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-23.

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.

Demographics
The population of the counties in Zone 2 experienced slightly negative growth from 2000 to 2010. The highest growth rate of 0.5 percent per year and the largest increase in population of 1,000 occurred in Vilas County.

Population in Zone 2 is projected to grow on an annual basis of 0.2 percent between 2010 and 2020. For the same period, Vilas County is projected to realize the largest increase in population of about 1,600, as well as the highest growth rate (0.7 percent).

During the same period, the annual employment also had a slightly negative growth rate of -0.3 percent. The highest growth rate and the highest increase in employment were in Marquette County (Michigan).

Employment in Zone 2 is projected to grow at 0.8 percent annually between 2010 and 2020. During this time period, Marquette County (Michigan) is projected to realize the largest increase in employment of over 4,100, while Luce County (Michigan) is projected to have the highest growth rate 0f 1.6 percent.

Employment			
Annual Growth Rate			
	2000-2010		2010-2020
Zone 2	-0.3	Zone 2	0.8
Marquette, MI	0.7	Luce, MI	1.6

Population			
Annual Growth Rate			
	2000-2010		2010-2020
Zone 2	-0.2	Zone 2	0.2
Vilas, WI	0.5	Vilas, WI	0.7

Total Increase			
	2000-2010		2010-2020
Zone 2	-4,761	Zone 2	13,225
Marquette, MI	2,540	Marquette, MI	4,140

Total Increase			
	2000-2010		2010-2020
Zone 2	-6,708	Zone 2	7,009
Vilas, WI	1,077	Vilas, WI	1,606

Zone 2 environmental considerations

Zone 2 includes a small part of the far northeast portion of Wisconsin and the eastern portion 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.

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 2011, 2015, 2020 and 2025 are shown in Table ZS-9. 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 decrease at roughly 0.75 percent annually from 2011 through 2020. 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.

Zone 2 transmission system issues

Key transmission facilities in Zone 2 include:

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

Transmission study drivers

An overriding general characteristic of the Zone 2 transmission system is the fact that it consists of load islands dispersed over a broad area and numerous components are near limits. Both the local and interconnecting components of this network have been generally adequate by historic standards, however, modern performance requirements, coupled with load increases or generation reductions of "modest" magnitudes could result in reinforcement needs. Furthermore, the inability to immediately serve nominal growth or generation changes could emerge. This indicates the need for extensive Strategic Flexibility analysis which requires the inclusion of varied internal and external factors. This is the basis for conducting the ATC Energy Collaborative – Michigan study process which contributes to the Zone 2 analysis in this 10-Year Assessment.

Key system performance issues in Zone 2 include:

- Proposed renewable generation source increases,
- Proposed point load increases,
- Proposed generation retirements,
- Limited import and export capability,
- Aging 69-kV and 138-kV infrastructure throughout the Upper Peninsula,
- Generator stability in the central portion of Upper Peninsula,
- 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,
- Record low Lake Superior water levels in previous years have resulted in potentially reduced hydro generation,

output in the eastern U.P., magnifying reliability concerns in this area,

- ❑ High voltage concerns at lighter load periods for central and eastern Upper Peninsula,
- ❑ **Low voltages, most pronounced in the western and eastern Upper Peninsula,**
- ❑ **Potential low voltages and overloads in the northwestern U.P. due to recent load increases, and**
- ❑ **Potential marginal voltages and overloads in the central U.P. due to *potential* load increases.**

Please refer to the ATC Energy Collaborative – Michigan for more information on the application of strategic flexibility planning to Zone 2.

Zone 2 - 2011 study results

Refer to Table ZS-1 and Figure ZS-5

Summary of key findings

- ❑ Low voltages throughout the Newberry area under contingency necessitate a project to transfer load off of line 6911,
- ❑ Maintaining reliability of service to load in and around the Escanaba area requires that system reinforcements be implemented in the near term, and
- ❑ High voltages and power flow in the eastern U.P. necessitate the need for system reinforcements in the near term.

There were a number of facility overloads and several facilities near their emergency ratings in Zone 2 based on the 2011 analysis. Many projects are either planned or proposed to address these near-term thermal problems by 2013. As a result, we propose the uprate of three 69-kV lines and two 138-kV lines. In addition, to address low voltages under contingency, two 8.0 MVAR capacitor banks will be installed at the Indian Lake Substation in 2010.

Eastern U.P.
High voltages have been experienced on an intact system in real time in the eastern U.P. The high voltages usually occur at lighter load levels. The primary sources are the Straits-McGulpin 138-kV submarine cables, which are significant reactive power sources (13 MVAR each) and act like capacitor banks which raise system voltages. To mitigate this operating limitation in the near term, two 13.8-kV reactors (total 25 MVAR) are proposed to be installed at the Straits Substation in late 2010.

Large market power flows through the eastern U.P. of Michigan result in inadequate voltage and loading performances, increased system losses, and high Locational Marginal Prices (LMPs) for local power purchases. Current measures taken to address the high flows include generation redispatch to adjust power flows and/or a manual split the U.P. system to eliminate the flows through the U.P. In order to eliminate these flow limitations, ATC is anticipating the use of flow control devices. One alternative being considered is back-to-back HVDC controls connected in series with the Straits-McGulpin 138-kV lines (9901/9903) for installation around the year 2014.

Power flow control in the eastern U.P. will adjust flows to more manageable levels and allow more economic dispatch of market generation due to the elimination of congestion, reduction of system losses, improved power quality and an increase in reliability of service for local customers, and more efficient scheduling of maintenance work. Further study is required to determine the best solution to control the flow of power into the eastern U.P.

In conjunction with the eastern U.P. power flow control, a project is being considered to energize the second circuit of the Hiawatha-Indian Lake line at 138 kV in the 2014 timeframe. This line energization project is contingent going forward with the eastern U.P. power flow control project. The Hiawatha-Indian Lake 138-kV project will increase the effectiveness of and help optimize the power flow control project. It will enhance reliability by relieving voltage limitations and by minimizing the need to operate area lines radially over an even greater range of daily system flows.

Escanaba area
As part of the ATC Energy Collaborative – Michigan, several projects were identified to address system issues in the Escanaba area:

- Install a second Chandler 138/69-kV transformer (2012),
- Construct Chander-18th Road double-circuit 138-kV lines (2014), and
- Install Arnold 345/138-kV transformer (2015).

In addition, since the publication of the 2009 10-Year Assessment, some additional projects have been identified in order to address Escanaba area limitations:

- Install Delta 69-kV bus tie breaker (2011), and
- Replace five 69-kV breakers at Delta Substation (2012).

These Escanaba area projects were identified as a result of the analyses of several potential futures, which indicated low voltages and overloaded facilities throughout the 69-kV system in central Delta County. These projects also address System Operations and Asset Renewal limitations. There are numerous System Operations needs associated with the Escanaba area driven by outage coordination issues that make maintenance work very difficult and/or expensive to perform. In addition, there are local issues associated with the lack of generation availability and/or possible network transmission service additions.

The solution development process utilized in the ATC Energy Collaborative – Michigan, in addition to our ongoing studies, identified the above Escanaba area solutions to address various limitations based upon ATC's Planning criteria.

Munising/Newberry area
As part of the ATC Energy Collaborative – Michigan, an uprate of the Munising-Blaney Park 69-kV line was identified to address Asset Renewal, System Operations, and network system issues in 2014. In addition to this project, a second Gwinn-Forsyth 69-kV line was identified to address future area limitations. These projects will address low voltages and overloaded facilities throughout the Munising/Newberry area.

September 2010 10-Year Assessment
www.atc10yearplan.com

Since the publication of ATC's 2009 10-Year Assessment, one additional project has been identified in order to address Munising area limitations:

- Engadine load move project
  - A facility outage of the Hiawatha-Engadine 69-kV line situates the Engadine load at the end of a long radial feed and causes the voltage criteria on the Newberry area 69-kV buses to be exceeded, and
  - This project will address these low voltages under low generation and single contingency conditions.

The solution development process utilized in the ATC Energy Collaborative – Michigan, in addition to ongoing studies, identified the above Munising/Newberry area solutions to address various Planning needs as well as the asset renewal and System Operations concerns.

Western area
As part of the ATC Energy Collaborative – Michigan, an uprate and minimum asset renewal of the Atlantic69 line is scheduled for completion in the 2014 timeframe. This project will address low voltages, overloaded facilities and facility condition throughout the Western area.

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

- None

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

- None

Please note that more information is presented fully in the ATC Energy Collaborative - Michigan section. This section presents a strategic flexibility approach to the multiple factors emerging across the U.P. and the status of current studies.

Zone 2 - 2015 study results

Refer to Table ZS-2 and Figure ZS-6

Summary of key findings

- The majority of the area needs were described and addressed in the Zone 2 – 2011 study results section,
- The potential for the Kinross load addition in the eastern U.P. may necessitate the need for system reinforcements, and
- Further reinforcement of the Munising/Newberry area may be required in the 2016 timeframe.

A new transmission-distribution interconnection, referred to as the Kinross load, was proposed for a 25-megawatt load addition in Chippewa County south of Sault Ste. Marie. This load represents a significant addition to the existing load in the Sault Ste. Marie area, and creates a sudden change in the load, generation, and transmission balance in the eastern U.P. Due to the uncertainty of the timeline of this potential load addition, ATC devised a plan to reinforce the eastern U.P. regardless if this load materializes.

Eastern U.P additions if Kinross load does not materialize

If the Kinross transmission-distribution load does not materialize, the following projects will be constructed:

- Rebuild Straits-Pine River lines 6904/5 for 138 kV and operate at 69 kV (2014), and
- Uprate Pine River-Nine Mile 69-kV line 6923 to 167 degrees F (2016).

These projects will be required to reinforce the eastern U.P. by improving the voltage profile and eliminating thermal limitations during this timeframe.

Eastern U.P additions if Kinross load materializes

If the Kinross transmission-distribution load does materialize, the following projects will be constructed. Several in-service dates are to be determined (TBD) and will depend upon the in-service date of the potential Kinross addition:

- Rebuild Straits-Pine River lines 6904/5 for 138 kV and operate at 69 kV (2014),
- Convert Straits-Pine River lines 6904/5 to 138 kV (2014),
- Construct/convert Pine River-Nine Mile 138/69-kV double-circuit line (2014),
- Install 138/69-kV 150 MVA transformer at Nine Mile (2014),
- Install 138/69-kV 150 MVA transformer at Pine River (2014), and
- Construct a line from Kinross load to Pine River/Nine Mile 69-kV line (2014).

If the Kinross load does materialize, these projects will be required to support the new interconnection and will also reinforce the eastern U.P. by improving voltage profile and

eliminating thermal limitations in this timeframe. It should be noted that the costs reflected in our Assessment depict the capital cost of projects if the Kinross load materializes.

A provisional project to construct a second Gwinn-Forsyth 69-kV line (TBD in-service date) would further reinforce the Munising/Newberry area. Further study is ongoing to determine the best timeframe for implementation of this project.

Several projects were identified as near term solutions for the U.P. The solutions for the eastern U.P., Munising/Newberry and Escanaba areas for the years 2011-2015 are outlined in the Zone 2 – 2011 study results section.

These solutions are presented fully in the ATC Energy Collaborative - Michigan section. This section presents a Strategic Flexibility approach to the multiple factors emerging across the U.P.

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

- ❑ None

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

- ❑ None

Zone 2 – 2020 study results

Refer to Table ZS-3 and Figure ZS-7

Summary of key findings

- ❑ All longer term area needs were described and addressed in the Zone 2 – 2011 study results and Zone 2 – 2015 study results sections.

There was one thermal limitation and three area bus voltage limitations that appeared in Table ZS-3. All of these limitations are addressed by generation adjustments and/or the projects outlined in Zone 2 – 2011 study results and Zone 2 – 2015 study results. In addition, further explanation can be found in the ATC Energy Collaborative – Michigan section.

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

- ❑ None

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

- ❑ None

Zone 2 - 2025 study results

Refer to Table ZS-4 and Figure ZS-8

Summary of key findings

- ❑ Limitations identified will be addressed in projects outlined in the 2011 and 2015 sections.

There are three thermal limitations and several voltage limitations listed in Table ZS-4. The voltage and thermal limitations occur in the Munising/Newberry, eastern U.P. and Escanaba areas and will be mitigated by projects described in the 2011 and 2015 study results.

Please refer to the ATC Energy Collaborative – Michigan for further information.

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

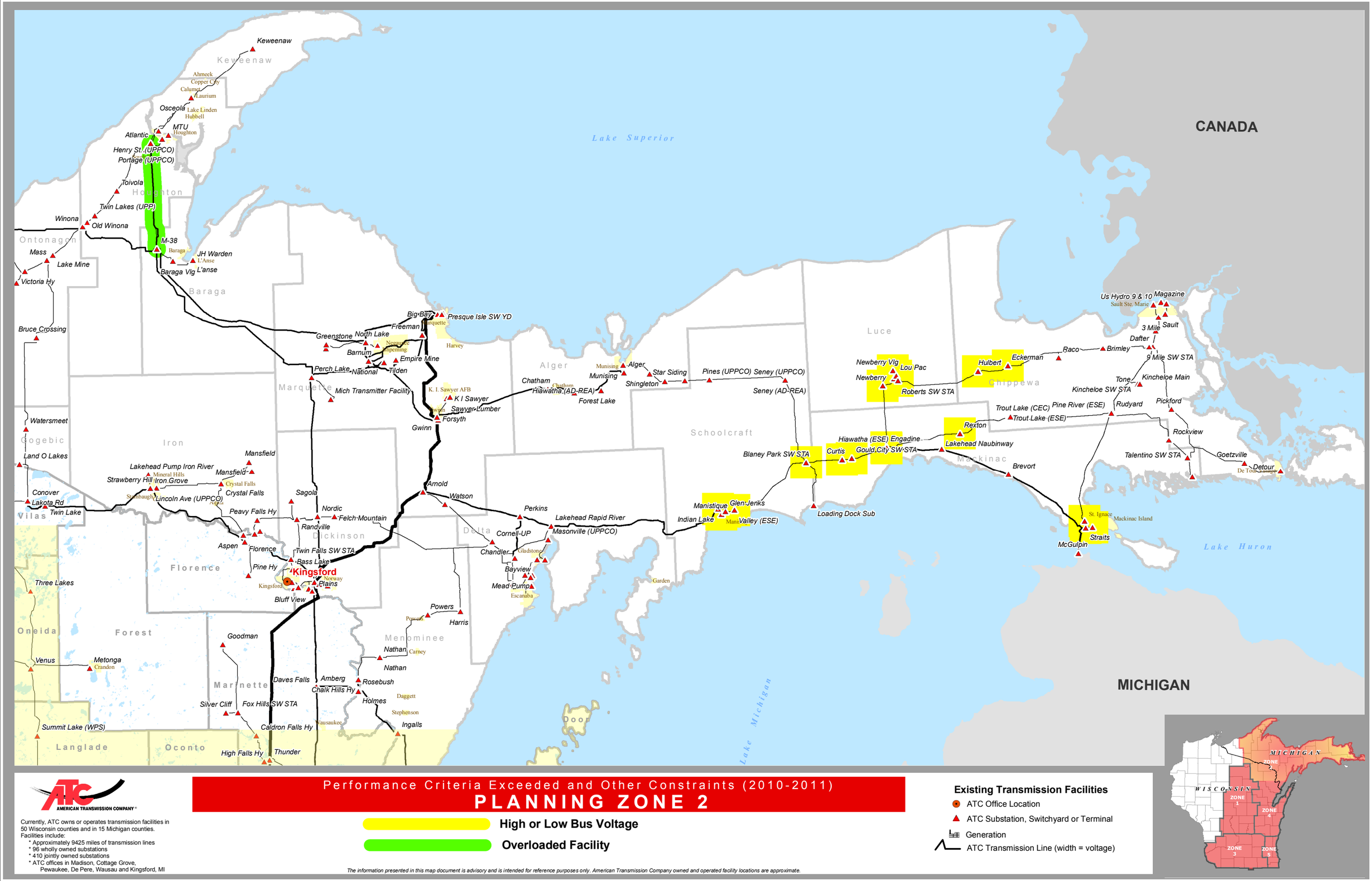
- ❑ None

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

- ❑ None

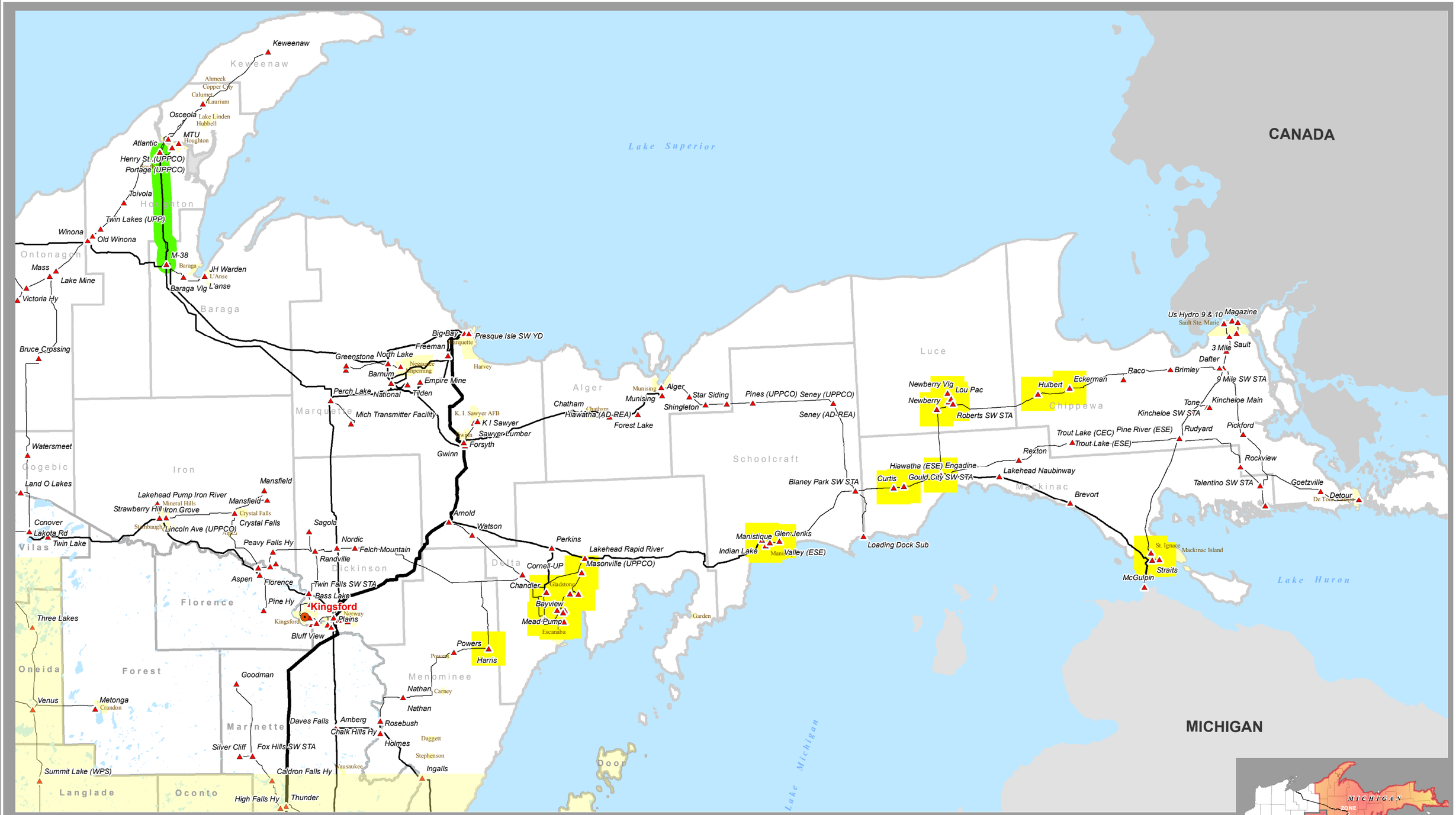
Assessment of Steady State Compliance with NERC Standards

The mitigation plans comprised of planned, proposed and provisional projects identified for Zone 2 in this Assessment will allow the ATC system in Zone 2 to meet the steady state portions of NERC standards TPL-001 and TPL-002 in each of the five years 2011-2015, and for the 2016-2020 planning horizon.



