--		97%	
2	Indian Lake 138-kV bus voltage		95%	Intact System		94%		
2	Atlantic-Elevation Tap #1 69-kV	115%		Atlantic-Elevation Tap #1 69-kV line outage	122%			
2	Sawyer, Gwinn, Chatham, Forest Lake 69-kV bus voltages		--	Forsyth-Gwinn 69-kV line outage		84-91%		
2	Sawyer, Gwinn 69-kV bus voltages		87-88%	Forsyth-Gwinn 69-kV line outage		--		
2	Bruce Crossing, Watersmeet, Land O' Lakes, Conover, and Twin Lakes 69-kV bus voltages		--	Mass-Bruce Crossing 69-kV line outage		84-89%		
2	Bruce Crossing, Watersmeet, Land O Lakes, Conover 69-kV bus voltages		87-91%	Mass-Bruce Crossing 69-kV line outage		--		
2	L'Anse, Baraga, M-38 69-kV bus voltages		89-91%	M-38 138/69-kV transformer outage		88-90%		
2	Munising and Alger 69-kV bus voltages		91%	Munising 138/69-kV transformer, Munising-Forsyth 138-kV line outage		90-91%		
2	L'Anse 69-kV bus voltage and Atlantic 138-kV bus voltage		91%	M38-Perch Lake 138-kV line outage		--		
2	L'Anse and Baraga 69-kV bus voltages, and M38 and Atlantic 138-kV bus voltages		--	M38-Perch Lake 138-kV line outage		89-91%		
2	Hiawatha, Lakehead and Brevort 138-kV bus voltages		90%	Hiawatha-Lakehead 138-kV line outage, Lakehead-Brevort 138-kV line outage, Brevort-Straits 138-kV line outage		--		
2	Hiawatha, Lakehead, Brevort, and Indian Lake 138-kV bus voltages		--	Hiawatha-Lakehead 138-kV line outage, Lakehead-Brevort 138-kV line outage, Brevort-Straits 138-kV line outage		89-91%		
2	Engadine, Newberry Village, Newberry Hospital, Louisiana Pacific, Roberts, Hulbert, and Eckerman 69-kV bus voltages		--	Engadine-Hiawatha 69-kV line outage, Engadine-Newberry 69-kV line outage		85-90%		
2	Engadine, Newberry Village, Newberry Hospital, Louisiana Pacific, Roberts, Hulbert 69-kV bus voltages		88-91%	Engadine-Hiawatha 69-kV line outage, Engadine-Newberry 69-kV line outage		--		
2	St. Ignace, Straits, Evergreen, Michigan Limestone, Talentino, and Rockview 69-kV bus voltages		--	Straits 138-69-kV transformer		88-90%		
2	St. Ignace, Straits, Evergreen, Michigan Limestone 69-kV bus voltages		90-91%	Straits 138-69-kV transformer		--		
2	Keweenaw, Osceola, MTU, Henry St. 69-kV bus voltages			Atlantic 138/69-kV transformer outage, Atlantic-M38 138-kV line outage		89-91%		
2	Indian Lake 138-kV bus voltage			Plains-Arnold 138-kV line outage		91%		
3	Brodhead-Blacksmith 69-kV line	106%		North Monroe 138/69-kV transformer outage, Town line Road-Albany 138-kV line outage, Albany-North Monroe 138-kV line outage, North Monroe-Idle Hour 69-kV line outage	111.5%			
3	Brick Church-Cobblestone-Zenda Tap 69-kV line	139%		North Lake Geneva-Lake Geneva 69-kV line outage, Lake Geneva-South Lake Geneva 69-kV line outage	150%		98%	
3	Brick Church-North Lake Geneva 69-kV line	114%		North Lake Geneva 138/69-kV transformer outage	122%			
3	Hillman 138/69-kV transformer	126%		Various DPC 69-kV line outages	136%		98%	
3	Hillman-Belmont 69-kV line	96%		Nelson Dewey-Lancaster 138-kV line outage, Lancaster-Eden 138-kV line outage	107%		117%	
3	Darlington-Darlington North-Rock Branch 69-kV line	102%		Nelson Dewey-Lancaster 138-kV line outage, Lancaster-Eden 138-kV line outage	109%			
3	Colley Road-Park Ave Tap 69-kV line	103%		Paddock 138/69-kV transformer outage	102%			

TABLE ZS-2
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2011 Peak, Hot Summer and Shoulder Cases (continued)

Planning Zone	Criteria Exceeded/Need	% of Facility Rating Peak Case	% of Nominal Bus Voltage Peak Case	Cause	% of Facility Rating Hot Summer Case	% of Nominal Bus Voltage Hot Summer Case	% of Facility Rating Shoulder Case	% of Nominal Bus Voltage Shoulder Case
3	Paddock 138/69-kV transformer			Rockdale-Wempletown 345-kV line outage			106%	
3	Ruskin 1 and 2 bus tie			North Madison-Vienna 138-kV line outage, Vienna-Yahara River 138-kV line outage, American Center – Yahara River 138-kV line outage, American Center-Sycamore 138-kV line outage			110%	
3	Bio Enzyme Systems-RCEC Clinton-Clinton 69-kV line	98%		Brick Church 138/69-kV transformer outage	103%			
3	North Lake Geneva-Lake Geneva 69-kV line	110%		Brick Church-Cobblestone 69-kV line outage	117%			
3	Janesville-Parkview 69-kV line	122%		McCue 138/69-kV transformer outage	126%		109%	
3	Janesville 138/69-kV transformer	97%		McCue 138/69-kV transformer outage	102%			
3	McCue-Milton Lawns 69-kV line	100%		Janesville 138/69-kV transformer outage	106%			
3	Black Earth-Cross Plains-Stagecoach-Timberlane 69-kV line	135%		Spring Green 138/69-kV transformer outage	145%			
3	Portage-Columbia 69-kV line	113%		Portage 138/69-kV transformer outage	116%		102%	
3	Columbia 138/69-kV transformer	109%		Portage 138/69-kV transformer outage, Deforest-North Madison 69-kV line outage	112%			
3	Kilbourn 47 MVA 138/69-kV transformer	133%		Kilbourn 93 MVA 138/69-kV transformer outage	132%		107%	
3	Huiskamp-Ruskin 69-kV line	115%		North Madison-Vienna 138-kV line outage, Vienna-Yahara River 138-kV line outage, American Center-Sycamore 138-kV line outage, Martinsville-North Madison 138-kV line outage, Martinsville-West Middleton 138-kV line outage	117%		129%	
3	Royster-Pflaum 69-kV line	98%		Fitchburg-Syene 69-kV line outage	103%			
3	Ruskin 69-kV 1-2 bus tie	107-98%		North Madison-Vienna 138-kV line outage, Vienna-Yahara River 138-kV line outage, American Center – Yahara River 138-kV line outage	118-105%			
3	Portage-Trienda 138-kV line	113%		Second Portage-Trienda 138-kV line outage	115%			
3	Portage-Columbia 138-kV line	96%		Second Portage-Columbia 138-kV line outage	99%			
3	Columbia 345/138-kV transformer #2	103%		Columbia 345/138-kV transformer #1 and #3 outage	106%			
3	Fitchburg-Syene 69-kV line	107%		Royster-Pflaum Tap 69-kV line outage	111%			
3	Brick Church-Cobblestone-Zenda Tap 69-kV line			North Lake Geneva 138/69-kV transformer outage	96%			
3	Zenda Tap-Katzenberg 69-kV line			North Lake Geneva-Lake Geneva 69-kV line outage	101%			
3	Janesville-Parkview 69-kV line			Russell 138/69-kV transformer outage	96%			
3	West Middleton-Timberlane 69-kV line			Spring Green 138/69-kV transformer outage	96%			
3	Rock Springs Tap-Artesian 138-kV line			Trienda-Lewiston 138-kV line outage	96%			
3	Academy-Columbus 69-kV line			North Randolph-Fox Lake 138-kV line outage	95%			
3	Koch Oil Tap-South Fond Du Lac 69-kV line			North Randolph-Fox Lake 138-kV line outage	98%			
3	Nine Springs-Syene 69-kV line			Royster- Pflaum Tap 69-kV line outage	97%			
3	Portage-Trienda 138-kV line			Second Portage-Trienda 138-kV line outage	96%			
3	Waunakee Switching Station-Waunakee #2 69-kV line			Martinsville-North Madison 138-kV line outage	96%			
3	Pheasant Branch-West Port 69-kV line			Martinsville-North Madison 138-kV line outage Martinsville-West Middleton 138-kV line outage	102%			
3	Kegonsa-Christiana 138-kV line			Second Kegonsa-Christiana 138-kV line outage	101%			
3	Idle Hour, Monroe, Monroe Tap, South Monroe, Blacksmith 69-kV bus voltages		89-92%	North Monroe-Idle Hour 69-kV line outage		87-91%		
3	Idle Hour, Monroe, Monroe Tap, South Monroe, North Monroe, Monticello, Monticello Tap, New Glarus 69-kV bus voltages		91-92%	North Monroe 138/69-kV transformer		88-92%		
3	Brodhead Muni 3, Brodhead Muni 2, Brodhead, Brodhead Muni 1, RCEC Orfordville, Orfordville, Bass Creek, Footville, RCEC Center 69-kV bus voltages		90-92%	Brodhead Switching Station-Brodhead Muni 3 69-kV line outage		88-92%		90-92%
3	Brodhead Muni 2, Brodhead, Brodhead Muni 1 69-kV bus voltages			Brodhead Muni 2 -Brodhead Muni 3 69-kV line outage		92%		92%

