



Zone 4 overview

Zone 4 includes the Wisconsin counties of:

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

The physical boundaries of Zone 4 and transmission facilities located in Zone 4 are shown in [Figure ZS-25](#).

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

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

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

Demographics

The population of the counties in Zone 4 grew at an annual rate of 0.6 percent from 1998 to 2008. The highest growth rate occurred in Calumet County, while the largest increase in population over the period occurred in Brown County, which increased by 23,600 people.

During the same period, the annual employment growth rate was 1.3 percent. The highest growth rate occurred in Calumet County, while the largest increase in employment occurred in Brown County, which increased by 29,400 people.



Future Population and Employment Projections

Population in Zone 4 is projected to grow annually at 0.9 percent for both the 2008 through 2013 and 2013 through 2018 periods. From 2008 to 2013, Brown County is projected to realize the largest increase in population and the highest growth rate.

Employment in Zone 4 is projected to grow at 1.3 percent annually for both the 2008 and 2013 and 2013 through 2018 periods. From 2008 to 2013, Brown County is projected to realize the largest increase in employment, while Door County is projected to have the highest growth rate.

	1998-2008	2008-2013	2013-2018	1998-2008	2008-2013	2013-2018
Employment	Annual Growth Rate			Increase		
Zone 4	1.31	1.32	1.25	90,971	50,676	50,931
Calumet County	3.58					
Door County		1.74	1.60			
Brown County				29,363	16,806	16,813
Population						
Zone 4	0.63	0.87	0.89	67,101	48,829	52,124
Calumet County	1.25					
Brown County		1.16	1.15	23,634	14,584	15,271

Zone 4 environmental considerations

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

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

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

Zone 4 electricity demand and generation

The coincident peak load forecasts for Zone 4 for 2009, 2013, 2018 and 2023 are shown in Table ZS-11. Existing generation, along with proposed generation based on projected in-



service year, are also shown. The resultant capacity margins, with or without the proposed generation, are shown as well.

This table shows that load is projected to grow at roughly 1.6 percent annually from 2009 through 2018. Comparing load with generation (at maximum output) within the zone indicates that Zone 4 has more generation than load during peak load periods. Actual operating experience indicates that during lighter load periods, Zone 4 is a net exporter of power.

Zone 4 transmission system issues

Key transmission facilities in Zone 4 include:

- ❑ four 345-kV lines extending from the Kewaunee and Point Beach nuclear units, 138-kV network in the Fox River Valley/Green Bay area,
- ❑ two 345-kV lines extending from the Edgewater Power Plant,
- ❑ the eastern portion of the Rocky Run-North Appleton 345-kV line,
- ❑ 345-kV lines from South Fond du Lac to Columbia, Edgewater and Fitzgerald and
- ❑ a 345-kV line from Fitzgerald to North Appleton.

Key system performance issues in Zone 4 include:

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



Zone 4 - 2009 study results

Refer to Table ZS-1 and Figure ZS-13

Summary of key findings

- ❑ By 2010, construction of a new 345-kV line from Morgan to Werner West will significantly increase transfer capability between Wisconsin and the Upper Peninsula, avert overloads in and around the Green Bay area, improve 138-kV voltage profiles in the Fox Valley and Green Bay areas and significantly lower losses.
- ❑ Load growth in Marinette and Menominee areas will drive the need for additional 138/69-kV transformer capacity.
- ❑ Load growth and generation patterns in the Upper Peshtigo area will drive the need for transmission reinforcements.

Several potential line overloads were confirmed and new low voltage issues were identified in Zone 4 based on the 2009 model.

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

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

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

- rebuilding the Morgan-Falls-Pioneer-Stiles 138-kV line (2005),
- rebuilding the Plains-Amberg 138-kV line (2005),
- rebuilding/converting the West Marinette-Amberg 69-kV line to 138 kV (2005),
- rebuilding the Amberg-Crivitz-Stiles 138-kV line (2006),
- constructing a 345/138-kV Substation at Werner West (2006), and
- rebuilding the Hiawatha-Indian Lake 69-kV line (2006).

As discussed in the 2007 10-Year Assessment Update, the following projects have been planned in Zone 4 as long-term solutions to these issues:

- construct a new 345/138-kV substation at Werner West (in service),
- construct a Cranberry-Conover 115-kV line (in service),
- rebuild and convert the Conover-Plains 69-kV line to 138-kV (2010), and



- construct a new Morgan-Werner West 345-kV line (Dec 2009).