Modified:February 24, 2010

Figure ZS-6



AMERICAN TRANSMISSION COMPANY®

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties.
Facilities include:
* Approximately 9425 miles of transmission lines
* 96 wholly owned substations
* 410 jointly owned substations
* ATC offices in Madison, Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI

Performance Criteria Exceeded and Other Constraints (2011-2015)

PLANNING ZONE 2

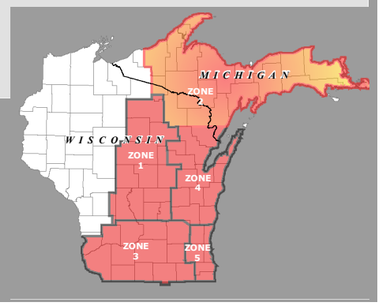
High or Low Bus Voltage

Overloaded Facility

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

Existing Transmission Facilities

- ATC Office Location
- ATC Substation, Switchyard or Terminal
- Generation
- ATC Transmission Line (width = voltage)



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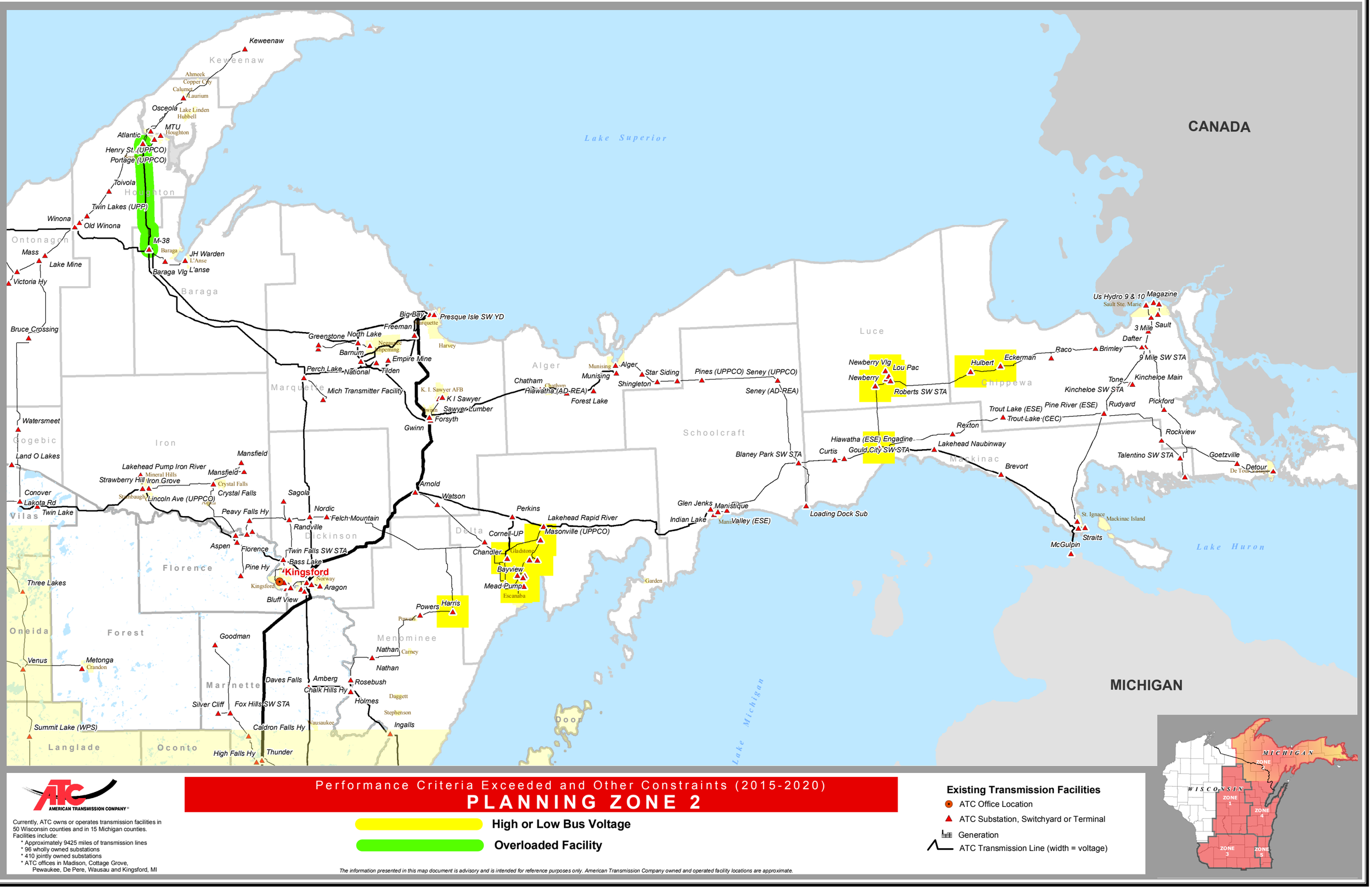

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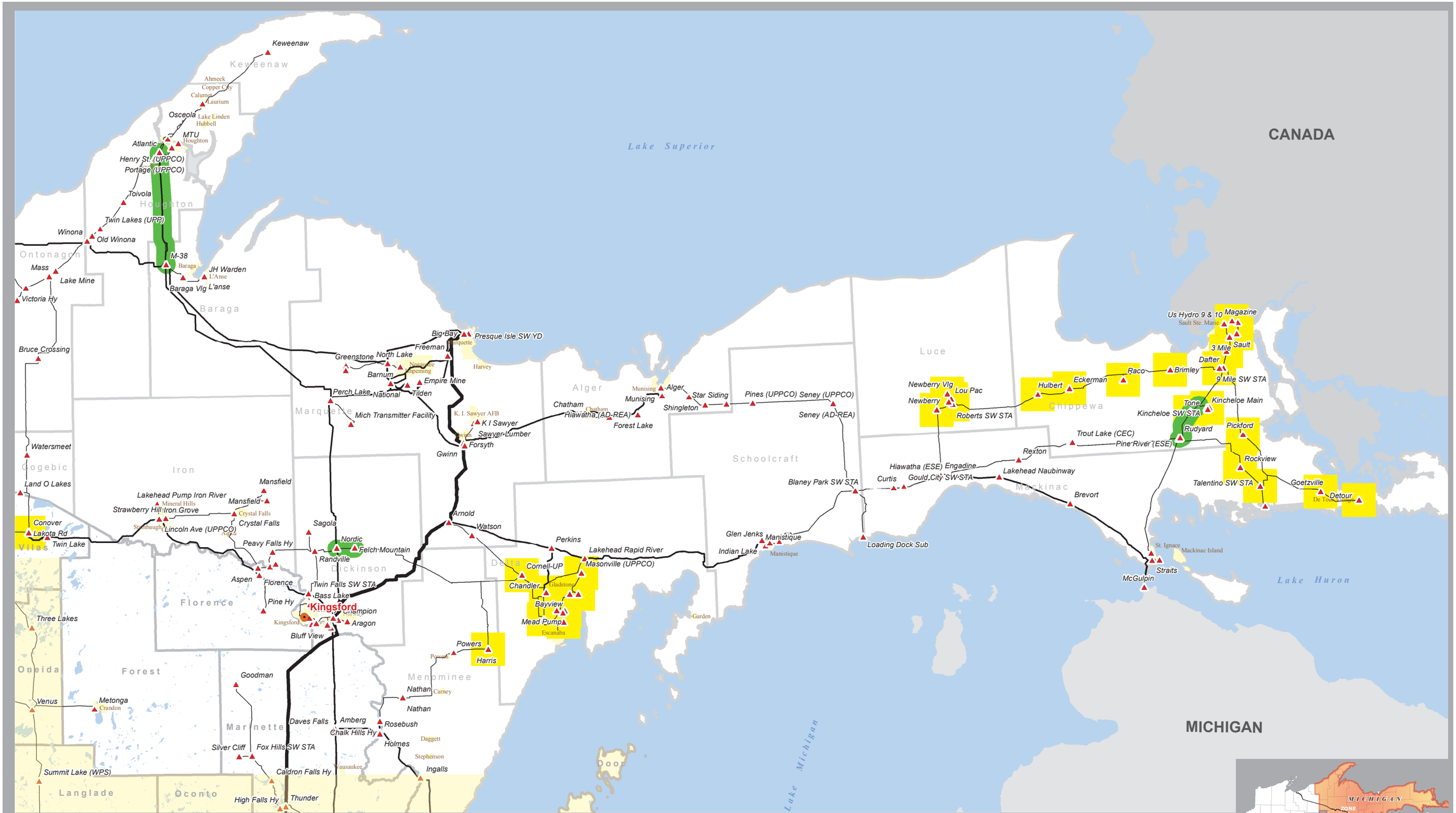

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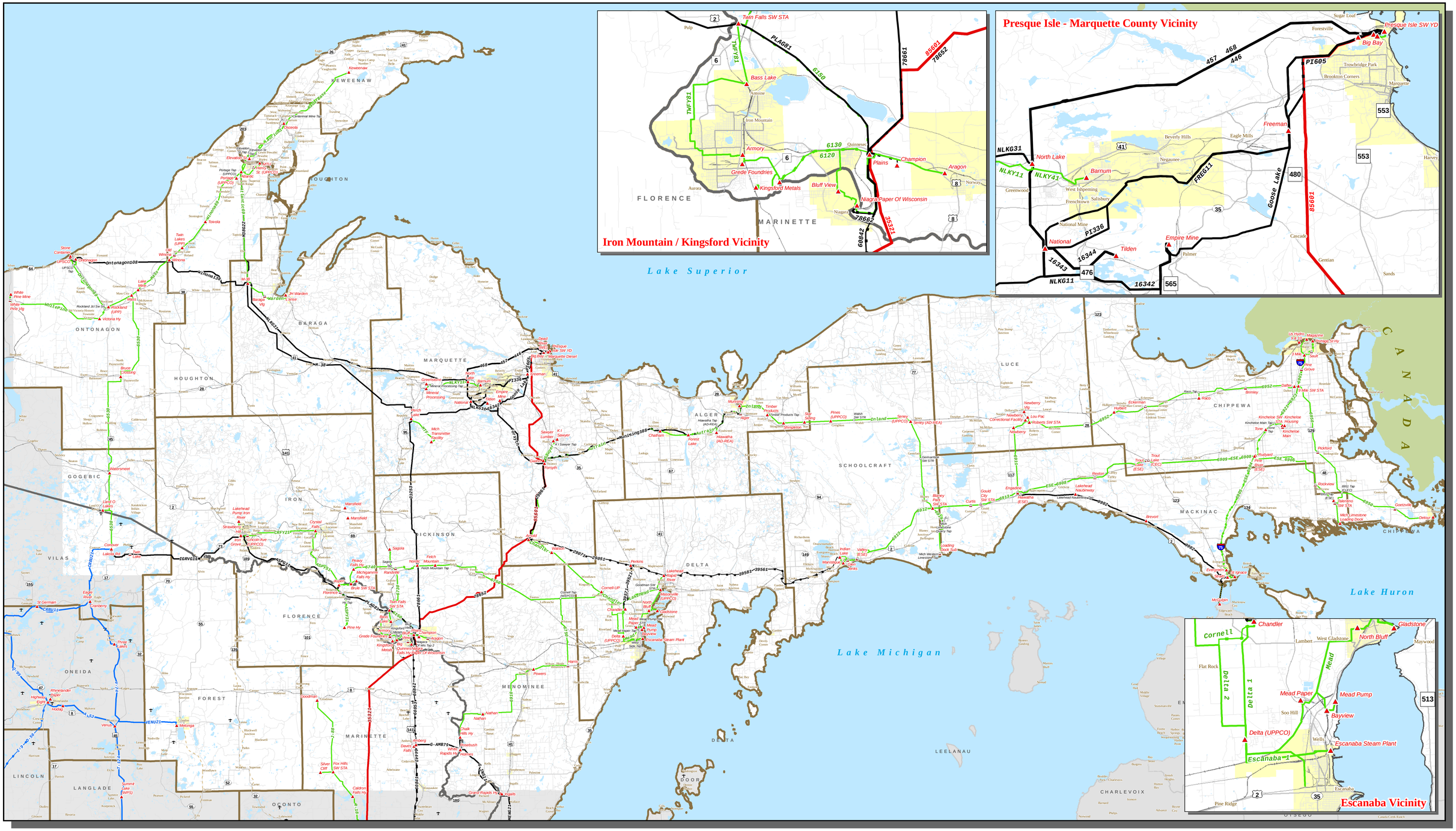


Electrical Transmission and Related Facilities

Transmission Facilities

- Substation or Switchyard
- Tap or Switching Structure
- Generation
- **ATC Office Location**

Transmission Line Voltage and Type

69 kV	69 kV Double Circuit	69 kV Underground
115 kV	115 kV Double Circuit	115 kV Underground
138 kV	138 kV Double Circuit	138 kV Underground
345 kV	345 kV Double Circuit	

Mixed voltage double circuit lines drawn using line colors representative of voltage. Actual line configuration may be obscured due to map scale. Please notify ATC Real Estate/GIS of any errors or omissions found.

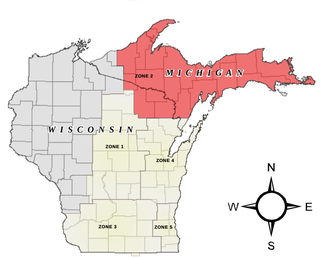
- MI Paved Airport or Airfield
- MI Unpaved Airport or Airfield
- WI Airport or Airfield

Transmission Network and Substations

PLANNING ZONE 2

Miles

10 0 10 20 30 40



AMERICAN TRANSMISSION COMPANY®

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- ** 96 wholly owned substations*
- ** 410 jointly owned substations*
- ** ATC offices in Madison, Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI*

The information presented in this map document represent the most current and accurate georeferenced compilation of ATC owned and operated transmission facilities available - some facility locations may be approximate. This map is advisory and intended for reference purposes only. Please direct any revisions or corrections to ATC Asset Applications and GIS Group.

Base Map Information: ATC, PSCW, MiDNR, WDNR

G:\WORKSPACE\ArcMap Templates\Zone Maps\Zone2.mxd Modified: May 20, 2010

Revised May 2010

Table ZS-1
2011 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2011 Summer Peak Case		2011 90% Load Case		2011 70% Load Case		2011 Minimum Load Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
1	Base case loading criteria exceeded	FALSE	--	FALSE	--	FALSE	--	FALSE	--	System Intact	
1	Base case voltage criteria exceeded	--	FALSE	--	FALSE	--	FALSE	--	TRUE	System Intact	
1	Dartford 69-kV bus	--	91.7%	--	--	--	--	--	--	Metomen – Ripon 69-kV line	Marginal voltage, no mitigation needed within this timeframe
1	Petenwell and Council Creek 138-kV buses	--	89.2% 89.2 – 89.8%	--	90.3 – 96.7% 90.1 – 91.2%	--	--	--	--	ACEC Badger West – Saratoga 138-kV line ACEC Badger West – Petenwell 138-kV line	Adjust Council Creek 138/69-kV transformer LTC
1	ACEC Badger West 138-kV bus	--	89.2%	--	90.3%	--	--	--	--	ACEC Badger West – Saratoga 138-kV line	Adjust Council Creek 138/69-kV transformer LTC
1	Necedah, ACEC Dellwood, Friendship, ACEC Friendship and Houghton Rock 69-kV buses	--	87.9 – 91.9% 87.9 – 91.9% 88.9 – 91.9% 90.9 – 91.4%	--	87.9 – 91.9% 88.7 – 91.5% 88.7 – 91.5% 90.0 – 91.4%	--	--	--	--	Petenwell 138/69-kV transformer Petenwell – Big Pond 69-kV line Necedah Tap – Big Pond 69-kV line Necedah Tap – Whistling Wings Tap 69-kV line	Mitigated by generation adjustments
1	Brooks Corner 69-kV bus	--	87.5%	--	88.2%	--	90.2%	--	91.5%	Whitcomb – Deer Trail 69-kV line[4]	Adjust Brooks Corners 69/34.5-kV transformer LTC
1	Arpin 345-kV bus	--	--	--	--	--	--	--	105.4% 110.0%	System Intact Arpin – Rocky Run 345-kV line[1]	Switch Port Edwards 69-kV and McMillan 115-kV capacitors offline
1	Harrison 69-kV bus	--	--	--	--	--	--	--	106.4%	System Intact	Switch Harrison 69-kV capacitor offline
1	Caroline 115-kV bus	--	--	--	--	--	--	--	106.3%	System Intact	Switch area capacitor banks offline and adjust area transformer LTCs
1	Whitcomb 115-kV bus	--	--	--	--	--	--	--	106.0%	System Intact	Switch Birnamwood 69-kV capacitor bank offline and/or corrected Whitcomb transformer modeling
1	Petenwell 138/69-kV transformer	99.0% 95.6%	--	--	--	--	--	--	--	McKenna – Houghton Rock 69-kV line Castle Rock – Quincy ACEC 69-kV line	Mitigated by generation adjustments
1	Vulcan – Port Edwards 138-kV line #1 Vulcan – Port Edwards 138-kV line #2	123.0% 122.8%	--	123.0% 122.8%	--	123.0% 122.8%	--	123.0% 122.8%	--	Port Edwards – Vulcan Chemical 138-kV #2 line Port Edwards – Vulcan Chemical 138-kV #1 line	Change tap on free standing CT's at Port Edwards
2	Base case loading criteria exceeded	FALSE	--	FALSE	--	FALSE	--	FALSE	--	System Intact	
2	Base case voltage criteria exceeded	--	TRUE	--	TRUE	--	TRUE	--	TRUE	System Intact	
2	M38 – Atlantic 69-kV line	116.8 – 121.6%	--	105.0% 105.0% 110.9%	--	--	--	-- --	-- --	M38 – Atlantic 138-kV line Atlantic 138/69-kV transformer M38 – Atlantic 138-kV line[5]	Mitigated by generation adjustments or uprate line
2	Nordic – Mountain 69-kV line	--	--	--	--	96.8% 98.8%	--	--	--	Plains – Arnold 138-kV line Chandler 138/69-kV transformer	Targeted for mitigation by Escanaba area reinforcements

Table ZS-1
2011 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2011 Summer Peak Case		2011 90% Load Case		2011 70% Load Case		2011 Minimum Load Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
2	Plains – Arnold 138-kV line	--	--	--	--	95.2%	--	--	--	Dead River 345/138-kV transformers[2]	Targeted for mitigation by Escanaba area reinforcements
2	Straits – McGulpin 138-kV line 9903	97.6%	--	97.6%	--	--	--	--	--	Straits – McGulpin 138-kV line 9901	Targeted for mitigation by Eastern U.P. area reinforcements
2	Pine River – Straits 69-kV line Pine River – Evergreen 69-kV line Evergreen – Straits 69-kV line	--	--	102.4 – 108.8% 102.1 – 108.4% 107.1 – 113.8% 106.7 – 111.9% 105.7 – 111.0%	--	--	--	--	--	Straits – Hiawatha 138-kV line 9902 Straits 138/69-kV transformer Straits – Brevort 138-kV line Brevort – Lakehead 138-kV line Hiawatha – Lakehead 138-kV line	Targeted for mitigation by Eastern U.P. area reinforcements
2	Engadine, Newberry, Newberry Hospital, Roberts, LouPac, Newberry Village, Hulbert and Eckerman 69-kV buses	--	82.9 – 90.7%	--	--	--	--	--	--	Hiawatha – Engadine 69-kV line Engadine – Newberry 69-kV line	Mitigated by generation adjustments
2	Engadine, Newberry, LouPac, Newberry Hospital, Newberry Village, Roberts 69-kV buses	--	--	--	89.4 – 89.9%	--	--	--	--	Hiawatha – Engadine 69-kV line	Mitigated by generation adjustments
2	Engadine, Newberry, Newberry Hospital, Roberts, LouPac, Newberry Village 69-kV buses	--	--	--	89.1 – 89.6%	--	--	--	--	Hiawatha – Engadine 69-kV line[6]	Mitigated by generation adjustments
2	Brevort, Hiawatha and Lakehead 138-kV buses	--	--	--	91.2 – 91.4%	--	--	--	--	Brevort – Straits 138-kV line	Targeted for mitigation by Eastern U.P. area reinforcements
2	Brevort and Lakehead 138-kV buses	--	--	--	91.6 – 91.7%	--	--	--	--	Brevort – Lakehead 138-kV line	Targeted for mitigation by Eastern U.P. area reinforcements
2	Hiawatha 138-kV bus	--	--	--	91.4%	--	--	--	--	Hiawatha – Lakehead 138-kV line	Targeted for mitigation by Eastern U.P. area reinforcements
2	North Bluff, Bay View, Mead, Gladstone, Masonville and Lakehead 69-kV buses	--	90.8 – 91.6%	--	--	--	--	--	--	Chandler 138/69-kV transformer	Mitigated by generation adjustments
2	Chandler, Delta, Escanaba, Masonville, Mead, Gladstone, West, Lakehead, North Bluff, Bay View, Cornell, Harris 69-kV buses	--	--	--	--	--	88.4 – 91.1%	--	--	Chandler 138/69-kV transformer	Mitigated by generation adjustments
2	Ontonagon, Stone Container and Winona 138-kV buses	--	91.3 – 91.7%	--	--	--	91.5 – 91.9%	--	--	M38 – Winona 138-kV line	Mitigated by generation adjustments
2	Straits, St. Ignace, Indian Lake, Evergreen, Valley, Glen Jenks, Manistique, Engadine, Hiawatha, Gould City, Curtis, Rexton, and Blaney Park 69-kV buses and Straits 138-kV bus	--	104.1 – 105.7%	--	--	--	104.2 – 108.0%	--	104.6 – 106.2%	System Intact	Adjust transformer tap settings at Hiawatha, Indian Lake, Straits
2	Hiawatha and Lakehead 138-kV buses	--	--	--	94.2 – 95.2%	--	--	--	105.9 – 106.0%	System Intact	Mitigated by generation adjustments
2	Alger Delta Hiawatha, Sault, Eckerman, Goetzville, Pickford, Rudyard, Newberry Hospital, Newberry Village, Three Mile, Magazine, Kinchloe, Trout Lake, Munising, Alger, Hulbert, Brimley, Dafter, Detour, Engadine, Newberry, Raco, LouPac, Roberts, ESE Hydro, Nine Mile, Pine River, Rockview, Pine Grove, Tone, Talentino 69-kV buses and Brevort 138-kV bus	--	--	--	--	--	--	--	105.0 – 106.5%	System Intact	Mitigated by generation adjustments
2	Lakota Road 69-kV bus	--	--	--	--	--	--	--	119.1%	Lakota Road – Conover 69-kV line	Resolved by transformer model adjustments
2	Lakota Road 115-kV bus	--	--	--	--	--	--	--	110.4%	Eagle River – Cranberry 115-kV line	Mitigated by generation adjustments
2	Atlantic 138-kV bus	--	--	--	--	--	--	--	113.0%	Atlantic – M38 138-kV line	Mitigated by generation adjustments
3	Base Case Loading Criteria Exceeded	FALSE	--	FALSE	--	FALSE	--	FALSE	--	System Intact	
3	Base Case Voltage Criteria Exceeded	--	FALSE	--	FALSE	--	FALSE	--	FALSE	System Intact	

