



## Zone 3 overview

Zone 3 includes the Wisconsin counties of:

- ❑ Columbia
- ❑ Crawford (southern portion)
- ❑ Dane
- ❑ Dodge
- ❑ Grant
- ❑ Green
- ❑ Iowa
- ❑ Lafayette
- ❑ Jefferson
- ❑ Richland
- ❑ Rock
- ❑ Sauk
- ❑ Walworth and
- ❑ Winnebago, Ill. (northern portion)

The physical boundaries of Zone 3 and transmission facilities located in Zone 3 are shown in [Figure ZS-24](#).

Land use in Zone 3 is a mix of rural, urban and agricultural. The major population centers are the Madison metropolitan area and the Janesville/Beloit area.

Zone 3 typically experiences peak demands during the summer months. Manufacturing, food processing, state government and institutional loads are among the largest electricity users in the zone.

### *Demographics*

The population of the counties in Zone 3 grew at an annual rate of 1.0 percent from 1998 to 2008. The highest growth rate of 1.4 percent per year and the largest increase in population of 64,000 occurred in Dane County.

Population in Zone 3 is projected to grow at 1.0 percent annually for the 2008 to 2019 period. From 2008 to 2019, Dane County is projected to realize the largest increase in population and is projected to have the highest growth rate.

During the same period, the annual employment growth rate was 1.6 percent. The highest growth rate and the largest increase in employment occurred in Dane County.

Employment in Zone 3 is projected to grow at 1.4 percent annually between 2008 and 2019. Dane County is projected to realize the largest increase in employment and Sauk County the highest growth rate.



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Employment				Population			
Annual Growth Rate				Annual Growth Rate			
1998-2008		2008-2019		1998-2008		2008-2019	
Zone 3	1.6	Zone 3	1.4	Zone 3	1.0	Zone 3	1.0
Dane, WI	2.0	Sauk, WI	1.6	Dane, WI	1.4	Dane, WI	1.5

Total Increase				Total Increase			
1998-2008		2008-2019		1998-2008		2008-2019	
Zone 3	121,815	Zone 3	132,610	Zone 3	109,633	Zone 3	144,764
Dane, WI	71,834	Dane, WI	73,382	Dane, WI	64,189	Dane, WI	86,382

### Zone 3 environmental considerations

Zone 3 covers the south central and southwestern portions of Wisconsin and the Illinois county of Winnebago.

The ecological landscapes in this zone vary from Southeast Glacial Plains in the east through the Central Sand Hills area to areas that are part of the Southwest Savanna and Western Coulee and Ridges landscapes in the west. The eastern portions of the zone generally are level to gently rolling terrain, while the western areas are characterized by the ridges and valleys of the drift less area.

The northern and western portions of this zone are located in the Lower Wisconsin River Drainage Basin, and the Mississippi River forms the zone’s western boundary. Other portions of this zone are located in the Grant-Platte, Sugar River-Pecatonica, Upper and Lower Rock and Fox Illinois drainage basins. Horicon Marsh National Wildlife Refuge is located in the northeast part of the zone, and the Upper Mississippi River Wildlife and Fish Refuge is located along the zone’s western edge. The Baraboo Hills are located in the north-central portion of the zone. The Lower Wisconsin River State Riverway also is found in this zone.

### Zone 3 electricity demand and generation

The coincident peak load forecasts for Zone 3 for 2010, 2014, 2019 and 2024 are shown in [Table ZS-10](#). Existing generation, along with proposed generation based on projected in-service year, also are shown. The resultant capacity margins, with or without the proposed generation, are shown as well.

The table shows that load is projected to grow at roughly 2.4 percent annually from 2010 through 2019. Comparing load with generation (at maximum output) within the zone indicates that Zone 3 has more generation than peak load during peak load periods. However, actual operating experience indicates that during most load periods, Zone 3 is a net importer of power.

### Zone 3 transmission system issues

Key transmission facilities in Zone 3 include:

- ❑ the Columbia-North Madison 345-kV lines,
- ❑ the Columbia-Rockdale-Paddock-Wempletown 345-kV line
- ❑ the Paddock-Wempletown 345-kV line and
- ❑ the 138-kV facilities from the Nelson Dewey Power Plant, around the Madison area, and in the northwest and southeast portions of Zone 3.



Key system performance issues in Zone 3 include:

- ❑ import capability into the Madison area, whether from sources internal or external to the zone,
- ❑ contingency thermal overloads on the Fitchburg-Royster 69-kV line,
- ❑ contingency low voltage issues on the Sheepskin-Bass Creek-Brodhead 69-kV line,
- ❑ low voltages and line overloads on the 69-kV system in Monroe area,
- ❑ contingency thermal overloads on the Spring Green 138/69-kV transformer,
- ❑ insufficient 69-kV line capability in Dodge and Walworth Counties,
- ❑ low voltages and line overloads on the 69-kV system in the Dam Heights area,
- ❑ potential contingency overloads on the West Middleton 345/138-kV transformer and West Middleton-Blackhawk 69-kV line in the 2018 timeframe,
- ❑ contingency low voltages in northern Rock County and eastern Dane County,
- ❑ widespread intact system 138- and 69-kV low voltages in Jefferson, and Dane Counties are a serious emerging problem in 2014 and beyond, and
- ❑ impact of new generation.

### Zone 3 - 2010 study results

Refer to [Table ZS-1](#) and [Figure ZS-9](#)

#### Summary of key findings

- ❑ Low voltages throughout Zone 3 require a total of 245 MVAR of capacitor banks be installed by 2010.
- ❑ A significant number of lines and substation terminals will be upgraded to avoid overloads under single contingency.
- ❑ Maintaining reliability of service to load in and around the Madison area requires that system reinforcements be implemented in the near term. Longer term, a 345-kV source on the west side of Madison will be required.
- ❑ Load growth in Rock and Walworth counties, higher than the ATC average, is driving the need for several system reinforcements in these counties.
- ❑ Import capability from Illinois can be severely limited by transmission facilities outside of our system for loss of the Wempletown-Paddock 345-kV line (ATC/Commonwealth Edison facility). This limitation has been addressed to some degree by installing a second 345-kV line between Wempletown and south central Wisconsin (Paddock Substation). The underlying 138-kV transmission system in the Janesville area and to the north still poses limitations for transfers into the Madison area.

Import capability from the areas to the south and southwest of Zone 3 has been a major concern. To help address this, ATC proposed the first transmission project within the Midwest Independent System Operator (MISO) footprint driven by economics. This project, the Paddock-Rockdale 345-kV transmission line, significantly reduces congestion and enhances import capability into Zone 3 and ATC as a whole.

ATC received approval May 30, 2008, from the Public Service Commission of Wisconsin to construct this additional circuit primarily on an existing transmission line corridor between the



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Paddock Substation in the town of Beloit and the Rockdale Substation in the town of Christiana. (approximately 35 miles).

This project benefits electric consumers differently from other electric transmission projects that ATC has proposed in recent years, which largely have been in response to weaknesses on the system and related reliability issues. The primary purpose of a high-voltage transmission line to the south is to give local distribution utilities improved access to lower cost power from other areas in the region and bring it into Wisconsin. While this project is largely driven by economics, it also benefits electric consumers with a stronger, more stable electric system.

Wisconsin has limited transmission line connections to other states compared to its neighboring states. This limits the ability of electric utilities to access wind energy or sources of lower-cost electricity from other regions.