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

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

Two-1.2 MVAR distribution capacitor banks will be in service at the Sister Bay 69/24.9-kV Substation in 2008. The addition of these capacitor banks will boost the voltages in the area under normal and single-contingency conditions until longer term solutions are in place. The long-term solution may include constructing a Canal-Dunn Road 138-kV line (2012) and a Dunn Road-Egg Harbor 69-kV line (2016) which were delayed due to the planned installation of these capacitor banks. The long-term solution will address not only the potential low voltages in the area under normal and single-contingency conditions but also the potential overloads of the 138/69-kV transformers and 69-kV lines in the area under single-contingency conditions (See Zone 4-2013 study results).

Rebuilding the Crivitz-High Falls double-circuit 69-kV lines is planned for 2009 in order to address the potential overloads on the Pioneer-Sandstone 69-kV line or the Crivitz-High Falls 69-kV line and to provide voltage support in the area under normal and single contingency conditions. The 2009 in-service date is possible because of the interim load-shifting measure from the Sandstone 69-kV to the Crivitz 138-kV Substation in 2008. Due to the non-coincident nature of the load for this area and the hydro generation patterns in the area, the potential overloads and low voltage issues may also occur during off-peak periods.

A new 138/69-kV transformer at the existing Menominee 69-kV (2008) is under construction to address West Marinette and Roosevelt Road 138/69-kV transformer overloads under single-contingency conditions. The placement of a 138/69-kV transformer at Menominee, rather than replacing the transformers at West Marinette or Roosevelt Road



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will provide greater geographical diversity, while adding the needed capacity. In addition, it will provide operational and maintenance flexibility during the double-circuit outages of the West Marinette-Menominee 138- and 69-kV lines.

As discussed in earlier Assessments, the rebuild of the Sunset Point-Pearl Avenue 69-kV line would address the potential overload of the line under single-contingency conditions. The project is planned for 2009.

A new 138-kV substation at Cedar Ridge (2008) is currently under construction to accommodate the 98-MW Wind generation interconnection in Fond du Lac County. The existing Ohmstead-Kettle Moraine 138-kV line will be looped into the new substation.

The Mishicot Substation will be relocated in 2009 to accommodate a 99-MW wind generation addition in Kewaunee County.

In the summer of 2008, the North Appleton-Mason Street and North Appleton-Lost Dauphin 138-kV lines were uprated to accommodate the transmission service request associated with the Fox Energy Center wind generation.

An uprate of the North Appleton-Fox River 345-kV line was recently completed. Significant clearance violations on the line were identified in recent LiDar clearance studies. As a result, uneconomic generation redispatch was needed to relieve the loading on the line in anticipation of a North Appleton-Kewaunee 345-kV line outage. The situation became aggravated when the ATC system experienced heavy east-to-west biases in system flow. The project provides additional capacity to the line and addresses the loading issue.

New to this Assessment, installing a second 138-kV reserve auxiliary transformer at Kewaunee and removing the existing tertiary auxiliary transformer (TAT) load from the 345/138-kV transformer T10 is proposed for 2009. Implementing the project will increase the offsite power reliability and provide better operations and maintenance flexibility. With the existing Kewaunee TAT connection on T10, a T10 failure will result in the reduction of the number of offsite power sources to one independent source. This will result in the Kewaunee nuclear unit entering a 7-day Limiting Condition for Operation (LCO). If T10 cannot be replaced or repaired within those 7 days, the unit would be required to shut down. In general, the repair/replacement for a faulted transformer takes more than 7 days. Furthermore, the existing TAT connection makes T10 unavailable for maintenance outside of a refueling outage.

Also, new to this Assessment, significant new loads forecasted at the Sobieski 69-kV Substation would result in unexpected low voltages at Suamico and Sobieski 69-kV substations under normal and single-contingency conditions and heavy flow on the Pioneer-Sobieski 69-kV line under single-contingency condition. However, recent



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information from Wisconsin Public Service Corporation indicates that the new load will not be interconnected, and the load forecast at the substation will be revised in future Assessments.



Zone 4 - 2013 study results

Refer to Table ZS-2 and Figure ZS-14

Summary of key findings

- ❑ Additional reinforcements will be required in Northern Door County to facilitate maintenance outages, improve voltages and provide a second source to the area.
- ❑ Additional reinforcements are being considered at the Kewaunee Substation to improve offsite power reliability of the nuclear plant, provide operations and maintenance flexibility and provide more economical base generation to the network and marketplace under certain transmission outage conditions.

