



# 10-Year Assessment

An annual report summarizing proposed additions and expansions to the transmission system to ensure electric system reliability.

2006

November 2006 10-Year Assessment  
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## Zones & study results

### Zone 2 Overview

Zone 2 includes the counties of:

- Alger, Mich.
- Baraga, Mich.
- Chippewa, Mich.
- Delta, Mich.
- Dickinson, Mich.
- Florence, Wis.
- Forest, Wis. (northern portion)
- Gogebic, Mich. (eastern portion)
- Houghton, Mich.
- Iron, Mich.
- Keweenaw, Mich.
- Luce, Mich.
- Mackinac, Mich.
- Marinette, Wis. (northern portion)
- Marquette, Mich.
- Menominee, Mich. (northern portion)
- Ontonagon, Mich. (eastern portion)
- Schoolcraft, Mich.
- Vilas, Wis. (northern portion)

The physical boundaries of Zone 2 and transmission facilities located in Zone 2 are shown in Figure ZS-18.

Land use in Zone 2 is largely rural and heavily forested.

Zone 2 typically experiences peak electric demands during the winter months. Ore mining and paper mills are the largest electricity users in the zone.

### Zone 2 demographics

The population of the counties in Zone 2 experienced no overall growth from 1995 to 2005. The highest growth rate occurred in Luce County (1.8 percent), while the largest increase in population over the period occurred in Vilas County, which increased by 2,500 people.

During the same period, the annual employment growth rate was 0.7 percent. The highest growth rate occurred in Keewenaw County, while the highest increase in employment occurred in Marquette County.



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## Zone 2 future population and employment projections

Population in Zone 2 grew slightly between 2001 and 2006 (0.1 percent) and is projected to grow only 0.3 percent from 2006 through 2011. From 2001 to 2006, Vilas County realized the largest increase in population and the highest growth rate.

Employment in Zone 2 grew at 1.0 percent annually between 2001 and 2006 and is projected to grow at 1.4 percent from 2006 through 2011. From 2001 to 2006, Marquette County realized the largest increase in employment, while Forest County had the highest growth rate.

## Zone 2 environmental considerations

Zone 2 includes a small part of the far northeast portion of Wisconsin and approximately the eastern two-thirds of the Upper Peninsula of Michigan. The Wisconsin portions of the zone fall into the Northeast Sands and North Central Forest ecological landscape regions. The portions of the zone located in Michigan are part of the Eastern Upper Peninsula eco-region. A description of the characteristics of the Eastern Upper Peninsula eco-region may be found on the Michigan Department of Environmental Quality Web page at [http://www.michigan.gov/dnr/0,1607,7-153-10366\\_11865-31471--,00.html](http://www.michigan.gov/dnr/0,1607,7-153-10366_11865-31471--,00.html).

Large expanses of this zone are forested and there are large numbers of streams, lakes and wetlands throughout the zone. The Niagara Escarpment is situated in the Eastern Upper Peninsula. Lakes Superior, Huron and Michigan form the northern and eastern boundaries of the zone. Two Michigan State Natural Rivers (Fox and Two-Hearted) and nine National Wild and Scenic Rivers (Tahquamenon, Indian, Sturgeon, Whitefish, Yellow Dog, Ontonagon, Paint, Carp and North Sturgeon) are found in this zone. Portions of the Nicolet, Ottawa, and Hiawatha national forests, and numerous state forests and parks are found in this zone. Several Indian reservations are found in this zone. The Seney National Wildlife Area, Pictured Rocks National Lakeshore and numerous federal wilderness areas also are found in this zone.

## Zone 2 electricity demand and generation

The coincident peak load forecasts for Zone 2 for 2007, 2011 and 2015 are shown in Table ZS-8. Existing generation along with proposed generation based on projected in-service year also are 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 0.4 percent annually from 2007 through 2015. Comparing load with generation (at maximum output) within the zone indicates that Zone 2 has more generation than peak load, though actual operating experience indicates that during most periods, Zone 2 is a net importer of power.



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## Zone 2 transmission system issues

Key transmission facilities in Zone 2 include:

- the Morgan-Plains and Plains-Dead River 345-kV lines,
- the Plains-Stiles 138-kV double-circuit line and
- the 138-kV facilities tying the Upper Peninsula of Michigan to the Lower Peninsula.

Key system performance issues in Zone 2 include:

- limited import and export capability,
- aging 69-kV and 138-kV infrastructure throughout the Upper Peninsula,
- generator stability at the Presque Isle Power Plant,
- parallel path flow around Lake Michigan that contributes to heavy loading on the 138-kV and 69-kV systems, and results in the need for transmission loading relief incidents and reconfiguration of the system, and
- low voltages, most pronounced in the western and eastern Upper Peninsula.

## Zone 2 - 2007 study results

Refer to Table ZS-1 and Figure ZS-4

### *Summary of key findings*

- The 138-kV Stiles-Plains double-circuit line rebuild project will begin to address the limitations on the transfer capability from Wisconsin to the Upper Peninsula. These limitations result in numerous transmission loading relief incidents requiring costly generation redispatch. Relief is hampered by limited redispatch options. By addressing these issues, the difference between the locational marginal price of energy in the Upper Peninsula and the rest of the ATC footprint should be reduced.
- The construction of the new 69-kV Aspen Substation (replaces the existing Brule Substation in 2007) addresses maintenance and reliability issues at Brule, and will provide enhanced system reliability and performance subsequent to the addition of the 138-kV Aspen Substation in 2009 associated with the Cranberry-Conover-Plains 138-kV line project.
- Low voltages for critical outages in Zone 2 may be adequately addressed with capacitor bank installations or distribution power factor correction, and the addition of the Cranberry-Conover line project, 69-kV initial phase, in 2008.

The first contingency overloads of one Atlantic-Osceola 69-kV line, for the loss of the other Atlantic-Osceola line, were observed in the 2007 study. One of the lines is scheduled to be rebuilt in 2008 to address existing condition issues. A companion project also is being initiated to improve the capability of the other Atlantic-Osceola 69-kV line in the same timeframe.



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Various first-contingency outages are expected to result in voltages less than 90 percent of nominal at the Sawyer, L'Anse, and Engadine 69-kV buses. Additional capacitor banks at Ontonagon (2x8.16 MVAR) Substation in 2007, and L'Anse (1x5.4 MVAR) and Roberts (1x5.4 MVAR) substations in 2008 will improve the system voltages in the L'Anse and Engadine areas. A review of the power factor profile in the Sawyer area is underway, with an apparent poor power factor profile in this area causing the low voltage. A Best Value Planning initiative is underway to determine the best method to address the voltage issues in this area.

Marginal voltages were observed at the Gwinn, Bruce Crossing, Watersmeet, Baraga, Munising, M-38, Newberry, Roberts, Straits, and St. Ignace 69-kV buses as well as on the 138-kV system between Hiawatha and Straits substations. In addition to the voltage profile improvements above, additional capacitor banks at Lincoln (1x8.16 MVAR) Substation in 2007, and Munising (1x5.4 MVAR) Substation in 2008 as well as the addition of the Cranberry-Conover project (new 69-kV line in Phase 1) will improve the voltage performance in these areas.

The construction of the Indian Lake-Hiawatha double-circuit 138-kV line was completed in spring, 2006. Due to constraints in northeastern Wisconsin this rebuilt line will be operated as single-circuit 69-kV until the completion of the Northern Umbrella Plan in 2009.

Projects whose "Need date" doesn't match the "In-service" date:

*Install 1-5.4 MVAR capacitor bank at Sawyer 69 kV (2007 need, to be determined in-service date):* A best-value planning effort with Upper Peninsula Power Co. is underway to determine whether a distribution or transmission solution is selected.