ATC submitted a construction application to the PSC in the spring of 2007 outlining its proposal and seeking regulatory approval. The route the PSC approved was ATC's designated preferred (recommended) route along an existing utility corridor where a 345-kilovolt line is located. A second route alternative along another utility corridor approximately two miles east of the approved route was rejected by the PSC.

In response to low voltages throughout Zone 3, a total of 245 MVAR of capacitor banks distributed at the Sheepskin, Richland Center, Brewer, Beaver Dam, Kilbourn, Artesian, Lamar, Union Townline, Dickinson, and Spring Green substations were deemed to be the most feasible solutions in the 2009-2010 timeframe. In 2009, 182 MVAR of reactive compensation was installed. The remaining 63 MVAR will be in service (Sheepskin, Lamar and Spring Green) in 2010.

We currently mitigate several of the identified 138-kV low voltages through remote control of the 138/69-kV transformers in the affected areas. In certain instances, transformer load tap changers are adjusted to bring the 138-kV contingency voltages above the planning criteria limits while maintaining the 69-kV bus voltages above criteria limits. This is a balancing act, and as loads continue to grow the process will no longer be effective.

There were a number of facility overloads and several facilities near their emergency ratings in Zone 3 based on the 2010 analysis. Many projects are either planned or proposed to address these near-term thermal problems by 2010. As a result, we propose to uprate three 69-kV lines and two 69-kV substation terminals.

Overloads for outages of the Dane-Waunakee, Blount-Ruskin or West Middleton-Pheasant Branch 69-kV lines or the North Madison 138/69-kV transformer highlight the need for additional transmission reinforcements in this area. The first phase of the reinforcements is complete. This included uprating the Dane-Waunakee, Waunakee-Huiskamp and West Middleton-Pheasant Branch 69-kV lines as well as uprating the North Madison 138/69-kV transformer. The second phase of the reinforcements includes the construction of a new 138-kV line, North Madison-Huiskamp, and the construction of a new substation with a 138/69-kV transformer near Huiskamp, which was completed in 2009.

Several pending overloads and low voltages in southern Dane and Green counties are prompting the need for additional transmission system support in the area. The existing 69-kV line between



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Oregon and Verona substations will be rebuilt on new structures with larger conductor in part because of its deteriorated condition. This rebuild will help relieve some of the voltage and loading problems in the near term. In addition, a new 138-kV line from the Fitchburg area (Oak Ridge Substation) to Verona (previously Montrose Substation) is being planned to provide additional support that is needed as loads continue to grow in southern Dane County at a rate of twice the ATC system average. The Montrose endpoint was changed to the existing Verona Substation due to routing issues, public input and the Oregon-Verona rebuild plan.

The western portion of Jefferson County and the eastern portion of Dane County have also experienced high residential, commercial, and industrial load growth. Much of the area is served by the Rockdale Substation. Studies conducted by Planning indicate that by 2009, unacceptable voltages could be experienced in the Academy, Boxelder, London, Cambridge, Lakehead, and Jefferson substation areas with the outage of any segment of the Rockdale-Boxelder or Rockdale-Jefferson 138-kV lines. In order to provide reliable service to the area, a new Jefferson-Lake Mills-Stony Brook 138-kV line has been planned.

There are several pockets of low voltages and some overloads in eastern Rock and western Walworth counties. The recently completed maintenance rebuild of the Turtle-West Darien 69-kV line with initial operation at 69 kV remedies this situation. In conjunction with this project, a new line from West Darien through a new Southwest Delavan Substation to the Delavan area is planned. This project allows ATC to retire a portion of the existing Turtle-Bristol line, which is routed through an environmentally sensitive area, and to provide service to requested transmission-to-distribution interconnections (Southwest Delavan and North Shore substations).

Walworth County will require additional support to accommodate transmission-to-distribution interconnections, mitigate impending overloads on various facilities and support voltages at numerous substations under contingency. The conversion of the Rock River-Elkhorn line from 69-kV to 138 kV was recently completed to resolve these issues. The 138-kV Rock River to Elkhorn line conversion project will not only address thermal overloads but also make the system ready for rebuilding both Colley Road to Brick Church 138- and 69-kV lines. These two lines have condition issues that require they be rebuilt in the near future. In addition, the current operating guide which is to open the Colley Road to Brick Church 69-kV line for the loss of the Colley Road to Brick Church 138-kV line can be eliminated.

ATC and the city of Madison have proposed to bury part of the two Blount-Ruskin 69-kV overhead lines underground. This project will be completed in 2011.

In the 2008 Assessment, ATC planned to install a 12.24 MVAR 69-kV mobile capacitor bank at the Brick Church Substation. Due to the new load forecast changes, the plan has been changed. The new location for the mobile capacitor bank is Spring Green substation. It will not only help to support the area 69-kV system voltages under the Spring Green transformer outage, but also reduce load curtailment risk during several planned line construction outages in this area during 2009-2010 timeframe.



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

- Construct Oak Ridge-Verona 138-kV line**  
The need year is listed as 2009. However, due to regulatory delays, the in-service year is 2010. The mitigation measures for the potential 2009 system violations include upgrading the existing Verona and New Glarus 69-kV capacitor banks (2007), rebuilding the Stoughton 69-kV bus (2009) and distribution load shifting at Stoughton.
- Uprate McCue-Lamar 69-kV line**  
Due to an enhanced generation dispatch scenario utilized in the 2008 Assessment<sup>1</sup>, potential single-contingency low voltage problems in the Lamar area and an overload of the McCue-Lamar 69-kV line were observed in the 2009 summer peak model. Considering reasonable project lead times, the 2010 in-service date was chosen for this provisional project of uprating the McCue-Lamar line and installing capacitor banks at Lamar. In the interim, dispatching Sheepskin generation could be one possible mitigation strategy to address these constraints.
- Jefferson-Tyrannena-Stony Brook 138-kV line and associated line uprates**  
The construction of a new 138-kV line from Jefferson Substation to Stony Brook Substation has previously been identified as the long-term solution to the voltage problems in this area. The PSCW issued an order to ATC in August of 2006 for the construction of this line with an expectation that it would be completed by 6/1/2008. However, several legal challenges have limited ATC's ability to complete the detailed design, procure necessary materials, and procure the necessary easements to support start of construction in the fall of 2007 in order to meet this in-service date. As an interim measure, ATC decided to install a temporary 24.5 MVAR 138-kV capacitor bank at Boxelder in 2008 to address the imminent voltage violations.

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

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

- Uprate X-23 Colley Road-Marine 138-kV terminals

### **Zone 3 - 2014 study results**

Refer to Table ZS-2 and Figure ZS-10

#### *Summary of key findings*

- The numerous low voltages and line overloads along with the potential for voltage collapse in the Madison area signal the need for another new 345-kV source on the west side of Madison.
- Significant load growth in the Rock and Green Counties, along with the mismatch of load to generation in the area, will result in the Monroe area 69-kV network being subjected to unacceptably low voltages and thermal overloads under both normal and contingency

<sup>1</sup> Please refer to Methodology & Assumptions for a designation of the dispatch scenario



conditions in the summer of 2011. Rebuilding the 69-kV line Y-33 from Brodhead to South Monroe will address these issues.

- ❑ Load growth in Green County, west of Rock County and south of Dane County requires one additional 138-kV source into the area. Adding Bass Creek 138/69-kV transformation will address a number of potential low voltage problems and transformer overloads.
- ❑ As a result of the recent completion of the Rock River-Elkhorn 138-kV conversion project, it is feasible to uprate/rebuild the existing Colley Road-Brick Church 69-kV line for both reliability and maintenance needs.
- ❑ Potential thermal overloads and low voltage issues on the Fitchburg-Royster 69-kV line will require system reinforcements.