Two Northern Door County projects are being considered to address potential low voltages under normal and single contingency conditions and potential thermal overloads under single contingency conditions. The two projects consist of:

- Construct a Canal-Dunn Road 138-kV line (roughly 7.7 miles) and install a new 138/69-kV transformer at Dunn Road Substation by June 2012.
- Construct a second Dunn Road-Egg Harbor 69-kV line (roughly 15 miles) by June 2016.

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

New to this Assessment, the reconfiguration of the Kewaunee switchyard along with the addition of a second 345/138-kV transformer is being proposed in order to increase offsite power reliability for the nuclear plant, facilitate switchyard maintenance, provide more generation to the ATC footprint under certain transmission outages and to bring more economical base generation to the marketplace. This project is being considered as a joint effort with Dominion Energy with a tentative in-service date of 2011.

A provisional project for replacing the metering current transformer at the North Mullet River 69-kV Substation is scheduled for 2011 to address a potential overload of the North Mullet River-Mullet River 69-kV line under single-contingency conditions. In order to obtain an accurate analysis, the ratings of the line are under investigation. Depending on the ratings of the line, the in-service date of the project may need to be adjusted.



Zone 4 – 2018 study results

Refer to Table ZS-3 and Figure ZS-15

Summary of key findings

- ❑ Load growth in the northern Brown County will drive the need for system reinforcements.
- ❑ Additional reinforcements are needed due to load growth in the Oshkosh, Manitowoc and eastern Calumet County areas.

A provisional project to rebuild and convert the Bayport-Pioneer 69-kV line to 138-kV operation is tentatively scheduled for 2016. This project would provide network service to the currently radially-served Bayport, Suamico and Sobieski and address potential low voltages and thermal overloads under single-contingency conditions.

Several capacitor bank projects have been deferred and are now scheduled for the 2015-2018 timeframe. Additional adjustment of the in-service dates may be needed upon further analysis. Those projects are:

- Install 2-16.3 MVAR capacitor banks at the Mears Corners 138-kV Substation (2015) - This provisional project is to address the potential low voltage issues in the Woodenshoe, Mears Corners, and Sunset Point areas under single contingency conditions until additional reinforcements are implemented in the area. The provisional project has been deferred from 2011 to 2015 primarily due to an updated load model in the area.
- Install 2-16.3 MVAR capacitor banks at the Rosiere 138-kV Substation (2015) - This provisional project is to address the potential low voltage issue in the Ontario, Dyckesville, and Rosiere areas under single contingency conditions until additional reinforcements are implemented in the area. Due to the uncertainty of load demand in the area, a detailed study needs to be done for an accurate in-service date. The provisional project has been deferred from 2011 to 2015 primarily due to an updated load model in the area.
- Install 1-28.8 MVAR capacitor bank at the Butternut 138-kV Substation (2016) –This provisional project is to address potential low voltages at the Butternut, Forward Energy Center and Hickory 138-kV substations under single contingency conditions. The project has been deferred from 2015 to 2016 due to an updated load model in the area.
- Install 2-16.3 MVAR capacitor banks at the Aviation 138-kV Substation (2018) – This provisional project is to address the potential low voltage issues at the Progress and Ellinwood Substations under single contingency conditions. The project has been deferred from 2015 to 2018 due to updated load model in the area.



A new 138-kV line project is proposed to address potential heavy flows on the Shoto-Mirro-Northeast-Revere 69-kV line or the Shoto 138/69-kV transformer under single-contingency conditions during non-peak periods under certain generation patterns. The project includes constructing a new Shoto to Custer 138-kV line and installing a new 138/69-kV transformer at Custer Substation. This project has been deferred from 2014 to 2016 based upon updated generator information. In addition, the in-service date may need to be adjusted after a more detailed study is completed (such as economic benefit analysis).

A provisional project for replacing the two existing Glenview 138/69-kV transformers is scheduled for 2014. It would address the potential overload of the transformers under single contingency conditions. The transformer overloads are primarily due to higher load demand at Brillion Iron Works (BIW). This project may be able to be deferred several years by swapping the loads on the Glenview 69-kV and 138-kV buses.

In the 2018 summer peak timeframe, the two 138/69-kV transformers at the Sunset Point Substation would be overloaded under single contingency conditions. To address these overload issues, replacing the two existing transformers with larger transformers is proposed for 2018. The project has been deferred from 2015 to 2018 due to an updated load model in the area. In addition, the in-service date may need to be adjusted further depending on the analysis performed in the 2009 10-Year Assessment.

Replacing the 1200A breaker at the Edgewater T22 345/138-kV transformer is proposed for 2018 to address potential transformer overloads under single contingency conditions. The project has been deferred from 2014 to 2018 due to an updated load model in the area. The in-service date may need to be adjusted further depending on the analysis performed in the 2009 10-Year Assessment.