TABLE ZS-2
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2011 Peak, Hot Summer and Shoulder Cases (continued)

Planning Zone	Criteria Exceeded/Need	% of Facility Rating Peak Case	% of Nominal Bus Voltage Peak Case	Cause	% of Facility Rating Hot Summer Case	% of Nominal Bus Voltage Hot Summer Case	% of Facility Rating Shoulder Case	% of Nominal Bus Voltage Shoulder Case
3	Orfordville, Bass Creek, Footville, RCEC Center, Evansville 69-kV bus voltages		88-92%	Evansville-Sheepskin 69-kV line outage		87-92%		
3	Lake Geneva, South Lake Geneva, Twin Lake, Richmond, Katzenberg 69-kV bus voltages		84-86%	North Lake Geneva-Lake Geneva 69-kV line outage		81-91%		90-92%
3	South Lake Geneva, Twin Lake, Richmond, Katzenberg 69-kV bus voltages		90-91%	Lake-Geneva-South Lake Geneva 69-kV line outage		89-90%		
3	Harmony, Lamar, Fulton, Saunders Creek 69-kV bus voltages		92%	McCue-Harmony 69-kV line outage		89-92%		
3	Harmony, Lamar, Fulton, Saunders Creek, Dana Cooperation, RCEC Edgerton, Sheepskin 69-kV bus voltages			McCue-Harmony 69-kV line outage				89-92%
3	Lamar, Fulton 69-kV bus voltages			Harmony-Lamar 69-kV line outage		90-91%		
3	Lamar, Fulton, Saunders Creek, Dana Cooperation, Sheepskin, 69-kV bus voltages			Harmony-Lamar 69-kV line outage				89-92%
3	Pine River, Richland Center, Richland, Lone Rock 69-kV bus voltages		90%	Pine River-Richland 69-kV line outage, Lone Rock-Richland 69-kV line outage, Lone Rock 69 kV phase shifter outage		89-90%		
3	Avoca, Muscoda, Lone Rock, Blue River 69-kV bus voltages		91-92%	Lone Rock-Spring Green 69-kV line outage		89-91%		
3	Arena 69-kV bus voltage		92%	Spring Green-Arena 69-kV line outage				
3	Spring Green, Avoca, Muscoda, Lone Rock, Arena, Mazomanie, Mazomanie Industrial, Blue River, Pine River, Richland Center 69-kV bus voltages		88-92%	Spring Green 138/69-kV transformer outage		88-92%		
3	Spring Green, Arena 69-kV bus voltages			Spring Green 138/69-kV transformer outage				92%
3	McFarland, Femrite 138-kV bus voltages		91%	McFarland-Kegonsa 138-kV line outage		91%		
3	Femrite 138-kV bus voltage		92%	McFarland-Femrite 138-kV line outage		92%		
3	Burke, Colorado 69-kV bus voltages		87-91%	Reiner-Burke Tap 69-kV line outage		86-90%		
3	Burke, Colorado, Reiner 69-kV bus voltages		87-91%	Reiner 138/ 69-kV transformer outage		86-90%		
3	Burke 69-kV bus voltage			Reiner-Burke Tap 69-kV line outage, Reiner 138/ 69-kV transformer outage				92%
3	Hubbard 138-kV bus voltage		90%	Hustiford-Hubbard 138-kV line outage		90%		89%
3	Hustisford, Hubbard 138-kV bus voltages		90%	Hustiford-Rubicon 138-kV line outage		90%		89%
3	Pflaum, Pflaum Tap , AGA Gas, Nine Springs 69-kV bus voltages		90-91%	Royster-Pflaum Tap 69-kV line outage		90-91%		
3	Pflaum, Pflaum Tap , AGA Gas 69-kV bus voltages			Royster-Pflaum Tap 69-kV line outage				92%
3	Pflaum 69-kV bus voltage		92%	Pflaum-Pflaum Tap 69-kV line outage		92%		
3	Kilbourn, Loch Mirror, Birchwood, Dell Creek, Zobel, Nishan, Artesian, Rock Springs 138-kV bus voltages, Artesian, Loganville, Reedsburg 69-kV bus voltages		86-90%	East Dells-Lewiston 138-kV line outage		85-91%		
3	Kilbourn, Loch Mirror, Birchwood, Dell Creek 138-kV bus voltages			East Dells-Lewiston 138-kV line outage				91-92%
3	Kilbourn, Loch Mirror, Birchwood, Dell Creek, Zobel, Nishan, Artesian, Rock Springs 138-kV bus voltages, Artesian, Loganville, Reedsburg 69-kV bus voltages		86-90%	East Dells-Kilbourn 138-kV line outage		85-92%		
3	Kilbourn, Loch Mirror, Birchwood 138-kV bus voltages			East Dells-Kilbourn 138-kV line outage				91-92%
3	Lancaster, Eden, Wyoming Valley, Spring Green, Troy 138-kV bus voltages		90-92%	Nelson Dewey-Lancaster 138-kV line outage		88-92%		
3	Eden, Wyoming Valley 138-kV bus voltages		92%	Lancaster-Eden 138-kV line outage		91-92%		
3	Lake Delton, City View, Kirkwood, Spring Green Troy, Zobel, Nishan, Artesian, Rock Springs 138-kV bus voltages, Artesian, Reedsburg 69-kV bus voltages		90-92%	Lake Delton-Trienda 138-kV line outage		89-92%		
3	Lewiston, East Dells, Kilbourn, Loch Mirror, Birchwood, Dell Creek, Zobel, Nishan, Artesian, Rock Springs 138-kV bus voltages, Artesian, Loganville, Reedsburg 69-kV bus voltages		90-92%	Lewiston-Trienda 138-kV line outage		84-91%		

TABLE ZS-2
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2011 Peak, Hot Summer and Shoulder Cases (continued)

Planning Zone	Criteria Exceeded/Need	% of Facility Rating Peak Case	% of Nominal Bus Voltage Peak Case	Cause	% of Facility Rating Hot Summer Case	% of Nominal Bus Voltage Hot Summer Case	% of Facility Rating Shoulder Case	% of Nominal Bus Voltage Shoulder Case
3	Lewiston, East Dells, Kilbourn, Loch Mirror, Birchwood, Dell Creek 138-kV bus voltages			Lewiston-Trienda 138-kV line outage				91-92%
3	Richland Center, Pine River 69-kV bus voltages		91-92%	DPC Dayton-T RC 69-kV line outage		89-90%		
3	Richland Center, Pine River, Gays Mills 69-kV bus voltages		90-91%	DPC Seneca-Bell Center 161-kV line outage		89-90%		
3	Verona 138-kV bus voltage		85%	Verona-Oak Ridge 138-kV line outage		84%		87%
3	Cobblestone, Zenda 69-kV bus voltage		92%	Cobblestone-Brick Church 69-kV line outage		90-92%		
3	City View, Kirkwood, Rock Springs, Artesian 138-kV bus voltages		92%	City View- Lake Delton 138-kV line outage		91-92%		
3	Monroe, South Monroe 69-kV bus voltages			Monroe Tap-South Monroe 69-kV line outage		91%		
3	South Lake Geneva, Twin Lake, Richmond, Katzenberg 69-kV bus voltages			North Lake Geneva 138/69-kV transformer outage		91-92%		
3	Richland Center, Pine River 69-kV bus voltage			Richland Center-T RC 69-kV line outage		90-91%		
3	South, Sun Prairie, Bird St.69-kV bus voltages			Reiner-Burke Tap 69-kV line outage		92%		
3	South, Sun Prairie, Bird St.69-kV bus voltages			Reiner 138/ 69-kV transformer outage		92%		
3	Artesian, Nishan, Zobel 138-kV bus voltages, Artesian, Reedsburg 69-kV bus voltages			Rock Springs Tap-Artesian 138-kV line outage		92%		
3	Rock Springs, Dell Creek, Artesian, Nishan, Zobel 138-kV bus voltages, Artesian, Reedsburg 69-kV bus voltages			Rock Springs Tap-Kirkwood 138-kV line outage		91-92%		
3	Loch Mirror, Birchwood 138-kV bus voltages			Kilbourn-Loch Mirror 138-kV line outage		92%		
3	Concord 138-kV bus 4 and 5 voltages			Jefferson-Crawfish River 138-kV line outage		91%		
3	Concord, Hubbard, Hustiford 138-kV bus voltages			Concord bus 4 and 5 outage		91-92%		
3	Concord 138-kV bus 4 and 5 voltages			Concord bus G and 5 outage		91%		
3	Wyoming Valley, Spring Green, Troy 138-kV bus voltages			Eden-Wyoming Valley 138-kV line outage		92%		
3	Dickinson 138-kV bus voltage			Colley Road-Dickinson 138-kV line outage		91%		
3	Spring Green 138-kV bus voltage			Spring Green-Wyoming Valley 138-kV line outage		92%		
3	North Beaver Dam, Beaver Dam East, Fox Lake 138-kV bus voltages			North Randolph-Fox Lake 138-kV line outage		91%		
3	Kirkwood, Rock Springs, Artesian, Nishan, Zobel 138-kV bus voltages			City View-Kirkwood 138-kV line outage		91-92%		
4	West Marinette 138/69-kV transformer #1	95-111%		Wells St-Roosevelt Rd 69-kV line outage, Roosevelt Rd 138/69-kV transformer outage, West Marinette 138/69-kV transformer #2 outage	98-116%			
4	West Marinette 138/69-kV transformer #2	97-100 %		Wells St-Roosevelt Rd 69-kV line outage, Roosevelt Rd 138/69-kV transformer outage	102-104%			
4	Sunset Point-Pearl Ave 69-kV line	97%		Ellinwood-12th Ave 69-kV line outage	102%			
4	Henry St-Danz Ave 69-kV line	<95%		Pulliam-Van Buren 69-kV line outage	97%			
4	Sunset Point 138/69-kV transformer #1	<95%		Sunset Point 138/69-kV transformer #2 outage	99%			
4	Mirro-North East 69-kV line	<95%		Shoto-Manrap 69-kV line outage			98%	
4	Glenview 138/69-kV transformer #1	<95%		Glenview 138/69-kV transformer #2 outage			97%	
4	Glenview 138/69-kV transformer #2	<95%		Glenview 138/69-kV transformer #1 outage			96%	
4	Quarry Run, Woodenshoe, Mears Corners 138-kV bus voltages		91%	Neevin-Quarry Run 138-kV line outage, Quarry Run-Woodenshoe 138-kV line outage		90-92%		
4	Sunset Point 138-kV bus voltage		>92%	Neevin-Quarry Run 138-kV line outage		92%		
4	East Krok 69-kV bus voltage		>92%	East Krok 138/69-kV transformer outage		92%		
4	Hickory, Butternut, Forward Energy Center 138-kV bus voltages		>92%	Hickory-South Fond du Lac 138-kV line outage		92%		
5	Germantown 138-kV bus		-----	Base Case		92%		
5	Country Aire 138-kV bus		-----	Base Case		91%		
5	Bain 345/138-kV transformer #5	156%		Splitting Pleasant Prairie 345-kV bus sections 3 and 4	157%		158%	
5	Albers – Bain	98%		Bain – Kenosha 138-kV line	105%			
5	Oak Creek – Pennsylvania 138-kV line	100 – 108%		Various Contingencies	113%		95 – 100%	