In response to low voltages in certain Zone 3 areas, a total of 165 MVAR of capacitor banks distributed at the Brick Church, Femrite and Verona substations in the 2011-2014 timeframe were proposed as preliminary solutions.

There were a number of facility overloads and several facilities near their emergency ratings in Zone 3 based on the 2014 analysis. Several projects are either planned or proposed to address these near-term thermal problems. As a result, we propose to uprate two 69-kV lines (Sheepskin-Dana line Y-61 and McCue-Milton Lawns Y-79). In addition, the Verona-Oregon 69-kV line and part of the Colley Road-Brick Church 69-kV line will be rebuilt due to reliability and condition issues (refer to [Zone 3 2010 study results](#)).

The Rockdale-West Middleton 345-kV line will address line overloads and low voltage issues in Dane County and is planned to be in-service in 2013. Demand in Dane County is projected to grow at an above-average rate for the ATC system. Above-average growth in demand coupled with potential generation retirements, concerns about the age, high cost, and limited amount of remaining generator capacity, and stress on the transmission lines that are critical for importing power to Dane County will continue to increase. By the end of 2011 Madison Gas and Electric (MGE) has plans to stop burning coal at the Blount Power Plant and MGE intended to retire units 3, 4 and 5 at the same time. However, due to reliability needs, the Midwest ISO is requiring that MGE defer retirement of these units, which would reduce the capacity of this power plant by 90 megawatts, until after the Rockdale-West Middleton 345kV line project is implemented. The remaining two units at Blount will remain in service and will use natural gas as the primary fuel.

Significant load growth in the Rock and Green Counties, along with the mismatch of load to generation in the area, will result in unacceptable low voltages in the Monroe area. Under several single contingency conditions, thermal overloads also arise on the 69-kV line Y-33 sections Brodhead-Spring Grove, Spring Grove-Blacksmith, and Blacksmith-South Monroe. The preferred solution to address these issues is to rebuild the Brodhead-South Monroe 69-kV line (Y-33) using 138-kV construction standards and initially operate the line at 69 kV.

The Evansville and Brodhead areas are facing unacceptably low voltages under single contingency conditions. In addition, the North Monroe 138/69-kV transformer loading is approaching to its summer normal rating under system intact conditions. In conjunction with the rebuild of line Y-33 from Brodhead to South Monroe (2011), a new Bass Creek 138/69-kV transformer and the Townline Road-Bass Creek 138-kV line uprate in 2013 will address these problems and provide



one additional 138-kV source into Green and Rock County. This project will also allow us to delay a new Brooklyn to Evansville 69-kV line project outside of our 10-year planning horizon.

The Fitchburg to Royster 69-kV line is susceptible to thermal overloads and the area experiences low voltages at Syene, Nine Springs, and Pflaum for loss of either end of the line. Looping the Nine Springs to Pflaum 69-kV line in and out of the Femrite Substation was proposed to address these issues. However, due to the project schedule constraints and Femrite substation constraints, it has been replaced by uprating Fitchburg-Nine Springs and Royster-Pflaum 69-kV lines, moving AGA to Femrite-Royster line and installing capacitor banks at the Nine Springs Substation.

A portion of the 69-kV Dane-Dam Heights line Y-8 will be rebuilt in the year 2012 as a part of an asset renewal project that addresses first contingency overloads in the year 2015. To address thermal overloads, the rating of the Portage-Trienda 138-kV line will be increased in 2016.

In addition, the withdrawal of the Nelson Dewey third generator and its associated transmission projects does not cause significant impact on the transmission system in Zone 3. Based on generation merit order in Alliant's control area, the dispatch scenario without the Nelson Dewey third generator facilitates a reduction of thermal loads on the following lines and transformers:

- McCue-Sheepskin 69-kV line,
- Stoughton-Sheepskin 69-kV line,
- Gran Grae-Boscobel 69-kV line,
- Spring Green 138/69-kV transformer, and the
- Hillman 138/69-kV transformer.

It has also been observed that the West Middleton-Stage Coach 69-kV line loading increases when the Nelson Dewey third generator is not in the model.

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

- Rebuild the Y-119 Verona-Oregon 69-kV line*  
The need year is listed as 2008. The in-service year is 2011. Distribution load shifting at Stoughton will eliminate potential system violations in the 2008-2010 timeframe.
- Bass Creek transformer and uprate Town Line Road-Bass Creek 138-kV line X-12*  
The need year is listed as 2010. The in-service year is 2013. Mitigation measures for the potential 2010-2012 system violations include installing a 5.7 MVAR distribution capacitor bank at the Union Townline 69-kV Substation (2009) and upgrading the existing Sheepskin capacitor bank from 10.8 MVAR to 16.2 MVAR (2009).
- Uprate Fitchburg-Nine Springs and Royster-Pflaum 69-kV lines, move AGA to the Femrite-Royster 69-kV line and install Nine Springs capacitor bank*  
The need year is listed as 2006. The in-service year is 2013. Post-contingency distribution load bridging will be utilized as an interim mitigation measure to alleviate potential single-contingency thermal and voltage issues.





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

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

- Uprate Y-40 Gran Grae-Boscobel 69-kV line to achieve a 99 MVA summer emergency rating
- Rebuild part of the Y-8 Dane-Dam Heights 69-kV line

Our asset renewal team initially identified 116 structures on the Gran Grae-Boscobel line to be replaced due to various maintenance issues. Based on the Y-40 thermal rating analysis, it was determined that the additional scope for uprating the line from 200 degrees F to 300 degrees F would be to replace an additional 19 structures. It makes sense to combine this uprate with the previously identified maintenance project because these structures are very close to the previously identified poles. There are significant cost savings that can be obtained from performing the additional work as part of the maintenance project rather than completing the work as a separate future project.

### **Zone 3 - 2019 study results**

Refer to Table ZS-3, Table ZS-3a and Figure ZS-11

#### *Summary of key findings*

- Additional reactive support is needed throughout the Zone 3.
- Under single contingency, all three Columbia 345/138-kV transformers are approaching to their maximum summer emergency ratings.
- Load growth in Lake Geneva area causes several single-contingency thermal overloads and low voltages.
- Potential single-contingency thermal overloads on the Dane-Lodi 69-kV line and the Kirkwood-Artesian 138-kV line will require system reinforcements.
- The existing Hillman 138/69-kV transformer potentially overloads under single contingency in the Dairyland Power system.
- With no generation running at Concord Substation, severe low voltages are observed under both system intact and single-contingency conditions. Economic benefit analysis may be performed to evaluate whether new transmission projects can be justified.
- Several projects in the Madison area were on hold due to a potential large T-D project development although the project need years were delayed based on the 2009 analysis.
- Potential single-contingency thermal overloads on the Gran Grae-Boscobel 69-kV line will require system reinforcements.
- The in-service date for a second 138/69-kV transformer at the Spring Green Substation is delayed due to other project and load changes.

In response to low voltages throughout Zone 3, a total of 362 MVAR of capacitor banks distributed at the Eden, Mazomanie, Concord, Sun Prairie, Dam Heights, North Monroe and Boscobel substations in the 2015-2019 timeframe were deemed to be the preliminary solutions.



The provisional project of constructing a Hubbard-East Beaver Dam 138-kV line will address not only several 69-kV thermal overloads, but also the low voltages in the Beaver Dam area for an outage of the North Randolph-North Beaver Dam 138-kV line.