Upgrading the Melissa-Tayco 138-kV line (0.16 miles) is scheduled for 2016 to address the line overload under single contingency conditions and certain generation patterns. The project has been deferred from 2014 to 2016 based on updated generation dispatch information. The in-service date may need to be adjusted further depending on the results of an economic benefit analysis and system studies performed in the 2009 10-Year Assessment.

Due to generation retirements and/or updated load forecast information, several projects have been cancelled. Those projects are:

- replacing the existing 138/69-kV transformer at South Sheboygan Falls with a 100 MVA transformer,
- reconductoring Pulliam-Danz-Henry Street and Pulliam-Van Buren 69-kV lines, and
- constructing the Northside-City Limits 138-kV line.



Zone 4 – 2023 study results

Refer to Table ZS-4 and Figure ZS-17

Summary of key findings

- Load growth in the Sheboygan and northern Ozaukee Counties may drive the need for system reinforcements.
- Additional reinforcements may be needed due to the load growth in the Appleton area.
- Additional reinforcements may be needed due to load growth in central Kewaunee County.

Transmission reinforcements appear to be needed in the Sheboygan, Kewaunee, and Green Bay areas. The reinforcements listed below are based upon our preliminary analysis to address system problems under single-contingency conditions. Further adjustments will be made to reflect needs as well as in-service dates in the upcoming 2009 10-year Assessment.

- Between 2019 and 2023, additional transmission reinforcements such as installing capacitor banks may be needed to boost the voltages at the Holland, Plymouth #4 and Howards Grove 138-kV substations under single contingency conditions.
- Heavy flows on the 138-kV lines around the City Limits 138-kV Substation may occur under single-contingency conditions. The City Limits-Maes 138-kV line ratings are currently under review. A detailed study will be performed with the updated/validated line ratings during the 2009 10-Year Assessment to identify the need year of this project. Constructing a second North Appleton-Apple Hills 138-kV line could be one of alternatives studied to address the heavy flow issues.
- Uprating the Edgewater-Washington 69-kV line may be needed in the 2022 timeframe to address line overloads under single-contingency conditions.
- Additional transmission reinforcements such as adding a second 138/69-kV transformer at the East Krok Substation may be needed in the 2024 timeframe to boost voltages at the 69-kV substations along line J-10 under single-contingency conditions.
- Additional transmission reinforcements such as rebuilding the existing Oak Street-Ashland 69-kV line may be needed in the 2023 timeframe to address line overloads under single-contingency conditions.

With the Kewaunee bus reconfiguration and the addition of a second 345/138-kV transformer project expected to be in-service by 2011, the next equipment limiting the generation at the Kewaunee Nuclear Power Plant under certain transmission outage conditions is the Kewaunee-East Krok 138-kV line. If additional generation from Kewaunee is desired, transmission reinforcements such as uprating the Kewaunee-East Krok 138-kV line will be required.



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Summary of Compliance with NERC Standards

The mitigation plans, planned, proposed and provisional projects identified for Zone 4 in this Assessment will allow the ATC system in Zone 4 to meet NERC standards TPL-001, TPL-002, TPL-003 and TPL-004 in each of the four years 2009-2013, and for the 2014-2018 planning horizon.

**TABLE ZS-1
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2009 Summer Peak, 70% High Transfer and 90% East-to-West Bias Cases**