TABLE ZS-2
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2011 Peak, Hot Summer and Shoulder Cases (continued)

Planning Zone	Criteria Exceeded/Need	% of Facility Rating Peak Case	% of Nominal Bus Voltage Peak Case	Cause	% of Facility Rating Hot Summer Case	% of Nominal Bus Voltage Hot Summer Case	% of Facility Rating Shoulder Case	% of Nominal Bus Voltage Shoulder Case
5	Arcadian4 – Waukesha 1 138-kV line	114%		Arcadian6 – Waukesha 3	125%		117%	
5	Arcadian 345/138-kV transformer #3	110%		Arcadian 345/138-kV transformer #1 outage	118%		103%	
5	Oak Creek 345/138-kV transformer #1	96%		Oak Creek 345/138-kV transformer #2 outage	100%			
5	Nicholson – Ramsey 138-kV line	95%		Oak Creek – Pennsylvania 138-kV line outage	98%		96%	
5	Oak Creek – Ramsey 138-kV line	94%		Oak Creek – Pennsylvania 138-kV line outage	97%		95%	
5	Arcadian6 – Waukesha3 138-kV line	115%		Arcadian4 – Waukesha 1 138-kV line outage	126%		118%	
5	Bluemound – Brookdale W 138-kV line			Bluemound – 96th St 2 138-kV line outage	104%			
5	Bark River – Sussex 138-kV line			Maple – Saukville 138-kV line outage	104%			
5	Maple – Saukville 138-kV line			Bark River – Sussex 138-kV line outage	104%			
5	Bluemound5 – Butler 138-kV line			Various Contingencies			107 -109%	
5	Bluemound6 – Butler 138-kV line			Various Contingencies			99 – 101%	
5	Harbor – Kansas 183-kV line			Various Contingencies			97 – 99%	
5	Albers – Kenosha 138-kV line			Albers – Bain 138-kV line outage			102%	
5	Granville – Rangeline 138-kV line			Cornell – Granville 138-kV line outage			102%	

TABLE ZS-3
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2015 Peak Summer Case

Planning Zone	Criteria Exceeded/Need	% of Facility Rating Peak Case	% of Nominal Bus Voltage Peak Case	Cause
1	Antigo, Aurora Street, Cranberry and St. Germain 115-kV bus voltages		89 – 92%	Gardner Park-Blackbrook-Antigo-Aurora St. 115-kV outage Gardner Park-Blackbrook-Antigo 115-kV line outage Blackbrook-Antigo 115-kV line outage Eagle River-Cranberry 115-kV line outage
1	Bunker Hill – Blackbrook 115-kV line	103%		Gardner Park-Blackbrook 115-kV line outage
1	Gardner Park – Blackbrook 115-kV line	97%		Maine-Pine 115-kV line outage
1	Sigel, Young Road, Lakehead Vesper and Port Edwards 138-kV bus voltages		88 – 91%	Arpin-Sigel 138-kV line outage Young Road-Sigel 138-kV line outage Young Road-Lakehead Vesper 138-kV line outage Port Edwards-Lakehead Vesper 138-kV line outage
1	Port Edwards, Vulcan, Hollywood and Saratoga 138-kV bus voltages		89 – 92%	Arpin-Sigel 138-kV line outage Young Road-Sigel 138-kV line outage Young Road-Lakehead Vesper 138-kV line outage Port Edwards-Lakehead Vesper 138-kV line outage
1	Castle Rock – Quincy 69-kV line	96 - 112%		Petenwell 138/69-kV transformer outages Petenwell-Big Pond 69-kV line outage Necedah Tap-Big Pond 69-kV line outage Various other line outages
1	McKenna – Quincy 69-kV line	100%		Petenwell 138/69-kV transformer outages Petenwell-Big Pond 69-kV line outage Necedah tap-Big Pond 69-kV line outage
1	Council Creek 69-kV bus tie (ATC-DPC)	95 – 121%		Hillsboro-Hillsboro tap 69-kV line outage King-Eau Claire-Arpin 345-kV line outage Eau Claire-Arpin 345-kV line outage Various other line outages
1	Council Creek and Petenwell 138-kV bus voltage		90 – 95%	Base Case Arpin-Sigel 138-kV line outage Young Road-Sigel 138-kV line outage Council Creek-Petenwell 138-kV line outage
1	Necedah, Whistling Wings, Dellwood, Friendship, Houghton Rock 69-kV bus voltages		85 – 92%	Petenwell 138/69-kV transformer Petenwell-Big Pond 69-kV line outage Big Pond-Necedah tap 69-kV line outage Various other 69-kV line outages
1	Hilltop, Mauston, West Mauston, Lyndon Station, Wisconsin Dells 69-kV bus voltages		88 – 92%	Kilbourn-Wisc. Dells 69-kV line outage E. Dells-Lewiston 138-kV line outage Trienda-Lewiston 138-kV line outage
1	Wautoma and Sand Lake 138-kV bus voltages		90 – 96%	Base Case Arpin-Sigel 138-kV line outage Young Road-Sigel 138-kV line outage Young Road-Lakehead Vesper 138-kV line outage
1	Sand Lake 138/69-kV transformer	95 – 109%		Wautoma 138/69-kV transformer outage Trienda-Lewiston 138-kV line outage E. Dells-Lewiston 138-kV line outage Various other line outages
1	Hancock, Hancock (ACEC), Plainfield and Plainfield (ACEC) 69-kV bus voltages		88 – 92%	Sand Lake 138/69-kV transformer outage Sand Lake-Plainfield Tap 69-kV line outage

TABLE ZS-3
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2015 Peak Summer Case (continued)

Planning Zone	Criteria Exceeded/Need	% of Facility Rating Peak Case	% of Nominal Bus Voltage Peak Case	Cause
1	Metomen 138/69-kV transformer	95 – 119%		Base Case North Fond du Lac-Rosendale 69-kV line outage Metomen-Rosendale 69-kV line outage Various other line outages
1	Metomen – Ripon 69-kV line	96 – 103%		Winneconne-Sunset Point 69-kV line outage Omro-Winneconne 69-kV line outage Markesan tap-North Randolph 69-kV line outage Wautoma-Silver Lake 69-kV line outage
1	NW Ripon – Ripon 69-kV line	96 – 106%		Winneconne-Sunset Point 69-kV line outage Omro-Winneconne 69-kV line outage
1	Winneconne – Sunset Point 69-kV line	95 – 103%		NW Ripon - Ripon 69-kV line outage Metomen-Ripon 69-kV line outage
1	Omro – Winneconne 69-kV line	98%		NW Ripon - Ripon 69-kV line outage
1	Berlin area 69-kV bus voltages		85 – 92%	NW Ripon - Ripon 69-kV line outage Metomen-Ripon 69-kV line outage Winneconne-Sunset Point 69-kV line outage Wautoma-Silver Lake 69-kV line outage Various other line outages
1	Montello, Roslin, Endeavor and Lakehead Portage 69-kV bus voltages		89 – 92%	Portage-Lakehead Portage 69-kV line outage Endeavor Tap-Lakehead Portage 69-kV line outage
1	Whitcomb 115/69-kV transformer	95 – 98%		Gardner Park-Blackbrook-Antigo 115-kV line outage Antigo-Blackbrook 115-kV line outage Werner West-White Lake 138-kV line outage
1	Caroline 115/69-kV transformer	95%		Whitcomb 115/69-kV transformer
1	Coloma (ACEC), Lincoln Pumping Station, Brooks (ACEC) and Grand Marsh 69-kV bus voltages		88 – 92%	Chaffee Creek-Coloma tap 69-kV line outage Lincoln Pumping Station-Coloma Tap 69-kV line outage Sand Lake 138/69-kV transformer outage Petenwell 138/69-kV transformer outage
1	White Lake, Waupaca, Harrison and Hartman Creek 138-kV bus voltages		90 – 92%	Werner West-White Lake 138-kV line outage
1	Hillsboro, Wonewoc and Union Center 69 kV bus voltages		90 – 91%	Hillsboro-Hillsboro tap 69-kV line outage
2	Indian Lake 138-kV bus voltage		95%	Base Case
2	St. Ignace, Straits, Evergreen, Michigan Limestone, and Talentino 69-kV bus voltages		90-91%	Straits 138/69-kV transformer
2	Engadine, Newberry Village, Newberry Hospital and Louisiana Pacific bus voltages		91%	Engadine-Hiawatha 69-kV line outage
3	McCue 138/69-kV transformer	101%		Base Case
3	North Monroe 138/69-kV transformer	104%		Base Case
3	Kirkwood-Skillet Creek 69-kV line	110%		Base Case
3	Brodhead-Blacksmith 69-kV line	134-95%		North Monroe 138/69-kV transformer outage, Town Line Road-Albany 138-kV line outage, Albany-North Monroe 138-kV line outage, North Monroe-Idle Hour 69-kV line outage, Brodhead-Brodhead Muni 3 69-kV line outage, North Monroe – Idle Hour 69-kV line outage
3	Hillman-Elmo 69-kV line	99%		Pilot NB-Galena 69-kV line outage
3	North Monroe-Monticello Tap 69-kV line	95%		Wempletown-Rockdale 345-kV line outage
3	North Monroe 138/69-kV transformer	97-95%		Darlington 138/69-kV transformer outage, Paddock-Newark 69-kV line outage
3	Janesville-Park View 69-kV line	99%		McCue 138/69-kV transformer outage
3	Janesville 138/69-kV transformer	104%		McCue 138/69-kV transformer outage
3	Milton-Lawns-McCue 69-kV line	110%		Janesville 138/69-kV transformer outage