There were a number of facility overloads and several facilities near their emergency ratings in Zone 3 based on the 2019 analysis. Three line uprate projects (one 138-kV uprates and two 69-kV uprates) and one 138/69-kV transformer upgrade (Hillman Substation) have been proposed to address these thermal problems.

The Columbia and Sauk County areas are experiencing high load growth, especially in Wisconsin Dells. A total of 98 MVAR of capacitor banks were installed at the Kilbourn and Artesian substations in 2009. However, potential Kirkwood to Artesian line overloads and serious post-contingency low voltages around the Reedsburg loop call for additional transmission reinforcements. The Lake Delton-Birchwood 138-kV project in 2017 will not only interconnect a new T-D substation, but also address impending low voltages and overloads identified on the transmission system.

Back In the 2008 Assessment, the West Middleton 138/69-kV transformers and West Middleton-Blackhawk 69-kV line were observed to be potentially overloaded under single-contingency conditions in the 2017 timeframe. To address these thermal overloads, a West Middleton to Blount 138-kV line project was being considered. In conjunction with the Rockdale-West Middleton 345-kV line project (2013), the West Middleton-Blount 138-kV line could eliminate the thermal overload issues in the long term and provide additional transfer capability to into downtown Madison. The status of this project was provisional for several reasons.

- The West Middleton 345/138 kV transformer ratings need to be validated.
- The 2017 in-service date driver needs to be confirmed, to determine whether the summer normal overloads can be mitigated by other means.
- Project alternatives have not been thoroughly developed and evaluated.

Since the 2008 Assessment, the West Middleton 345/138 kV transformer ratings have been validated with higher ratings. In addition, with the new load forecast used for the 2009 Assessment, the needs for the West Middleton-Blount 138-kV project were out of 10-year planning horizon. However, due to a potential large T-D project development in Madison area, the in-service date for this project will be kept as 2017 in the project table along with the following three projects until the T-D project development is finalized.

- Femrite capacitor bank project (2014),
- Sun Prairie capacitor bank project (2016), and
- Royster-Sycamore line uprate project (2016).

Constructing a 5.13-mile 138-kV line from North Lake Geneva to South Lake Geneva and installing a 138/69-kV transformer at South Lake Geneva substation will address several potential system violations in Lake Geneva area. Potential violations include the single-contingency thermal overloads on the Cobblestone-Zenda and North Lake Geneva-South Lake Geneva lines, and low voltage issues at Cobblestone and Lake Geneva. The status of this project is also provisional because Planning has not thoroughly compared it with other project alternatives in a long term study.



Significant load growth near the Lamar area causes numerous system constraints. Near term solutions are developed. They include:

1. Upgrading Stoughton Substation terminal equipment to achieve a 169 MVA summer emergency rating on Y46 in 2009 (recently completed).
2. Upgrading the McCue-Lamar section of the Y-61 to a minimum summer emergency rating of 115 MVA in 2010.
3. Installing 2-12.45 MVAR 69-kV capacitor banks at Lamar Substation in 2010.

However, these near-term solutions will not be sufficient after approximately six years. Subsequently, a longer term plan will be developed and implemented before 2017 to address emerging McCue-Lamar and Bass Creek-Footville thermal overloads and voltage issues at Lamar Substation under single-contingency conditions. A second 69-kV line from McCue-Lamar is currently being considered as a placeholder to resolve the issues in this area.

Based on the 2009 Assessment and due to the following three reasons, the need for the second Spring Green transformer has been delayed from 2013 to 2016.

1. The Nelson Dewey third generator project and supporting projects have been canceled.
2. The load forecast in the area was reduced; speculative load at Arena was removed.
3. Spring Green 2-16.33 MVAR capacitor banks also reduces var flow through the existing Spring Green 138/69-kV transformer.

A project to construct a Spring Valley-North Lake Geneva 138-kV line is being considered in 2018. Please refer to [Zone 5 – 2019 study results](#) for details.

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

- None

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

- None

### *Zone 3 - 2019 futures study results*

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

- 20% Wind Future  
 Slow Growth Future

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

In the 20% Wind Future, line overloads and bus voltages generally improve in Zone 3. However, line overloads and bus voltages worsen significantly in the Lamar/Fulton/Harmony, Richland Center, Boscobel, Sheepskin and Monroe areas. Future projects, adjusting area phase shifters and/or increasing area generation mitigates the situation(s). These results occur because of area generation dispatch and the associated change in the flow of power associated with the 20% Wind scenario.



In the Slow Growth Future, voltages generally improve throughout Zone 3. In addition, line overloads generally improve, but worsen under certain contingencies. This result is consistent with the reduced loading and associated generation redispatch throughout the zone. Please refer to [Table ZS-3a](#) for the limitations and performance criteria exceeded for these futures.

### Zone 3 - 2024 study results

Refer to [Table ZS-4](#) and [Figure ZS-12](#)

#### Summary of key findings

- Load growth in the Green and Rock County areas will drive the need for additional 138/69-kV transformer capacity and 69-kV line uprate.
- Several 69-kV lines in the West Middleton and Waunakee area are approaching their summer emergency ratings under single contingency conditions.
- Potential terminal or line uprates may be needed in the 2023 timeframe for the Sun Valley-Oregon 69-kV line and the Stoughton-Stoughton South 69-kV line.
- System intact low voltages exist on the 138-kV system in Dane County and on the 138-kV system from Nelson Dewey to Kilbourn.
- System intact low voltages exist on the 69-kV system in the Boscobel and Mazomanie areas.
- Numerous low voltage violations exist under single-contingency conditions throughout the Zone 3 system.

The 2024 results suggest that further study of Zone 3, particularly around Dane, Green and Grant Counties, is needed to identify an appropriate long-term solution for this area that may be required beyond the year 2019.

Both of the Columbia 200 MVA, 345/138-kV transformers are close to their summer emergency ratings for the loss of the Columbia 400 MVA, 345/138-kV transformer. In addition, the Columbia-Portage 138-kV line is overloaded for the loss of the other Columbia to Portage 138-kV line by 2021. Adding a North Randolph 345/138-kV transformer along with an uprate of the Columbia 345/138-kV transformer T22 are proposed to relieve these overloads. This project is also expected to provide needed voltage support for Dodge and Jefferson Counties.

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

- None

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

- None

#### Summary of Compliance with NERC Standards

The mitigation plans, planned, proposed and provisional projects identified for Zone 3 in this Assessment will allow the ATC system in Zone 3 to meet NERC standards TPL-001, TPL-002, TPL-003 and TPL-004 in each of the four years 2010-2014, and for the 2015-2019 planning horizon.