*Increase ground clearance of M38-Atlantic 69-kV line from 120 to 167 degrees F (2008 need, to be determined in-service date):* The latest studies, with the most recent load forecasts, did not show a need for this project in any study case. This will be dropped from the list when the lack of need is confirmed.

*Convert Indian Lake-Hiawatha 69-kV line to double-circuit 138-kV operation, construct new Hiawatha 138-kV Substation (2010 need, to be determined in-service date):* The final assessment of the Eastern U.P. transmission needs is not yet completed.

*Construct new Mackinac 138/69-kV Substation (2010 need, to be determined in-service date):* The final assessment of the Eastern U.P. transmission needs is not yet completed.

*Upgrade overhead portions of Straits-McGulpin 138-kV circuits #1 & #3 to 230 F degree summer emergency ratings (2010 need, to be determined in-service date):* The final assessment of the Eastern U.P. transmission needs is not yet completed.



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*Upgrade Empire-Forsyth 138-kV line terminal equipment* (2010 need, to be determined in-service date): An in-service date has not yet been identified.

*Upgrade Chandler-Cornell 69-kV line clearance from 120 to 167 degrees F* (2010 need, to be determined in-service date): An in-service date has not yet been identified.

Projects whose “Need” and “In-service” dates are to be determined:

- Install 2-5.4 MVAR capacitor banks at Osceola 69-kV Substation
- Upgrade M38 138/69-kV transformer
- Install 2-8.16 MVAR capacitor banks at M38 69-kV Substation
- Install 1-5.4 MVAR capacitor bank at MTU or Henry Street 69-kV Substation

All four of the above projects require further study to determine when and if the project should be implemented.

## Zone 2 - 2011 study results

Refer to Table ZS-2 and Figure ZS-5

### Summary of key findings

- The completion of the Northern Umbrella Plan by 2010, including the addition of the Cranberry-Conover-Plains project and a second 345/138-kV transformer at Plains, will result in a dramatic increase in Wisconsin-Michigan transfer capability, likely reducing the locational marginal price of energy. In addition, substantial reliability benefits will be realized with these sets of projects.

A complete review of ATC's needs in the Eastern Upper Peninsula (U.P.) is underway and nearly completed. Earlier 10-Year Assessments specified various projects in the Eastern U.P., including the creation of a double-circuit 138-kV conduit from Indian Lake to Straits. This review will assess if all or some of those projects should still be constructed in the 2010 timeframe, constructed in a phased manner, or perhaps a different set of projects proposed. The results of this review and ATC's transmission plans in the Eastern U.P. for 2009 and beyond will be communicated when the review is more fully developed, and will also be included in the next 10-Year Assessment update.

One new project in the Eastern U.P. positively identified is the rebuild of the older of the two Hiawatha-Straits 69-kV lines, line 6908. This rebuild will conform to 138-kV double-circuit standards but will initially be operated as single-circuit 69 kV. The distribution taps to Rexton and Trout Lake substations will be transferred over to the other Hiawatha-Straits 69-kV line 6909. This project will improve the voltage profile near the Pine River and Straits substations.



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Conversion of the Conover to Plains 69-kV corridor to 138 kV, along with the addition of 138/69-kV transformations at Iron Grove (formerly Iron River Substation) and Aspen (formerly Brule Substation) will greatly improve the reliability and voltage profile on the western U.P. 69-kV system.

The addition of the Munising and Roberts 69-kV capacitor banks will address the remaining voltage violations.

The overload of the Atlantic-Osceola 69-kV line observed in the 2011 study will be addressed by the Atlantic-Osceola line projects in 2008.

An approved Transmission Service Request for 35 MW from the White Pine Mine in 2008 was modeled in the 2011 study case, including the uprates of numerous 69-kV lines in that area to accommodate that service. The studies showed that the addition of this generation in the northwestern portion of the U.P. provided an additional voltage profile benefit due to the reduced level of import to this portion of the system.

Three transmission lines were identified to be limiting elements under specific shoulder peak conditions by 2011 and are listed as new projects in this Assessment: uprate the Straits-McGulpin 138-kV line (both circuits, overhead portion only), uprate the Empire-Forsyth 138-kV line, and uprate the Chandler-Cornell 69-kV line. These projects are listed with a TBD (to be determined) in-service date, with the project scopes and dates pending further review. However, ATC intends to propose a plan in time to meet the need dates.

Updated Zone 2 load modeling for the 2006 10-Year Assessment resulted in several transmission projects identified in the 2005 Assessment being either postponed to an unidentified future date (pending confirmation of no need) or cancelled. Specifically, the addition of capacitor banks at Osceola Substation in 2008, and M38 Substation in 2012, and MTU/Henry St. Substation in 2013 were given a TBD in-service date pending further study in this area of the system. The project to uprate the M38 138/69-kV transformer was also given a TBD in-service date for this reason. The addition of an M38 69-kV capacitor bank in 2015 was cancelled.

## *Zone 2 - 2015 study results*

Refer to Table ZS-3 and Figure ZS-6

## *Summary of key findings*

- The poor condition of the line and system reliability considerations will require rebuilding the Blaney Park-Munising 69-kV line to operate at 138 kV.
- The poor condition of the line and system reliability considerations may require rebuilding the 69-kV Chalk Hills-Chandler line to operate at 138 kV.



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- The only low voltages observed in 2015 were in the Eastern U.P., and will be addressed as part of the review performed for this portion of the ATC system.

Portions of the Blaney Park-Munising 69-kV line will need to be rebuilt due to poor physical condition. Reliability of service to customers served by this line is also a concern because this relatively long line is currently operated radially from Munising (open at Blaney Park). The condition and rating of the line prevents us from closing both ends at the same time. If this line is converted to 138 kV, it also could provide the continuation of another 138-kV outlet from the Presque Isle Power Plant in the Marquette area, enhancing the reliability of the substation.

Portions of the Chalk Hills-Chandler 69-kV line may need to be rebuilt due to poor physical condition. Rebuilding and converting the 69-kV Chalk Hills-Chandler line to 138 kV will allow the line to be operated normally closed (currently a portion of the line is operated radially from Chalk Hills), address physical condition issues associated with the line, and improve and diversify the ties between Zone 2 and Zone 4.

As previously mentioned, a review of the immediate and long-term needs in the Eastern U.P. is being performed. The projects resulting from that review will address the limitations found in the 2015 study as well as provide a reliable and robust system to meet the needs of the Eastern U.P. system.