TABLE ZS-3
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2015 Peak Summer Case (continued)

Planning Zone	Criteria Exceeded/Need	% of Facility Rating Peak Case	% of Nominal Bus Voltage Peak Case	Cause
3	Dana Corporation Tap – Sheepskin 69-kV line	103%		McCue-Harmony 69-kV line outage
3	Black Earth - Cross Plain - Stage Coach - Timberlane - West Middleton 69-kV line	115%		Spring Green 138/69-kV transformer outage
3	North Stoughton-Stoughton Muni 69-kV line	100-95%		McCue-Harmony 69-kV line outage, Harmony-Lamar 69-kV line outage
3	Stoughton-Aaker 69-kV line	95%		Verona 138/69-kV transformer outage, Verona-Oak Ridge 138-kV line outage
3	Kegonsa – Cottage Grove 69-kV line	99%		Deforest-North Madison 69-kV line outage
3	Deforest-Arlington Tap 69-kV line	102%		Deforest-North Madison 69-kV line outage
3	Arlington Tap – Poynette 69-kV line	115%		Deforest-North Madison 69-kV line outage
3	Waunakee Industrial Park – Huiskamp 69-kV line	96%		North Madison 138/69-kV transformer outage
3	Rock Springs Tap – Artesian 138-kV line	113-108%		Trienda-Lewiston 138-kV line outage, East Dells-Lewiston 138-kV line outage, East Dells-Lewiston 138-kV line outage
3	Academy-Columbus Muni 2 Tap 69-kV line	100%		North Randolph-Fox Lake 138-kV line outage
3	Columbus Muni 2 Tap- Columbus 69-kV line	96%		North Randolph-Fox Lake 138-kV line outage
3	Waupun – Koch Oil Tap 69-kV line	97%		North Randolph-Fox Lake 138-kV line outage
3	Koch Oil Tap – South Fond Du Lac 69-kV line	101-96%		North Randolph-Fox Lake 138-kV line outage, Fox Lake-North Beaver Dam 138-kV line outage
3	47 MVA Kilbourn 138/69-kV transformer	120%		93 MVA Kilbourn 138/69-kV transformer outage
3	Huiskamp-Ruskin 69-kV line	132-108%		North Madison-Vienna 138-kV line outage, Vienna-Yahara River 138-kV line outage, Yahara River-American Center 138-kV line outage, American Center-Sycamore 138-kV line outage
3	East Dells-Kilbourn 138-kV line	96%		Lake Delton-Trienda 138-kV line outage
3	East Dells-Lewiston 138-kV line	98%		Lake Delton-Trienda 138-kV line outage
3	X-19 Portage-Trienda 138-kV line	126%		X-67 Portage-Trienda 138-kV line
3	X-67 Portage-Trienda 138-kV line	105%		X-19 Portage-Trienda 138-kV line
3	Portage-Columbia 138-kV line	105%		Second Portage-Columbia 138-kV line outage
3	Trienda-Lewiston 138-kV line	99-95%		Lake Delton-Trienda 138-kV line outage, Rock Springs Tap-Kirkwood 138-kV line outage
3	Columbia 345/138 transformer T21	99%		Columbia 345/138 transformer T22 outage
3	Columbia 345/138 transformer T23	99%		Columbia 345/138 transformer T22 outage
3	Ruskin 69-kV bus tie	104-98%		North Madison-Vienna 138-kV line outage, Vienna-Yahara 138-kV line outage
3	Idle Hour, Monroe, Monroe Tap, South Monroe, Blacksmith, Browntown, Green Wind, Jennings Road, Wiota 69-kV bus voltages		85-92%	North Monroe-Idle Hour 69-kV line outage
3	Idle Hour, Monroe, Monroe Tap, South Monroe, North Monroe, Monticello, Monticello Tap, New Glarus, Belleville, Montrose, Brooklyn, Sun Valley, Oregon, Verona 69-kV bus voltages		85-92%	North Monroe 138/69-kV transformer
3	Monticello, Monticello Tap, New Glarus, Belleville, Montrose, Brooklyn, Sun Valley, Oregon, Verona, Jennings South Monroe, Blacksmith, Browntown, Green Wind, Aakar Road, Wiota 69-kV bus voltages, Verona 138-kV bus voltage		87-92%	North Monroe-Monticello Tap 69-kV line outage
3	South Monroe, Monroe, Blacksmith, Browntown 69-kV bus voltages		88-91%	Idle Hour-Monroe Tap 69-kV line outage
3	New Glarus, Belleville, Montrose, Brooklyn, Sun Valley, Oregon 69-kV bus voltages, Verona 138-kV bus voltage		88-91%	Monticello Tap-New Glarus 69-kV line outage
3	Brodhead Muni 3, Brodhead Muni 2, Brodhead, Brodhead Muni 1, RCEC Orfordville, Orfordville, Bass Creek, Footville, RCEC Center, Evansville 69-kV bus voltages		88-91%	Brodhead Switching Station-Brodhead Muni 3 69-kV line outage

TABLE ZS-3
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2015 Peak Summer Case (continued)

Planning Zone	Criteria Exceeded/Need	% of Facility Rating Peak Case	% of Nominal Bus Voltage Peak Case	Cause
3	Brodhead Muni 2, Brodhead, Brodhead Muni 1, RCEC Orfordville, Orfordville, Bass Creek, Footville, RCEC Center 69-kV bus voltages		90-91%	Brodhead Muni 2 -Brodhead Muni 3 69-kV line outage
3	Orfordville, Bass Creek, Footville, RCEC Center, Evansville 69-kV bus voltages		87-92%	Evansville-Sheepskin 69-kV line outage
3	Brodhead Switching Station, Brodhead Muni 3, Brodhead Muni 2, Brodhead, Brodhead Muni 1 69-kV bus voltages		92%	Paddock-Newark 69-kV line
3	Bradford, West Darien, SW Delavan, North Shore, Delavan, Bristol, Elkhorn, Como, Williams Bay, North Lake Geneva, White River, South Lake Geneva, Brick Church 138-kV bus voltages		90-92%	RCEC La Prairie-RCEC Bradford 138-kV line outage
3	La Prairie, Bradford, West Darien, SW Delavan, North Shore, Delavan, Bristol, Elkhorn, Como, Williams Bay, North Lake Geneva, White River, South Lake Geneva, Brick Church 138-kV bus voltages		90-92%	Rock River-RCEC La Prairie 138-kV line outage
3	Twin Lakes, Richmond, Katzenberg 69-kV bus voltages		90%	Katzenberg-South Lake Geneva 69-kV line outage
3	West Darien, SW Delavan, North Shore, Delavan, Bristol, Elkhorn, Como, Williams Bay, North Lake Geneva, White River, South Lake Geneva, Brick Church 138-kV bus voltages		90-92%	West Darien-West Darien Tap 138-kV line outage
3	West Darien Tap, West Darien, SW Delavan, North Shore, Delavan, Bristol, Elkhorn, Como, Williams Bay, North Lake Geneva, White River, South Lake Geneva, Brick Church 138-kV bus voltages		90-92%	RCEC Bradford-West Darien Tap 138-kV line outage
3	SW Delavan, North Shore, Delavan, Bristol, Elkhorn, Como, Williams Bay, North Lake Geneva, White River 138-kV bus voltages		91-92%	West Darien-SW Delavan 138-kV line outage
3	Harmony, Lamar, Fulton, Saunders Creek, Evansville, Dana Corporation, RCEC Center 69-kV bus voltages		85-92%	McCue-Harmony 69-kV line outage
3	Lamar, Fulton, Saunders Creek, Evansville 69-kV bus voltages		88-92%	Harmony-Lamar 69-kV line outage
3	Avoca, Avoca Tap, Muscoda 69-kV bus voltages		91-92%	Avoca Tap-Lone Rock 69-kV line outage
3	Pine River, Richland Center, Richland, Lone Rock 69-kV bus voltages		91-92%	Lone Rock 69-kV Phase Shifter outage, Lone Rock-Richland Center 69-kV line outage
3	Pine River, Richland Center, Richland, Lone Rock, Muscoda, Avoca, Blue River, Boscobel, Boscobel Muni 69-kV bus voltages		88-90%	Lone Rock-Spring Green 69-kV line outage
3	Arena, Mazomanie, Mazomanie Industrial, Black Earth 69-kV bus voltages		90-91%	Spring Green-Arena 69-kV line outage
3	Spring Green, Avoca, Muscoda, Lone Rock, Arena, Mazomanie, Mazomanie Industrial, Blue River, Pine River, Richland Center, Black Earth, Boscobel, Boscobel Muni 69-kV bus voltages		84-92%	Spring Green 138/69-kV transformer outage
3	Mazomanie, Mazomanie Industrial, Black Earth 69-kV bus voltages		91-92%	Arena-Mazomanie 69-kV line outage
3	Black Earth, Mazomanie, Mazomanie Industrial 69-kV bus voltages		92%	Black Earth-Cross Plains 69-kV line outage
3	Cross Plains, Black Earth, Mazomanie, Mazomanie Industrial 69-kV bus voltages		89-90%	Stage Coach-Cross Plains 69-kV line outage
3	Timberlane, Cross Plains, Stage Coach, Black Earth, Mazomanie, Mazomanie Industrial, Mount Horeb, Forward 69-kV bus voltages		88-92%	Timberlane-West Middleton 69-kV line outage
3	Asker Rd, Sun Valley, Oregon, Brooklyn 69-kV bus voltages		90-92%	Stoughton-Aakar 69-kV line outage
3	Cottage Grove, Gaston Road 69-kV bus voltages		90%	Kegonsa-Cottage Grove 69-kV line outage, Kegonsa 138/69-kV transformer outage
3	McFarland, Femrite, Sprecher, Reiner Road 138-kV bus voltages		88-91%	McFarland-Kegonsa 138-kV line outage
3	Femrite, Sprecher, Reiner Road 138-kV bus voltages		89-91%	McFarland-Femrite 138-kV line outage