TABLE ZS-1

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

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

TABLE ZS-1

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

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

TABLE ZS-1

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

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

TABLE ZS-1

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

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



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

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

TABLE ZS-2

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

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

TABLE ZS-2

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

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

TABLE ZS-2

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

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

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

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

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

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

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

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

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

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



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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



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2009 10-Year Assessment - 2019 Futures Constraints

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

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

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

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2009 10-Year Assessment - 2019 Futures Constraints

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

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

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

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

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

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

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

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

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

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

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



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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



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

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

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

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

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

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

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

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

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

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

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

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

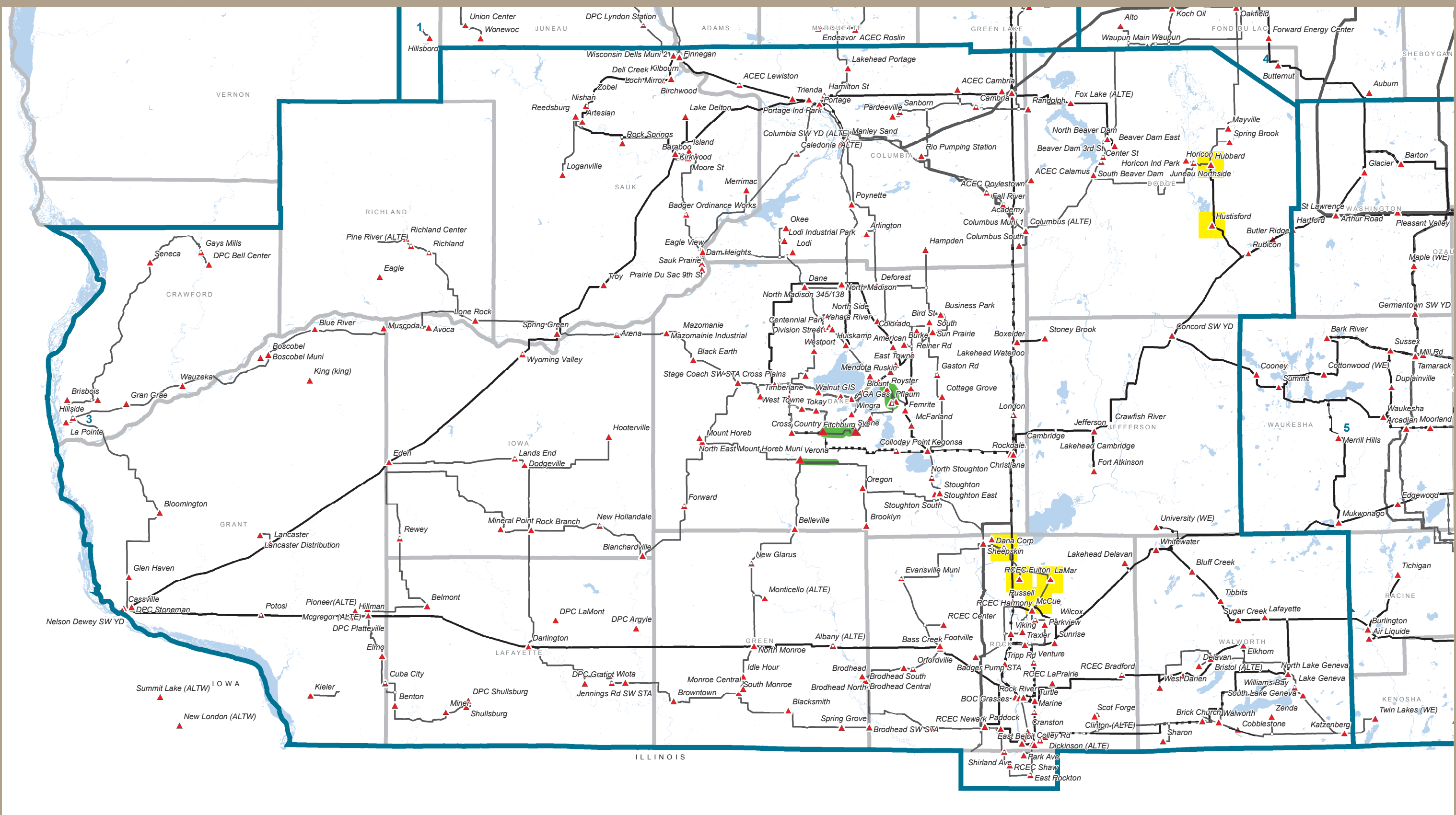
**TABLE ZS-4  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case**

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

*Table ZS-10  
Zone 3 Load and Generation*

Zone 3	2010	2014	2019	2024
Peak Forecast (megawatts)	3179.2	3501.5	3936.5	4375.7
Average Peak Load Growth	N/A	2.44%	2.37%	2.14%
Existing Generation Capacity (megawatts)	3933.6	3933.6	3933.6	3933.6
Existing Capacity Less Load	754.4	432.1	-2.9	-442.1
Existing Generation Capacity plus Modeled Generating Capacity Additions (megawatts)	4267.6	4366.6	4366.6	4366.6
Modeled Capacity Less Load (megawatts)	1088.4	865.1	430.1	-9.1





Performance Criteria Exceeded and Other Constraints 2009-2010  
**PLANNING ZONE 3**

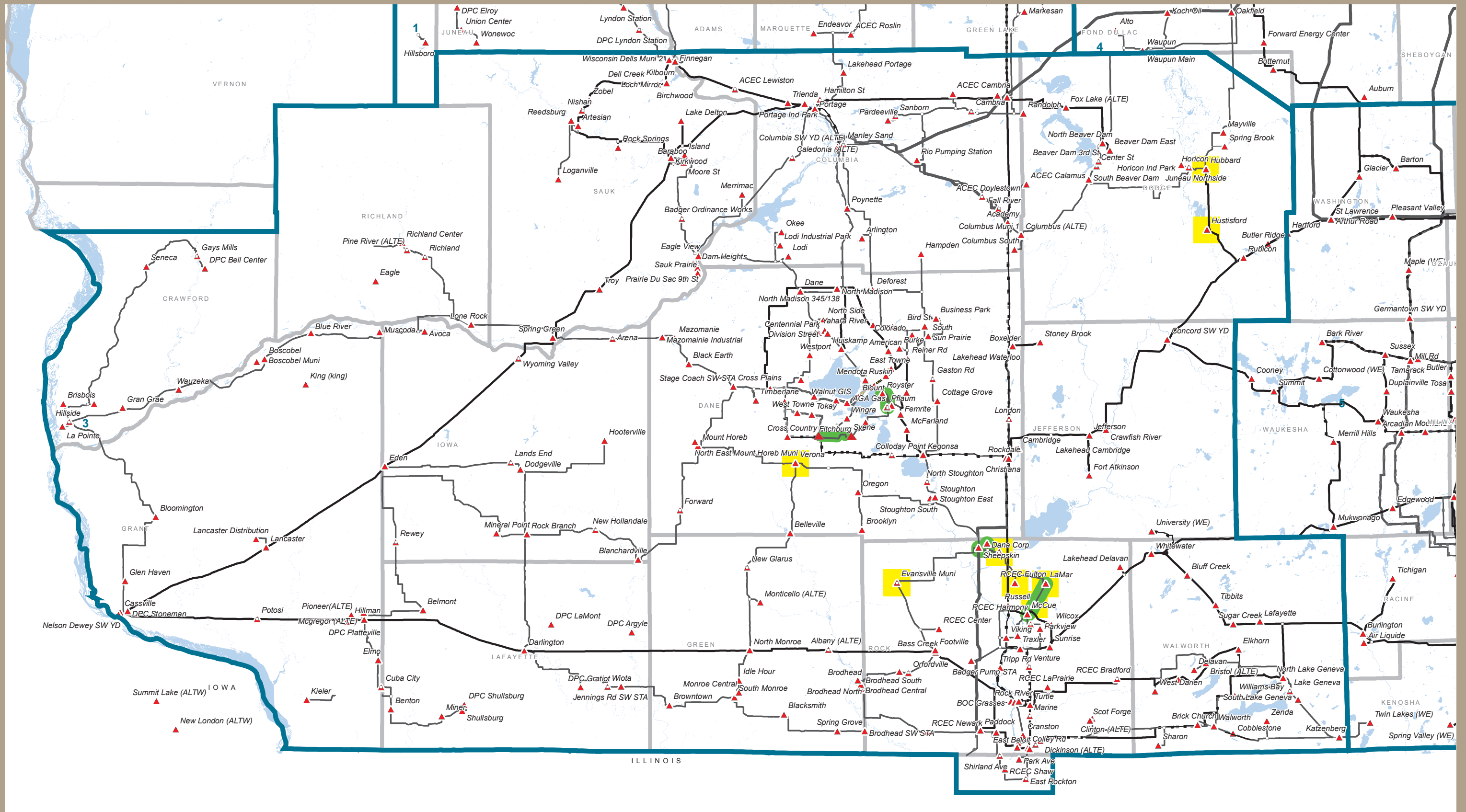
Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties. Facilities include:  
 \* Approximately 9350 miles of transmission lines  
 \* 96 wholly owned substations  
 \* 410 jointly owned substations  
 \* ATC offices in Madison, Cottage Grove, Pewaukee,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