**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		85 – 90%	
1	Port Edwards, Hollywood, & Saratoga 138-kV bus voltages	88 – 92%	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%	Arpin-Sigel 138-kV line outage		95 – 107%	
1	Council Creek 69-kV bus tie	97 – 100%	Sigel-Lakehead Vesper 138-kV line outage		98 – 102%	
1	Council Creek and Petenwell 138-kV bus voltage	90 – 96%	Arpin-Sigel 138-kV line outage Base Case		91%	
1	Necedah, Whistling Wings, Dellwood, Friendship, Houghton Rock 69-kV bus voltages	89 – 91%	Sigel-Lakehead Vesper 138-kV line outage Petenwell 138/69-kV transformer		88 – 92%	
1	Wautoma, Sand Lake and Roeder 138-kV bus voltages	88 – 95%	Petenwell-Big Pond 69-kV line outage Big Pond-Necedah tap 69-kV line outage Base Case		86 – 92%	
1	Metomen 138/69-kV transformer	97 – 102%	Various line outages		96 – 107%	
1	Metomen-Ripon 69-kV line	98%	North Fond Du Lac-Rosendale 69-kV line outage Rosendale-Metomen 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%	Winneconne-Sunset Point 69-kV line outage 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, Gilen 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, Gwin 69-kV bus voltages	89-91%	Forsyth-Gwin 69-kV line outage		88-90%	
2	Bruce Crossing, Watersmeet 69-kV bus voltages	90-91%	Mass-Brue 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 transformer	91%	Straits 138-69-kV transformer			
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.		89-90%	
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		111%	
3	Colley Road-Brick Church 69-kV line	111%	Colley Road-Brick Church 138-kV line outage		131%	
3	Paddock-Shirland Ave 69-kV line	104%	Colley Road 138/69-kV transformer outage		115%	
3	Colley Road-Park Ave Tap 69-kV line	110%	Paddock 138/69-kV transformer outage		108%	
3	Colley Road 138/69-kV transformer	96%	Paddock 138/69-kV transformer outage		116%	
3	North Lake Geneva-Lake Geneva 69-kV line	109%	Brick Church-Cobblestone 69-kV line outage		100%	
3	Brick Church-Cobblestone 69-kV line	114%	North Lake Geneva-Lake Geneva 69-kV line outage		114%	
3	Janesville-Parkview 69-kV line	113%	McCue 138/69-kV transformer outage		119%	
3	Royster-Pflaum 69-kV line	104%	Fitchburg-Syene 69-kV line outage		120%	
3	Blount-Ruskin 69-kV line	106%	Second Blount-Ruskin 69-kV line outage		109%	
3	Fitchburg-Syene 69-kV line	111%	Royster-Pflaum Tap 69-kV line outage		119%	
3	Stage Coach-Black Earth 69-kV line	102%	Spring Green 138/69-kV transformer outage		117%	
3	Verona-Oregon 69-kV line	121%	Stoughton-Aaker Road 69-kV line outage, Stoughton-Sheepskin 69-kV line outage		109%	
3	North Monroe-Monticello 69-kV line	95%	Stoughton-Aaker Road 69-kV line outage		131%	
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		99%	
3	Hillman-Belmont 69-kV line	97%	Nelson Dewey-Lancaster 138-kV line outage		116%	
3	Hillman 138/69-kV transformer	115%	Various DPC 69-kV line outages		97%	
3	Darlington-Rock Branch 69-kV line	97%	Nelson Dewey-Lancaster 138-kV line outage		121%	
3	Kilbourn 47 MVA 138/69-kV transformer	144%	Kilbourn S3 MVA 138/69-kV transformer outage		98%	
3	Portage-Columbia 69-kV line	113%	Portage 138/69-kV transformer outage		152%	
3	Columbia 138/69-kV transformer	105%	Portage 138/69-kV transformer outage, North Madison 138/69-kV transformer outage		118%	
3	Portage-Trienda 138-kV line	98%	Second Portage-Trienda 138-kV line outage		109%	
3	Columbia 345/138-kV transformer #2	98%	Columbia 345/138-kV transformer #1 and #3 outage		104%	
3	Academy-Columbus 69-kV line	110%	North Randolph-Fox Lake 138-kV line outage, Fox Lake-North Beaver Dam 138-kV line outage		103%	
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-Harmony 69-kV line			McCue 138/69-kV transformer outage Sheepskin-Sheepskin Peak Unit 69-kV line outage; Paddock-Newark 69-kV line outage, Brodhead Switching Station-Brodhead Muni 3 69-kV line outage	96% 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, Brownstown, 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 1' 38-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, Horizon 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			Royer-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				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				
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%	Apin-Sigel 138-kV line outage	89 – 90%		91 – 92%	
1	Port Edwards, Hollywood, and Saratoga 138-kV bus voltages		90 – 91%	Apin-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%			
1	Council Creek and Petenwell 138-kV bus voltage		90 – 95%	Base Case  Apin-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%	95 – 113%	--	
1	Neededah, 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-Neededah 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. Delis 69-kV line outage				
1	Wautoma, Sand Lake and Roeder 138-kV bus voltages	91 – 96%		Base Case  Sigel-Arpin 138-kV line outage	89 – 91%		--	
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. Delis-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 – Ripon 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-Lkhk 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 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	--			--
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, Gwinnett, Chatham, Forest Lake 69-kV bus voltages	--		Forsyth-Gwinnett 69-kV line outage		84-91%		
2	Sawyer, Gwinnett 69-kV bus voltages	87-88%		Forsyth-Gwinnett 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, MI-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, Hubert, 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, Hubert 69-kV bus voltages	88-91%		Engadine-Hiawatha 69-kV line outage, Engadine-Newberry 69-kV line outage, Engadine-Straits 138-69-kV transformer		--		
2	St. Ignace, Straits, Evergreen, Michigan Limestone, Talentino, and Rockview 69-kV bus voltages	--				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-South 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 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 Ruskin 1 and 2 bus tie			Rockdale-Wempletown 345-kV line outage			106%	110%
3	Bio Enzyme Systems-RCEC Clinton-Clinton 69-kV line North Lake Geneva-Lake Geneva 69-kV line Janesville-Parkview 69-kV line Janesville 138/69-kV transformer McCue-Milton Lawns 69-kV line Black Earth-Cross Plains-Stagecoach-Timberlane 69-kV line Portage-Columbia 69-kV line Columbia 138/69-kV transformer Kilbourn 47 MVA 138/69-kV transformer Huiskamp-Ruskin 69-kV line	98% 110% 122% 97% 100% 135% 113% 109% 133% 115%		North Madison-Vienna 738-kV line outage, Yahara River 138-kV line outage, American Center – Sycamore 138-kV line outage Brick Church 138/69-kV transformer outage Brick Church-Cobblestone 69-kV line outage McCue 138/69-kV transformer outage McCue 138/69-kV transformer outage Janesville 138/69-kV transformer outage Spring Green 138/69-kV transformer outage Portage 138/69-kV transformer outage Portage 138/69-kV transformer outage, Deforest-North Madison 69-kV line outage Kilbourn 93 MVA 138/69-kV transformer outage North Madison-Vienna 738-kV line outage, 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 Fitchburg-Syene 69-kV line outage	103% 117% 126% 102% 106% 145% 116% 112% 132% 117%		106% 109% 102% 106% 102% 107% 129%	
3	Royster-Pflaum 69-kV line Ruskin 69-kV 1-2 bus tie	98% 107-98%		North Madison-Vienna 738-kV line outage, Yahara River 138-kV line outage, American Center – Yahara River 138-kV line outage Second Portage-Trienda 138-kV line outage	118-105%			
3	Portage-Trienda 138-kV line Portage-Columbia 138-kV line Columbia 345/138-kV transformer #2 Fitchburg-Syene 69-kV line Brick Church-Cobblestone-Zenda Tap 69-kV line Zenda Tap-Katzenberg 69-kV line Janesville-Parkview 69-kV line West Middleton-Timberlane 69-kV line Rock Springs Tap-Antesian 138-kV line Academy-Columbus 69-kV line Koch Oil Tap-South Fond Du Lac 69-kV line Nine Springs-Syene 69-kV line Portage-Trienda 138-kV line Waunakee Switching Station-Waunakee #2 69-kV line Pheasant Branch-West Port 69-kV line Kegonsa-Christianiana 138-kV line Idle Hour, Monroe, Monroe Tap, South Monroe, Blacksmith 69-kV bus voltages	113% 96% 103% 107% 101% 96% 96% 106% 95% 98% 97% 96% 96% 102% 101% 96% 96% 96% 96% 96% 96% 101%		Columbia 345/138-kV transformer #1 and #3 outage Royster-Pflaum Tap 69-kV line outage North Lake Geneva 138/69-kV transformer outage North Lake Geneva-Lake Geneva 69-kV line outage Russell 138/69-kV transformer outage Spring Green 138/69-kV transformer outage Trienda-Lewiston 138-kV line outage North Randolph-Fox Lake 138-kV line outage Royster- Pflaum Tap 69-kV line outage Second Portage-Trienda 138-kV line outage Martinsville-North Madison 138-kV line outage Martinsville-North Madison 138-kV line outage Second Kegonsa-Christianiana 138-kV line outage North Monroe-Idle Hour 69-kV line outage North Monroe 138/69-kV transformer	99% 106% 111% 96% 96% 96% 96% 96% 96% 96% 96% 96% 96% 96% 87-91%		88-92% 88-92% 90-92% 92%	90-92% 90-92% 92%
3	Idle Hour, Monroe, Monroe Tap, South Monroe, New Glarus 69-kV bus voltages Brodhead Muni 3, Brodhead Muni 2, Brodhead, Brodhead Muni 1, RCEC Orfordville, Orfordville, Bass Creek, Footville, RCEC Center 69-kV bus voltages	91-92%		Brodhead Switching Station-Brodhead Muni 3 69-kV line outage				
3	Brodhead Muni 2, Brodhead, Brodhead Muni 1 69-kV bus voltages			Brodhead Muni 2-Brodhead Muni 3 69-kV line outage				