Table ZS-1
2011 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2011 Summer Peak Case		2011 90% Load Case		2011 70% Load Case		2011 Minimum Load Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
3	Concord 138-kV bus	--	95.5%	--	--	--	--	--	--	System Intact	Mitigated by generation adjustments
3	Concord, Butler Ridge, and Rubicon 138-kV buses	--	--	--	95.2 – 95.9%	--	--	--	--	System Intact	Mitigated by generation adjustments
3	Butler Ridge and Rubicon 138-kV buses	--	90.9 – 91.4%	--	--	--	--	--	--	Hartford – St. Lawrence 138-kV line	Mitigated by generation adjustments
3	Crawfish River 138-kV bus	--	--	--	91.1%	--	--	--	--	Jefferson – Crawfish River 138-kV line	Mitigated by generation adjustments
3	Crawfish River and Concord 138-kV buses	--	90.5 – 91.7%	--	--	--	--	--	--	Jefferson – Crawfish River 138-kV line	Mitigated by generation adjustments
3	Paddock – Townline 138kV line	--	--	--	--	99.0% 97.1%	--	--	--	NW Beloit – Paddock 138-kV line Blackhawk – NW Beloit 138kV	Mitigated by generation adjustments
3	Hubbard and Hustisford 138-kV buses	--	96% 86.5% 87.1% 87.1% 90.7 – 90.9%	--	95.9% 87.2% 87.7% 87.% --	--	-- -- 87.2% 87.3% --	--	--	System Intact Rubicon – Hustisford 138-kV line Hustisford – Hubbard 138-kV line Rubicon – Hustisford – Hubbard 138-kV line Hartford – St. Lawrence 138-kV line	Adjust Hubbard 138/69-kV transformer LTC
3	Fox Lake, North Beaver Dam and Beaver Dam East 138-kV buses	--	89.2 – 89.3%	--	--	--	--	--	--	North Randolph – Fox Lake 138-kV line	Adjust North Beaver Dam 138/69-kV transformer LTC
3	Fitchburg 138-kV bus	--	--	--	--	--	96.0%	--	--	System Intact	Femrite and Kegonsa 138-kV capacitor banks
3	Huiskamp 138-kV bus	--	--	--	88.6%	--	88.4%	--	--	Huiskamp – North Madison 138-kV line	Adjust Huiskamp 138/69-kV transformer LTC
3	Verona and Fitchburg 138-kV buses	--	--	--	--	--	91.8 – 91.9%	--	--	Columbia generator #1	Femrite and Kegonsa 138-kV capacitor banks
3	Nelson Dewey 161/138-kV transformer	--	--	--	--	95.6% 95.4%	--	--	--	CE Byron generator #1 CE Byron generator #2	Mitigated by generation adjustments
3	Nelson Dewey – Cassville 161-kV line	--	--	--	--	99.6% 95.8%	--	--	--	DPC Genoa generator #3 Columbia generator #2	DPC line limitation / further study needed
3	Fitchburg – Syene 69-kV line	104.9%	--	95.3%	--	--	--	--	--	Royster – AGA Tap 69-kV line	Short term Operating Guide / Nine Springs, Pflaum area project
3	Royster – AGA Gas Tap 69-kV line	103.0%	--	--	--	--	--	--	--	Fitchburg – Syene 69-kV line	Short term Operating Guide / Nine Springs, Pflaum area project
3	Verona 138-kV bus	--	95.7% 90.2%	--	-- 90.2%	--	--	--	-- 114.8%	System Intact Verona – Oak Ridge 138-kV line	Adjust Verona 138/69-kV transformer LTC / Verona 69-kV capacitor bank project
3	Fitchburg, Cross County, Oak Ridge and Pleasant View 138-kV buses	--	95.3 – 95.9%	--	--	--	--	--	--	System Intact	Femrite and Kegonsa 138-kV capacitor banks
3	Verona, Oak Ridge, Pleasant View, Cross Country, Pleasant View, and Fitchburg 138-kV buses	--	--	--	95.0 – 95.9%	--	--	--	--	System Intact	Femrite and Kegonsa 138-kV capacitor banks
3	REC Harmony, Milton Tap and Milton 69-kV buses	--	91.9 – 92.0%	--	--	--	--	--	--	McCue – Harmony 69-kV line	Lamar 69-kV capacitor bank project
4	Base case loading criteria exceeded	FALSE	--	FALSE	--	FALSE	--	FALSE	--	System Intact	
4	Base case voltage criteria exceeded	--	TRUE	--	FALSE	--	FALSE	--	TRUE	System Intact	
4	Badger & Belle Plaine 115-kV buses	--	105.0%	--	--	--	--	--	106.4%	System Intact	Switch Badger 138-kV capacitor banks offline
4	East Krok 138/69-kV transformer	103.2%	--	103.1%	--	98.1%	--	--	--	Canal – East Krok 138-kV line	No project needed Investigation into limiting facility resulted in higher facility ratings
4	Sunset Point – Pearl Avenue 69-kV line	108.2% 107.8%	--	97.1% 97.0%	--	--	--	--	--	Ellinwood 138/69-kV transformer[3] Ellinwood – 12th Avenue 69-kV line	Rebuild line
4	Morgan – Falls 138-kV line	--	--	--	--	105.7%	--	--	--	Morgan – Plains 345-kV line	Mitigated by generation adjustments
4	White Clay 138-kV 1-2 bus tie	--	--	--	--	96.0%	--	--	--	Morgan – Highway 22 345-kV line	Further study needed
4	North Appleton, Apple Hills, Maes, Combined Locks tap & City Limits 138-kV buses	--	--	--	--	--	--	--	104.1 – 105.3%	System Intact	Switch off area capacitor banks

Table ZS-1
2011 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2011 Summer Peak Case		2011 90% Load Case		2011 70% Load Case		2011 Minimum Load Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
4	Werner West, Werner & Hintz 138-kV buses	--	--	--	--	--	--	--	105.4 – 105.5%	System Intact	Switch off area capacitor banks
4	City Limits, Lake Park & Forest Junction 138-kV buses	--	--	--	--	--	--	--	104.1 – 105.1%	System Intact	Switch off area capacitor banks
4	Butte des Morts, Northside, Tayco, Melissa, Meadows Kaukauna Central tap & Forest Junction 138-kV buses	--	--	--	--	--	--	--	104.2 – 105.1%	System Intact	Switch off area capacitor banks
4	Kaukauna Central tap, Kaukauna Central, Kaukauna North & North Appleton 138-kV buses	--	--	--	--	--	--	--	104.9 – 105.3%	System Intact	Switch off area capacitor banks
4	Glenview 138-kV bus	--	--	--	--	--	--	--	105.1%	System Intact	Switch off area capacitor banks
5	Base Case Loading Criteria Exceeded	FALSE	--	FALSE	--	FALSE	--	FALSE	--	System Intact	
5	Base Case Voltage Criteria Exceeded	--	TRUE	--	TRUE	--	FALSE	--	TRUE	System Intact	
5	Bluemound 230-kV bus, Allerton, Bark River, Brookdale, Cooney, Cottonwood, Germantown, Hartford, Maple and Summit 138-kV buses	--	94.5 – 96.0%	--	--	--	--	--	--	System Intact	Mitigated by generation adjustments
5	Bluemound 230-kV bus, Bark River, Cooney, Cottonwood, Germantown, Hartford, Mukwonago, Maple and Summit 138-kV buses	--	--	--	94.5 – 95.9%	--	--	--	--	System Intact	Mitigated by generation adjustments
5	Montana, Barland, Valley, Racine, Dewey, Albers, Allerton, Branch, Center, Everett, Fiebrantz, Hayes, Harbor, Haymarket, Kansas, Kenosha, Lincoln, Nicholson, Norwich, Oak Creek, Parkhill, Pennsylvania, Racine, Ramsey, St. Rita, 28th St, and Somers 138-kV buses	--	--	--	--	--	--	--	105.0 – 105.8%	System Intact	Mitigated by generation adjustments
5	Germantown 138-kV bus	--	91.3%	--	--	--	--	--	--	Germantown – Maple 138-kV line	Mitigated by generation adjustments
5	Bark River and Germantown 138-kV buses	--	91.6 – 91.7%	--	--	--	--	--	--	Bark River – Sussex 138-kV line	Mitigated by generation adjustments
5	Bark River, Cottonwood and Germantown 138-kV buses	--	--	--	91.5 – 91.9%	--	--	--	--	Bark River – Sussex 138-kV line	Mitigated by generation adjustments
5	Hartford 138-kV bus	--	90.4%	--	91.9%	--	--	--	--	Hartford – St. Lawrence 138-kV line	Mitigated by generation adjustments
5	Maple, Germantown, Bark River, and Cottonwood 138-kV buses	--	85.8 – 91.6%	--	--	--	--	--	--	Maple – Saukville 138-kV line	Mitigated by generation adjustments
5	Maple and Germantown 138-kV buses	--	--	--	88.7 – 89.1%	--	--	--	--	Maple – Saukville 138-kV line	Mitigated by generation adjustments
5	Bain 345/138-kV transformer #5	159.5% 113.6%	--	159.2% --	--	146.9% --	--	146% --	--	Split Pleasant Prairie 345-kV bus 34 Split Pleasant Prairie 345-kV bus 23	Mitigated by generation adjustments
5	Oak Creek 345/230-kV transformer T895	104.7% 103.4%	--	104.7%	--	--	--	--	--	Split Oak Creek 230-kV bus 78 Split Oak Creek 230-kV bus 67	Mitigated by generation adjustments
5	Arcadian4 – Waukesha1 138-kV line	107.1%	--	131.1%	--	115.0%	--	--	--	Arcadian6 – Waukesha3 138-kV line	Rebuild line
5	Arcadian6 – Waukesha3 138-kV line	110.8%	--	126.7% 111.3%	--	111.2% 99.8%	--	--	--	Arcadian4 – Waukesha1 138-kV line Split Waukesha 138-kV bus 12	Rebuild line
5	Arcadian 345/138-kV transformer #3	101.5%	--	109.9% 105.8%	--	100.3%	--	--	--	Arcadian 345/138-kV transformer #1 Split Arcadian 345-kV bus 12	Replace transformer
5	Arcadian 345/138-kV transformer #2	--	--	101.8% 97.5%	--	--	--	--	--	Arcadian 345/138-kV transformer #1 Split Arcadian 345-kV bus 12	Replace transformer
5	Albers – Kenosha 138-kV line	--	--	102.5%	--	116.0%	--	--	--	Albers – Bain 138-kV line	Mitigated by generation adjustments
5	Waukesha 138-kV bus 12	--	--	98.2%	--	--	--	--	--	Arcadian6 – Waukesha3 138-kV line	Mitigated by generation adjustments
5	Harbor – Kansas 138-kV line	--	--	102.1% 97.4% 97.3% -- -- --	--	108.7% 99.4% 106.3% 106.4% 105.4% 102.4%	--	--	--	Kansas – Norwich 138-kV line Harbor – Norwich 138-kV line Split Dewey 138-kV bus Dewey – Norwich 138-kV line Montana – Dewey 138-kV line Montana – Valley 138-kV line	Mitigated by generation adjustments
5	Granville – Rangeline 138-kV line	--	--	101.2%	--	--	--	--	--	Cornell – Granville 138-kV line	Mitigated by generation adjustments

Table ZS-1
2011 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2011 Summer Peak Case		2011 90% Load Case		2011 70% Load Case		2011 Minimum Load Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
5	Oak Creek – Ramsey 138-kV line	--	--	102.1% 101.3% 100.5% 100.0% 97.4%	--	--	--	--	--	Valley generator #1 Edgewater generator #5 Oak Creek – Pennsylvania 138-kV line Edgewater generator #4 System Intact	Mitigated by generation adjustments
5	Edgewood – St. Martins 138-kV line	--	--	--	--	99.9%	--	--	--	Merrill Hills – Waukesha 138-kV line	Mitigated by generation adjustments

Table ZS-1_2011 constraints

Definition of Event Based Contingencies to be included in Appendix:	
1	Arpin - Rocky Run 345-kV line + Port Edwards - Sand Lake 138-kV line + Port Edwards - Hollywood 138-kV line + Council Creek - Council Creek DPC 69-kV line
2	Dead River 345/138-kV xfmr #1 and Dead River 345/138-kV xfmr 1A
3	Ellinwood 138/69 kV xfmr #1 + Ellinwood - Twelfth Ave 69 kV circuit + Ellinwood - Fitzgerald 138 kV circuit +Ellinwood 138 kV bus tie 1-2
4	Whitcomb - CWEC Wittenberg Tap - Wittenberg Tap - Birnamwood Tap - Brooks Corner - Deer Trail 69-kV line
5	M38 – Atlantic 138-kV line + Atlantic 138/69-kV transformer
6	Hiawatha-Engadine 69-kV line + Hiawatha 138/69-kV transformer

Table ZS-2
2015 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2015 Summer Peak Case		2015 70% Load Case		2015 90% Load Case		2015 105% Load Case		2015 High Wind		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
1	Base case loading criteria exceeded	TRUE	--	FALSE	--	FALSE	--	TRUE	--	FALSE	--	System Intact	
1	Base case voltage criteria exceeded	--	FALSE	--	FALSE	--	TRUE	--	FALSE	--	FALSE	System Intact	
1	Silver Lake, ACEC Spring Lake, Redgranite, Fountain Valley and River Run 69-kV buses	--	89.5 – 91.6% 91.3 – 91.7% -- --	--	--	--	--	--	88.2 – 91.5% 90.0 – 91.7% 91.1 – 91.9% 91.2 – 91.4%	--	--	Wautoma – Silver Lake Tap 69-kV line Silver Lake – ACEC Spring Lake 69-kV line ACEC Spring Lake – Redgranite 69-kV line Metomen – Ripon 69-kV line	Adjust Sunset Point 138/69-kV transformer LTCs
1	Dartford,Ripon Industrial Park, Northwest Ripon and Ripon 69-kV buses	--	89.0 – 89.7% 90.3 – 91.4%	--	--	--	--	--	87.9 – 89.5% 89.4 – 91.0% 91.2% 91.4% 92.0%	--	--	Metomen – Ripon 69-kV line Ripon – Northwest Ripon Tap 69-kV line Wautoma – Silver Lake Tap 69-kV line Northwest Ripon Tap – Dartford Tap 69-KV line Silver Lake – ACEC Spring Lake 69-KV line	Ripon Capacitor Expansion Project
1	Winneconne, Omro and Omro Industrial Park 69-kV buses	--	91.1 – 91.6%	--	--	--	--	--	90.0% – 90.6%	--	--	Winneconne – Sunset Point 69-kV line	Marginal voltage, no mitigation needed within this timeframe
1	ACEC Brooks and Grand Marsh (PP&L) 69-kV buses	--	--	--	--	--	--	--	91.9% – 92.0% 92.0%	--	--	Necedah Tap – Big Pond 69-kV line Petenwell – Big Pond 69-kV line	Marginal voltage, no mitigation needed within this timeframe
1	Petenwell and Council Creek 138-kV buses	--	95.7% 88.2 – 89.4% 88.2 – 89.4% 88.3 – 89.5% 90.6 – 90.7%	--	91.6% 91.6% 91.7%	--	89.6 – 90.8% 89.5 – 90.8% 89.6 – 90.8%	--	95.8 – 95.9% 87.7 – 88.9% 87.7 – 88.9% 87.8 – 89.0% 90.4 – 90.6%	--	--	System Intact ACEC Badger West – Petenwell 138-kV line Saratoga – Petenwell 138-kV line[1] ACEC Badger West – Saratoga 138-kV line Arpin – Rocky Run 345-kV line[2]	Adjust Council Creek 138/69-kV transformer LTC
1	Necedah, Petenwell, Big Pond, ACEC Dellwood, Friendship, Houghton Rock and McKenna 69-kV buses	--	84.9 – 91.1% 84.9 – 91.1% 85.2 – 91.3% 88.8 – 91.8%	--	90.8% – 91.6% 90.8% – 91.6% 90.7% – 91.6%	--	86.8% – 91.0% 86.8% – 91.0% 86.7% – 91.0% 89.9% – 91.7%	--	84.1 – 90.5% 84.0 – 90.5% 84.0 – 90.4% 88.2 – 91.2%	--	91.5% – 91.6% 91.5% – 91.6% 91.5% – 91.6%	Petenwell 138/69-kV transformer Petenwell – Big Pond 69-kV line Necedah Tap – Big Pond 69-kV line Necedah Tap – Whistling Wings Tap 69-kV line	McKenna Capacitor Expansion Project
1	Okee 69-kV bus	--	--	--	--	--	--	--	91.7%	--	--	Dane – Lodi Tap 69 kV line	Marginal voltage, no mitigation needed within this timeframe
1	ACEC Coloma 69-kV bus	--	--	--	--	--	--	--	91.6%	--	--	Chaffee Creek – Coloma Tap 69-kV line	Marginal voltage, no mitigation needed within this timeframe
1	Brooks Corner 69-kV bus	--	87.4%	--	89.5%	--	87.8%	--	87.5%	--	89.7%	Whitcomb – Deer Trail 69-kV line[3]	Adjust Brooks Corners 69/34.5-kV transformer LTC
1	Badger West 138-kV bus	--	88.3%	--	91.7%	--	89.6%	--	87.7%	--	--	ACEC Badger West – Saratoga 138-kV line	Adjust Council Creek 138/69-kV transformer LTC
1	Arrowhead 345-kV bus	--	--	--	--	--	105.0%	--	--	--	--	System Intact	Switch Arrowhead 230-kV capacitor bank offline
1	Petenwell 138/69-kV transformer	103.3% 111.4% 108.7% 107.0% 105.9% 104.8 – 98.2%	--	--	--	100.9%	--	105.5% 116.7% 111.1% 107.5% 107.6% 108.0 – 102.6%	--	--	--	System Intact McKenna – Houghton Rock 69-kV line Castle Rock – Quincy ACEC 69-kV line McKenna – Quincy ACEC 69-kV line Castle Rock – McKenna 69-kV line Plus other less severe contingencies	Replace Petenwell transformer
1	Castle Rock – ACEC Quincy 69-kV line	104.8% 104.7% 104.6%	--	--	--	--	--	107.9% 107.9% 107.9%	--	--	--	Petenwell 138/69-kV transformer Petenwell – Big Pond 69-kV line Necedah Tap – Big Pond 69-kV line	Uprate Castle Rock – McKenna 69-kV line