- Low/High Voltages
- Overloaded Facility

**Transmission Related Facilities**

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

Figure ZS-10



Performance Criteria Exceeded and Other Constraints 2011-2014  
**PLANNING ZONE 3**

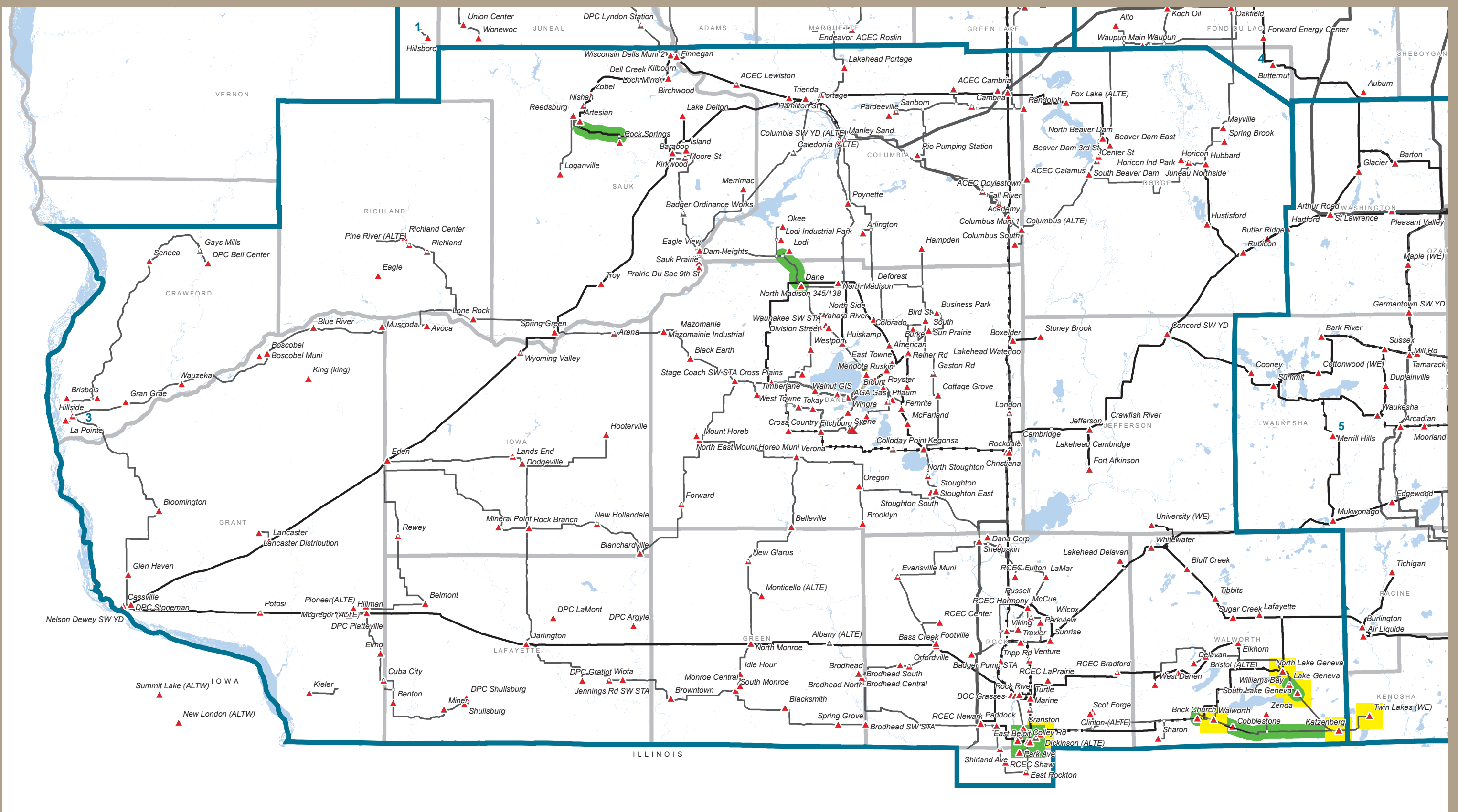
Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties. Facilities include:  
 \* Approximately 9350 miles of transmission lines  
 \* 96 wholly owned substations  
 \* 410 jointly owned substations  
 \* ATC offices in Madison, Cottage Grove, Pewaukee,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

- Low/High Voltages
- Overloaded Facility

**Transmission Related Facilities**

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

Figure ZS-11



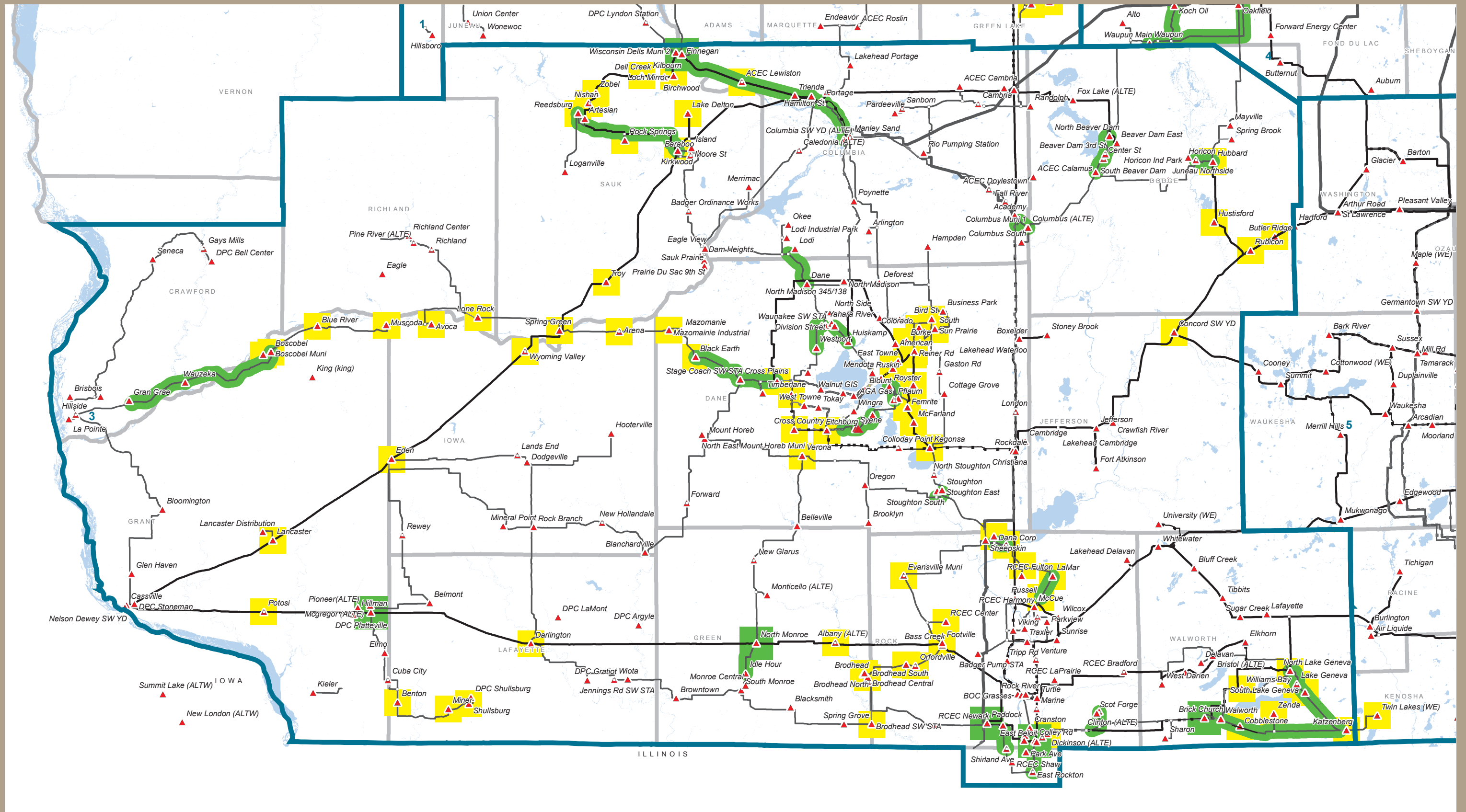
Performance Criteria Exceeded and Other Constraints 2015-2019  
**PLANNING ZONE 3**