**TABLE ZS-2**  
**PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2011 PEAK, HOT SUMMER AND SHOULDER CASES (CONTINUE**



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 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
		Rating Peak Case	Bus Voltage Peak 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 – Waukesha 3 138-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%	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 138/69-kV transformer outages Petenwell-Big Pond 69-kV line outage Necedah Tap-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%		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 69-kV bus tie (ATC-DPC)	95 – 121%		Base Case
1	Council Creek and Petenwell 138-kV bus voltage		90 – 95%	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
1	Sand Lake 138/69-kV transformer	95 – 109%		Arpin-Sigel 138-kV line outage Young Road-Sigel 138-kV line outage 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%		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 Gardner Park-Blackbrook-Antigo 115-kV line outage Antigo-Blackbrook 115-kV line outage Werner West-White Lake 138-kV line outage
1	Whitcomb 115/69-kV transformer	95 – 98%		Whitcomb 115/69-kV transformer
1	Caroline 115/69-kV transformer	95%		Chaffee Creek-Coloma tap 69-kV line outage
1	Coloma (ACEC), Lincoln Pumping Station, Brooks (ACEC) and Grand Marsh 69-kV bus voltages		88 – 92%	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%	Warner West-White Lake 138-kV line outage
1	Hillsboro, Woneewoc 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-Blacksmit 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 Pilot NB-Galena 69-kV line outage
3	Hillman-Elmo 69-kV line	99%		Wempleton-Rockdale 345-kV line outage
3	North Monroe-Monticello Tap 69-kV line	95%		Darlington 138/69-kV transformer outage, Paddock-Newark 69-kV line outage
3	North Monroe 138/69-kV transformer	97-95%		Janesville-Park View 69-kV line Janesville 138/69-kV transformer Milton-Lawins-McCue 69-kV line
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-Lawins-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
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-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 River 138-kV line outage
3	Idle Hour, Monroe, Monroe Tap, South Monroe, Blacksmith, Brownstown, 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, Blacksmith, Brooklyn, Sun Valley, Oregon, New Glarus, Belleville, Montrose, Monticello, Monticello Tap, New Glarus, Belleville, Montrose, Brooklyn, Sun Valley, Oregon, Verona, Jennings South Monroe, Blacksmith, Brownstown, Green Wind, Aakar Road, Wiota 69-kV bus voltages, Verona 138-kV bus voltage	85-92%		North Monroe-Monticello Tap 69-kV line outage
3	South Monroe, Monroe, Blacksmith, Brownstown 69-kV bus voltages			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, Evansville 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, 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%	Kegonsa-Cottage Grove 69-kV line outage, Kegonsa 138/69-kV transformer outage
3	Cottage Grove, Gaston Road 69-kV bus voltages		90%	Stoughton-Aakar 69-kV line 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 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 Colorado 69-kV bus voltage	85-91%	85-91%	Reiner Road-Burke Tap 69-kV line outage Reiner 138/69-kV transformer outage
3	Deforest, Sun Prairie, South, Bird St., Gaston Rd, Token Creek, Hampden Tap, Hampden 69-kV bus voltages Hubbard 138-kV bus voltage	82-92%	92%	Colorado-Burke Tap 69-kV line outage Deforest-Token Creek 69-kV line outage
3	Hustiford, Hubbard 138-kV bus voltages Birchwood, Dell Creek, Zobel, Nishan 138-kV bus voltages	92%	92%	Deforest-North Madison 69-kV line outage Hustiford-Hubbard 138-kV line outage Hustiford-Rubicon 138-kV line outage Loch Mirror-Birchwood 138-kV line outage
3	Birchwood, Dell Creek, Zobel, Nishan 138-kV bus voltages 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 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	90-91%	89%	Loch Mirror-Kilbourn 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	87-92%	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%	88-91%	East Dells-Lewiston 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%	82-92%	Lake Delton-Trienda 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%	90-92%	Trienda-Lewiston 138-kV line outage
3	Spring Green, Troy, Wyoming Valley, Kirkwood 138-kV bus voltages	91-92%	91-92%	City View-Lake Delton 138-kV line outage
3	Sugar Creek 138-kV bus voltage	92%	92%	Sugar Creek-University 138-kV line
3	Fort Atkinson 138-kV bus voltage	91%	91%	Jefferson 4-5 138-kV bus tie outage
3	Crawfish, Rockvale 138-kV bus voltages	91-92%	91-92%	Jefferson-Crawfish River 138-kV line outage
3	Concord, Hubbard, Hustiford, Rubicon 138-kV bus voltages Rockvale 138-kV bus voltage	90-92%	90%	Concord 4-5 138-kV bus tie outage Rockvale-Concord 138-kV line outage
3	North Shore, Delavan, Bristol, Elkhorn, Como 138-kV bus voltages	91-92%	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%	88-92%	Nelson Dewey-Lancaster 138-kV line outage
3	Potosi, Hillman, Lafayette Wind, Darlington 138-kV bus voltages	90%	90%	Nelson Dewey-Potosi 138-kV line outage
3	Hillman, Lafayette Wind, Darlington 138-kV bus voltages	90%	90%	Potosi-Hillman 138-kV line outage
3	Darlington 138-kV bus voltage	92%	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, Wyoming Valley, Spring Green, Troy 138-kV bus voltages, Avoca, Muscoda 69-kV bus voltages	90.91%	90.91%	Eden-Lancaster 138-kV line outage
3	North Monroe, Darlington, Lafayette Wind 138-kV bus voltages	91.92%	91.92%	Eden-Wyoming Valley 138-kV line outage
3	Albany, North Monroe, Darlington, Lafayette Wind 138-kV bus voltages	90.92%	90.92%	North Monroe-Albany 138-kV line outage
3	Dickinson, Brick Church, Williams Bay 138-kV bus voltages	88.92%	88.92%	Town line Road-Albany 138-kV line outage
3	Brick Church, Williams Bay 138-kV bus voltages	89.91%	89.91%	Colley Road-Dickinson 138-kV line outage
3	Spring Green, Troy 138-kV bus voltages	91.92%	91.92%	Dickinson-Brick Church 138-kV line outage
3	Fort Atkinson 138-kV bus voltage	92%	92%	Spring Green-Wyoming Valley 138-kV line outage
3	Reiner Road, Sprecher 138-kV bus voltages	91.92%	91.92%	Rockdale-Lakehead Cambridge 138-kV line
3	Fox Lake, Beaver Dam East bus voltages	91.92%	91.92%	Reiner Rd-Sycamore 138-kV line outage
3	Rockvale 138-kV bus voltage	91.92%	91.92%	North Randolph-Fox Lake 138-kV line outage
3	LCI, Pflaum, Femrite, Nine Springs, Syene 69-kV bus voltages Brisbois, Grangrae, Boscobel, Boscobel Muni, Wauzeka, Hillside, Lapointe 69-kV bus voltages	90.92%	90.92%	Bark River-Cottonwood 138-kV line outage, Bark River-Sussex 138-kV line outage
3	Miner 69-kV bus voltage	91.92%	91.92%	Femrite 138/69-kV transformer outage
3	Miner, Shullsburg 69-kV bus voltages	92%	92%	Grangrae 138/69-kV transformer outage
3	Boscobel, Muscoda, Blue River, Brisbois 69-kV bus voltages	91%	92%	DPC Terr TP – Pilot NB 69-kV line outage
3	Brisbois, Vienna, Yahara River, American Center, Reiner Rd, Sprecher, Vienna, Yahara River, American Center, Reiner Rd, Sprecher, Femrite, Sycamore 138-kV bus voltages	91.92%	91.92%	DPC Pilot NB-Galena 69-kV line outage
3	Yahara River, American Center, Reiner Road, Sprecher, Femrite, Femrite, Sycamore 138-kV bus voltages	91.92%	91.92%	Seneca-Genoa 161-kV line outage
3	Reiner Rd, Sprecher, Femrite, Sycamore 138-kV bus voltages	91.92%	91.92%	North Madison-Vienna 138-kV line outage
3	Verona, Sun Valley, Brooklyn, Oregon, Montrose, Belleville, Aker, Stoughton, Stoughton Muni, Mount Horeb, New Glarus, Forward, Monticello 69-kV bus voltages	86.91%	86.91%	Yahara River-American Center 138-kV line outage
3	Aker, Stoughton, Stoughton Muni, Mount Horeb, New Glarus, Forward, Monticello 69-kV bus voltages	87.91%	87.91%	Verona 138/69-kV transformer outage
3	Sun Valley, Oregon, Brooklyn 69-kV bus voltages	88.90%	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%	88.92%	Cobble Stone-Brick Church 69-kV line outage
4	Pulliam-Van Buren 69-kV line	97%	97%	Pulliam-Danz Avenue 69-kV line outage
4	Henry-Danz Avenue 69-kV line	105%	105%	Pulliam-Van Buren 69-kV line outage
4	Pulliam-Danz Avenue 69-kV line	102%	102%	Pulliam-Van Buren 69-kV line outage
4	Sunset Point-Pearl Avenue 69-kV line	104%	104%	Elinwood-Twelfth Avenue 69-kV line outage
4	Sunset Point 138/69-kV transformer #1	101%	101%	Sunset Point 138/69-kV transformer #2 outage
4	Sister Bay 69-kV bus voltage	95%	95%	Base Case
4	Bluestone, Westmark 69-kV bus voltages	86-88%	86-88%	Finger Road-Bluestone 69-kV line outage
4	Booster, Barnett, Beardsley St, East Krok 69-kV bus voltages	90.91%	90.91%	East Krok 138/69-kV transformer outage
4	Quarry Run, Woodenshoe, Mears Corners, Sunset Point 138-kV bus voltages	89.91%	89.91%	Neevin-Quarry Run 138-kV line outage
4	Hickory Butternut, Forward Energy Center 138-kV bus voltages	92%	92%	Quarry Run-Woodenshoe 138-kV line outage
5	Oak Creek 345/230-kV transformer	100%	100%	Hickory-South Fond du Lac 138-kV line outage
5	Granville 345/138-kV transformer	95%	95%	Splitting Oak Creek 230-kV bus 78
5	Tichigan and Burlington 138-kV bus voltages	102%	102%	Splitting Granville 345-kV bus 23
5	Edgewood – St. Martins 138-kV line	110%	110%	Walworth – Mukwonago 138-kV bus outage
5	Albers – Bain 345-kV line			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 – Waukesha#1 138-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	Bair 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 – Waukesha#3 138-kV line	118%		Arcadian4 – Waukesha#1 138-kV line outage
5	Germantown, Maple 138-kV bus voltages		91-92%	Maple – Saukville 138-kV line outage