Table ZS-2
2015 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2015 Summer Peak Case		2015 70% Load Case		2015 90% Load Case		2015 105% Load Case		2015 High Wind		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
1	ACEC Quincy – McKenna 69-kV line	98.3% 98.2% 98.2%	--	--	--	96.0% 96.0% 96.0%	--	101.1% 101.1% 101.1%	--	--	--	Petenwell 138/69-kV transformer Petenwell – Big Pond 69-kV line Necedah Tap – Big Pond 69-kV line	Uprate Castle Rock – McKenna 69-kV line
1	Mauston – Hilltop 69-kV line	--	--	--	--	--	--	--	--	99.3%	--	Arpin – Rocky Run 345-kV line[2]	Marginal issue, no mitigation needed within this timeframe
1	Saratoga – ACEC Badger West 138-kV line	--	--	--	--	--	--	96.9% 96.5% 96.4%	--	--	--	Eau Claire – Arpin 345 kV line[4] King – Arpin 345-kV line[22] King – Eau Claire 345 kV line[5]	Marginal issue, no mitigation needed within this timeframe
1	Caroline 115/69-kV transformer	95.9%	--	--	--	--	--	101.2%	--	--	--	Whitcomb 115/69-kV transformer	Marginal issue, no mitigation needed within this timeframe
1	Chaffee Creek – Coloma Tap 69-kV line	95.0%	--	--	--	--	--	100.7%	--	--	--	Petenwell 138/69-kV transformer	Marginal issue, no mitigation needed within this timeframe
1	Harrison 138/69-kV transformer	99.8%	--	--	--	--	--	102.7%	--	--	--	System Intact	Replace Harrison transformer
1	Metomen 138/69-kV transformer	96.3%	--	--	--	--	--	106.1% 104.6%	--	--	--	System Intact North Fond du Lac 138/69-kV transformer #3[6]	Adjust Metomen 138/69-kV transformer LTC
1	Northwest Ripon – Ripon 69-KV line	--	--	--	--	--	--	95.9%	--	--	--	Winneconne – Sunset Point 69-kV line	Marginal issue, no mitigation needed within this timeframe
1	Sigel – Auburndale 69-kV line	95.4%	--	--	--	--	--	101.1%	--	--	--	System Intact	Higher ratings -- validated
1	Vulcan – Port Edwards 138-kV line #2 Vulcan – Port Edwards 138-kV line #1	123.2% 123.0%	--	123.2% 123.0%	--	122.9% 122.9%	--	123.1% 122.9%	--	123.1% 122.9%	--	Port Edwards – Vulcan Chemical 138-kV #1 line Port Edwards – Vulcan Chemical 138-kV #2 line	Change tap on free standing CT's at Port Edwards
2	Base case loading criteria exceeded	TRUE	--	FALSE	--	FALSE	--	FALSE	--	FALSE	--	System Intact	
2	Base case voltage criteria exceeded	--	TRUE	--	TRUE	--	TRUE	--	TRUE	--	TRUE	System Intact	
2	M38-Atlantic 69-kV line	115.0% – 119.8%	--	--	--	-- -- 108.6%	--	122.2% 122.2% 122.4%	--	--	--	M38 – Atlantic 138-kV line Atlantic 138/69-kV transformer M38 – Atlantic 69-kV line[23]	Mitigated by generation adjustments or uprate line
2	Straits – McGulpin 138-kV line 9901 Straits – McGulpin 138-kV line 9903	--	--	--	--	97.7%	--	--	--	--	--	Straits – McGulpin 138-kV line 9903 Straits – McGulpin 138-kV line 9901	Targeted for mitigation by Eastern U.P. area reinforcements
2	Lakota Road 69-kV bus	--	--	--	--	--	118.1%	--	--	--	118.1%	Lakota Road – Conover 69-kV line	Resolved by transformer model adjustments
2	Brevort, Hiawatha and Lakehead 138-kV buses	--	--	--	--	--	90.8 – 91.0%	--	--	--	--	Straits 138/69-kV transformer	Targeted for mitigation by Eastern U.P. area reinforcements
2	Engadine, Newberry, Newberry Hospital, Roberts, LouPac, Newberry Village, Hulbert and Eckerman 69-kV buses	--	74.6 – 91.9%	--	--	--	84.8 – 90.4%	--	61.9 – 73.3% 80.9 – 86.9%	--	--	Hiawatha – Engadine 69-kV line Engadine – Newberry 69-kV line	Mitigated by generation adjustments
2	Brimley, Goetzville, Pickford, Raco, Magazine and Talentino 69-kV buses	--	--	--	--	--	--	--	79.0 – 89.9% 79.1 – 89.1%	--	--	Hiawatha – Engadine 69-kV line Engadine – Newberry 69-kV line	Mitigated by generation adjustments
2	North Bluff, Bay View, Mead, Gladstone, Masonville, Lakehead, West Side, Escanaba, Delta, Harris and Chandler 69-kV buses	--	89.6 – 91.8%	--	88.0 – 90.7%	--	--	--	87.5 – 89.8%	--	--	Chandler 138/69-kV transformer	Mitigated by generation adjustments
2	Hulbert, Eckerman, LouPac, Newberry Hospital, Newberry Village and Roberts 69-kV buses	--	--	--	--	--	--	--	87.7 – 91.8%	--	--	Newberry – Newberry Hospital 69-kV line	Targeted for mitigation by Eastern U.P. area reinforcements
2	LouPac, Newberry Village, Roberts 69-kV buses	--	--	--	--	--	--	--	89.7 – 90.1% 89.7 – 90.1%	--	--	Hiawatha – Roberts[24] 69-kV line Newberry Hospital – Roberts 69-kV line	Targeted for mitigation by Eastern U.P. area reinforcements
2	Ontonagon, Stone Container and Winona 138-kV buses	--	91.3 – 91.7%	--	--	--	--	--	--	--	--	M38 – Winona 138-kV line	Mitigated by generation adjustments

Table ZS-2
2015 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2015 Summer Peak Case		2015 70% Load Case		2015 90% Load Case		2015 105% Load Case		2015 High Wind		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
2	Straits, St. Ignace, Indian Lake, Evergreen, Valley, Glen Jenks, Manistique, Engadine, Hiawatha, Gould City and Curtis 69-kV buses	--	104.0 – 105.3%	--	105.1 – 105.8%	--	--	--	--	--	104.7 – 105.6%	System Intact	Adjust transformer tap settings at Hiawatha, Indian Lake, Straits
2	Nordic – Mountain 69-kV line	--	--	99.7 – 101.3%	--	--	--	100.9% --	--	--	--	Chandler 138/69-kV transformer Plains – Arnold 138-kV line	Mitigated by generation adjustments
2	Rudyard – Pine River 69-kV line Rudyard – Tone 69-kV line Kinchloe – Tone 69-kV line	--	--	--	--	--	--	100.0 – 100.1% 103.3 – 103.4% 97.2 – 97.3%	--	--	--	Hiawatha – Engadine 69-kV line Engadine – Newberry 69-kV line	Mitigated by generation adjustments
2	Hiawatha 138-kV bus	--	--	--	--	--	94.5%	--	--	--	--	System Intact	Targeted for mitigation by Eastern U.P. area reinforcements
2	Straits 69-kV bus	--	--	--	--			--	105.1%	--	--	System Intact	Targeted for mitigation by Eastern U.P. area reinforcements
2	Pine River – Straits 69-kV line Pine River – Evergreen 69-kV line Straits – Evergreen 69-kV line	--	--	--	--	101.4 – 105.2% 101.0 – 104.8% 106.5 -110.5%	--	--	--	--	--	Hiawatha – Straits[25] 138-kV line Straits 138/69-kV transformer	Targeted for mitigation by Eastern U.P. area reinforcements
3	Base case loading criteria exceeded	FALSE	--	FALSE	--	FALSE	--	FALSE	--	FALSE	--	System Intact	
3	Base case voltage criteria exceeded	--	FALSE	--	FALSE	--	FALSE	--	FALSE	--	FALSE	System Intact	
3	Dane – Lodi Tap 69-kV line	--	--	--	--	--	--	98.6%	--	--	--	Island Street – Kirkwood 69-KV line	Marginal issue, no mitigation needed within this timeframe
3	Lake Geneva, Katzenberg, Twin Lakes, and South Lake Geneva 69-kV buses	--	88.6 – 90.2%	--	--	--	--	--	--	--	--	North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Cobblestone 69-kV bus	--	91.4%	--	--	--	--	--	91.2%	--	--	Cobblestone – Brick Church 69-kV line	North Lake Geneva – South Lake Geneva 138-kv line
3	Concord, Brick Church, Williams Bay and Fort Atkinson 138-kV buses+B73	--	--	--	95.6 – 95.9%	--	95.9%	--	--	--	--	System Intact	Marginal voltage, no mitigation needed within this timeframe
3	Lake Geneva 69-kV bus	--	--	--	--	--	91.8%	--	86.6%	--	--	North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kv line
3	Beloit Gateway 138-kV bus	--	--	--	--	--	91.6%	--	--	--	--	Beloit Gateway – Dickinson 138-kV line	Marginal voltage, no mitigation needed within this timeframe
3	Katzenberg, Twin Lakes, and South Lake Geneva 69-kV buses	--	--	--	--	--	--	--	87.6 – 88.3%	--	--	North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Concord 138-kV bus	--	--	--	95.9% --	--	95.4% 91.7%	--	--	--	--	System Intact Jefferson – Crawfish River 138-kV line	Marginal voltage, no mitigation needed within this timeframe
3	Brick Church 138-kV bus	--	--	--	95.6% --	--	95.6% 91.9%	--	--	--	--	System Intact Beloit Gateway – Dickinson 138-kV line	Marginal voltage, no mitigation needed within this timeframe
3	Crawfish River 138-kV bus	--	--	--	--	--	90.7%	--	--	--	--	Jefferson – Crawfish River 138-kV line	Marginal voltage, no mitigation needed within this timeframe
3	Butler Ridge 138-kV bus	--	--	--	--	--	95.9% 91.8%	--	--	--	--	System Intact Hartford – St. Lawrence 138-kV line	Marginal voltage, no mitigation needed within this timeframe
3	Williams Bay, Bristol, Delavan, SW Delavan, Brick Church and Elkhorn 138-kV buses	--	--		91.3 – 91.9%	--	--	--	--	--	--	Wempletown – Paddock 345-kV line	Marginal voltage, no mitigation needed within this timeframe

Table ZS-2
2015 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2015 Summer Peak Case		2015 70% Load Case		2015 90% Load Case		2015 105% Load Case		2015 High Wind		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
3	Beloit Gateway, BOC Gas, NW Beloit, RC9, Williams Bay, Bristol, Delavan, West Darien, RC2, Sunrise, Venture, Tichigan, EL&W, Sugar Creek, Burlington, Whitewater, SW Delavan, Rock River, Blackhawk, Paddock, Colley Road, Dickinson, Marine, Brick Church, North Lake Geneva, Elkhorn, Janesville, Russell, McCue, Viking, Townline, Wilcox, Kennedy, Tripp, Air Liquide, University, Bluff Creek, Lakehead-Delavan 138-kV buses	--	--	--	87.8 – 91.8%	--	--	--	--	--	--	Paddock 345/138-kV transformer	Further study needed
3	Beloit Gateway, BOC Gas, NW Beloit, RC9, Williams Bay, Bristol, Delavan, West Darien, RC2, Venture, SW Delavan, Rock River, Blackhawk, Paddock, Colley Road, Dickinson, Marine, Brick Church, Townline 138-kV buses	--	--	--	--	--	--	--	--	--	90.9 – 91.9%	Paddock 345/138-kV transformer	Marginal voltage, no mitigation needed within this timeframe
3	Cobblestone – Zenda Tap 69-kV line	105.0%	--	--	--	--	--	112.7%	--	--	--	North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Colley Road 138/69-kV transformer	96.9%	--	--	--	--	--	100.2%	--	--	--	Paddock 138/69-kV transformer	Marginal issue, no mitigation needed within this timeframe
3	Katzenberg – Zenda Tap 69-kV line	95.3%	--	--	--	--	--	102.2%	--	--	--	North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Paddock – Townline 138-kV line	--	--	102.4% 100.9% 99.9%	--	--	--	--	--	--	--	NW Beloit – Paddock 138-kV line Blackhawk – NW Beloit – Paddock 138-kV line Blackhawk – NW Beloit 138-kv	Mitigated by generation adjustments
3	NW Beloit – Paddock 138-kV line	--	--	97.6%	--	--	--	--	--	--	--	Paddock – Townline 138-kV line	Marginal issue, no mitigation needed within this timeframe
3	Lake Geneva – South Lake Geneva 69-kV line	--	--	--	--	--	--	97.7%	--	--	--	Cobblestone – Brick Church 69-kV line	Marginal issue, no mitigation needed within this timeframe
3	North Monroe – Idle Hour 69-kV line	103.9 – 96.1%	--	--	--	95.4% -- -- -- -- --	--	109.1 – 96.2%	--	--	--	Paddock – Newark 69-kV line Paddock – Brodhead Switching Station 69-kV line[7] Brodhead – Newark 69-kV line Darlington – Gratiot 69-kV line Wiota – Gratiot 69-kV line Darlington 138/69-kV transformer	Bass Creek transformer project
3	McCue – REC Harmony – Milton Tap – Lamar 69-kV line	103.3 – 95.4%	--	--	--	--	--	109.1 – 97.7%	--	--	--	Kegonsa – Stoughton North Tap2 69-kV line Kegonsa 138/69-kV transformer Stoughton North Tap1 – Stoughton North Tap2 69-kV line Stoughton East – Stoughton North 69-kV line	McCue to Lamar line uprate project
3	Sheepskin – Dana 69-kV line	--	--	--	--	--	--	99.9%	--	--	--	McCue – Lamar 69-kV line	Sheepskin terminal upgrade
3	Boscobel – Wauzeka – Gran Grae 69-kV line	--	--	--	--	--	--	98.0 – 96.4%	--	--	--	Spring Green 138/69-kV transformer Spring Green – Lone Rock 69-kV line	Gran Grae line uprate project
3	Wauzeka – Gran Grae 69-kV line	95.3%	--	--	--	--	--	--	--	--	--	Spring Green 138/69-kV transformer	Gran Grae line uprate project
3	Timberlane Tap – West Middleton 69-kV line	101.4%	--	--	--	96.9%	--	108.0%	--	--	--	Spring Green 138/69-kV transformer	West Middleton to Stagecoach line uprate
3	Royster – AGA Gas Tap – Pflaum 69-kV line	111.8 – 95.2%	--	--	--	--	--	117.8 – 99.1%	--	--	--	Fitchburg – Syene 69-kV line Nine Springs – Syene 69-kV line Fitchburg – Nine Springs 69-kV line[8]	Nine Springs, Pflaum area project
3	Royster – AGA Gas Tap	--	--	--	--	101.5%	--	--	--	--	--	Fitchburg – Syene 69-kV line	Nine Springs, Pflaum area project
3	Fitchburg – Syene – Nine Springs 69-kV line	113.4 – 97.3%	--	--	--	--	--	119.3 – 102.4%	--	--	--	Royster – AGA tap 69-kV line Pflaum – AGA tap 69-kV line Royster – AGA tap 69-kV line[9]	Nine Springs, Pflaum area project
3	Fitchburg – Syene 69-kV line	--	--	--	--	102.8%	--	--	--	--	--	Royster – AGA tap 69-kV line	Nine Springs, Pflaum area project

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2015 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2015 Summer Peak Case		2015 70% Load Case		2015 90% Load Case		2015 105% Load Case		2015 High Wind		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
3	Verona 138-kV bus	--	95.4% 87.2%	--	-- 90.05%	--	-- 88.4%	--	95.1% 86.5%	--	-- 91.4%	System Intact Verona – Oak Ridge 138-kV line	Adjust Verona 138/69-kV transformer LTC / Verona 69-kV capacitor bank project
3	Fitchburg 138-kV bus	--	95.9%	--	--	--	--	--	--	--	--	System Intact	Verona 69-kV capacitor bank project
3	Fitchburg and Oak Ridge 138-kV buses	--	--	--	--	--	--	--	95.8 – 95.9%	--	--	System Intact	Verona 69-kV capacitor bank project
3	Southwest Verona 69-kV bus	--	89.6%	--	--	--	91.2%	--	88.5%	--	--	Verona – Southwest Verona 69-kV line	Further study needed
3	Huiskamp 138-kV bus	--	88.9%	--	88.2%	--	87.7%	--	87.8%	--	--	Huiskamp – North Madison 138-kV line	Adjust Huiskamp 138/69-kV transformer LTC
3	Brodhead Muni2, Brodhead Muni3, Brodhead and Brodhead Muni1 69-kV buses	--	91.6 – 91.8%	--	--	--	--	--	--	--	--	Brodhead Switching Station – Brodhead Muni3 69-kV line	Bass Creek transformer project
3	Brodhead Muni2, Brodhead Muni3, Brodhead, Brodhead Muni1, REC Orfordville, Orfordville, Bass Creek and Footville 69-kV buses	--	--	--	--	--	--	--	90.1 – 91.7%	--	--	Brodhead Switching Station – Brodhead Muni3 69-kV line Brodhead Muni 2 – Brodhead Muni3 69-kV line	Bass Creek transformer project
3	REC Harmony, Milton, Milton Tap, Lamar, Fulton and Saunders Creek 69-kV buses	--	88.5 – 91.9%	--	--	--	--	--	86.5 – 91.9%	--	--	McCue – Harmony 69-kV line Milton Tap – Harmony 69-kV line McCue – Lamar 69-kV line[10]	Lamar 69-kV capacitor bank project
3	AGA Gas 69-kV bus	--	--	--	--	--	--	--	92.0%	--	--	Royster – AGA tap 69-kV line	Nine Springs, Pflaum area project
3	McFarland, Femrite and Sprecher 138-kV buses	--	--	--	--	--	--	--	91.2 – 91.5%	--	--	Kegonsa – McFarland 138-kV line Femrite – McFarland 138-kV line Kegonsa – Femrite 138-kV line[11]	Dane County Corrective Plan
3	REC Harmony, Milton, Milton Tap, Lamar, Fulton 69-kV buses	--	--	--	--	--	91.3 – 91.9%	--	--	--	--	McCue – Harmony 69-kV line	Lamar capacitor bank
3	Hubbard and Hustisford 138-kV buses	--	-- 86.2% 86.8% 86.8% --	--	--	--	96.0% 86.8% 87.3% 87.3% 91.8%	--	-- 85.8% 86.5% 86.5% --	--	-- -- 87.4% 87.4% --	System Intact Rubicon – Hustisford 138-kV line Hustisford – Hubbard 138-kV line Rubicon – Hustisford – Hubbard 138-kV line Hartford – Saint Lawrence 138-kV line	Adjust Hubbard 138/69-kV transformer LTC
3	Fox Lake, North Beaver Dam and Beaver Dam East 138-kV buses	--	88.2 – 88.3% 88.9% 88.9%	--	--	--	89.4 – 89.5% -- --	--	87.4 – 87.5% 88.2 – 88.3% 88.2 – 88.3%	--	--	North Randolph – Fox Lake 138-kV line Fox Lake – North Beaver Dam 138-kV line North Randolph – North Beaver Dam 138-kV line[12]	Adjust North Beaver Dam 138/69-kV transformer LTC
3	Nelson Dewey – DPC Cassville 161-kV line	--	--	98.2 – 95.2%	--	--	--	--	--	--	--	Paddock 345/138-kV transformer DPC Genoa generator #3 Columbia generator #1 Columbia generator #2	Mitigation by potential generation adjustments / Futher study needed
3	Nelson Dewey – DPC Cassville 161-kV line	--	--	--	--	--	--	--	--	111.2 – 109.2%	--	DPC Seneca – DPC Genoa 161-kV line Genoa 161/69-kV transformer[13]	DPC line limitation / further study needed
3	Darlington – North Monroe 138-kV line	--	--	--	--	--	--	--	--	109.3 – 95.2%	--	Paddock 345/138-kV transformer Darlington 138/69-kV transformer	Mitigation by potential generation adjustments / Futher study needed
3	Nelson Dewey 161/138-kV transformer	--	--	--	--	--	--	--	--	100.5 – 95.5%	--	ComEd Byron generator #1 ComEd Braidwood generator #1 ComEd Braidwood generator #2 Point Beach generator #1 Point Beach generator #2 Kewaunee generator #1	Mitigation by potential generation adjustments / Futher study needed
3	West Middleton – Black Hawk 69-kV line	--	--	98.5 – 96.3%	--	--	--	--	--			North Madison – Vienna 138-kV line Vienna – Yahara River 138-kV line North Madison – Yahara River 138-kV line[14]	Mitigated by generation adjustments/ Potential Cardinal – Blount 138-kV line
3	Verona, Oak Ridge, and Fitchburg 138-kV buses	--	--	--	95.5 – 95.7%	--	--	--	--	--	--	System Intact	Femrite and Kegonsa 138-kV capacitor banks
4	Base case loading criteria exceeded	FALSE	--	FALSE	--	FALSE	--	FALSE	--	FALSE	--	System Intact	
4	Base case voltage criteria exceeded	--	FALSE	--	FALSE	--	FALSE	--	FALSE	--	FALSE	System Intact	
4	Non Converged Solution	--	--	Applies	--	--	--	--	--	Applies	--	Morgan – Plains 345-kV line[15] Morgan – Plains 345-kV line	Mitigated by generation adjustments
4	Morgan – Falls 138-kV line	--	--	103.4% 103.4%	--	--	--	--	--	96.0% 95.9%	--	Morgan – Plains 345-kV line[15] Morgan – Plains 345-kV line	Mitigated by generation adjustments