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

- Low/High Voltages
- Overloaded Facility

**Transmission Related Facilities**

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



Performance Criteria Exceeded and Other Constraints 2020-2024  
**PLANNING ZONE 3**

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

- Low/High Voltages
- Overloaded Facility

**Transmission Related Facilities**

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

Table PR-16  
Zone 3 Transmission System Additions

<b>System Additions</b>	<b>System Need Year</b>	<b>Projected In-Service Year</b>	<b>Planning Zone</b>	<b>Need Category</b>	<b>Planned, Proposed or Provisional</b>
Construct a Jefferson-Tyranena-Stony Brook 138-kV line	2006	2009	3	reliability	Planned
Uprate X-8 Rockdale to Boxelder 138-kV line	2008	2009	3	reliability	Planned
Uprate Y-41 Walworth- North Lake Geneva 69-kV to achieve a 69 MVA summer emergency rating	2009	2009	3	reliability	Planned
Uprate Y-61 McCue-Lamar 69-kV line to achieve 300 deg F line ratings and install 2-12.45 Mvar 69 kV capacitor banks at Lamar Substation	2008	2010	3	reliability	Proposed
Uprate X-23 Colley Road-Marine 138-kV line terminals	2014	2010	3	reliability	Proposed
Construct new Oak Ridge-Verona 138-kV line and install a 138/69-kV transformer at Verona with a 100 MVA summer normal rating	2009	2010	3	reliability	Planned
Upgrade Sheepskin capacitor bank from 10.8 MVAR to 16.2 MVAR	2009	2010	3	reliability	Planned
Construct second Paddock-Rockdale 345-kV line and replace 345/138-kV transformer T22 at Rockdale Substation	2010	2010	3	economics	Planned
Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation	2010	2010	3	reliability	Planned
Uprate the Royster Substation terminals	2010	2010	3	reliability	Planned

Table PR-16 (continued)  
Zone 3 Transmission System Additions

System Additions	System Need Year	Projected In-Service Year	Planning Zone	Need Category	Planned, Proposed or Provisional
Replace two overhead Blount-Ruskin 69-kV lines with one underground 69-kV line	2010	2011	3	completion of earlier project per agreement with the City of Madison	Proposed
Rebuild the Y-119 Verona to Oregon 69-kV line	2008	2011	3	reliability, condition	Proposed
Rebuild Y-33 Brodhead to South Monroe 69-kV line	2011	2011	3	generation interconnection, reliability	Planned
Uprate terminal limitations at McCue for the Y-79 McCue-Milton Lawns 69-kV line	2011	2011	3	reliability	Proposed
Install 2-24.5 MVAR 138-kV capacitor bank and 1-18 MVAR 69-kV capacitor bank at Brick Church substation	2011	2011	3	reliability	Provisional
Rebuild part of the Y-8 Dane-Dam Heights 69-kV line	2015	2012	3	reliability, asset renewal, potential T-D interconnection	Provisional
Uprate Y-40 Gran Grae-Boscobel 69-kV line to achieve a 99 MVA summer emergency rating	2017	2012	3	reliability	Proposed
Uprate Fitchburg-Nine Springs 69-kV and Royster-Pflaum 69-kV lines and move AGA load to the Royster-Femrite 69-kV line	2006	2013	3	reliability	Proposed
Rebuild Y-32 Colley Road-Brick Church 69-kV line	2013	2013	3	reliability, condition	Provisional

Table PR-16 (continued)  
Zone 3 Transmission System Additions

<b>System Additions</b>	<b>System Need Year</b>	<b>Projected In-Service Year</b>	<b>Planning Zone</b>	<b>Need Category</b>	<b>Planned, Proposed or Provisional</b>
Install 2-16.33 MVAR 69-kV capacitor banks at Nine Springs Substation	2013	2013	3	reliability	Proposed
Install a 138/69-kV transformer at Bass Creek Substation	2010	2013	3	reliability	Proposed
Uprate X-12 Town Line Road-Bass Creek 138-kV line to 300 deg F	2010	2013	3	reliability	Proposed
Construct 345-kV line from Rockdale to West Middleton	2013	2013	3	reliability	Planned
Construct a 345-kV bus and install a 345/138 kV 500 MVA transformer at West Middleton Substation	2013	2013	3	reliability	Planned
Uprate Y-61 Sheepskin-Dana 69-kV line to 95 MVA	2013	2013	3	reliability	Proposed
Install 2-16.33 MVAR 69-kV capacitor banks and 2-24.5 MVAR 138-kV capacitor banks at Femrite Substation	2014	2014	3	reliability	Provisional
Install 1-16.33 MVAR 69-kV capacitor bank at Verona Substation	2014	2014	3	reliability	Provisional
Replace the existing 46 MVA Hillman 138/69-kV transformer with a 100 MVA transformer	2015	2015	3	reliability	Provisional
Install 1-8.16 MVAR capacitor bank at Boscobel 69-kV Substation and upgrade existing 5.4 MVAR bank with an 8.16 MVAR bank	2015	2015	3	reliability	Provisional
Uprate Columbia 345/138-kV transformer T-22 to 527 MVA	2015	2015	3	reliability	Provisional