*Table ZS-8*  
*Forecast of Peak Load and Generation in Zone 2*

	2007	2011	2015
Peak Forecast (megawatts)	835.3	846.4	862
Average Peak Load Growth	N/A	0.33%	0.46%
Existing Generation Capacity (megawatts)	1063.9	1063.9	1063.9
Existing Capacity Less Load	228.6	217.5	201.9
Existing Generation Capacity plus Modeled Generating Capacity Additions (megawatts)	1076.4	1076.4	1063.9
Modeled Capacity Less Load (megawatts)	241.1	230	201.9

*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.*

Figure ZS-4

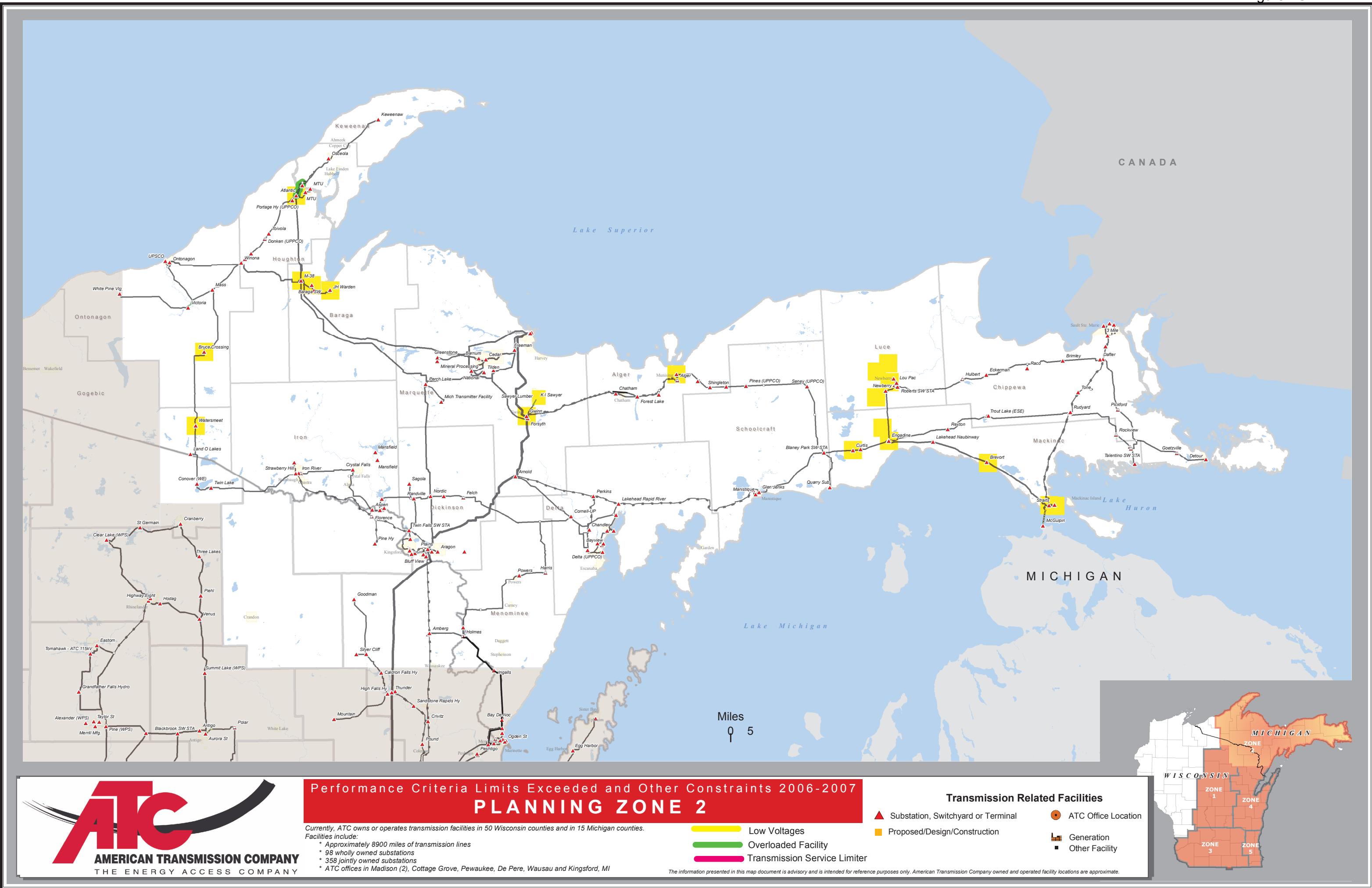
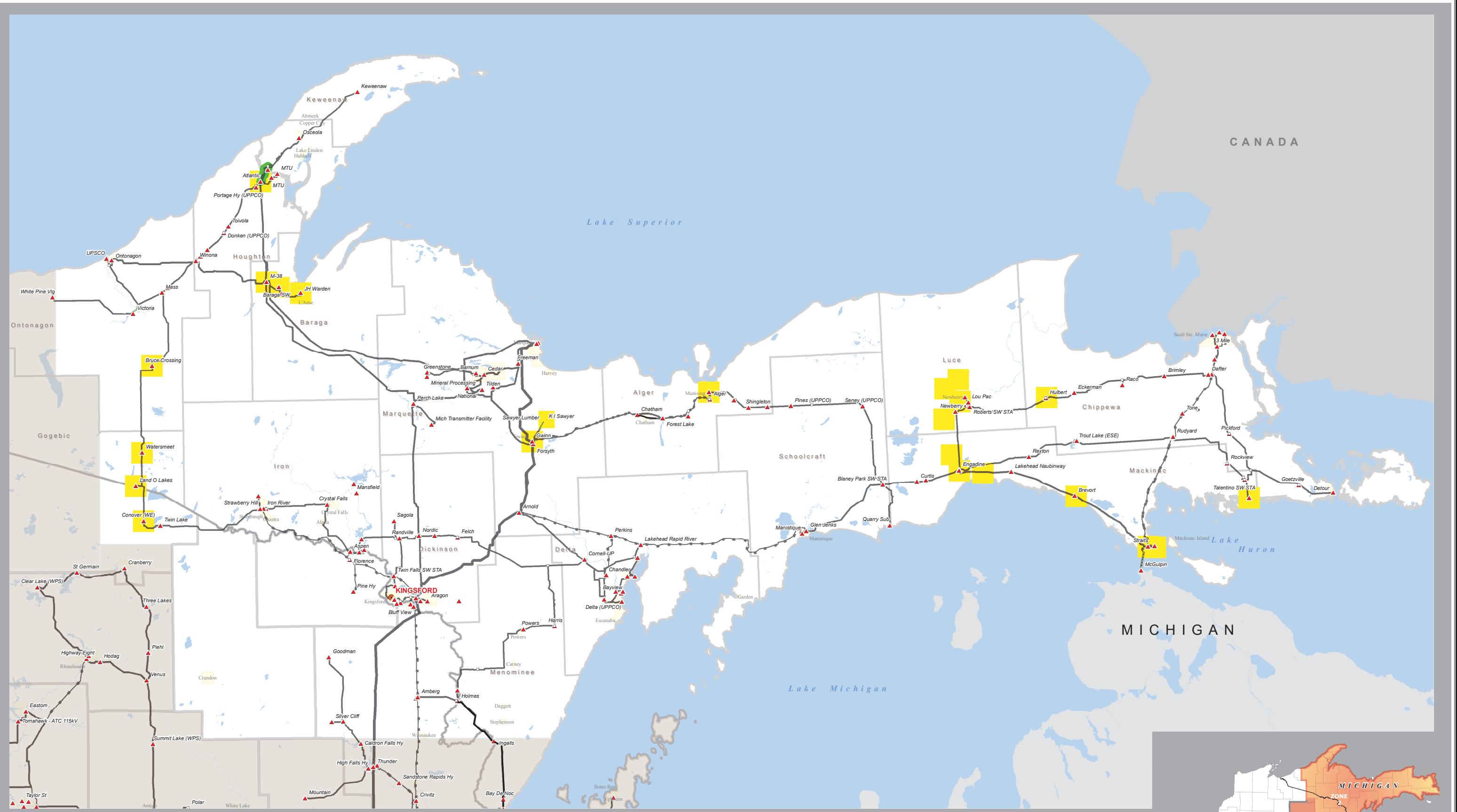


Figure ZS-5