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2015 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2015 Summer Peak Case		2015 70% Load Case		2015 90% Load Case		2015 105% Load Case		2015 High Wind		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
4	East Krok 138/69-kV transformer	105.1% -- --	--	99.8% -- --	--	102.7% -- --	--	107.1% 96.5% 95.7%	--	--	--	Canal – East Krok 138-kV line Highway V 138/69-kV transformer #2[16] Highway V – East Krok 138-kV line	No project needed; Investigation into limiting facility resulted in higher facility ratings
4	Sunset Point – Pearl Avenue 69-kV line	116.3% 115.7%	--	--	--	104.6% 103.7%	--	122.6% 121.4%	--	--	--	Ellinwood 138/69-kV transformer[17] Ellinwood – 12th Avenue 69-kV line	Rebuild line
4	Highway V – Ontario 138-kV line	99% --	--	--	--	--	--	103.5% 98.7%	--	--	--	East Krok 138/69-kV transformer[18] Canal 138/69-kV transformer #1[19]	Uprate line
4	Dyckesville – Rosiere 69-kV line	95.0%	--		--	--	--	99.2%	--	--	--	East Krok 138/69-kV transformer[18]	Further study needed
4	White Clay 138-kV 1-2 bus tie	--	--	99.7%	--	--	--	--	--	--	--	Morgan – Highway 22 345-kV line	Further study needed
4	Highway V – Preble 138-kV line	--	--	97.5%	--	--	--	--	--	--	--	Morgan – Highway 22 345-kV line	Further study needed
4	Canal – East Krok 138-kV line	--	--	--	--	--	--	98.0%	--	--	--	Highway V 138/69-kV transformer #1[20]	Further study needed
4	Edgewater – Sauk Trail 138-kV line	--	--	--	--	--	--	96.8%	--	--	--	Edgewater – Huebner 138-kV line	Further study needed
4	East Krok – Kewaunee 138-kV line	--	--	--	--	96.0%	--	--	--	--	--	North Appleton 345/138 kV xfmr #1[21]	Further study needed
4	Manrap – Custer 69-kV line	--	--	--	--	--	--	97.2%	--	--	--	Dewey – Lakefront 69-kV line	Further study needed
5	Base Case Loading Criteria Exceeded	FALSE		FALSE		FALSE		FALSE		FALSE			
5	Base Case Voltage Criteria Exceeded		TRUE		FALSE		TRUE		TRUE		FALSE		
5	Bluemound 230-kV bus, Allerton, Brookdale, Cottonwood, Edgewood, and 28th St 138-kV buses	--	94.6 – 95.9%	--	--	--	--	--	--	--	--	System Intact	Shift Allerton load from T9 to T8
5	Bluemound 230-kV bus, Allerton, Brookdale, Cottonwood, and 28th St 138-kV buses	--	--	--	--	--	--	--	94.6 – 95.8%	--	--	System Intact	Shift Allerton load from T9 to T9
5	Burlington and Tichigan 138-kV buses	--	--	--	90.8 – 91.0%	--	--	--	--	--	--	Split Burlington 138-kV bus	Marginal voltage, no mitigation needed within this timeframe
5	Bark River 138-kV bus	--	--	--	--	--	95.6% 91.3%	--	--	--	--	System Intact Bark River – Sussex 138-kV line	Marginal voltage, no mitigation needed within this timeframe
5	Cottonwood 138-kV bus	--	--	--	--	--	95.3% 91.6%	--	--	--	--	System Intact Bark River – Sussex 138-kV line	Marginal voltage, no mitigation needed within this timeframe
5	Germantown 138-kV bus	--	--	--	-- -- -- 91.9%	--	94.6% 91.9% 91.5% 87.6%	--	--	--	--	System Intact Germantown – Maple 138-kV line Bark River – Sussex 138-kV line Maple – Saukville 138-kV line	Mitigated by generation adjustments
5	Hartford 138-kV bus	--	--	--	--	--	95.8% 91.4%	--	--	--	--	System Intact Hartford – St. Lawrence 138-kV line	Marginal voltage, no mitigation needed within this timeframe
5	Maple 138-kV bus	--	--	--	-- 91.7%	--	94.8% 87.3%	--	--	--	--	System Intact Maple – Saukville 138-kV line	Mitigated by generation adjustments
5	Summit, Cooney and Mukwonago 138-kV buses	--	--	--	--	--	95.5 – 95.8%	--	--	--	--	System Intact	Marginal voltage, no mitigation needed within this timeframe
5	Bain 345/138-kV transformer #5	159.7% 117.9%	--	147.3% --	--	159.3% --	--	159.2% 108.2%	--	147.5% 107.6%	--	Split Pleasant Prairie 345-kV bus 34 Split Pleasant Prairie 345-kV bus 23	Mitigated by generation adjustments
5	Oak Creek 345/230-kV transformer T895	105.0% 105.3%	--	95.3% --	--	104.7% --	--	104.9% 104.5%	--	95.1% --	--	Split Oak Creek 230-kV bus 78 Split Oak Creek 230-kV bus 67	Mitigated by generation adjustments
5	Arcadian4 – Waukesha1 138-kV line	104.8%	--	119.6%	--	134.2%	--	105.2%	--	--	--	Arcadian6 – Waukesha3 138-kV line	Rebuild line
5	Arcadian6 – Waukesha3 138-kV line	101.1% --	--	115.6% 103.5%	--	129.7% 113.6%	--	101.5% --	--	--	--	Arcadian4 – Waukesha1 138-kV line Split Waukesha 138-kV bus 12	Rebuild line
5	Arcadian 345/138-kV transformer #3	-- -- 99.8%	--	101.7% 99.7% 98.3%	--	105.6% 105.2% 110.9%	--	-- -- 101.8%	--	--	--	Split Arcadian 345-kV bus 12 Arcadian 345-kV bus outage Arcadian 345/138-kV transformer #1	Replace transformer
5	Arcadian 345/138-kV transformer #2	--	--	95.7% --	--	97.4% 102.4%	--	--	--	--	--	Split Arcadian 345-kV bus 12 Arcadian 345/138-kV transformer #2	Replace transformer
5	Bain – Kenosha 138-kV line	97.9%	--	--	--	--	--	--	--	--	--	Pleasant Prairie – Zion 345-kV line	Uprate Bain – Kenosha
5	Pleasant Prairie – Zion 345-kV line	95.7% -- -- -- --	--	--	--	--	--	98.1% 96.2% 100.2% 98.5% 95.4%	--	--	--	Zion – Arcadian 345-kV line Cherry Valley – Silver Lake 345-kV line Braidwood generator #1 or #2 Dresden generator #2 or #3 Zion Energy Ctr #1 or #2	Marginal issue, no mitigation needed within this timeframe
5	Granville 345/138-kV transformer #1	--	--	95.0%	--	107.2%	--	--	--	--	--	Split Granville 345-kV bus 23	Mitigated by generation adjustments

Table ZS-2
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Planning Zone	Criteria Exceeded/Need	2015 Summer Peak Case		2015 70% Load Case		2015 90% Load Case		2015 105% Load Case		2015 High Wind		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
5	Harbor – Kansas 138-kV line	--	--	109.5% 106.7% 106.6% 105.7% 99.6 – 102.5%	--	--	--	--	--	--	--	Kansas – Norwich 138-kV line Dewey – Norwich 138-kV line Split Dewey 138-kV bus Dewey – Montana 138-kV line Plus Other Less Severe Outages	Mitigated by generation adjustments
5	Albers – Kenosha 138-kV line	--	--	120.3%	--	103.3%	--	100.9%	--	--	--	Albers – Bain 138-kV line	Mitigated by generation adjustments
5	Edgewood – St. Martins 138-kV line	--	--	102.1% 98.8% 97.4% 96.5%	--	--	--	--	--	--	--	Merrill Hills – Waukesha 138-kV line Paris – Air Liquide 138-kV line Paris – Air Liquide – Burlington 138-kV line Burlington – Air Liquide 138-kV line	Mitigated by generation adjustments
5	Oak Creek – Ramsey 138-kV line	--	--	--	--	95.6%	--	--	--	--	--	Oak Creek – Pennsylvania 138-kV line	Marginal issue, no mitigation needed within this timeframe
5	Wauesha 138-kV bus 12	--	--	--	--	100.1%	--	--	--	--	--	Arcadian6 – Waukesha3 138-kV line	Mitigated by generation adjustments
5	Kenosha – Lakeview 138-kV line	--	--	--	--	--	--	100.7%	--	--	--	Pleasant Prairie – Zion 345-kV line	Rebuild line
5	Lakeview – Zion 138-kV line	--	--	--	--	--	--	96.7%	--	--	--	Pleasant Prairie – Zion 345-kV line	Further study needed

Event Based Contingency	Definition of Event Based Contingency
1	Saratoga – ACEC Badger West – Petenwell138-kV line
2	Arpin – Rocky Run 345-kV line + Port Edwards – Sand Lake 138-kV line + Port Edwards – Hollywood 138-kV line + Council Creek – Council Creek DPC 69-kV line
3	Whitcomb – CWEC Wittenberg Tap – Wittenberg Tap – Birnamwood Tap – Brooks Corner – Deer Trail 69-kV line
4	Eau Clare – Arpin 345-kV line + Council Creek DPC – Council Creek 69-kV line + Hilltop – Mauston 69-kV line
5	King – Eau Claire 345-kV line + Eau Clare – Arpin 345-kV line + Eau Clare 345/161-kV transformer + Council Creek DPC – Council Creek 69-kV line + Hilltop – Mauston 69-kV line + Lubin – Lakehead 69-kV line
6	North Fond du Lac 138/69-kV transformer #3 + North Fond du Lac – Hickory Street Tap 69-kV line + North Fond du Lac – Rosendale 69-kV line + North Fond du Lac 69-kV bus capacitor
7	Paddock – REC Newark – Brodhead Switching Station 69-kV line
8	Fitchburg – Syene – Nine Springs 69-kV line
9	Royster – AGA tap – LCI 69-kV line
10	McCue – Harmony – Milton Tap – Lamar 69-kV line
11	Kegonsa – McFarland – Femrite 138-kV line
12	North Randolph – Fox Lake – North Beaver Dam 138-kV line
13	Genoa 161/69-kV transformer + Genoa-Seneca 161-kV line + Genoa-Lansing W 161-kV line+ Genoa-Lac Tap 161-kV line
14	North Madison-Vienna-Yahara River 138-kV line
15	Morgan – Plains 345-kV line + Morgan 24.9 kV reactor + Plains 24.9 kV reactor
16	Highway V 138/69 kV xfmr #2 + Highway V - East Krok 138 kV circuit + Highway V - Mystery Hills 138 kV circuit + Highway V - Oak Street 69 kV circuit
17	Ellinwood 138/69 kV xfmr #1 + Ellinwood - Twelfth Ave 69 kV circuit + Ellinwood - Fitzgerald 138 kV circuit +Ellinwood 138 kV bus tie 1-2
18	East Krok 138/69 kV xfmr + Highway V - East Krok 138 kV circuit + East Krok - Canal 138 kV circuit + East Krok - Kewaunee 138 kV circuit + Beardsely - East Krok 69 kV circuit
19	Canal 138/69 kV xfmr #1 + Canal - East Krok 138 kV circuit + Canal - Sawyer 69 kV circuit + Canal - Algoma 69 kV circuit + Canal 69 kV cap banks, 2 x 16.3 MVAr
20	Highway V 138/69 kV xfmr #1 + Highway V - Ontario 138 kV circuit + Highway V - Preble 138 kV circuit + Highway V - Finger Road 69 kV circuit + Highway V - Rockland 138 kV circuit + Highway V 138 kV cap bank, 2 x 18.9 MVAr
21	North Appleton 345/138 kV xfmr #1 + North Appleton - Kewaunee 345 kV circuit
22	King – Eau Clare 345-kV line + Eau Clare – Arpin 345-kV line + Eau Clare 345/161-kV transformer + Council Creek DPC – Council Creek 69-kV line + Hilltop – Mauston 69-kV line
23	M38-Atlantic 69-kV line + Atlantic 138/69-kV transformer
24	Hiawatha-Engadine-Newberry-Newberry Hospital-Roberts 69-kV line
25	Hiawatha-Lakehead-Brevort-Straits 138-kV line

Table ZS-3
2020 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2020 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
1	Base case loading criteria exceeded	TRUE	--	System Intact	
1	Base case voltage criteria exceeded	--	TRUE	System Intact	
1	Silver Lake, ACEC Spring Lake, Redgranite, Fountain Valley, River Run and Berlin 69-kV buses	--	84.5 – 88.2% 86.6 – 89.6% 87.2 – 90.6% 88.0 – 90.6% 88.6 – 91.9%	Wautoma – Silver Lake Tap 69-kV line Silver Lake – ACEC Spring Lake 69-kV line Metomen – Ripon 69-kV line ACEC Spring Lake – Redgranite 69-kV line Plus other less severe contingencies	Ripon capacitor expansion and Install capacitors at Dartford
1	Dartford, Ripon Industrial Park, Northwest Ripon and Ripon 69-kV buses	--	94.8% 83.2 – 85.1% 85.0 – 86.9% 87.8 – 89.6% 87.9 – 91.6%	System Intact Metomen – Ripon 69-kV line Ripon – Northwest Ripon Tap 69-kV line Wautoma – Silver Lake Tap 69-kV line Plus other less severe contingencies	Ripon capacitor expansion and Install capacitors at Dartford
1	Winneconne, Omro and Omro Industrial Park 69-kV buses	--	84.2 – 85.0% 89.6 – 89.8% 90.5 – 91.2% 91.3 – 91.9% 91.3 – 91.9%	Winneconne – Sunset Point 69-kV line Winniconne – Omro Tap 69-kV line Metomen – Ripon 69-kV line Wautoma – Silver Lake Tap 69-kV line Plus other less severe contingencies	Ripon capacitor expansion and Install capacitors at Dartford
1	Mackford Prairie and Markesan 69-kV bus	--	91.7 – 91.9%	North Randolph – Markesan Tap 69-kV line	Ripon capacitor expansion
1	Metomen – Ripon 69-kV line	96.0% 104.9% 97.0% 95.9%	--	System Intact Winneconne – Sunset Point 69-kV line Winniconne – Omro Tap 69-kV line North Randolph – Markesan Tap 69-kV line	Second Metomen – Ripon 69-kV line
1	Metomen 138/69-kV transformer	109.4% 110.7% 109.2% 103.4% 103.2 – 95.9%	--	System Intact North Fond du Lac 138/69-kV transformer #3[2] North Fond du Lac – Rosendale Tap 69-kV line Metomen – North Fond du Lac 69-kV line[3] Plus other less severe contingencies	Replace Metomen 138/69-kV transformer
1	Northwest Ripon Tap – Ripon 69-kV line	106.8% 95.1%	--	Winneconne – Sunset Point 69-kV line Winneconne – Omro Tap 69-kV line	Uprate line
1	Omro – Winneconne 69-kV line	98.5% 95.1%	--	Ripon – Northwest Ripon Tap 69-kV line Harrison 138/69-kV transformer	Marginal issue, no mitigation needed within this timeframe
1	Winneconne – Sunset Point 69-kV line	103.5% 101.3%	--	Ripon – Northwest Ripon Tap 69-kV line Metomen – Ripon 69-kV line	Uprate line

Table ZS-3
2020 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2020 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
1	ACEC Brooks, Grand Marsh (PP&L) and Lincoln Pumping Station 69-kV buses	--	88.9 – 89.5% 91.2 – 91.6% 91.2 – 91.6%	Necedah Tap – Big Pond 69-kV line Chaffee Creek – Coloma Tap 69-kV line Necedah Tap – Whistling Wings Tap 69-kV line	McKenna capacitor expansion
1	Necedah, Petenwell, Big Pond, ACEC Dellwood, Friendship, ACEC Friendship, Houghton Rock and McKenna 69-kV buses	--	79.3 – 87.0% 84.8 – 89.8% 90.1 – 91.4% 90.3 – 91.5% 90.3 – 91.8%	Necedah Tap – Big Pond 69-kV line Necedah Tap – Whistling Wings Tap 69-kV line Dellwood ACEC – Whistling Wings Tap 69-kV line Petenwell – Big Pond 69-kV line Plus other less severe contingencies	McKenna capacitor expansion, Convert Necedah to 138 kV, redispatch Castle Rock generation
1	ACEC Winnebago, ACEC Glen and Neenah Creek 69-kV bus	--	90.1 – 92.0%	Kilbourn – Winnebago ACEC 69-kV line	Increase capacitance at Neenah Creek
1	ACEC Coloma, Plainfield, Sand Lake, Hancock and ACEC Hancock 69-kV buses	--	89.4 – 90.2% 90.9 – 91.9% 90.9 – 92.0% 90.9 – 92.0% 91.6%	Chaffee Creek – Coloma Tap 69-kV line Wautoma – Port Edwards 138-kV line Sand Lake Tap – Sand Lake 69-kV line Sand Lake 138/69-kV transformer Necedah Tap – Big Pond 69-kV line	McKenna capacitor expansion
1	ACEC Quincy and Castle Rock 69-kV bus	--	91.3 – 91.8%	Necedah Tap – Big Pond 69-kV line	McKenna capacitor expansion
1	Chaffee Creek – Coloma Tap 69-kV line	113.4% 96.3%	--	Necedah Tap – Big Pond 69-kV line Necedah Tap – Whistling Wings Tap 69-kV line	Uprate terminal equipment at Chaffee Creek
1	Castle Rock – ACEC Quincy 69-kV line	125.9% 112.1% 104.6% 104.6% 101.0%	--	Necedah Tap – Big Pond 69-kV line Necedah Tap – Whistling Wings Tap 69-kV line Petenwell – Big Pond 69-kV line Petenwell 138/69-kV Transformer Dellwood ACEC – Whistling Wings Tap 69-kV line	Uprate Castle Rock – McKenna 69-kV line
1	ACEC Quincy – McKenna 69-kV line	119.0% 105.3% 98.0% 98.0%	--	Necedah Tap – Big Pond 69-kV line Necedah Tap – Whistling Wings Tap 69-kV line Petenwell – Big Pond 69-kV line Petenwell 138/69-kV Transformer	Uprate Castle Rock – McKenna 69-kV line
1	Hilltop – Mauston 69kV line	100.3%	--	Arpin – Rocky Run 345-kV line[4]	Mitigated by generation adjustments

Table ZS-3
2020 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2020 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
1	Sigel, Lakehead Pipeline, Port Edwards and Vulcan 138-kV buses	--	90.7 – 91.9%	Sigel – Arpin 138-kV line	Marginal voltage, no mitigation needed in this timeframe
1	Sigel – Auburndale 69-kV line	114.2%	--	System Intact	Line validated with higher rating
1	Rozellville 69-kV bus	--	91.9%	Sigel 138/69-kV transformer	Marginal voltage, no mitigation needed in this timeframe
1	Vulcan – Port Edwards 138-kV line #2 Vulcan – Port Edwards 138-kV line #1	124.2% 123.9%	--	Port Edwards – Vulcan Chemical 138-kV #1 line Port Edwards – Vulcan Chemical 138-kV #2 line	Change tap on free standing CT's at Port Edwards
1	Petenwell and Council Creek 138-kV buses	--	94.7 – 94.9% 89.0 – 89.5% 89.0 – 89.6% 89.0 – 89.6% 89.6 – 91.6%	System Intact ACEC Badger West – Saratoga 138-kV line ACEC Badger West – Petenwell 138-kV line Saratoga – Petenwell 138-kV line[5] Plus other less severe contingencies	Expand capacitors at Council Creek and Adjust Council Creek 138/69-kV transformer LTC
1	Badger West 138-kV bus	--	95.8% 88.1% 91.7% 91.8%	System Intact ACEC Badger West – Saratoga 138-kV line Arpin – Rocky Run 345-kV line[4] Sigel – Arpin 138-kV line	Adjust Council Creek 138/69-kV transformer LTC
1	Petenwell 138/69-kV transformer	116.3% 122.7%	--	System Intact Castle Rock – Quincy ACEC 69-kV line	Replace Petenwell transformer
1	Lakehead Pipeline Portage, Endeavor and Roslin ACEC 69-kV buses	--	91.7 – 91.9%	Portage – Lakehead Pipeline Portage 69-kV line	Marginal voltage, no mitigation needed in this timeframe
1	Fairwater and Brandon 69-kV bus	--	91.2 – 91.5%	Metomen 138/69-kV transformer	Marginal voltage, no mitigation needed in this timeframe
1	Brooks Corner 69-kV bus	--	86.7%	Whitcomb – Deer Trail 69-kV line[6]	Adjust Brooks Corners 69/34.5-kV transformer LTC
1	Harrison 138/69-kV transformer	107.1%	--	System Intact	Replace Harrison 138/69-kV transformer
1	Rocky Run 345/115-kV transformer #3	95.7% 94.6%	--	Rocky Run 345/115-kV transformer #2 Rocky Run 345/115-kV transformer #1	Marginal issue, no mitigation needed within this timeframe

Table ZS-3
2020 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2020 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
1	Caroline 115/69-kV transformer	104.9%	--	Whitcomb 115/69-kV transformer	Replace Caroline 115/69-kV transformer
1	Wautoma 138/69-kV transformer T31	109.5% 103.4% 103.4% 99.7% 98.2 – 95.0%	--	System Intact Sand Lake Tap – Sand Lake 69-kV line Sand Lake 138/69-kV transformer Portage – Lakehead Pipeline Portage 69-kV line Plus other less severe contingencies	Second 138/69-kV Transformer at Wautoma
2	M38 – Atlantic 69-kV line	117.9 – 121.7%	--	M38-Atlantic 138-kV line Atlantic 138/69-kV transformer M38-Atlantic 138-kV line[13]	Uprate M38-Atlantic 69-kV line or mitigated by generation adjustments
2	Engadine, Newberry, Newberry Hospital, Roberts, LouPac, Newberry Village, Hulbert, Eckerman 69-kV buses	--	55.6 – 89.7%	Hiawatha-Engadine 69-kV line Engadine-Newberry 69-kV line Newberry-Newberry Hospital Tap 69-kV line	Mitigated by generation adjustments
2	North Bluff, Bay View, Mead, Gladstone, Masonville, Lakehead, West Side, Escanaba, Harris, Chandler 69-kV buses	--	88.5 – 90.8%	Chandler 138/69-kV transformer	Mitigated by generation adjustments
2	Straits, St. Ignace, Indian Lake, Evergreen, Valley, Glen Jenks, Manistique, Engadine, Hiawatha, Gould City 69-kV buses	--	104.0 – 105.2%	System Intact	Adjust transformer tap settings at Hiawatha, Indian Lake, Straits
2	Straits, Brevort, Lakehead, Hiawatha 138-kV buses	--	90.9 – 91.1%	Livingstone-Emmet 138-kV line	Adjust transformer tap settings at Hiawatha, Straits
3	Base case loading criteria exceeded	FALSE	--	System Intact	
3	Base case voltage criteria exceeded	--	TRUE	System Intact	
3	Okee, Lodi Industrial Park and Lodi 69-kV buses	--	90.2 – 91.4% 92.0%	Dane – Lodi Tap 69-kV line Lodi Tap – Okee Tap 69-kV line	Marginal voltage, no mitigation needed in this timeframe
3	Dane – Lodi Tap 69-kV line	107.9% 95.3% 95.3%	--	Island Street – Kirkwood 69-kV line Baraboo Tap – Moore Street Tap 69-kV line Island Street – Moore Street Tap 69-kV line	Rebuild line
3	Eagle View 69-kV bus	--	91.8%	Island Street – Kirkwood 69-kV line	Marginal voltage, no mitigation needed in this timeframe
3	Island Street, Baraboo, Sauk Prairie, Prairie du Sac Muni, Tower Street, Dam Heights and Prairie du Sac Hydro 69-kV buses	--	90.4 – 91.8%	Island Street – Kirkwood 69-kV line	Marginal voltage, no mitigation needed in this timeframe
3	Stoughton Muni South Tap – Stoughton 69-kV line	98.4%	--	Verona – Oak Ridge 138-kV line Verona 138/69-kV transformer	Potential Y-127 line uprate/ further study needed