TABLE ZS-3
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2015 Peak Summer Case (continued)

Planning Zone	Criteria Exceeded/Need	% of Facility Rating Peak Case	% of Nominal Bus Voltage Peak Case	Cause
3	Burke, Burke Tap, Colorado, Sun Prairie, South, Bird St., Business Park, Gaston Rd, Token Creek 69-kV bus voltages		85-91%	Reiner Road-Burke Tap 69-kV line outage
3	Reiner Rd, Burke, Burke Tap, Colorado, Sun Prairie, South, Bird St., Business Park, Gaston Rd, Token Creek, Cottage Grove, Hampden Tap, Hampden 69-kV bus voltages		82-92%	Reiner 138/69-kV transformer outage
3	Colorado 69-kV bus voltage		92%	Colorado-Burke Tap 69-kV line outage
3	Token Creek 69-kV bus voltage		92%	Deforest-Token Creek 69-kV line outage
3	Deforest, Sun Prairie, South, Bird St., Gaston Rd, Token Creek, Hampden Tap, Hampden 69-kV bus voltages		90-91%	Deforest-North Madison 69-kV line outage
3	Hubbard 138-kV bus voltage		89%	Hustiford-Hubbard 138-kV line outage
3	Hustiford, Hubbard 138-kV bus voltages		88%	Hustiford-Rubicon 138-kV line outage
3	Birchwood, Dell Creek, Zobel, Nishan 138-kV bus voltages		91-92%	Loch Mirror-Birchwood 138-kV line outage
3	Loch Mirror, Birchwood, Dell Creek, Zobel, Nishan, Artesian, Rock Springs, Spring Green, Troy, Wyoming Valley, Kirkwood 138-kV bus voltages, Artesian, Loganville, Reedsburg 69-kV bus voltages		87-92%	Loch Mirror-Kilbourn 138-kV line outage
3	East Dells, Kilbourn, Loch Mirror, Birchwood, Dell Creek, Zobel, Nishan, Artesian, Rock Springs, Spring Green, Troy, Wyoming Valley, Kirkwood, City View, Lake Delton, Eden 138-kV bus voltages, Artesian, Loganville, Reedsburg, Finnegan, Platte, Kilbourn 69-kV bus voltages		83-92%	East Dells-Lewiston 138-kV line outage
3	Kilbourn, Loch Mirror, Birchwood, Dell Creek, Zobel, Nishan, Artesian, Rock Springs, Spring Green, Troy, Wyoming Valley, Kirkwood, City View, Lake Delton 138-kV bus voltages, Artesian, Loganville, Reedsburg, Finnegan, Platte, Kilbourn 69-kV bus voltages		83-92%	East Dells-Kilbourn 138-kV line outage
3	Loch Mirror, Birchwood, Dell Creek, Zobel, Nishan, Artesian, Rock Springs, Spring Green, Troy, Wyoming Valley, Kirkwood, City View, Lake Delton, Eden 138-kV bus voltages, Artesian, Loganville, Reedsburg 69-kV bus voltages		88-91%	Lake Delton-Trienda 138-kV line outage
3	East Dells, Kilbourn, Loch Mirror, Birchwood, Dell Creek, Zobel, Nishan, Artesian, Rock Springs, Spring Green, Troy, Wyoming Valley, Kirkwood, City View, Lake Delton, Eden 138-kV bus voltages, Artesian, Loganville, Reedsburg, Finnegan, Platte, Kilbourn 69-kV bus voltages		82-92%	Trienda-Lewiston 138-kV line outage
3	Dell Creek, Zobel, Nishan, Artesian, Rock Springs, Spring Green, Troy, Wyoming Valley, Kirkwood, City View, Eden 138-kV bus voltages		90-92%	City View-Lake Delton 138-kV line outage
3	Spring Green, Troy, Wyoming Valley, Kirkwood 138-kV bus voltages		91-92%	City View-Kirkwood 138-kV line outage
3	Sugar Creek 138-kV bus voltage		92%	Sugar Creek-University 138-kV line
3	Fort Atkinson 138-kV bus voltage		91%	Jefferson 4-5 138-kV bus tie outage
3	Crawfish, Rockvale 138-kV bus voltages		91-92%	Jefferson-Crawfish River 138-kV line outage
3	Concord, Hubbard, Hustiford, Rubicon 138-kV bus voltages		90-92%	Concord 4-5 138-kV bus tie outage
3	Rockvale 138-kV bus voltage		90%	Rockvale-Concord 138-kV line outage
3	North Shore, Delavan, Bristol, Elkhorn, Como 138-kV bus voltages		91-92%	SW Delavan-North Shore 138-kV line outage
3	Lancaster, Eden, Wyoming Valley, Spring Green, Troy 138-kV bus voltages, Avoca, Blue River, Muscoda 69-kV bus voltages		88-92%	Nelson Dewey-Lancaster 138-kV line outage
3	Potosi, Hillman, Lafayette Wind, Darlington 138-kV bus voltages		90%	Nelson Dewey-Potosi 138-kV line outage
3	Hillman, Lafayette Wind, Darlington 138-kV bus voltages		90%	Potosi-Hillman 138-kV line outage
3	Darlington 138-kV bus voltage		92%	Darlington-Lafayette Wind 138-kV line outage

TABLE ZS-3
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2015 Peak Summer Case (continued)