Performance Criteria Limits Exceeded and Other Constraints 2008-2011  
**PLANNING ZONE 2**

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
- \* ATC offices in Madison (2), Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI

- Currently, ATC owns or operates transmission facilities in 30 Wisconsin counties and in 15 Michigan counties. Facilities include:

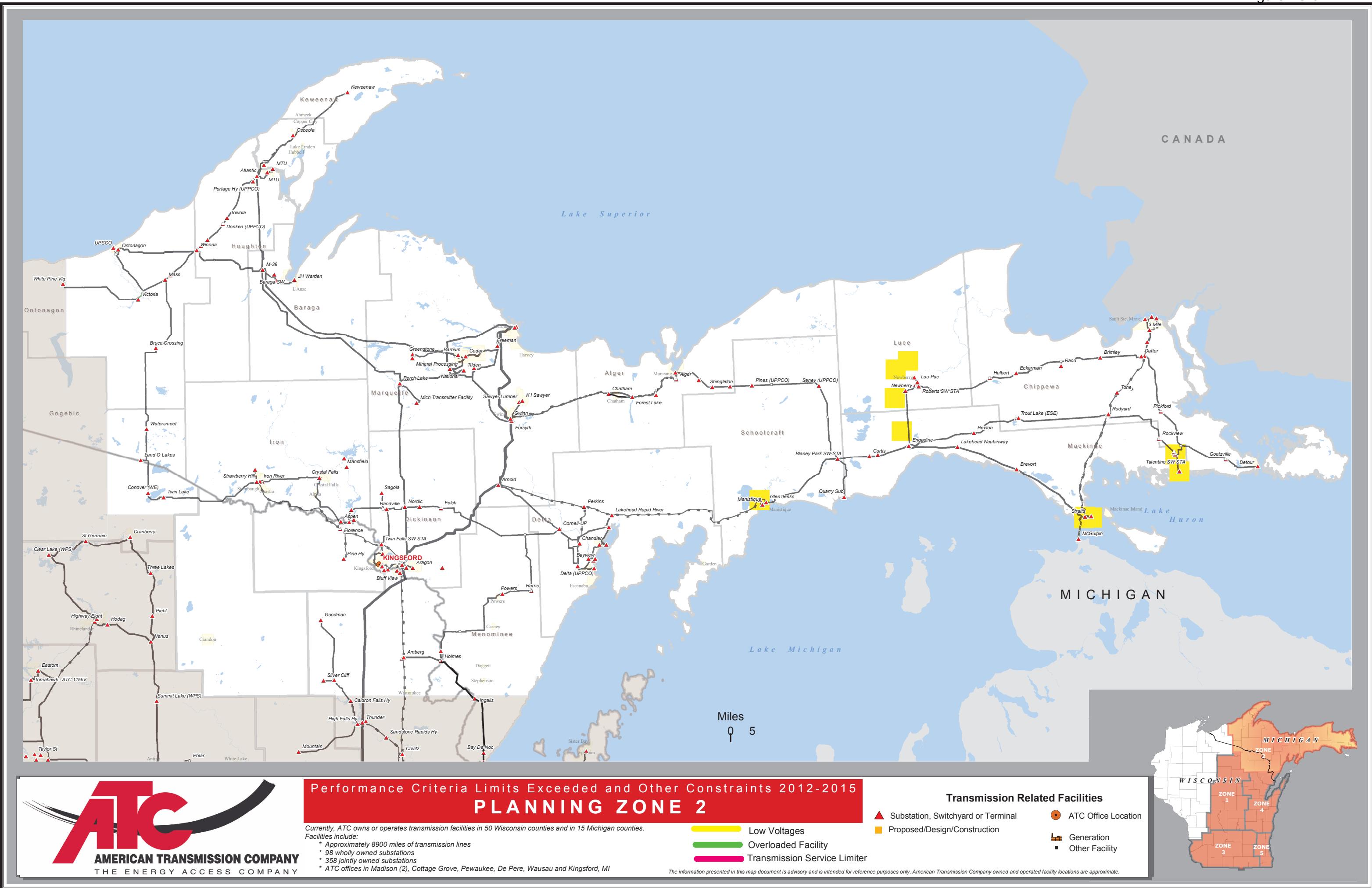
  - \* Approximately 8900 miles of transmission lines
  - \* 98 wholly owned substations
  - \* 358 jointly owned substations
  - \* ATC offices in Madison (2), Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI

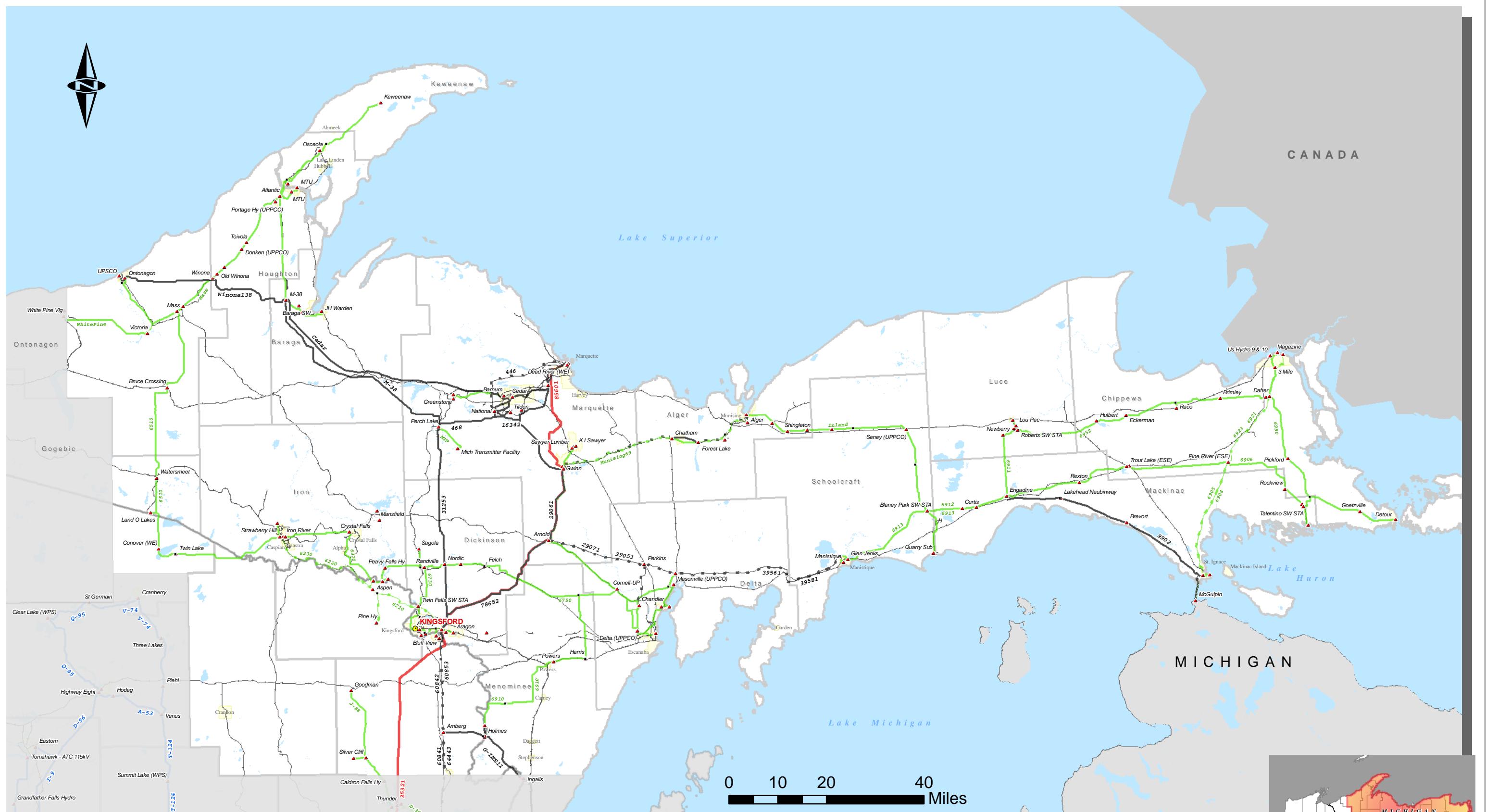
*The information presented in this map document is advisory and is intended for reference purposes only. American Transmission Company owned and operated facility locations are approximate.*

## **Transmission Related Facilities**

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

Figure ZS-6





## Electric Transmission Network & Substations PLANNING ZONE 2

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

Facilities include:

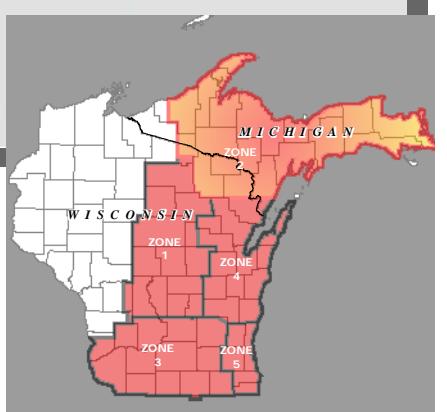
- \* Approximately 8900 miles of transmission lines
- \* 101 wholly owned substations
- \* 394 jointly owned substations
- \* ATC offices in Madison (2), Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI

### Transmission Line Voltage

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

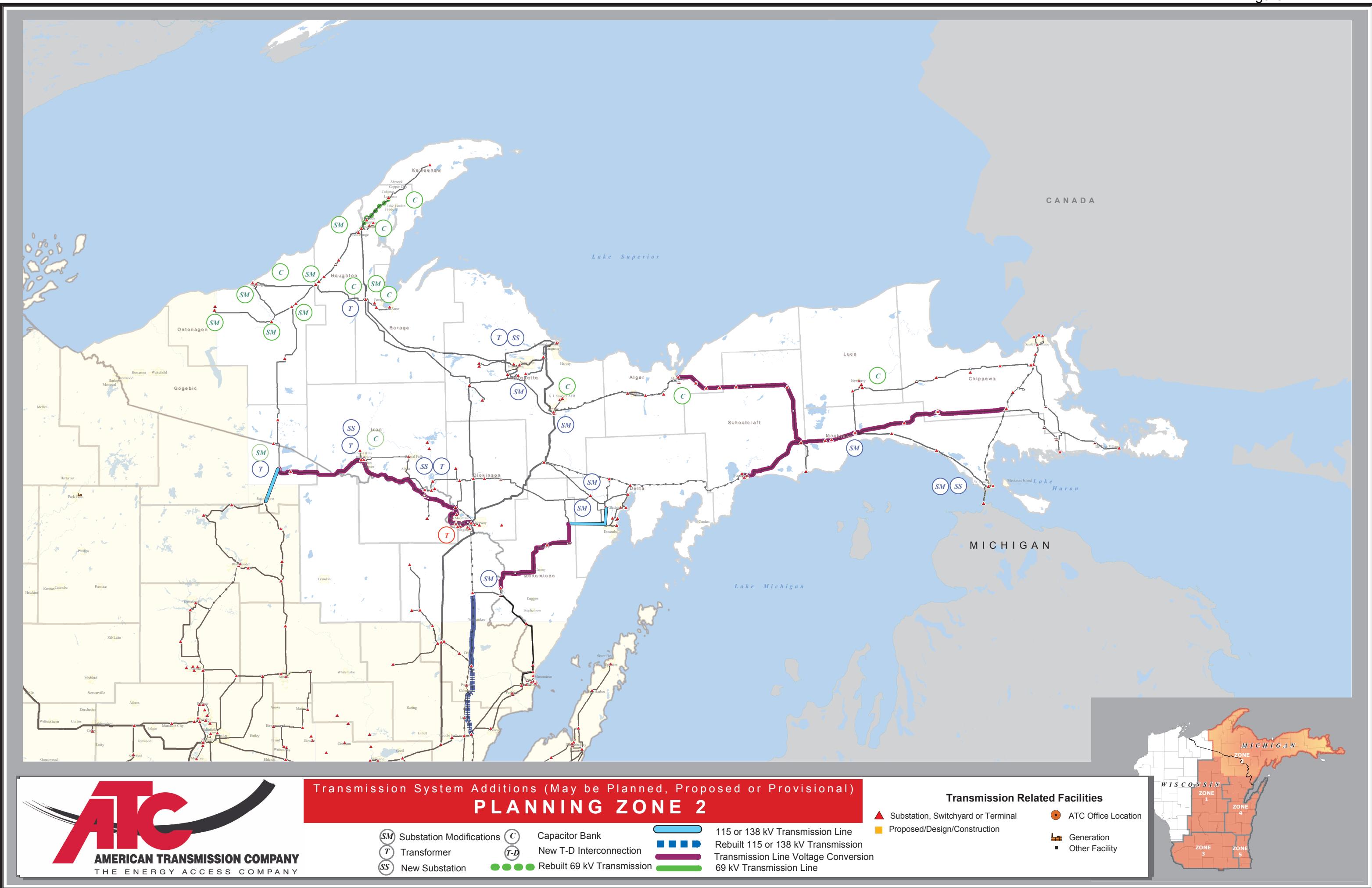
### Transmission Related Facilities

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



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.

Figure PR-2



**Table PR-14**  
**Transmission System Additions for Zone 2**

<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>
Uprate Victoria-Ontonagon 69-kV line clearance to 135 degrees F	2006	2006	2	new generation	Planned
Uprate Victoria-Mass 69-kV line clearance to 135 degrees F	2006	2006	2	new generation	Planned
Uprate Mass-Winona 69-kV line clearance to 135 degrees F	2006	2006	2	new generation	Planned
Uprate Winona-Atlantic 69-kV line clearance to 135 degrees F	2006	2006	2	new generation	Planned
Rebuild Stiles-Amberg double circuit 138-kV line	1996	2006	2 & 4	reliability, service limitation, condition	Planned
Install 1-5.4 MVAr capacitor bank at the Sawyer 69-kV Substation	2007	TBD	2	reliability	Provisional
Install 1-8.16 MVAr capacitor bank at the Lincoln 69-kV Substation	2007	2007	2	reliability	Planned
Relocate Brule Substation (Aspen)	2007	2007	2	reliability, condition	Planned
Uprate White Pine-Victoria 69-kV line clearance to 200 degrees F	2007	2007	2	new generation	Planned
Uprate Victoria-Ontonagon 69-kV line clearance to 185 degrees F	2007	2007	2	new generation	Planned
Uprate Victoria-Mass 69-kV line clearance to 185 degrees F	2007	2007	2	new generation	Planned
Install 2-8.16 MVAr capacitor banks at Ontonagon 138-kV Substation	2007	2007	2	reliability	Proposed
Construct 138 kV bus and install 138/115-kV 150 MVA and 138/69-kV 60 MVA transformers at Conover Substation	2008	2008	2	reliability, transfer capability	Planned
Install 1-5.4 MVAr capacitor bank at Munising 69-kV Substation	2008	2008	2	reliability	Proposed
Relocate Cedar Substation (North Lake)	2005	2008	2	reliability, condition	Proposed
Install 1-5.4 MVAr capacitor bank at the Roberts 69-kV Substation	2007	2008	2	reliability	Proposed
Install second 345/138-kV transformer at Plains Substation	2008	2008	2	reliability, transfer capability	Proposed
Rebuild Atlantic-Osceola 69-kV line (Laurium #1)	2006	2008	2	reliability, condition	Planned

**Table PR-14**  
**Transmission System Additions for Zone 2 (continued)**

<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 Mass-Winona 69-kV line clearance to 185 degrees F	2008	2008	2	generation	Planned
Upgrade Winona-Atlantic 69-kV line clearance to 185 degrees F	2008	2008	2	generation	Planned
Increase ground clearance of Atlantic-Osceola (Laurium #2) 69-kV line from 120 to 167 degrees F	2008	2008	2	reliability	Proposed
Install 1-5.4 MVAR capacitor bank at L'Anse 69-kV Substation	2007	2008	2	reliability	Provisional
Install 2-5.4 MVAR capacitor banks at Osceola 69-kV Substation	TBD	TBD	2	reliability	Provisional
Increase ground clearance of M38-Atlantic 69-kV line from 120 to 167 degrees F	2008	TBD	2	reliability	Provisional
Rebuild Hiawatha-Pine River 69-kV line ESE 6908	2009	2009	2	maintenance	Proposed
Rebuild/convert Conover-Plains 69-kV line to 138 kV	2009	2009	2	reliability, transfer capability	Planned
Construct 138 kV bus and install a 138/69 kV, 60 MVA transformer at Iron Grove Substation	2009	2009	2	reliability, transfer capability	Planned
Construct 138 kV bus and install a 138/69 kV, 60 MVA transformer at Aspen Substation	2009	2009	2	reliability	Planned
Relocate Iron River Substation (Iron Grove)	2009	2009	2	reliability	Planned
Convert Indian Lake-Hiawatha 69-kV line to double-circuit 138-kV operation, construct new Hiawatha 138-kV Substation	2010	TBD	2	reliability	Provisional
Construct new Mackinac 138/69-kV Substation	2010	TBD	2	reliability	Provisional
Upgrade overhead portions of Straits-McGulpin 138-kV circuits #1 & #3 to 230 F degree summer emergency ratings	2010	TBD	2	reliability	Provisional
Upgrade Empire-Forsyth 138-kV line terminal equipment	2010	TBD	2	reliability	Provisional
Upgrade Chandler-Cornell 69-kV line clearance from 120 to 167 deg F	2010	TBD	2	reliability	Provisional
Rebuild Blaney Park-Munising 69 kV to 138 kV	2012	2012	2	reliability, condition	Provisional
Upgrade M38 138/69-kV transformer	TBD	TBD	2	reliability	Provisional

*Table PR-14  
Transmission System Additions for Zone 2 (continued)*

<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>
Install 2-8.16 MVAR capacitor banks at M38 69-kV Substation	TBD	TBD	2	reliability	Provisional
Install 1-5.4 MVAR capacitor bank at MTU or Henry Street 69-kV Substation	TBD	TBD	2	reliability	Provisional
Rebuild/convert Holmes-Chandler 69 kV to 138-kV operation	2013	2013	2 & 4	reliability, condition	Provisional