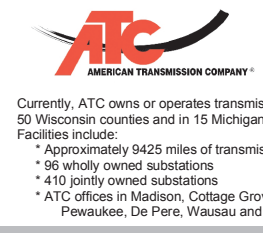
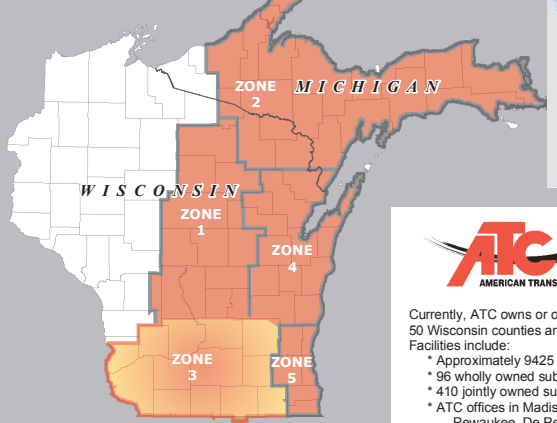
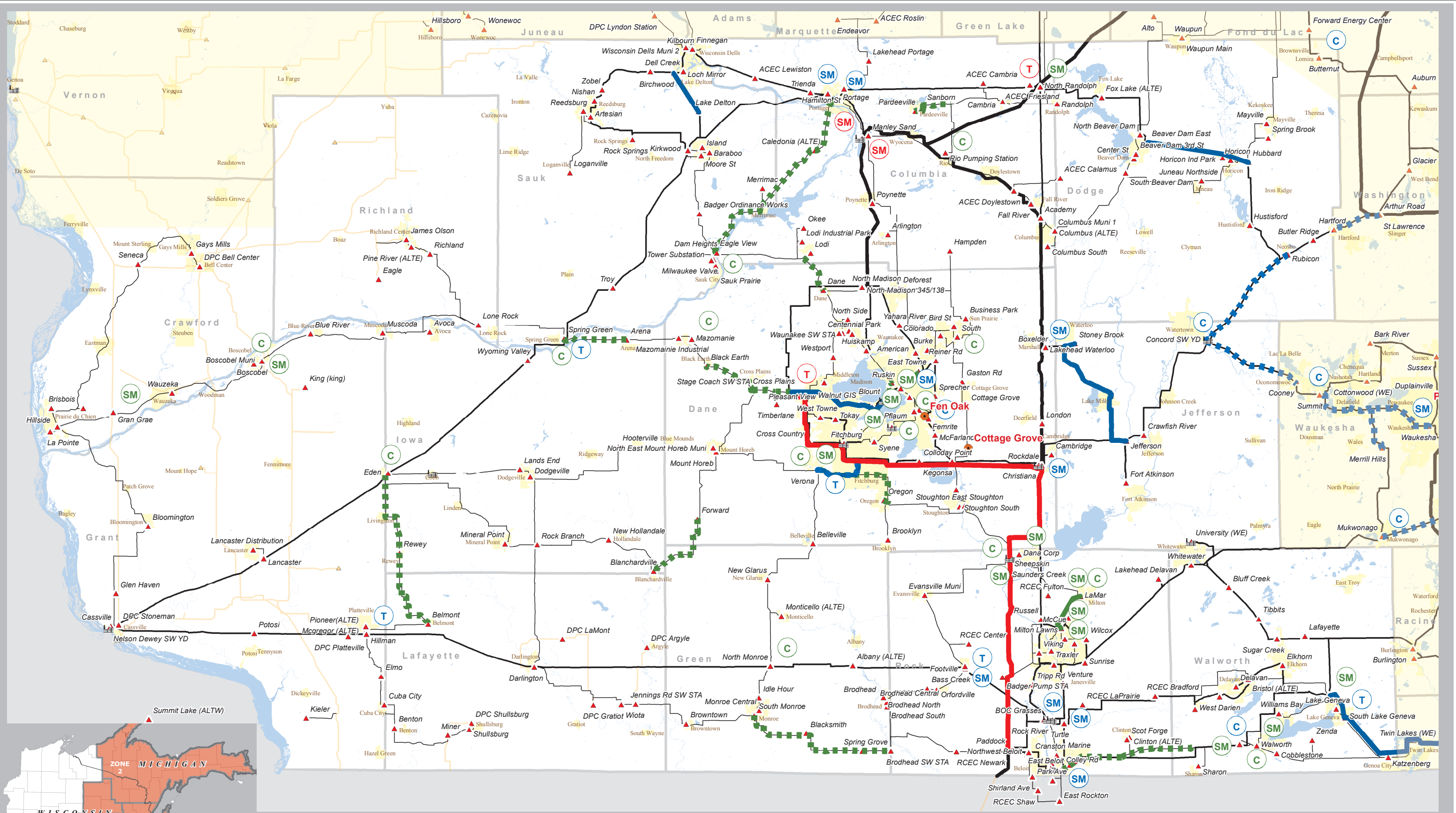
Table PR-16 (continued)  
Zone 3 Transmission System Additions

System Additions	System Need Year	Projected In-Service Year	Planning Zone	Need Category	Planned, Proposed or Provisional
Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating	2016	2016	3	reliability	Provisional
Uprate X-67 Portage-Trienda 138-kV line to 373 MVA	2016	2016	3	reliability	Provisional
Construct new 138-kV line from North Lake Geneva to South Lake Geneva Substation	2016	2016	3	reliability, T-D interconnection	Provisional
Construct new 138-kV bus and install a 138/69-kV 100 MVA transformer at South Lake Geneva Substation	2016	2016	3	reliability	Provisional
Install 2-16.33 MVAR 69-kV capacitor banks at Eden Substation	2016	2016	3	reliability	Provisional
Install 4-49 MVAR 138-kV capacitor banks at Concord Substation	2016	2016	3	reliability, economics	Provisional
Uprate the 6986 Royster to Sycamore 69-kV line to 115 MVA	2016	2016	3	reliability	Provisional
Install 2-16.33 MVAR 69-kV capacitor banks at Sun Prairie	2016	2016	3	reliability	Provisional
Uprate Y159 Brick Church-Walworth 69-kV line to 115 MVA	2017	2017	3	reliability	Provisional
Construct West Middleton-Blount 138-kV line	2017	2017	3	reliability	Provisional
Construct a Lake Delton-Birchwood 138-kV line	2017	2017	3	reliability	Provisional



Table PR-16 (continued)  
Zone 3 Transmission System Additions

System Additions	System Need Year	Projected In-Service Year	Planning Zone	Need Category	Planned, Proposed or Provisional
Install 2-12.25 MVAR 69-kV capacitor banks at Mazomanie Substation	2017	2017	3	reliability	Provisional
Construct 69-kV double-circuit line between McCue and Lamar substations	2017	2017	3	reliability	Provisional
Install 2-16.33 MVAR 69-kV capacitor banks at Dam Heights	2017	2017	3	reliability	Provisional
Install 2-16.33 MVAR 69-kV capacitor banks at North Monroe	2018	2018	3	reliability	Provisional
Construct Spring Valley-Twin Lakes-South Lake Geneva 138-kV line	2018	2018	3	T-D interconnection, reliability	Provisional
Construct a Horicon-East Beaver Dam 138-kV line	2019	2019	3	reliability	Provisional
Construct a 345-kV bus, install a 345/138-kV 500 MVA transformer at North Randolph and loop the Columbia to South Fond Du Lac 345-kV line into the substation	2021	2021	3	reliability	Provisional
Install 2-16.33 MVAR 69-kV capacitor banks at Rio	2022	2022	3	reliability	Provisional



2009 10-Year Assessment Projects  
**PLANNING ZONE 3**

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, WI

- New 69kV Transmission Line
- New 115, 138 or 161 kV Transmission Line
- New 345 kV Transmission Line
- Transmission Line Voltage Conversion
- - - Rebuilt 69 kV Transmission Line
- - - Rebuilt 115, 138 or 161 kV Transmission Line
- - - Rebuilt 345 kV Transmission Line

- (SS) New Substation
- (SM) Substation Modifications
- (T-D) T-D Interconnection
- (C) Capacitor Bank
- (T) Transformer
- ATC Office Location
- ▲ ATC Substation, Switchyard or Terminal
- ▲ Non-ATC Substation, Switchyard or Terminal
- ☰ Generation
- ATC Transmission Line (width = voltage)
- Non-ATC Transmission Line