Planning Zone	Criteria Exceeded/Need	% of Facility Rating Peak Case	% of Nominal Bus Voltage Peak Case	Cause
3	Eden, Wyoming Valley, Spring Green, Troy 138-kV bus voltages,		90-91%	Eden-Lancaster 138-kV line outage
3	Wyoming Valley, Spring Green, Troy 138-kV bus voltages, Avoca, Muscoda 69-kV bus voltages		91-92%	Eden-Wyoming Valley 138-kV line outage
3	North Monroe, Darlington 138-kV bus voltages		90-92%	North Monroe-Albany 138-kV line outage
3	Albany, North Monroe, Darlington, Lafayette Wind 138-kV bus voltages		88-92%	Town line Road-Albany 138-kV line outage
3	Dickinson, Brick Church, Williams Bay 138-kV bus voltages		89-91%	Colley Road-Dickinson 138-kV line outage
3	Brick Church, Williams Bay 138-kV bus voltages		91-92%	Dickinson-Brick Church 138-kV line outage
3	Spring Green, Troy 138-kV bus voltages		91-92%	Spring Green-Wyoming Valley 138-kV line outage
3	Fort Atkinson 138-kV bus voltage		92%	Rockdale-Lakehead Cambridge 138-kV line
3	Reiner Road, Sprecher 138-kV bus voltages		91-92%	Reiner Rd-Sycamore 138-kV line outage
3	Fox Lake, Beaver Dam East bus voltages		91-92%	North Randolph-Fox Lake 138-kV line outage
3	Rockvale 138-kV bus voltage		91-92%	Bark River-Cottonwood 138-kV line outage, Bark River-Sussex 138-kV line outage
3	LCI, Pflaum, Femrite, Nine Springs, Syene 69-kV bus voltages		90-92%	Femrite 138/69-kV transformer outage
3	Brisbois, Grangrae, Boscobel, Boscobel Muni, Wauzeka, Hillside, Lapointe 69-kV bus voltages		91-92%	Grangrae 138/69-kV transformer outage
3	Miner 69-kV bus voltage		92%	DPC Terr TP – Pilot NB 69-kV line outage
3	Miner, Shullsburg 69-kV bus voltages		91%	DPC Pilot NB-Galena 69-kV line outage
3	Boscobel, Muscoda, Blue River, Brisbois 69-kV bus voltages		91-92%	Seneca-Genoa 161-kV line outage
3	Vienna, Yahara River, American Center, Reiner Rd, Sprecher, Femrite, Sycamore, Blount 138-kV bus voltages		91-92%	North Madison-Vienna 138-kV line outage
3	Yahara River, American Center, Reiner Road, Sprecher, Femrite, Sycamore 138-kV bus voltages		91-92%	Yahara River-Vienna 138-kV line outage
3	Reiner Rd, Sprecher, Femrite, Sycamore 138-kV bus voltages		91-92%	Yahara River-American Center 138-kV line outage
3	Verona, Sun Valley, Brooklyn, Oregon, Montrose, Belleville, Aaker, Stoughton, Stoughton Muni, Mount Horeb, New Glarus, Forward, Monticello 69-kV bus voltages		86-91%	Verona-Oakridge 138-kV line outage
3	Verona, Sun Valley, Brooklyn, Oregon, Montrose, Belleville, Aaker, Stoughton, Stoughton Muni, Mount Horeb, New Glarus, Forward, Monticello 69-kV bus voltages		87-91%	Verona 138/69-kV transformer outage
3	Sun Valley, Oregon, Brooklyn 69-kV bus voltages		88-90%	Sun Valley-Verona 69-kV line outage
3	Cobble Stone, Lake Shore, Zenda Tap, Zenda, Katzenberg, Richmond, Twin Lakes 69-kV bus voltages		88-92%	Cobble Stone-Brick Church 69-kV line outage
4	Pulliam-Van Buren 69-kV line	97%		Pulliam-Danz Avenue 69-kV line outage
4	Henry-Danz Avenue 69-kV line	105%		Pulliam-Van Buren 69-kV line outage
4	Pulliam-Danz Avenue 69-kV line	102%		Pulliam-Van Buren 69-kV line outage
4	Sunset Point-Pearl Avenue 69-kV line	104%		Ellinwood-Twelfth Avenue 69-kV line outage
4	Sunset Point 138/69-kV transformer #1	101%		Sunset Point 138/69-kV transformer #2 outage
4	Sister Bay 69-kV bus voltage		95%	Base Case
4	Bluestone, Wesmark 69-kV bus voltages		86-88%	Finger Road-Bluestone 69-kV line outage
4	Booster, Barnett, Beardsley St, East Krok 69-kV bus voltages		90-91%	East Krok 138/69-kV transformer outage
4	Quarry Run, Woodenshoe, Mears Corners, Sunset Point 138-kV bus voltages		89-91%	Neevin-Quarry Run 138-kV line outage, Quarry Run-Woodenshoe 138-kV line outage
4	Hickory, Butternut, Forward Energy Center 138-kV bus voltages		92%	Hickory-South Fond du Lac 138-kV line outage
5	Oak Creek 345/230-kV transformer	100%		Splitting Oak Creek 230-kV bus 78
5	Granville 345/138-kV transformer	95%		Splitting Granville 345-kV bus 23
5	Tichigan and Burlington 138-kV bus voltages		89-90%	Spliiting Burlington 138-kV bus
5	Edgewood – St. Martins 138-kV line	102%		Walworth – Mukwonago 138-kV bus outage
5	Albers – Bain 345-kV line	110%		Bain – Kenosha 138-kV line outage

TABLE ZS-3

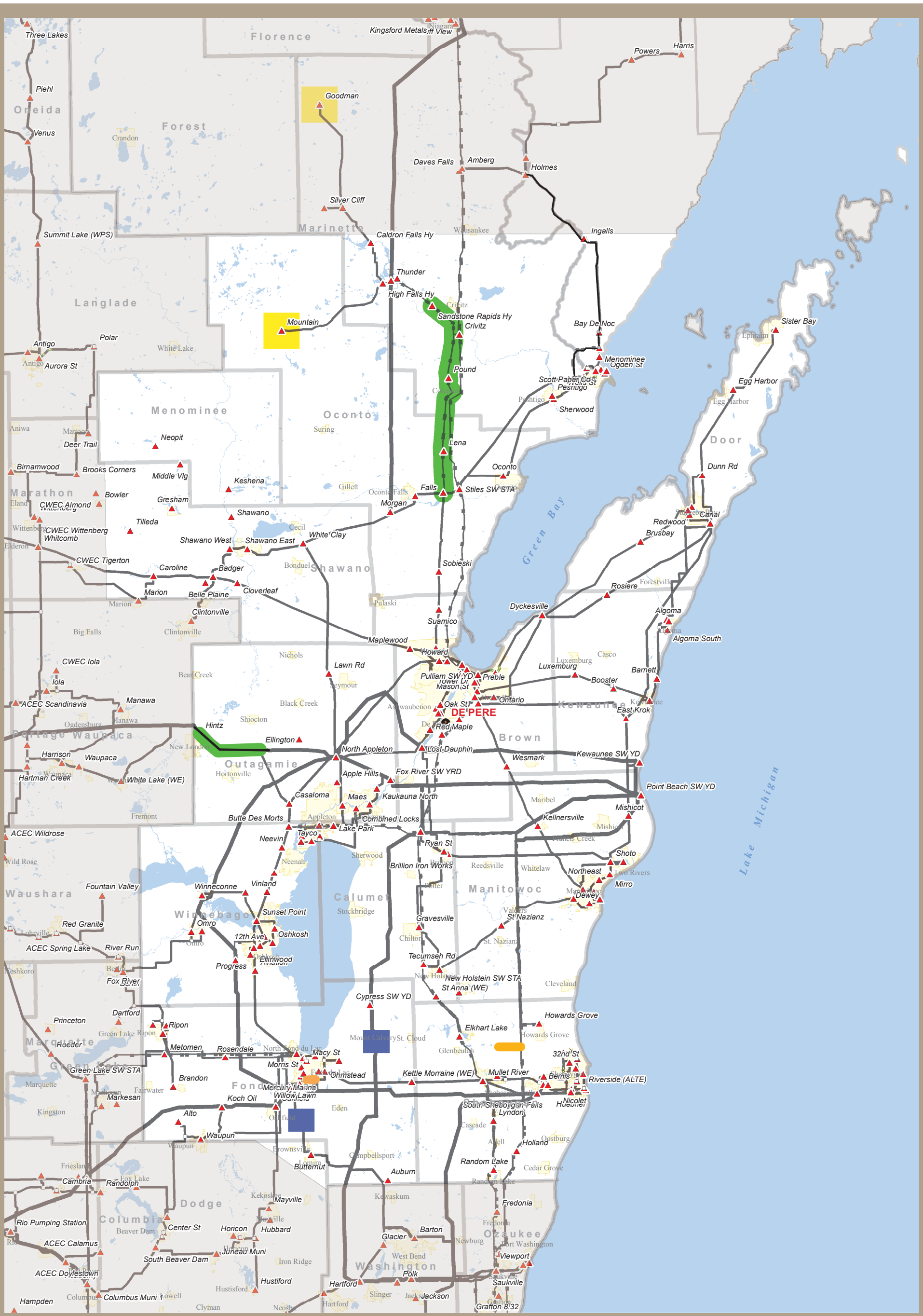
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2015 Peak Summer Case (continued)

Planning Zone	Criteria Exceeded/Need	% of Facility Rating Peak Case	% of Nominal Bus Voltage Peak Case	Cause
5	Oak Creek – Pennsylvania 138-kV line	95 – 103%		Various Contingencies
5	Arcadian4 – Waukesha1 138-kV line	103 – 117%		Various Contingencies
5	Arcadian 345/138-kV transformer #3	111%		Arcadian 345/138-kV transformer #1 outage
5	Fredonia 138-kV bus voltage		91%	Cedarsauk – Fredonia 138-kV line outage
5	Bark River and Cottonwood 138-kV bus voltages		91-92%	Various Contingencies
5	Oak Creek 345/138-kV transformer	97%		Oak Creek 345/138-kV transformer outage
5	Arcadian6 – Waukesha3 138-kV line	118%		Arcadian4 – Waukesha1 138-kV line outage
5	Germantown, Maple 138-kV bus voltages		91-92%	Maple – Saukville 138-kV line outage

Table ZS-10
Forecast of Peak Load and Generation in Zone 4

	2007	2011	2015
Peak Forecast (megawatts)	3288.5	3642.7	3978.4
Average Peak Load Growth	N/A	2.59%	2.23%
Existing Generation Capacity (megawatts)	5509.9	5509.9	5509.9
Existing Capacity Less Load	2221.4	1867.2	1531.5
Existing Generation Capacity plus Modeled Generating Capacity Additions (megawatts)	5808.9	5808.9	5808.9
Modeled Capacity Less Load (megawatts)	2520.4	2166.2	1830.5

*Modeled generating capacity additions in the table above reflect those proposed capacity additions that were included in the 2006 Assessment analyses models, as listed in the **Projects** section.*