Table ZS-3
2020 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2020 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
3	North Monroe – Idle Hour 69-kV line Monroe Tap – Idle Hour 69-kV line	118.5 – 95.4%	--	Paddock – Newark 69-kV line Darlington – Gratiot 69-kV line Brodhead – Newark 69-kV line Paddock – Newark – Brodhead Switching Station 69-kV line Wiota – Gratiot 69-kV line plus other less severe contingencies	Bass Creek transformer project / potential Y-87 line uprate/ further study needed
3	McCue – REC Harmony 69-kV line	101.4 – 98.7%	--	Sheepskin generator Kegonsa – Stoughton North Tap2 69-kV line Kegonsa 138/69-kV transformer	Y-61 line uprate
3	REC Harmony – Milton Tap – Lamar 69-kV line	96.0%	--	Sheepskin generator	Y-61 line uprate
3	Dana Corporation Tap – Sheepskin 69-kV line	111.5 – 103.0%	--	McCue – Harmony 69-kV line Milton Tap – Lamar 69-kV line McCue – Harmony – Milton Tap – Lamar 69-kV line Milton Tap – Harmony 69-kV line	Sheepskin terminal upgrade
3	Wauzeka – Gran Grae 69-kV line Wauzeka – Boscobel 69-kV line	104.8 – 95.0%	--	Spring Green 138/69-kV transformer Nelson Dewey – Lancaster 138-kV line Nelson Dewey – Lancaster – Eden 138-kV line Eden – Lancaster 138-kV line Lone Rock – Spring Green 69-kV line plus other less severe contingencies	Y-40 line uprate
3	Timberlane Tap – West Middleton 69-kV line	112.9 – 95.3%	--	Spring Green 138/69-kV transformer Verona – Southwest Verona 69-kV line Nelson Dewey – Lancaster 138-kV line Verona – Oak Ridge 138-kV line Verona 138/69-kV transformer Eden – Lancaster 138-kV line	6927 line uprate
3	Royster – AGA Gas Tap 69-kV line Pflaum – AGA Gas Tap 69-kV line	125.9 – 105.6%	--	Fitchburg – Syene 69-kV line Nine Springs – Syene 69-kV line Fitchburg – Syene – Nine Springs 69-kV line	Nine Springs, Pflaum area project
3	Royster – Sycamore 69-kV line	99.1%	--	Femrite 138/69-kV transformer	6986 line uprate
3	Fitchburg – Syene 69-kV line Nine Springs – Syene 69-kV line	128.1 – 109.5%	--	Royster – AGA tap 69-kV line Pflaum – AGA tap 69-kV line Royster – AGA tap – Pflaum 69-kV line	Nine Springs, Pflaum area project
3	Verona, Oak Ridge, Hawk Alliant, Hawk, Cross Country, and Fitchburg 138-kV buses	--	94.0 – 96.0%	System Intact	Femrite and Kegonsa 138-kV capacitor banks
3	Southwest verona, Mount Horeb Muni1, Mount Horeb, Mount Horeb Northeast, and Forward 69-kV buses	--	83.4 – 91.7%	Verona – Southwest Verona 69-kV line	Further T-D BVP study needed
3	Idle Hour, Monroe, Monroe Tap, and South Monroe 69-kV buses	--	90.6 – 91.0%	North Monroe – Idle Hour 69-kV line	Further study needed
3	Brodhead Muni3, Brodhead Muni2, Brodhead, and Brodhead Muni1 69-kV buses	--	91.8 – 92.0 %	rodhead Switching Station – Brodhead Muni3 69-kV lin	Bass Creek transformer project

Table ZS-3
2020 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2020 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
3	REC Harmony, Milton, Milton Tap, Lamar, Fulton 69-kV buses	--	88.9 – 91.1%	McCue – Harmony 69-kV line Milton Tap – Harmony 69-kV line Milton Tap – Lamar 69-kV line McCue – Harmony – Milton Tap – Lamar 69-kV line	Lamar 69-kV capacitor bank
3	Reiner, Burke and Burke Tap 69-kV buses	--	91.7 – 91.9%	Reiner – Burke Tap 69-kV line Reiner 138/69-kV transformer	Sun Prairie capacitor bank
3	AGA Gas, Pflaum, AGA Gas Tap, and Pflaum Tap 69-kV buses	--	91.1 – 91.2%	Royster – AGA tap 69-kV line	Nine Springs, Pflaum area project
3	Lancaster, Eden, Wyoming Valley, and Spring Green 138-kV buses	--	87.6 – 91.9%	Nelson Dewey – Lancaster 138-kV line Eden – Lancaster 138-kV line Nelson Dewey – Lancaster – Eden 138-kV line	Eden capacitor bank
3	Wyoming Valley, Spring Green, Troy, and Eden 138-kV buses	--	90.6 – 91.1%	Lake Delton – Trienda 138-kV line	Eden capacitor bank
3	Pleasant View, Hawk Alliant, and Hawk 138-kV buses	--	91.8 – 92.0%	West Middleton – Pleasant View 138-kV line	Femrite and Kegonsa 138-kV capacitor banks
3	Darlington 138-kV bus	--	90.5%	Darlington – Lafayette Wind 138-kV line	North Monroe capacitor bank
3	Verona 138-kV bus, Southwest verona, Sun Valley , and Verona 69-kV buses	--	83.5 – 91.9%	Verona – Oak Ridge 138-kV line Verona 138/69-kV transformer	Further T-D BVP study needed / Verona 69-kV capacitor banks
3	Muscoda, Avoca, and Avoca Tap 69-kV buses	--	91.2%	Lone Rock – Spring Green 69-kV line	Boscobel capacitor bank
3	Pioneer, Mcgregor , Platteville tap, Hillman, Elmo, Cuba City, and Benton 69-kV buses	--	89.5%	Hillman 138/69-kV transformer	Second Hillman transformer
3	Avoca, Muscoda, Avoca Tap, Arena, Spring Green, Lone Rock , Mazomanie Industrial, Mazomanie West, Mazomanie, Blue River Tap, and Blue River 69-kV buses	--	89.8 – 91.7%	Spring Green 138/69-kV transformer	Second Spring Green transformer
3	McFarland, Femrite, Sprecher 138-kV buses	--	91.2 – 91.8%	Kegonsa – McFarland 138-kV line McFarland – Femrite 138-kV line Kegonsa – McFarland – Femrite 138-kV line	Femrite capacitor bank
3	Huiskamp 138-kV bus	--	88.0%	Huiskamp – North Madison 138-kV line	Adjust Huiskamp 138/69-kV transformer LTC
3	Verona, Fitchburg 138-kV buses	--	91.4 – 92.0%	Rockdale – West Middleton 345-kV line West Middleton 345/138-kV transformer	Femrite and Kegonsa 138-kV capacitor banks
3	Verona, Eden, and Wyoming Valley 138-kV buses	--	91.5 – 91.9%	Columbia Generator unit 1 Columbia Generator unit 2	Eden capacitor bank / Dane County corrective plan
3	South Fond du Lac – Koch Oil Tap 69-kV line	95.4%	--	North Randolph – Fox Lake 138-kV line	Further study needed
3	Hubbard and Hustisford 138-kV bus	--	85.7 – 85.8% 86.4% 86.4%	Rubicon – Hustisford 138-kV line Hustisford – Hubbard 138-kV line Rubicon – Hustisford – Hubbard 138-kV line	Adjust Hubbard 138/69-kV transformer LTC
3	Fox Lake, North Beaver Dam and Beaver Dam East 138-kV buses	--	86.1 – 86.2% 87.0 – 87.1% 87.2 – 87.3%	North Randolph – Fox Lake 138-kV line North Randolph – North Beaver Dam 138-kV line[7] Fox Lake – North Beaver Dam 138-kV line	Adjust North Beaver Dam 138/69-kV transformer LTC

Table ZS-3
2020 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2020 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
3	Cobblestone – Zenda Tap 69-kV line	162.3% 99.8% 99.1%	--	North Lake Geneva – Lake Geneva 69-kV line Lake Geneva – South Lake Geneva 69-kV line North Lake Geneva – Lake Geneva – South Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Colley Road 138/69-kV transformer	111.8% 97.4%	--	Paddock 138/69-kV transformer Paddock – Shirland 69-kV line	Bass Creek 138/69-kV transformer
3	Katzenberg – Zenda tap 69-kV line	149.6%	--	North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Katzenberg – South Lake Geneva 69-kV line	113.0%	--	Cobblestone – Brick Church 69-kV line	Third source into area, possibly from Spring Valley
3	North Lake Geneva – Lake Geneva 69-kV line	105.2%	--	Cobblestone – Brick Church 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Lake Geneva – South Lake Geneva 69-kV line	118.8% 95.8%	--	Cobblestone – Brick Church 69-kV line Cobblestone – Zenda tap 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Cobblestone – Brick Church 69-kV line	133.3%	--	North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Brick Church 138/69-kV transformer	105.6% 97.1%	--	North Lake Geneva 138/69-kV transformer North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Enzyme Bio – RC3 69-kV line	96.5%	--	Brick Church 138/69-kV transformer	Line Y-32 rebuild
3	Paddock 138/69-kV transformer	97.3%	--	Colley Road 138/69-kV transformer	Bass Creek 138/69-kV transformer
3	Lake Geneva, Katzenberg, Twin Lakes, and South Lake Geneva, and Zenda 69-kV buses	--	68.6 – 82.0%	North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Twin Lakes, Katzenberg, and South Lake Geneva 69-kV buses	--	90.6 – 91.7%	North Lake Geneva – Lake Geneva – South Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Brick Church 138-kV bus	--	91.6% 91.5% 90.8%	Beloit Gateway – Brick Church 138-kV line Colley Road – Dickinson – Beloit Gateway – Brick Church 138-kV line Dickinson – Beloit Gateway 138-kV line	Brick Church capacitors or third line into the area, possibly from Spring Valley
3	Twin Lakes, Katzenberg, and South Lake Geneva 69-kV buses	--	90.4 – 91.5%	Lake Geneva – South Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Cobblestone, Zenda, Twin Lakes, Katzenberg 69-kV buses	--	87.7 – 91.4%	Cobblestone – Brick Church 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Twin Lakes 69-kV bus	--	91.3%	Katzenberg – South Lake Geneva 69-kV line	Third source into area, possibly from Spring Valley

Table ZS-3
2020 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2020 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
4	Base case loading criteria exceeded	FALSE	--	System Intact	
4	Base case voltage criteria exceeded	--	FALSE	System Intact	
4	Highway V – Ontario 138-kV line	106.7% 102.1%	--	East Krok 138/69-kV transformer[8] Canal 138/69-kV transformer #1[9]	Uprate line
4	Canal – East Krok 138-kV line	101.9% 96.5%	--	Highway V 138/69-kV transformer #1[10] Highway V – Ontario 138-kV line	Uprate line
4	East Krok 138/69-kV transformer	109.4% 99.4% 99.1% 95.6%	--	Canal – East Krok 138-kV line Highway V 138/69-kV transformer #1[10] Highway V – East Krok 138-kV line Highway V 138/69-kV transformer #2[11]	No project needed Investigation into limiting facility resulted in higher facility ratings
4	Dyckesville – Rosiere 69-kV line	95.7%	--	East Krok 138/69-kV transformer[8]	Further study needed
4	Sunset Point – Pearl Avenue 69-kV line	119.1% 118.9%	--	Ellinwood 138/69-kV transformer[12] Ellinwood – 12th Avenue 69-kV line	Rebuild line
4	Edgewater – Sauk Trail 138-kV line	105.8%	--	Edgewater – Huebner 138-kV line	Uprate line
4	Sauk Trail – 20th Street 138-kV line	95.3%	--	Edgewater – Huebner 138-kV line	Uprate line
4	East Krok – Kewaunee 138-kV line	96.0%	--	North Appleton 345/138-kV transformer #1[1]	Further study needed
4	Manrap – Custer 69-kV line	95.4%	--	Dewey – Lakefront 69-kV line	Further study needed
5	Base Case Loading Criteria Exceeded	TRUE		System Intact	
5	Base Case Voltage Criteria Exceeded	--	FALSE	System Intact	
5	Bain 345/138-kV transformer #5	159.6% 108.8%	--	Split Pleasant Prairie 345-kV bus 34 Split Pleasant Prairie 345-kV bus 23	Mitigated by generation adjustments
5	Oak Creek 345/230-kV transformer T895	105.2% 104.9%	--	Split Oak Creek 230-kV bus 78 Split Oak Creek 230-kV bus 67	Mitigated by generation adjustments
5	Arcadian4 – Waukesha1 138-kV line	106.8%	--	Arcadian6 – Waukesha3 138-kV line	Rebuild line
5	Arcadian6 – Waukesha3 138-kV line	103.1%	--	Arcadian4 – Waukesha1 138-kV line	Rebuild line
5	Arcadian 345/138-kV transformer #3	101.9%	--	Arcadian 345/138-kV transformer #1	Replace transformer
5	Pleasant Prairie – Zion 345-kV line	95.6% 95.4%	--	Zion – Arcadian 345-kV line Cherry Valley – Silver Lake 345-kV line	Marginal issue, no mitigation needed within this timeframe
5	Kenosha – Lakeview 138-kV line	102.1%	--	Pleasant Prairie – Zion 345-kV line	Rebuild line. The existing conductor is 477 ACSR and is the limitation.
5	Lakeview – Zion 138-kV line	97.3%	--	Pleasant Prairie – Zion 345-kV line	No overload
5	Albers – Kenosha 138-kV line	106.0%	--	Bain – Kenosha 138-kV line	Uprate the 477 ACSR section of the Kenosha – Albers 138-kV line
5	Bluemound 230-kV bus, Allerton, Bark River, Brookdale, Edgewood, Cottonwood,Germantown, Mukwonago, Maple, O'Connor, and 28th St 138-kV buses	--	94.4 – 96.0%	System Intact	Shift Allerton load from T9 to T8 or connecting KK5063 to Brookdale 138-kV bus
5	Maple and Germantown 138-kV buses	--	90.4 – 90.9%	Saukville – Maple 138-kV line	Mitigated by generation adjustments

Table ZS-3_2020 constraints

Event Based Contingency Number	**Definition of Event Based Contingency**
1	North Appleton 345/138 kV xfmr #1 + North Appleton - Kewaunee 345 kV circuit
2	North Fond du Lac 138/69-kV transformer #3 + North Fond du Lac - Hickory Street Tap 69-kV line + North Fond du Lac - Rosendale 69-kV line + North Fond du Lac 69-kV bus capacitor
3	Metomen - Rosendale - North Fond du Lac 69-kV line
4	Arpin - Rocky run 345-kV line + Port Edwards - Sand Lake 138-kV line + Port Edwards - Hollywood 138-kV line + Council Creek - Council Creek DPC 69-kV line
5	Saratoga – ACEC Badger West - Petenwell 138-kV line
6	Whitcomb - CWEC Wittenberg Tap - Wittenberg Tap - Birnamwood Tap - Brooks Corner - Deer Trail 69-kV line
7	North Randolph – Fox Lake – North Beaver Dam 138-kV line
8	East Krok 138/69 kV xfmr + Highway V - East Krok 138 kV circuit + East Krok - Canal 138 kV circuit + East Krok - Kewaunee 138 kV circuit + Beardsely - East Krok 69 kV circuit
9	Canal 138/69 kV xfmr #1 + Canal - East Krok 138 kV circuit + Canal - Sawyer 69 kV circuit + Canal - Algoma 69 kV circuit + Canal 69 kV cap banks, 2 x 16.3 MVAr
10	Highway V 138/69 kV xfmr #1 + Highway V - Ontario 138 kV circuit + Highway V - Preble 138 kV circuit + Highway V - Finger Road 69 kV circuit + Highway V - Rockland 138 kV circuit + Highway V 138 kV cap bank, 2 x 18.9 MVAr
11	Highway V 138/69 kV xfmr #2 + Highway V - East Krok 138 kV circuit + Highway V - Mystery Hills 138 kV circuit + Highway V - Oak Street 69 kV circuit
12	Ellinwood 138/69 kV xfmr #1 + Ellinwood - Twelfth Ave 69 kV circuit + Ellinwood - Fitzgerald 138 kV circuit +Ellinwood 138 kV bus tie 1-2
13	M38-Atlantic 138-kV line + Atlantic 138/69-kV transformer

Table ZS-4
2025 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2025 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
1	Base case loading criteria exceeded	TRUE	--	System Intact	
1	Base case voltage criteria exceeded	--	FALSE	System Intact	
1	Silver Lake, ACEC Spring Lake, Redgranite, Fountain Valley, River Run, Berlin and Fox River 69-kV buses	--	84.6 – 88.8% 87.2 – 91.9% 87.5 – 90.8% 87.5 – 90.2% 88.8 – 91.9%	Wautoma – Silver Lake Tap 69-kV line Metomen – Ripon 69-kV line Silver Lake – ACEC Spring Lake 69-kV line Winneconne – Sunset Point 69-kV line Plus other less severe contingencies	Ripon capacitor expansion and Install capacitors at Dartford
1	Dartford,Ripon Industrial Park, Northwest Ripon and Ripon 69-kV buses	--	84.9 – 86.1% 87.1 – 88.1% 88.7 – 89.7% 91.1 – 91.9%	Metomen – Ripon 69-kV line Ripon – Northwest Ripon Tap 69-kV line Winneconne – Sunset Point 69-kV line Plus other less severe contingencies	Ripon capacitor expansion and Install capacitors at Dartford
1	Winneconne, Omro and Omro Industrial Park 69-kV buses	--	82.5 – 83.4% 89.6 – 89.9% 90.1 – 90.8% 90.8 – 91.5% 91.0 – 91.7%	Winneconne – Sunset Point 69-kV line Winneconne – Omro Tap 69-kV line Metomen – Ripon 69-kV line Ripon – Northwest Ripon Tap 69-kV line Wautoma – Silver Lake Tap 69-kV line	Ripon capacitor expansion and Install capacitors at Dartford
1	ACEC Brooks, Grand Marsh (PP&L) and Lincoln Pumping Station 69-kV buses	--	85.6 – 86.2% 85.6 – 86.1% 88.6 – 89.1% 90.2 – 90.5% 90.5 – 91.9%	Necedah Tap – Big Pond 69-kV line Chaffee Creek – Coloma Tap 69-kV line Necedah Tap – Whistling Wings Tap 69-kV line Wautoma – Port Edwards 138-kV line Plus other less severe contingencies	McKenna capacitor expansion
1	Sigel, Lakehead Pipeline, Port Edwards, Vulcan and Hollywood 138-kV buses	--	89.8 – 91.8%	Sigel – Arpin 138-kV line	Further Study needed
1	Petenwell and Council Creek 138-kV buses	--	95.8 – 96.4% 90.2 – 91.0% 90.2 – 91.0% 90.3 – 90.8% 91.9%	System Intact King – Arpin 345-kV line[1] Eau Claire to Arpin 345 kV[2] Arpin – Rocky Run 345-kV line[3] Sigel – Arpin 138-kV line	Marginal voltage, no mitigation needed within this timeframe
1	Necedah, Petenwell, Big Pond, ACEC Dellwood, Friendship, ACEC Friendship, Houghton Rock and McKenna 69-kV buses	--	95.8 – 96.1% 74.5 – 83.3% 81.3 – 87.0% 87.0 – 89.9% 87.0 – 89.8% 87.0 – 92.0%	System Intact Necedah Tap – Big Pond 69-kV line Necedah Tap – Whistling Wings Tap 69-kV line Dellwood ACEC – Whistling Wings Tap 69-kV line Petenwell – Big Pond 69-kV line Plus other less severe contingencies	McKenna capacitor expansion, Convert Necedah to 138 kV, redispatch Castle Rock generation

Table ZS-4
2025 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2025 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
1	Lakehead Pipeline Portage, Endeavor, Roslin ACEC and Montello ACEC 69-kV buses	--	89.5 – 90.8% 91.4 – 91.5%	Portage – Lakehead Pipeline Portage 69-kV line Endeavor – Lakehead Pipeline 69-kV line	Further Study needed
1	Sand Lake and Wautoma 138-kV buses	--	95.2 – 95.5% 90.7 – 92.0% 91.2% 92.0%	System Intact Arpin – Rocky Run 345-kV line[3] Sigel – Arpin 138-kV line Port Edwards – Sand Lake 138-kV line	Marginal voltage, no mitigation needed within this timeframe
1	ACEC Winnebago, ACEC Glen, Neenah Creek, ACEC Chateau and Westfield 69-kV buses	--	86.2 – 91.0% 91.2 – 91.8% 91.5% 91.5% 91.2 – 91.8%	Kilbourn – Winnebago ACEC 69-kV line Wautoma – Port Edwards 138-kV line Sand Lake Tap – Sand Lake 69-kV line Sand Lake 138/69-kV transformer Wautoma – Port Edwards 138-kV line	Increase capacitance at Neenah Creek
1	ACEC Coloma, Plainfield, Sand Lake, Hancock and ACEC Hancock 69-kV buses	--	83.4 – 84.5% 86.8 – 90.7% 87.3 – 91.1% 87.3 – 91.1% 88.6 – 89.6% 90.8 – 91.8%	Chaffee Creek – Coloma Tap 69-kV line Wautoma – Port Edwards 138-kV line Sand Lake Tap – Sand Lake 69-kV line Sand Lake 138/69-kV transformer Necedah Tap – Big Pond 69-kV line Plus other less severe contingencies	McKenna capacitor expansion
1	ACEC Quincy and Castle Rock 69-kV bus	--	88.6 – 89.2% 91.0 – 91.4%	Necedah Tap – Big Pond 69-kV line Necedah Tap – Whistling Wings Tap 69-kV line	McKenna capacitor expansion
1	Wittenburg 69-kV bus		92.0%	Whitcomb – Wittenberg CWEC 69 kV line	Marginal voltage, no mitigation needed within this timeframe
1	North Randolph – Markesan 69-kV line	96.6%	--	Metomen – Ripon 69-kV line	Marginal issue, no mitigation needed within this timeframe
1	Markesan – Mackford Pairie 69-kV line	98.4%	--	Metomen – Ripon 69-kV line	Marginal issue, no mitigation needed within this timeframe
1	Arnott 138/69 KV transformer #T31	100.9%	--	Harrison 138/69 kV transformer	Further Study needed
1	Caroline 115/69 KV transformer #T61	116.3%	--	Whitcomb 115/69-kV transformer	Replace Caroline 115/69-kV transformer
1	Chaffee Creek – Coloma Tap 69-kV line	136.3% 115.0% 106.4% 106.3% 106.2% -- 98.2%	--	Necedah Tap – Big Pond 69-kV line Necedah Tap – Whistling Wings Tap 69-kV line King – Eau Claire 345 kV tie line[1] King – Arpin 345-kV line[4] Plus other less severe contingencies	Uprate terminal equipment at Chaffee Creek