AMERICAN TRANSMISSION COMPANY
THE ENERGY ACCESS COMPANY

Performance Criteria Limits Exceeded and Other Constraints 2006-2007

PLANNING ZONE 4

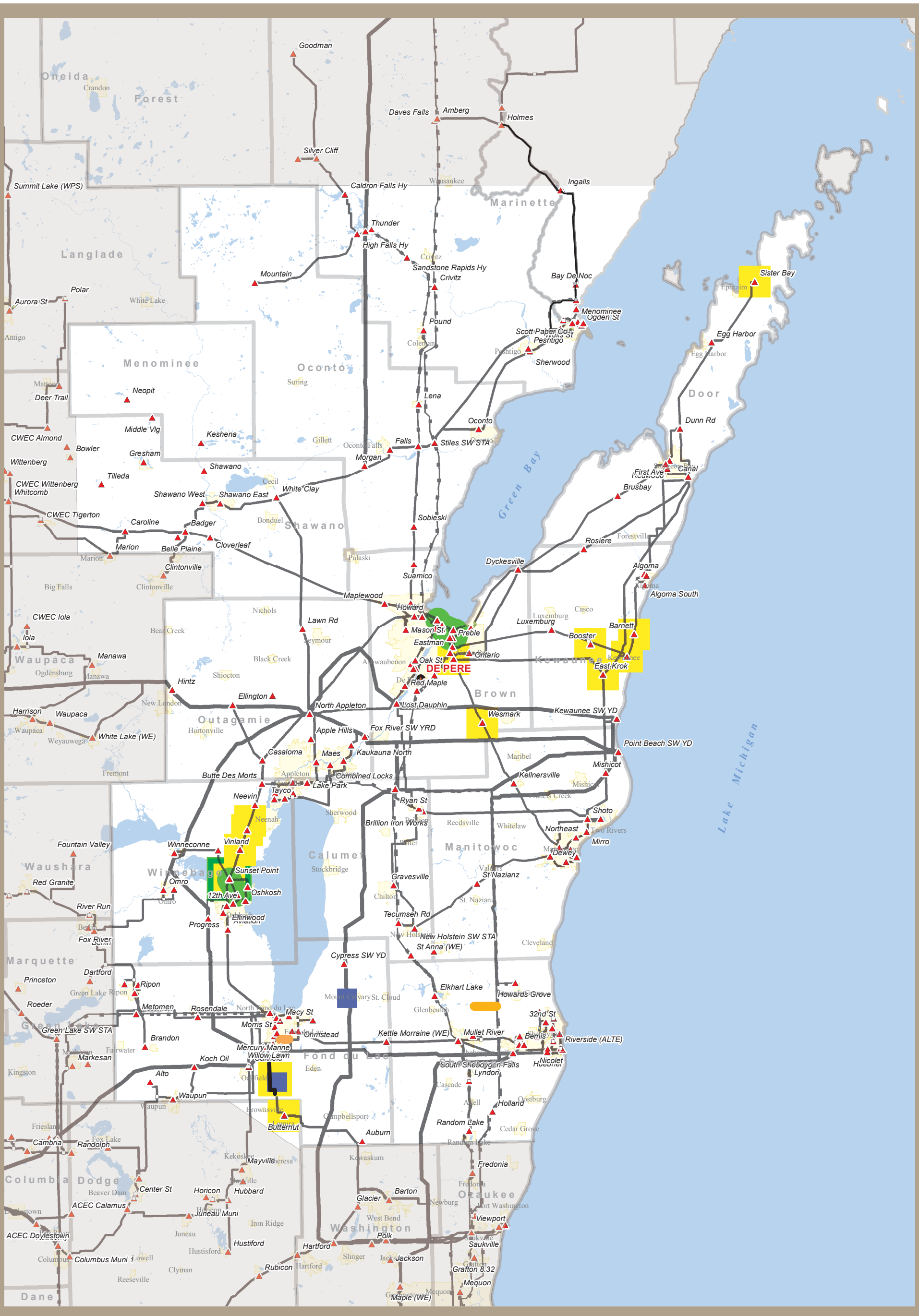
Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties. Facilities include:

- *Approximately 8900 miles of transmission lines*
- *98 wholly owned substations*
- *358 jointly owned substations*
- *Offices in Madison (2), Cottage Grove, Pewaukee, De Pere Wausau and Kingsford, MI*

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

Transmission Related Facilities

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



AMERICAN TRANSMISSION COMPANY
THE ENERGY ACCESS COMPANY

Performance Criteria Limits Exceeded and Other Constraints 2012-2015

PLANNING ZONE 4

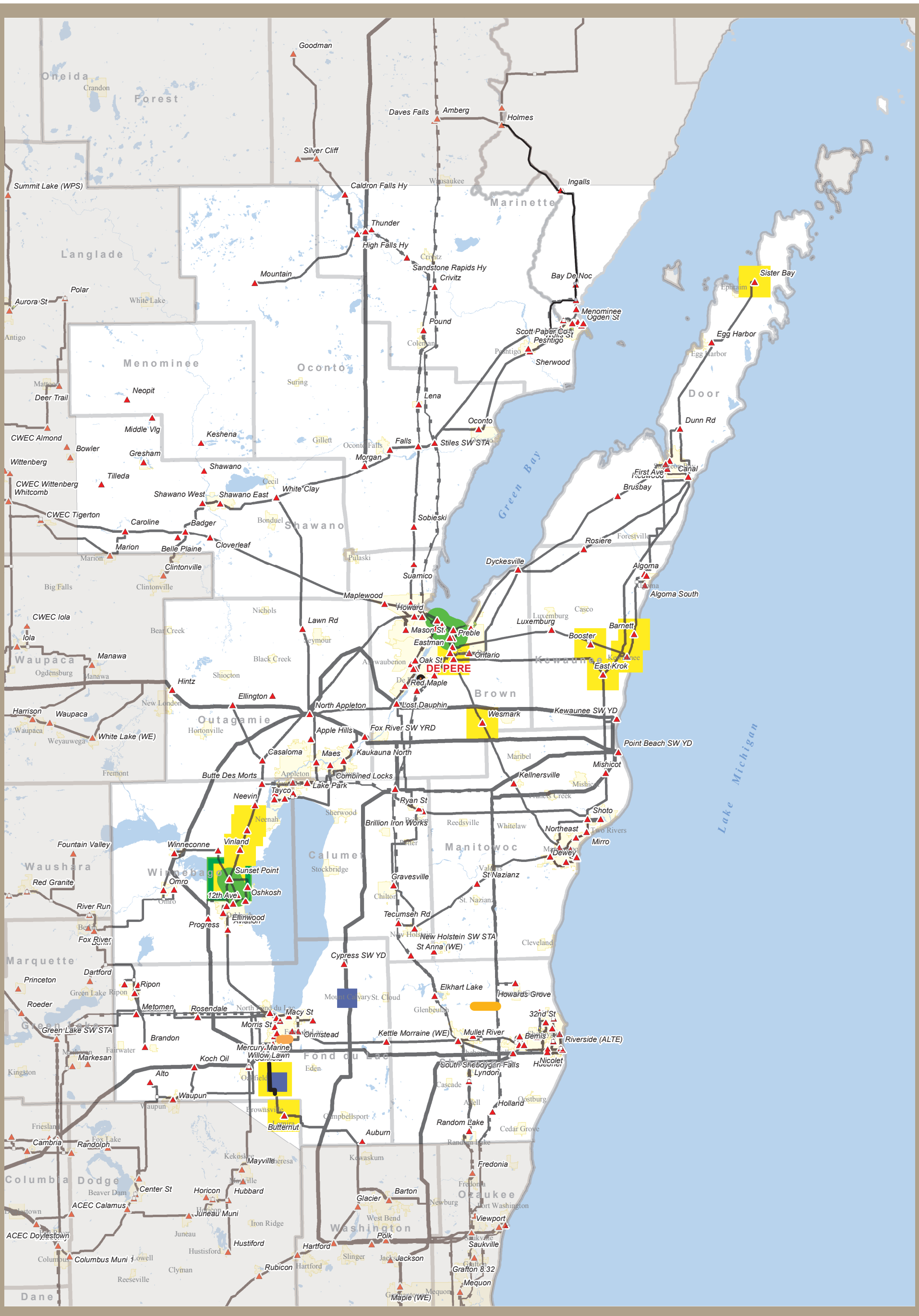
Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties. Facilities include:

- *Approximately 8900 miles of transmission lines*
- *98 wholly owned substations*
- *358 jointly owned substations*
- *Offices in Madison (2), Cottage Grove, Pewaukee, De Pere Wausau and Kingsford, MI*