Table ZS-4
2025 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2025 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
1	Castle Rock – ACEC Quincy 69-kV line	138.6% 120.7% 112.9% 112.9% 108.1% 105.3% -- 99.5%	--	Necedah Tap – Big Pond 69-kV line Necedah Tap – Whistling Wings Tap 69-kV line Petenwell – Big Pond 69-kV line Petenwell 138/69-kV transformer Dellwood ACEC – Whistling Wings Tap 69-kV line Plus other less severe contingencies	Uprate Castle Rock – McKenna 69-kV line
1	ACEC Quincy – McKenna 69-kV line	131.4% 113.6% 105.9% 105.9% 101.1% 95.2%	--	Necedah Tap – Big Pond 69-kV line Necedah Tap – Whistling Wings Tap 69-kV line Petenwell – Big Pond 69-kV line Petenwell 138/69-kV transformer Dellwood ACEC – Whistling Wings Tap 69-kV line Chaffee Creek – Coloma Tap 69-kV line	Uprate Castle Rock – McKenna 69-kV line
1	Brooks Corners 69-kV bus	--	85.9%	Whitcomb – Deer Trail 69-kV line[22]	Adjust Brooks Corners 69/34.5-kV transformer LTC
1	Harrison – Harrison Tap 69-kV line	116.1% 108.6% 108.1% 106.0% 105.7 – 100.3%	--	Wautoma 138/69-kV transformer Winneconne – Sunset Point 69-kV line Portage – Lakehead Pipeline Portage 69-kV line Endeavor – Lakehead Pipeline 69-kV line Plus other less severe contingencies	Further Study needed
1	Harrison 138/69 KV transformer #T1	124.1% 104.8% 100.7% 100.7% 100.0 – 97.2%	--	System Intact Arnott 138/69-kV transformer Whitcomb – Rosholt Tap 69-kV line Arnott 69-kV bus Plus other less severe contingencies	Replace Harrison 138/69-kV transformer
1	Hilltop – Mauston 69-kV line	106.7%	--	Arpin – Rocky Run 345-kV line3	Further Study needed
1	Metomen – Ripon 69-kV line	106.5% 118.8% 109.7% 104.2% 103.9 -- 95.8%	--	System Intact Winneconne – Sunset Point 69-kV line Winneconne – Omro Tap 69-kV line North Randolph – Markesan Tap 69-kV line Plus other less severe contingencies	Second Metomen – Ripon 69-kV line

Table ZS-4
2025 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2025 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
1	Metomen 138/69 KV transformer #T31	109.8% 117.5% 115.7% 109.1% 108.9 – 97.0%	--	System Intact North Fond du Lac 138/69-kV transformer #3[5] North Fond du Lac – Rosendale Tap 69-kV line Metomen – North Fond du Lac 69 kV line[6] Plus other less severe contingencies	Replace Metomen 138/69-kV transformer
1	Northwest Ripon – Ripon 69-kV line	119.4% 105.2% 97.0%	--	Winneconne – Sunset Point 69-kV line Winneconne – Omro Tap 69-kV line Omro – Omro Industrial Tap 69-kV line	Uprate line
1	NW Ripon – Dartford 69-kV line	100.9%	--	Winneconne – Sunset Point 69-kV line	Further Study needed
1	Omro – Winneconne 69-kV line	102.2% 113.1% 112.4% 100.9%	--	System Intact Ripon – Northwest Ripon Tap 69-kV line Metomen – Ripon 69-kV line Northwest Ripon Tap – Dartford Tap 69-kV line	Further Study needed
1	Petenwell – ACEC Badger West 138-kV line	104.9% 104.9% 104.5% 104.4%	--	Eau Claire to Arpin 345 kV line[2] Eau Claire to Arpin 345 kV line[7] King – Arpin 345-kV line[1] King – Eau Claire 345-kV line[4]	Further Study needed
1	Petenwell 138/69-kV transformer	101.0% 107.6% 107.1% 104.9% 104.0% 104.0 – 97.1%	--	System Intact McKenna – Houghton Rock 69-kV line Castle Rock – Quincy ACEC 69-kV line Hilltop – Buckhorn Tap 69-kV line McKenna – Quincy ACEC 69-kV line Plus other less severe contingencies	Replace Petenwell transformer
1	Sand Lake 138/69-kV transformer	103.0% 99.9% 95.2%	--	System Intact Wautoma 138/69-kV transformer Necedah Tap – Big Pond 69-kV line	Further Study needed
1	Sand Lake – Sand Lake Tap 69-kV line	106.3% 112.5% 111.5% 107.6% 107.0 – 99.3%	--	System Intact Wautoma 138/69-kV Transformer Necedah Tap – Big Pond 69-kV line Trienda – Lewiston ACEC 138-kV line Plus other less severe contingencies	Further Study needed

Table ZS-4
2025 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2025 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
1	Saratoga – ACEC Badger West 138-kV line	109.3% 109.3% 108.9% 108.8%	--	Eau Claire to Arpin 345-kV tie line[2] Eau Claire to Arpin 345-kV line[2] King – Arpin 345-kV line[1] King – Eau Claire 345 kV tie line[4]	Further Study needed
1	Sigel – Auburndale 69-kV line	130.2%	--	System Intact	Line validated with higher rating
1	Vulcan – Port Edwards 1 138-kV line	123.8%	--	Vulcan – Port Edwards 138-kV line #2	Change tap on free standing CT's at Port Edwards
1	Vulcan – Port Edwards 2 138-kV line	123.8%	--	Vulcan – Port Edwards 138-kV line #1	Change tap on free standing CT's at Port Edwards
1	Rocky Run 345/115-kV transformer #T4	99.8% 99.6% 98.7% 95.2%	--	Rocky Run 345/115-kV transformer #T2 Sigel – Arpin 138-kV line Rocky Run 345/115-kV transformer #T1 Arpin 345/138-kV transformer	Marginal issue, no mitigation needed in this timeframe
1	Wautoma 138/69-kV transformer #T31	118.1% 113.9% 113.9% 105.8% 105.0 – 95.9%	--	System Intact Sand Lake Tap – Sand Lake 69-kV line Sand Lake 138/69-kV transformer Portage – Lakehead Pipeline Portage 69-kV line Plus other less severe contingencies	Second 138/69-kV Transformer at Wautoma
1	Whitcomb 115/69-kV transformer #T31	99.4%	--	System Intact	Marginal issue, no mitigatin needed in this timeframe
1	Winneconne – Sunset Point 69-kV line	118.6% 118.2% 107.2% 102.2% 97.1%	--	Ripon – Northwest Ripon Tap 69-kV line Metomen – Ripon 69-kV line Northwest Ripon Tap – Dartford Tap 69-kV line Wautoma – Silver Lake Tap 69-kV line Silver Lake – ACEC Spring Lake 69-kV line	Uprate line
2	Base case loading criteria exceeded	FALSE	--	System Intact	
2	Base case voltage criteria exceeded	--	FALSE	System Intact	
2	Atlantic – M38 69-kV line	121.7% 121.6% 117.9%	--	M38 – Atlantic 138-kV line[23] Atlantic 138/69-kV transformer Roberts – Newberry Hospital 69-kV line	Uprate line
2	Nordic – Mountain 69-kV line	102.4%	--	Chandler 138/69-kV transformer	Targeted for mitigation by Escanaba area reinforcements

Table ZS-4
2025 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2025 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
2	Rudyard – Pine River 69-kV line Rudyard – Tone 69-kV line Kinchloe – Tone 69-kV line	111.4% 114.7% 107.9%	--	Engadine – Newberry 69-kV line	Mitigated by generation adjustments
2	Hulbert, Brimley, Detour, Eckermann, Goetzville, Pickford, Raco, Lou-Pac, Newberry Village, Roberts, Talantino 69-kV buses	--	75.4 – 90.4%	Hiawatha – Roberts 69-kV line 6911[24]	Targeted for mitigation by Eastern U.P. area reinforcements
2	Lakota Road 69-kV bus	--	118.1%	Lakota – Conover 138/69-kV transformer	Resolved by transformer model adjustments
2	Chandler, Delta, Escanaba 1, Escanaba 2, Masonville, Mead, Gladstone, West, North Bluff, Lakehead, Bay View, Cornell, Harris 69-kV buses	--	87.1 – 90.2%	Chandler 138/69-kV transformer	Targeted for mitigation by Escanaba area reinforcements
2	Detour 69-kV bus, Brevort, Hiawatha, Lakehead 138-kV buses	--	90.9 – 91.9%	Straits 138/69-kV transformer	Targeted for mitigation by Eastern U.P. area reinforcements
2	Hulbert, Sault, Brimley, Dafter, Detour, Eckermann, Goetzville, Newberry, Pickford, Raco, Lou-Pac, Newberry Hospital, Newberry Village, Roberts, Three Mile, ESE Hydro, Magazine, Nine Mile, Kinchloe, Rockview, Michigan Limestone, Pine Grove, Tone, Talantino 69-kV buses	--	56.3 – 88.2%	Engadine – Newberry 69-kV line	Targeted for mitigation by Eastern U.P. area reinforcements
2	Hulbert, Brimley, Detour, Eckermann, Goetzville, Pickford, Raco, Lou-Pac, Newberry Hospital, Newberry Village, Roberts, Talantino 69-kV buses	--	72.9 -88.9%	Newberry – Newberry Hospital 69-kV line	Targeted for mitigation by Eastern U.P. area reinforcements
2	Hulbert, Brimley, Detour, Eckermann, Goetzville, Pickford, Raco, Lou-Pac, Newberry Village, Roberts, Three Mile, Magazine, Michigan Limestone, Pine Grove, Talantino 69-kV buses	--	71.6 – 90.2%	Newberry Hospital – Roberts 69-kV line	Targeted for mitigation by Eastern U.P. area reinforcements
3	Base case loading criteria exceeded	TRUE	--	System Intact	
3	Base case voltage criteria exceeded	--	TRUE	System Intact	
3	Kilbourn, Loch Mirror, Birchwood, Dell Creek, Zobel, Nishan, Artesian, Rock Springs 138-kV bus	--	95.6 – 96.6% 86.3 – 89.0% 86.9 – 89.4% 86.9 – 89.4% 89.0 – 90.8% 91.1 – 92.0%	System Intact Trienda – Lewiston ACEC 138-kV line Kilbourn – Lewiston ACEC 138-kV line Trienda – Kilbourn 138-kV line Lake Delton – Trienda 138-kV line Plus other less severe contingencies	
3	Okee, Lodi Industrial Park and Lodi 69-kV buses	--	88.3 – 89.7% 90.2 – 91.6%	Dane – Lodi Tap 69-kV line Lodi Tap – Okee Tap 69-kV line	

Table ZS-4
2025 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2025 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
3	Kirkwood and Lake Delton 138-kV buses	--	95.0 – 95.1% 87.2 – 87.3% 90.0% 90.3 – 90.7% 90.4% 90.6 – 90.9% 90.6 – 90.9%	System Intact Lake Delton – Trienda 138-kV line Lake Delton – Kirkwood 138-kV line Trienda – Lewiston ACEC 138-kV line Trienda – Kirkwood 138-kV line8 Kilbourn – Lewiston ACEC 138-kV line Trienda – Kilbourn 138-kV line	
3	Island Street, Baraboo, Sauk Prairie, Prairie du Sac Muni, Tower Street, Dam Heights and Prairie du Sac Hydro 69-kV buses	--	88.2 – 90.2% 91.9% 91.9%	Island Street – Kirkwood 69-kV line Baraboo Tap – Moore Street Tap 69 kV line Island Street – Moore Street Tap 69-kV line	
3	Artesian – Rock Springs 138-KV line	101.9% 99.7% 99.7%	--	Trienda – Lewiston ACEC 138-kV line Kilbourn – Lewiston ACEC 138-kV line Trienda – Kilbourn 138-kV line	
3	Kirkwood – Rock Springs 138-KV line	105.4% 103.3% 103.2%	--	Trienda – Lewiston ACEC 138-kV line Trienda – Kilbourn 138-kV line Kilbourn – Lewiston ACEC 138-kV line	
3	Kilbourn – Lewiston 138-kV line	100.7%	--	Lake Delton – Trienda 138-kV line	
3	Trienda – Lewiston 138-kV line	102.6% 96.2% 95.0%	--	Lake Delton – Trienda 138-kV line Trienda – Kirkwood 138-kV line8 Lake Delton – Kirkwood 138-kV line	
3	Dane – Lodi Tap 69-kV line	122.5% 111.3% 108.7% 108.7% 102.9 – 96.5%	--	Island Street – Kirkwood 69-kV line Lake Delton – Trienda 138-kV line Baraboo Tap – Moore Street Tap 69-kV line Island Street – Moore Street Tap 69-kV line Plus other less severe contingencies	
3	Kilbourn 138/69-kV transformer #T32	99.3%	--	Kilbourn 138/69-kV transformer T31	
3	Portage – Columbia 1 138-kV line	100.5%	--	Portage – Columbia 2 138-kV line	
3	Portage – Columbia 2 138-kV line	100.5%	--	Portage – Columbia 1 138-kV line	
3	Portage – Trienda 1 138-kV line	97.5%	--	Portage – Trienda 2 138-kV line	
3	Portage – Trienda 2 138-kV line	107.4%	--	Portage – Trienda 1 138-kV line	
3	Cobblestone – Zenda Tap 69-kV line	218.6% 134.0% 132.3%	--	North Lake Geneva – Lake Geneva 69-kV line Lake Geneva – South Lake Geneva 69-kV line North Lake Geneva – Lake Geneva – South Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line

Table ZS-4
2025 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2025 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
3	Colley Road 138/69-kV transformer	127.8% 109.7% 106.4% 106.1% 103.3 – 98.5%	--	Paddock 138/69-kV transformer Paddock – Shirland 69-kV line System Intact Brick Church 138/69-kV transformer Plus other less severe outages	Bass Creek 138/69-kV transformer
3	Katzenberg – Zenda tap 69-kV line	201.5% 119.4% 117.8%	--	North Lake Geneva – Lake Geneva 69-kV line Lake Geneva – South Lake Geneva 69-kV line North Lake Geneva – Lake Geneva – South Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Katzenberg – South Lake Geneva 69-kV line	138.6% 104.3% 103.9%	--	Cobblestone – Brick Church 69-kV line North Lake Geneva – Lake Geneva 69-kV line Cobblestone – Zenda Tap 69-kV line	Third source into area, possibliy from Spring Valley
3	North Lake Geneva – Lake Geneva 69-kV line	126.7% 105.1%	--	Cobblestone – Brick Church 69-kV line Cobblestone – Zenda tap 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	North Lake Geneva 138/69-kV transformer	106.8%	--	Brick Church 138/69-kV transformer	North Lake Geneva – South Lake Geneva 138-kV line
3	Lake Geneva – South Lake Geneva 69-kV line	146.0% 116.9% 101.6%	--	Cobblestone – Brick Church 69-kV line Cobblestone – Zenda tap 69-kV line Katzenberg – Zenda tap 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Cobblestone – Brick Church 69-kV line	178.0% 114.7% 113.3%	--	North Lake Geneva – Lake Geneva 69-kV line Lake Geneva – South Lake Geneva 69-kV line North Lake Geneva – Lake Geneva – South Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Brick Church 138/69-kV transformer	126.8% 109.1% 97.0%	--	North Lake Geneva 138/69-kV transformer North Lake Geneva – Lake Geneva 69-kV line System Intact	North Lake Geneva – South Lake Geneva 138-kV line
3	Brick Church – Walworth 69-kV line	118.8%	--	North Lake Geneva 138/69-kV transformer	North Lake Geneva – South Lake Geneva 138-kV line
3	Enzyme Bio – RC3 69-kV line	104.1%	--	Brick Church 138/69-kV transformer	Line Y-32 rebuild
3	RC3 – Clinton Tap 69-kV line	97.2%	--	Brick Church 138/69-kV transformer	Line Y-32 rebuild
3	Paddock 138/69-kV transformer	112.5% 112.3% 104.2% 96.3%	--	Colley Road 138/69-kV transformer Intact System Colley Road – Park Street 69-kV line Park Street – East Rockton 69-kV line	Bass Creek 138/69-kV transformer
3	Walworth – Schofield tap 69-kV line	97.6%	--	North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Schofield tap – North Lake Geneva 69-kV line	96.9%	--	North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Paddock – Shirland Ave 69-kV line	105.2%	--	Colley Road 138/69-kV transformer	Further Study needed
3	Shaw – East Rockton 69-kV line	105.1%	--	Paddock 138/69-kV transformer	Bass Creek 138/69-kV transformer
3	East Rockton – Park St 69-kV line	98.5%	--	Paddock 138/69-kV transformer	Bass Creek 138/69-kV transformer

Table ZS-4
2025 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2025 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
3	Colley Road – Park St 69-kV line	109.4%	--	Paddock 138/69-kV transformer	Bass Creek 138/69-kV transformer
3	McCue – Milton Lawns 69-kV line	100.6%	--	Janesville 138/69-kV transformer	Further Study needed
3	Lake Geneva, South Lake Geneva, Twin Lakes, Katzenberg, Zenda, Cobblestone, Brick Church, Sharon, Walworth, Lakehead-Walworth 69-kV buses, Brick Church and Williams Bay 138-kV buses	--	47.1 – 92.0%	North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Twin Lakes, Katzenberg, South Lake Geneva, and Zenda 69-kV buses	--	80.9 – 89.2%	North Lake Geneva – Lake Geneva – South Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Twin Lakes and Zenda 69-kV buses	--	91.3 – 91.8%	Cobblestone – Zenda tap 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Twin Lakes, Katzenberg, South Lake Geneva and Zenda 69-kV buses	--	79.9 – 88.3%	Lake Geneva – South Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Cobblestone, Zenda, Twin Lakes, Katzenberg 69-kV buses	--	84.4 – 88.8%	Cobblestone – Brick Church 69-kV line	North Lake Geneva – South Lake Geneva 138kV line
3	Twin Lakes and Katzenberg 138-kV buses	--	87.1 -88.3%	Katzenberg – South Lake Geneva 69-kV line	Third source into area, possibliy from Spring Valley
3	Twin Lakes, Katzenberg, South Lake Geneva, Lake Geneva, North Lake Geneva, Zenda, and Schofield 69-kV buses	--	83.9 – 90.4%	North Lake Geneva 138/69-kV transformer	North Lake Geneva – South Lake Geneva 138-kV line
3	Brick Church and Williams Bay 138-kV buses	--	90.3 – 91.6%	Colley Road – Dickinson – Beloit Gateway – Brick Church 138-kV line	Y-32 line rebuild
3	Brick Church, Dickinson and Williams Bay 138-kV buses	--	90.6 – 91.6%	Colley Road – Dickinson 138-kV line	Y-32 line rebuild
3	Concord 5 138-kV bus	--	91.6%	Split Concord 138-kV bus	Marginal voltage, no mitigation needed within this timeframe
3	RC9 , RC2, West Darien and SW Delavan 138-kV buses	--	91.6 – 91.9%	RC9 – Rock River 138-kV line	Y-32 line rebuild
3	Brick Church and Williams Bay 138-kV buses	--	89.3 – 90.7%	Beloit Gateway – Dickinson 138-kV line	Y-32 line rebuild
3	Brick Church and Williams Bay 138-kV buses	--	90.3 – 91.5%	Beloit Gateway – Brick Church 138-kV line	Y-32 line rebuild
3	South Fond du Lac – Koch Oil Tap 69-kV line	101.0% 96.5% 96.3%	--	North Randolph – Fox Lake 138-kV line Fox Lake – North Beaver Dam 138-kV line North Randolph – North Beaver Dam 138-kV line[9]	Further study needed
3	Kock Oil Tap – Waupun 69-kV line	96.8%	--	North Randolph – Fox Lake 138-kV line	Further study needed
3	Hubbard and Hustisford 138-kV bus	--	85.3% 86.1% 86.1%	Rubicon – Hustisford 138-kV line Hustisford – Hubbard 138-kV line Rubicon – Hustisford – Hubbard 138-kV line	Adjust Hubbard 138/69-kV transformer LTC

Table ZS-4
2025 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2025 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
3	Fox Lake, North Beaver Dam and Beaver Dam East 138-kV buses	--	95.9 – 96.1% 84.6 – 84.7% 85.6 – 85.7% 85.6 – 85.7% 90.4 – 92.0%	System Intact North Randolph – Fox Lake 138-kV line Fox Lake – North Beaver Dam 138-kV line North Randolph – North Beaver Dam 138-kV line[9] Plus other less severe contingencies	Adjust North Beaver Dam 138/69-kV transformer LTC
3	North Randolph and Academy 138-kV bus	--	95.8 – 95.9% 91.1%	System Intact Boxelder – Academy 138-kV line	Further study needed
3	Koch Oil, Waupun and Alto Dairy 69-kV bus	--	91.0 – 91.1% 91.7 – 91.8%	South Fond du Lac – Koch Oil Tap 69-kV line Waupan – Koch Oil Tap 69-kV line	Further study needed
3	Horicon Industrial Park, Horicon and Juneau 69-kV bus	--	91.2 – 91.4% 91.7 – 91.8%	Hubbard – Horicon Industrial Park 69-kV line South Fond du Lac – Waupun 69-kV line[10]	Further study needed
3	Randolph and Didion Ethanol 69-kV bus	--	91.5 – 91.7%	North Randolph – Randolph Tap 69-kV line	Further study needed
3	McCue – REC Harmony 69-kV line	95.9%	--	System Intact	Second McCue-Lamar line
3	Hillman 138/69-kV transformer	100.0%	--	System Intact	Second Hillman transformer
3	North Monroe 138/69-kV transformer	113.0%	--	System Intact	Bass Creek transformer
3	REC Newark – Paddock 69-kV line	97.0%	--	System Intact	Bass Creek transformer
3	Timberlane Tap – West Middleton 69-kV line	106.0%	--	System Intact	Further Study needed
3	Verona 138/69-kV transformer	112.7 – 96%	--	Stoughton South – Stoughton 69-kV line Oregon – Stoughton 69-kV line Stoughton South tap – Oregon 69-kV line North Monroe 138/69-kV transformer West Middleton – Timberlane 69-kV line plus other less severe contingencies	Bass Creek and potential second Verona transformer
3	Stoughton – Stoughton Muni South Tap – Oregon 69-kV line	122.8 – 106.9%	--	Verona – Oak Ridge 138-kV line Verona 138/69-kV transformer	Y127 line uprate
3	Mount Horeb Northeast – Stagecoach 69-kV line	98.2%	--	Verona – Southwest Verona 69-kV line	Further Study needed
3	Sun Valley Tap – Oregon 69-kV line	102.1%	--	Stoughton South – Stoughton 69-kV line	Y119 rebuild and potential Oregon terminal upgrade
3	Hillman 138/69-kV transformer	122.1 – 95.4%	--	DPC Galena – Pilot NB 69-kV line DPC Terr Tap – Pilot NB 69-kV line DPC LNGHLLW8 – Terr Tap 69-kV line DPC LNGHLLW8 – Galna T8 69-kV line DPC Galna – Guilford 69-kV line plus other less severe contingencies	Secnd Hillman transformer

Table ZS-4
2025 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2025 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
3	North Monroe – Idle Hour – Monroe Tap 69-kV line	139.3 – 95.9%	--	Paddock – Newark 69-kV line Brodhead – Newark 69-kV line Paddock – Brodhead Switching Station 69-kV line[12] Darlington – Gratiot 69-kV line Spring Grove – Brodhead Switching Station 69-kV line Plus other less severe outages	Bass Creek transformer and potential Y87 line uprate
3	North Monroe 138/69-kV transformer	114.7 – 95.3%	--	Columbia generator #1 Columbia generator #2 Darlington 138/69-kV transformer	Bass Creek transformer
3	Jennings Switching Station – Wiota – DPC Gratiot Tap 69-kV line	104.5 – 97.5%	--	North Monroe – Idle Hour 69-kV line North Monroe 138/69-kV transformer	Y34 line uprate
3	Brodhead Switching Station – REC Newark – Paddock 69-kV line	112.2 – 95.3%	--	North Monroe – Idle Hour 69-kV line North Monroe 138/69-kV transformer Idel Hour – Monroe Central tap 69-kV line Albany – Townline 138-kV line	Bass Creek transformer
3	McCue – REC Harmony – Milton Tap – Lamar 69-kV line	115.6 – 95.6%	--	Kegonsa – Stoughton North Tap2 69-kV line Kegonsa 138/69-kV transformer Stoughton North Tap1 – Stoughton North Tap2 69-kV line Stoughton East – Stoughton North 69-kV line Stoughton East – Stoughton 69-kV line plus other less severe contingencies	Second McCue-Lamar line
3	Dana Corporation Tap – Sheepskin 69-kV line	137.1 – 125.4%	--	McCue – Harmony 69-kV line Milton Tap – Lamar 69-kV line McCue – Lamar 69-kV line[13] Milton Tap – Harmony 69-kV line	Y62 line uprate and second McCue-Lamar line
3	Gran Grae – Wauzeka – Boscobel 69-kV line	110.2 – 95.1%	--	Spring Green 138/69-kV transformer Nelson Dewey – Lancaster 138-kV line Nelson Dewey – Eden 138-kV line Eden – Lancaster 138-kV line Eden – Wyoming Valley 138-kV line Columbia generator #1 plus other less severe contingencies	Y40 line uprate
3	Boscobel – Blue River Tap 69-kV line	99.0 – 96.3%	--	Nelson Dewey – Lancaster 138-kV line Spring Green 138/69-kV transformer Nelson Dewey – Eden 138-kV line[11] Eden – Lancaster 138-kV line	Y124 line uprate
3	Spring Green 138/69-kV transformer	95.7%	--	Gran Grae – Wauzeka 69-kV line	Second Spring Green transformer

Table ZS-4
2025 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2025 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
3	Black Earth – Stagecoach 69-kV line	103.2%	--	Spring Green 138/69-kV transformer	Second Spring Green transformer
3	Stagecoach – Timberlane Tap – West Middleton 69-kV line	132.2 – 95.7%	--	Spring Green 138/69-kV transformer Verona – Southwest Verona 69-kV line Verona – Oak Ridge 138-kV line Verona 138/69-kV transformer Nelson Dewey – Lancaster 138-kV line plus other less severe contingencies	Further Study needed
3	Dane – North Madison 69-kV line	102.8 – 95.4%	--	Huiskamp 138/69-kV transformer Huiskamp – North Madison 138-kV line North Madison – Huiscamp 138-kV line Waunakee Industrial Park – Huiskamp 69-kV line North Madison – Deforest 69-kV line	Potential Huiskamp-Blount 138-kV line
3	Waunakee Industrial Park – Huiskamp 69-kV line	97.7%	--	North Madison 138/69-kV transformer	Y132 GOAB uprate
3	West Middleton – Pheasant Branch 69-kV line	98.5%	--	Waunakee Switching – Waunakee Municipal 2 69-kV line	6963 line uprate
3	West Middleton 138/69-kV transformer	103.8%	--	West Middleton 138/69-kV transformer	Cardinal-Blount 138-kV line
3	Westport – Waunakee Muni2 69-kV line	102.3%	--	West Middleton – Pheasant Branch 69-kV line	Y131 line uprate
3	Royster – Sycamore 69-kV line	104.1%	--	Femrite 138/69-kV transformer	Royster – Sycamore line uprate or second Femrite transformer
3	East Towne – Sycamore 69-kV line 2	98.7%	--	East Towne – Sycamore 69-kV line 1	Potential line uprate
3	East Towne – Sycamore 69-kV line 1	98.7%	--	East Towne – Sycamore 69-kV line 2	Potential line uprate
3	Nelson Dewey – Cassville 161-kV line	102.9 – 100.8%	--	Genoa 161/69-kV transformer DPC Seneca – Genoa 161-kV line	Further study needed
3	North Monroe – Albany – Townline Road 138-kV line	101.3 – 95.3%	--	Darlington – Lafayette Wind 138-kV line Nelson Dewey – Potosi 138-kV line Potosi – Hillman 138-kV line Hillman – Nelson Dewey 138-kV line[14]	Potential X-12 rebuild
3	Verona, Oak Ridge, Hawk Alliant, Hawk, Cross Country and Fitchburg 138-kV buses	--	93.6 – 95.8%	System Intact	Potential Oak Ridge capacitor bank
3	North Monroe 138-kV bus	--	95.7%	System Intact	North Monroe capacitor bank
3	Spring Green, Wyoming Valley and Troy 138-kV buses	--	95.5 – 95.7%	System Intact	Further study needed
3	Miner, Shullsburg, Benton, Cuba City and Elmo 69-kV buses	--	85.8 – 91.8%	DPC Galena – Pilot NB 69-kV line DPC Terr Tap – Pilot NB 69-kV line DPC LNGHLLW8 – Terr Tap 69-kV line	Further Study needed

Table ZS-4
2025 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2025 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
3	Southwest verona, Mount Horeb Muni1, Mount Horeb, Mount Horeb Northeast, Forward and Blanchardville 69-kV buses	--	77.8 – 91.6%	Verona – Southwest Verona 69-kV line	SW Verona Unity Power factor correction and 1-16.33 Mvar 69-kV capacitor bank
3	Aaker Road, Stoughton Muni South Tap and Brooklyn 69-kV buses	--	91.7 – 91.8%	Stoughton South – Stoughton 69-kV line	SW Verona Unity Power factor correction and 1-16.33 Mvar 69-kV capacitor bank
3	Huiskamp 138-kV bus	--	88.2%	Huiskamp – North Madison 138-kV line	Adjust Huiskamp 138/69-kV transformer LTC
3	Rewey and Belmont 69-kV buses	--	90.6 – 91.4%	Eden – Rewey 69-kV line Belmont – Rewey 69-kV line	Further Study needed
3	Idle Hour, Monroe, Monroe Tap, South Monroe, Blacksmith, Blacksmith Tap, Browntown and Spring Grove 69-kV buses	--	85.5 – 91.6%	North Monroe – Idle Hour 69-kV line Idel Hour – Monroe Central tap 69-kV line	Further study needed
3	Brodhead Muni3, Brodhead Muni2, Brodhead, Brodhead Muni1, REC Orfordville, Orfordville, Bass Creek and Footville 69-kV buses	--	90.3 – 92%	Brodhead Switching Station – Brodhead Muni3 69-kV line Brodhead Muni3 – Brodhead Muni2 69-kV line	Bass Creek transformer
3	REC Newark and Brodhead Muni2 69-kV buses	--	91.9 – 92%	Paddock – Newark 69-kV line	Bass Creek transformer
3	REC Harmony, Milton, Milton Tap, Lamar, Fulton, Saunders Creek, Dana corporation, Dana Corporation Tap, REC Edgerton, Sheepskin, Evansville and Union Townline 69-kV buses	--	83.8 – 92%	McCue – Harmony 69-kV line Milton Tap – Harmony 69-kV line Milton Tap – Lamar 69-kV line McCue – Lamar 69-kV line[13]	Second McCue-Lamar line
3	Arena 69-kV bus	--	91.5%	Spring Green – Arena 69-kV line	Mazomanie capacitor bank
3	Cottage Grove and Gaston Road 69-kV buses	--	90.4%	Kegonsa – Cottage Grove 69-kV line	Sun Prairie capacitor bank
3	Lancaster, Eden, Wyoming Valley, Spring Green and Troy 138-kV buses	--	87.4 – 91.9%	Nelson Dewey – Lancaster 138-kV line Eden – Lancaster 138-kV line Nelson Dewey – Eden 138-kV line[11]	Potential Y105 conversion
3	Albany and North Monroe 138-kV buses	--	90.2 – 91%	Albany – Townline 138-kV line North Monroe – Albany 138-kV line Townline Road – North Monroe 138-kV line[15]	North Monroe capacitor bank
3	Pleasant View, Hawk Alliant and Hawk 138-kV buses	--	91.6 – 91.8%	West Middleton – Pleasant View 138-kV line	Further study needed
3	Verona, Fitchburg, Oak Ridge and Cross Country 138-kV buses	--	90.7 – 91.9%	Rockdale – West Middleton 345-kV line	Potential Oak Ridge capacitor bank
3	Darlington and North Monroe 138-kV buses	--	87.4 – 90.3%	Darlington – Lafayette Wind 138-kV line	North Monroe capacitor bank
3	Muscoda, Avoca and Avoca Tap 69-kV buses	--	91.1 – 91.3%	Lone Rock – Spring Green 69-kV line	Boscobel capacitor bank
3	Mcgregor, Pioneer, Platteville tap, Hillman, Elmo, Cuba City, Benton, Belmont, Miner and Shullsburg 69-kV buses	--	85.5 – 90.5%	Hillman 138/69-kV transformer	Second Hillman transformer

Table ZS-4
2025 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2025 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
3	Idle Hour, Monroe, Monroe Tap, South Monroe, North Monroe, Monticello, Monticello Tap, New Glarus, Blacksmith, Blacksmith Tap, Belleville, and Browntown 69-kV buses	--	88.2 – 91.9%	North Monroe 138/69-kV transformer	North Monroe capacitor bank
3	Burke, Reiner, Burke Tap and Colorado 69-kV buses	--	90.9 – 91.5%	Reiner 138/69-kV transformer Reiner – Burke Tap 69-kV line	Sun Prairie capacitor bank
3	Avoca, Muscoda, Avoca Tap, Spring Green, Arena, Lone Rock, Mazomanie Industrial, Mazomanie West, Mazomanie , Blue River Tap, Blue River and Black Earth 69-kV buses	--	87.7 – 91.4%	Spring Green 138/69-kV transformer	Second Spring Green transformer
3	Southwest verona, Sun Valley, Verona, Sun Valley Tap, Brooklyn, Belleville, Oregon, Mount Horeb Muni1 and Mount Horeb 69-kV buses	--	87.3 – 91.9%	Verona 138/69-kV transformer Verona – Oak Ridge 138-kV line	SW Verona Unity Power factor correction and 1-16.33 Mvar 69-kV capacitor bank
3	Verona, Fitchburg and Oak Ridge 138-kV buses	--	90.9 – 92.0%	West Middleton 138/69-kV transformer	Potential Oak Ridge capacitor bank
3	Verona, Eden, Spring Green, Troy and Wyoming Valley 138-kV buses	--	90.3 – 91.8%	Columbia Generator Unit 1 Columbia Generator Unit 2	Potential Oak Ridge capacitor bank
4	Base case loading criteria exceeded	TRUE	--	System Intact	
4	Base case voltage criteria exceeded	--	FALSE	System Intact	
4	Highway V – Ontario 138-kV line	115.2% 110.6% 102.8%	--	East Krok 138/69-kV transformer[16] Canal 138/69-kV transformer #1[17] Canal – East Krok 138-kV line	Uprate line
4	Canal – East Krok 138-kV line	106.9% 101.0%	--	Highway V 138/69-kV transformer #1[18] Highway V – Ontario 138-kV line	Uprate line
4	East Krok 138/69-kV transformer	109.5% 99.3% 98.2% 97.7%	--	Canal – East Krok 138-kV line Highway V 138/69-kV transformer #1[18] Highway V – East Krok 138-kV line Highway V 138/69-kV transformer #2[19]	No project needed Investigation into limiting facility resulted in higher facility ratings
4	Dyckesville – Rosiere 69-kV line	96.0%	--	East Krok 138/69-kV transformer[16]	Further study needed
4	Sunset Point – Pearl Avenue 69-kV line	122.1% 121.9%	--	Ellinwood 138/69-kV transformer[20] Ellinwood – 12th Avenue 69-kV line	Rebuild line
4	Sunset Point 138/69-kV transformer #1	105.1%	--	Sunset Point 138/69-kV transformer #2	Replace transformer
4	Sunset Point 138/69-kV transformer #2	95.7%	--	Sunset Point 138/69-kV transformer #1	Further study needed
4	Neevin – Woodenshoe 138-kV line	97.5%	--	Fitzgerald 345/138-kV transformer #1[21]	Further study needed
4	Edgewater 345/138-kV transformer #1	95.1%	--	Edgewater 345/138-kV transformer #2	Further study needed
4	Edgewater 138/69-kV transformer #1	102.0% 99.0%	--	System Intact Edgewater 138/69-kV transformer #2	Replace transformer
4	Edgewater 138/69-kV transformer #2	100.0%	--	System Intact	Replace transformer
4	Edgewater – Sauk Trail 138-kV line	118.4% 95.0%	--	Edgewater – Huebner 138-kV line Lodestar – Huebner 138-kV line	Uprate line
4	Sauk Trail – 20th Street 138-kV line	107.0%	--	Edgewater – Huebner 138-kV line	Further study needed

Table ZS-4
2025 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2025 Summer Peak Case		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage		
4	Manrap – Custer 69-kV line	98.2%	--	Dewey – Lakefront 69-kV line	Further study needed
4	Bluestone 69-kV bus	--	90.5%	Finger Road – Bluestone 69-kV line	Further study needed
5	Base Case Loading Criteria Exceeded	FALSE		System Intact	
5	Base Case Voltage Criteria Exceeded	--	FALSE	System Intact	
5	Bain 345/138-kV transformer #5	159.4% 106.5%	--	Split Pleasant Prairie 345-kV bus 34 Split Pleasant Prairie 345-kV bus 23	Mitigated by generation adjustments
5	Oak Creek 345/230-kV transformer T895	105.0% 104.8%	--	Split Oak Creek 230-kV bus 67 Split Oak Creek 230-kV bus 78	Mitigated by generation adjustments
5	Arcadian 345/138-kV transformer #3	95.5%	--	Arcadian 345/138-kV transformer #1	Replace Arcadian transformer
5	Pleasant Prairie – Zion 345-kV line	101.9% 98.7% 95.4%	--	Zion – Arcadian 345-kV line Cherry Valley – Silver Lake 345-kV line Kenosha – Lakeview 138-kV line	Uprate line

Event Based Contingencies

Event Based Contingency Number	Definition of Event Based Contingency
1	King - Eau Claire 345-kV line + Eau Claire - Arpin 345-kV line + Eau Claire 345/161-kV transformer + Council Creek DPC - Council Creek 69-kV line + Hilltop - Mauston 69-kV line
2	Eau Claire - Arpin 345-kV line + Council Creek DPC - Council Creek 69-kV line + Hilltop - Mauston 69-kV line
3	Arpin - Rocky Run 345-kV line + Port Edwards - Sand Lake 138-kV line + Port Edwards - Hollywood 138-kV line + Council Creek - Council Creek DPC 69-kV line
4	King - Eau Claire 345-kV line + Eau Claire - Arpin 345-kV line + Eau Claire 345/161-kV transformer + Council Creek DPC - Council Creek 69-kV line + Hilltop - Mauston 69-kV line + Lubin - Lakehead 69-kV line
5	North Fond du Lac 138/69-kV transformer #3 + North Fond du Lac - Hickory Street Tap 69-kV line + North Fond du Lac - Rosendale 69-kV line + North Fond du Lac 69-kV bus capacitor
6	Metomen - Rosendale - North Fond du Lac 69-kV line
7	Eau Claire - Arpin 345-kV line + Council Creek DPC - Council Creek 69-kV line + Hilltop - Mauston 69-kV line + Lubin - Lakehead 69-kV line
8	Trienda - Lake Delton 138-kV line + Lake Delton - Kirkwood 138-kV line
9	North Randolph – Fox Lake – North Beaver Dam 138-kV line
10	South Fond du Lac - Koch Oil tap 69 kV circuit + Koch Oil tap - Waupun 69 kV circuit + Koch Oil tap - Koch Oil 69 kV circuit
11	Nelson Dewey – Lancaster – Eden 138-kV line
12	Paddock - Brodhead Switching Station 69-kV line
13	McCue – Harmony – Milton Tap – Lamar 69-kV line
14	Hillman – Potosi – Nelson Dewey 138-kV line
15	Townline Road – Albany – North Monroe 138-kV line
16	East Krok 138/69 kV xfmr + Highway V - East Krok 138 kV circuit + East Krok - Canal 138 kV circuit + East Krok - Kewaunee 138 kV circuit + Beardsely - East Krok 69 kV circuit
17	Canal 138/69 kV xfmr #1 + Canal - East Krok 138 kV circuit + Canal - Sawyer 69 kV circuit + Canal - Algoma 69 kV circuit + Canal 69 kV cap banks, 2 x 16.3 MVAr
18	Highway V 138/69 kV xfmr #1 + Highway V - Ontario 138 kV circuit + Highway V - Preble 138 kV circuit + Highway V - Finger Road 69 kV circuit + Highway V - Rockland 138 kV circuit + Highway V 138 kV cap bank, 2 x 18.9 MVAr
19	Highway V 138/69 kV xfmr #2 + Highway V - East Krok 138 kV circuit + Highway V - Mystery Hills 138 kV circuit + Highway V - Oak Street 69 kV circuit
20	Ellinwood 138/69 kV xfmr #1 + Ellinwood - Twelfth Ave 69 kV circuit + Ellinwood - Fitzgerald 138 kV circuit +Ellinwood 138 kV bus tie 1-2
21	Fitzgerald 345/138 kV xfmr + Fitzgerald - North Appleton 345 kV circuit + Fitzgerald - South Fond du Lac 345 kV circuit
22	Whitcomb - CWEC Wittenberg Tap - Wittenberg Tap - Birnamwood Tap - Brooks Corner - Deer Trail 69-kV line
23	Atlantic 138/69-kV transformer + M38 – Atlantic 138-kV line
24	Hiawatha – Engadine – Newberry – Roberts 69-kV line

Table ZS-9
Zone 2 Load and Generation

Zone 2	2011	2015	2020	2025
Peak Forecast (megawatts)	806.4	843.2	862.8	886.1
Average Peak Load Growth	N/A	1.12%	0.46%	0.53%
Existing Generation Capacity (megawatts)	875.2	875.2	875.2	875.2
Existing Capacity Less Load	68.8	32	12.4	-10.9
Existing Generation Capacity plus Modeled Generating Capacity Additions (megawatts)	875.2	875.2	875.2	875.2
Modeled Capacity Less Load (megawatts)	68.8	32	12.4	-10.9