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

Transmission Related Facilities

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



AMERICAN TRANSMISSION COMPANY
THE ENERGY ACCESS COMPANY

Performance Criteria Limits Exceeded and Other Constraints 2012-2015

PLANNING ZONE 4

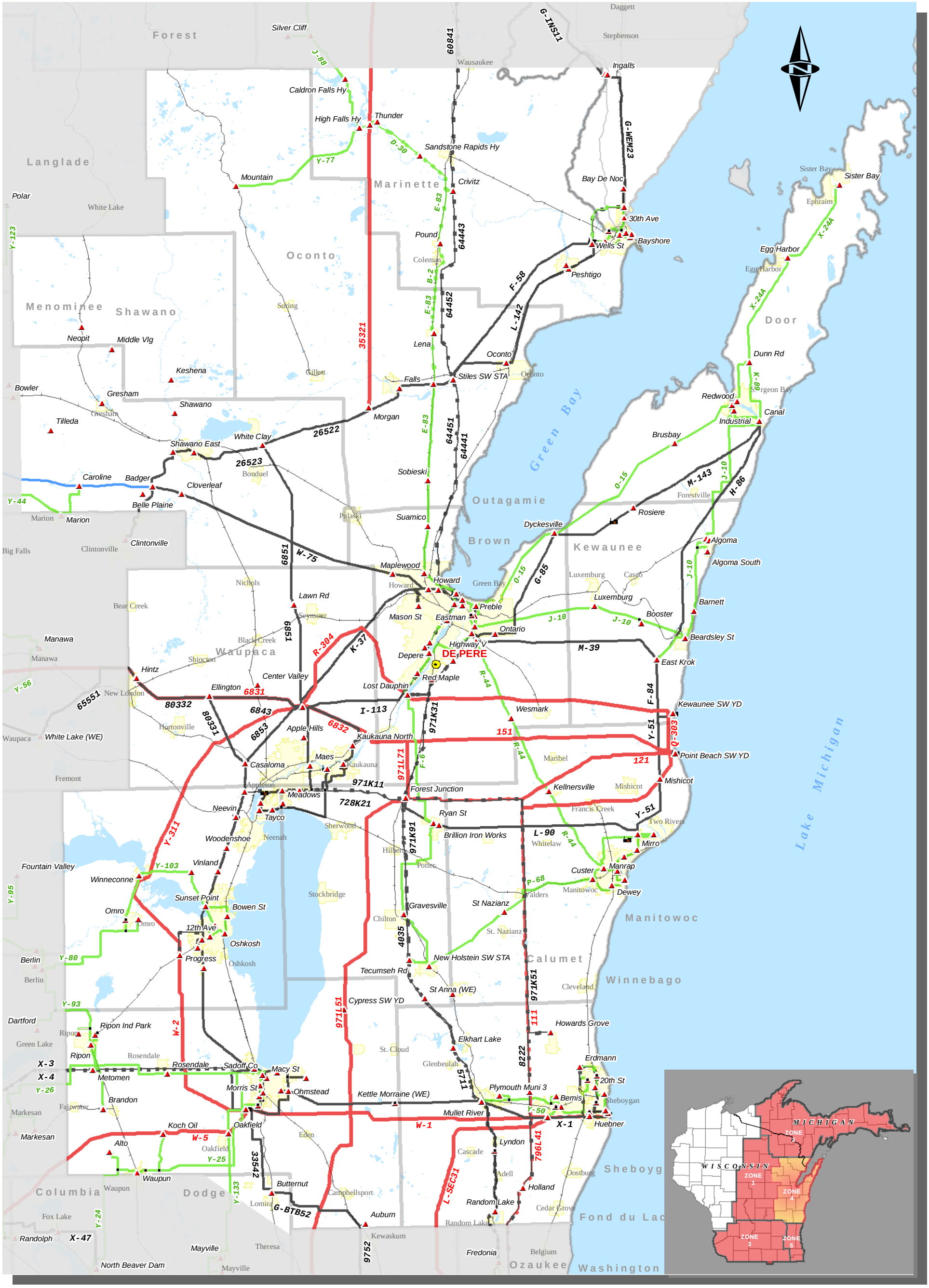
Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties. Facilities include:

- *Approximately 8900 miles of transmission lines*
- *98 wholly owned substations*
- *358 jointly owned substations*
- *Offices in Madison (2), Cottage Grove, Pewaukee, De Pere Wausau and Kingsford, MI*

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

Transmission Related Facilities

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



AMERICAN TRANSMISSION COMPANY
THE ENERGY ACCESS COMPANY

Electric Transmission Network & Substations

PLANNING ZONE 4

0 5 10 20 Miles

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

- *Approximately 8900 miles of transmission lines*
- *101 wholly owned substations*
- *394 jointly owned substations*
- *Offices in Madison (2), Cottage Grove, Pewaukee, De Pere Wausau and Kingsford, MI*

Transmission Line Voltage

- 69 kV
- 115 kV
- 138 kV
- 230 kV
- 345 kV
- 69 kV Double Circuit
- 115 kV Double Circuit
- 138 kV Double Circuit
- 230 kV Double Circuit
- 345 kV Double Circuit
- 69 kV Underground
- 138 kV Underground
- Non-ATC Line

Transmission Related Facilities

- Substation or Switchyard
- Tap or Switching Structure
- Facility (Design or Construction)
- ATC Office Location
- Generation

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.

Zone4 11x17.mxd Modified: March 23, 2006

Figure PR-4

AMERICAN TRANSMISSION COMPANY
THE ENERGY ACCESS COMPANY

Transmission System Additions (May be Planned, Proposed or Provisional)

PLANNING ZONE 4

- SS — New Substation
- SM — Substation Modifications
- T — Transformer
- C — Capacitor Bank
- T-D — New T-D Interconnection
- R — Reactor

- 345 kV Transmission Line
- 115 or 138 kV Transmission Line
- Rebuilt 115 or 138 kV Transmission Line
- Transmission Line Voltage Conversion
- 69 kV Transmission Line
- Rebuilt 69 kV Transmission Line

Transmission Related Facilities

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

Modified: 6/20/2006

Table PR-16
Transmission System Additions for Zone 4

System additions	System need year	Projected in-service year	Planning zone	Need category	Planned, Proposed or Provisional
Construct a 345/138-kV switchyard at a new Werner West Substation; install a 345/138-kV transformer. Loop existing Rocky Run to North Appleton 345 kV and existing Werner to White Lake 138-kV lines into Werner West	2004	2006	4	reliability, service limitation	Planned
Construct a 138-kV substation at a new Forward Energy Center; loop existing Butternut-South Fond du Lac line into Forward Energy Center	2006	2006	4	new generation	Planned
Construct a 345-kV substation at new Cypress; loop existing Forest Junction-Arcadian line into new Cypress	2006	2006	4	new generation	Planned
Rebuild Stiles-Amberg double circuit 138-kV line	1996	2006	2 & 4	reliability, service limitation, condition	Planned
Uprate Lakefront-Revere 69-kV line	2006	2007	4	reliability, service limitation	Provisional
String a new Ellinwood-Sunset Point 138-kV line on existing structures	2007	2007	4	reliability	Planned
Install 2-16.3 MVAR capacitor bank at Canal 69-kV Substation	2007	2007	4	reliability	Planned
Uprate North Appleton-Lawn Road-White Clay 138-kV line	2007	2007	4	reliability	Planned
Construct double circuit 138-kV line from Forest Junction/Howards Grove/Charter Steel to Plymouth #4 Substation	2007	2007	4	T-D interconnection	Planned
Rebuild Crivitz-High Falls 69-kV double circuit line	2008	2008	4	reliability	Proposed
Expand the Menominee 69-kV Substation and install 138 kV terminals. Loop the West Marinette-Bay De Noc 138-kV line into the Substation	2008	2008	4	reliability	Provisional
Install 138/69-kV transformer at the expanded Menominee Substation	2008	2008	4	reliability	Provisional
Uprate North Appleton-Mason Street 138-kV line	2008	2008	4	reliability, service limitation	Proposed
Uprate North Appleton-Lost Dauphin 138-kV line	2008	2008	4	reliability, service limitation	Proposed

Table PR-16
Transmission System Additions for Zone 4 (continued)

System additions	System need year	Projected in-service year	Planning zone	Need category	Planned, Proposed or Provisional
Install 2-4.1 MVAR capacitor bank at Sister Bay 69-kV Substation	2008	2008	4	reliability	Provisional
String a new 138-kV line from Clintonville-Werner West primarily on Morgan-Werner West 345-kV line structures	2004	2009	4	reliability, service limitation	Planned
Construct Morgan-Werner West 345-kV line	2004	2009	4	reliability, service limitation	Planned
Rebuild 2.37 miles of 69 kV from Sunset Point to Pearl Ave with 477 ACSR	2009	2009	4	reliability	Proposed
Install two 69-kV breakers at Beardsley Street Substation	2010	2010	4	reliability	Provisional
Replace the 400 amp metering CT at North Mullet River 69-kV Substation	2011	2011	4	reliability	Provisional
Install 2-16.3 MVAR capacitor bank at Mears Corners 138-kV Substation	2011	2011	4	reliability	Provisional
Install 2-16.3 MVAR capacitor bank at Rosiere 138-kV Substation	2011	2011	4	reliability	Provisional
Construct Shoto to Custer 138-kV line	2012	2012	4	reliability	Provisional
Install 138/69-kV transformer at Custer Substation	2012	2012	4	reliability	Provisional
Construct 138-kV line from Canal to Dunn Road	2012	2012	4	reliability	Proposed
Install 60 MVA 138/69-kV transformer at Dunn Road Substation	2012	2012	4	reliability	Proposed
Rebuild/convert Holmes-Chandler 69 kV to 138-kV operation	2013	2013	2 & 4	reliability, condition	Provisional
Replace the existing 138/69-kV transformer at South Sheboygan Falls Substation with 100 MVA transformer	2014	2014	4	reliability	Provisional
Replace the 1200 A breaker at Edgewater T22 345/138-kV transformer	2014	2014	4	reliability	Proposed
Replace two existing 138/69-kV transformers at Glenview Substation with 100 MVA transformers	2014	2014	4	reliability	Provisional
Uprate the Melissa-Tayco to 229 MVA (300F)	2014	2014	4	reliability	Provisional
Install 2-16.3 MVAR capacitor bank at Aviation Substation	2015	2015	4	reliability	Provisional

Table PR-16
Transmission System Additions for Zone 4 (continued)

System additions	System need year	Projected in-service year	Planning zone	Need category	Planned, Proposed or Provisional
Install 28.8 MVAR capacitor bank at Butternut 138-kV Substation	2015	2015	4	reliability	Provisional
Replace two existing 138/69-kV transformers at Sunset Point with 100 MVA transformers	2015	2015	4	reliability	Provisional
Reconductor Pulliam-Danz 69-kV line	2015	2015	4	reliability	Provisional
Reconductor Danz-Henry Street 69-kV line	2015	2015	4	reliability	Provisional
Reconductor Pulliam-Van Buren 69-kV line	2015	2015	4	reliability	Provisional
Construct a Northside-City Limits 138-kV line	2016	2016	4	reliability	Provisional
Rebuild/Convert Bayport-Suamico-Sobieski-Pioneer 69-kV line to 138 kV	2016	2016	4	reliability, condition	Provisional
Construct a second Dunn Road-Egg Harbor 69-kV line	2016	2016	4	reliability	Proposed