Planning Zone	Criteria Exceeded/Need	2009 Summer Peak Case		2009 High Transfer Case		2009 90% E-W Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
1	Sigel and Lakehead Vesper 138-kV bus voltages	–	91 – 92%	–	–	–	–	Arpin-Sigel 138-kV line	Publicly announced load curtailments
1	Council Creek and Petenwell 138-kV bus voltage	–	90 – 95%	–	–	–	91%	Base Case Saratoga-Petenwell 138-kV line	Monroe County – Council Creek 161-kV line
1	Necedah, Whistling Wings, Dellwood, and Friendship 69-kV bus voltages	–	90 – 92%	–	–	–	91 – 92%	Petenwell 138/69-kV transformer Petenwell-Big Pond 69-kV line Big Pond-Necedah tap 69-kV line	Mckenna capacitor bank expansion
1	Wien – Stratford 115-kV line	99 – 105%		103.5%	–	–	–	Arpin 345/138-kV transformer Arpin 138/115-kV transformer Arpin-Galvin 115-kV line Galvin-Hume 115-kV line	Use recently validated circuit ratings
2	Delta – Mead 69-kV line	103-163 %	-	95-111%	-	103-161%	-	Base Case 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	Dispatch local generation
2	Chandler – Delta 69-kV #1 line	109%	-	118%	-	109%	-	Chandler-Delta 69-kV #2 line	Dispatch local generation
2	Chandler – Delta 69-kV #2 line	103%	-	113%	-	103%	-	Chandler-Delta 69-kV #1 line	Dispatch local generation
2	Chandler 138/69-kV transformer	95-104%	-	101-102%	-	98-104%	-	Nordic-Mountain 69-kV line Mountain-Harris Tap 69-kV line Forsyth 138/69-kV transformer	Increased existing summer emergency rating from SELD
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	124-162%	-	98%-109%	-	121%-158%	-	Delta-Mead 69-kV line	Dispatch local generation
2	Pine River – Straits 69-kV line	104%-108%	-	-	-	103%-106%	-	Hiawatha-Lakehead 138-kV line Lakehead-Brevort 138-kV line Brevort-Straits 138-kV line	Dispatch of hydro and/or diesel generation
2	Straits– Evergreen 69-kV line Evergreen-Pine River 69-kV line	95%-105%	-	-	-	96%-104%	-	Hiawatha-Lakehead 138-kV line Lakehead-Brevort 138-kV line Brevort-Straits 138-kV line	Dispatch of hydro and/or diesel generation
2	Valley, Evergreen, Indian Lake, St. Ignace, Blaney Park, Curtis, Gould City, Straits, Engadine, Hiawatha 69-kV bus voltages	-	105.2%-105.8%	-	105.0%-105.6%	-	105.1% - 105.7%	Base Case	Operating guide
2	Engadine, Newberry Village, Lou Pac, Newberry, Newberry Hospital, Newberry Hospital Tap, Roberts, Hulbert, Eckerman, Raco 69 kV bus voltages	-	80.9%-91.4%	-	-	-	80.3%-91.3%	Hiawatha-Engadine 69-kV line Engadine-Newberry 69-kV line	9 Mile/Roberts 69-kV capacitor banks
2	Atlantic 138-kV bus voltage	-	88.9%	-	-	-	-	Atlantic-M-38 138-kV line outage	Operating guide
2	Iron Grove, Twin Lake 69-kV bus voltages	-	88.0%-88.9%	-	-	-	-	Twin Lake -Lakota Rd 138-kV line Twin Lake-Iron Grove 138-kV line	Operating guide
3	North Stoughton-Stoughton East – Stoughton 69-kV line	136.3% - 96.9%	–	–	–	119.4% - 103.2%	–	McCue-Harmony 69-kV line Harmony-Lamar 69-kV line Lamar-Fulton 69-kV line	Rebuild Stoughton Substation bus

TABLE ZS-1 (continued)
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2009 Summer Peak, 70% High Transfer and 90% East-to-West Bias Cases

Planning Zone	Criteria Exceeded/Need	2009 Summer Peak Case		2009 High Transfer Case		2009 90% E-W Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
3	Verona-Sun Valley-Oregon 69-kV line	121.3%	–	–	–	105.9%	–	Stoughton-Aaker 69-kV line	Rebuild the Y-119 Verona to Oregon 69-kV line
3	McCue-Harmony-Lamar 69-kV line	111.6% - 95.2%	–	–	–	99.6% - 97.2%	–	Kegonsa 138/69-kV transformer Kegonsa-North Stoughton 69-kV line North-Stoughton-Stoughton E 69-kV line	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
3	Fitchburg-Syene 69-kV line	101.1%	–	–	–	–	–	Royster-Pflaum Tap 69-kV line	Loop 6947 Nine Springs-Pflaum 69-kV line into Femrite Substation
3	Stage Coach-Black Earth 69-kV line	98.3%	–	–	–	97.7%	–	Spring Green 138/69-kV transformer	Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating
3	Royster-Pflaum Tap 69-kV line	97.8%	–	–	–	–	–	Fitchburg-Syene 69-kV line	Loop 6947 Nine Springs-Pflaum 69-kV line into Femrite Substation
3	Enzyme Bio Systems-RC3 69-kV line	97.7%	–	–	–	98.1% - 95.5%	–	Colley Road – Dickinson 138-kV line	Operating guide
3	McCue-Harmony 69-kV line	95.2%	–	–	–	–	–	Brodhead Switching Station-Brodhead South 69-kV line	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
3	Concord, Rubicon, Hustisford, Hubbard and Butler Ridge 138-kV buses	–	93.4% - 94.7%	–	–	–	94.1% -94.8%	Base Case	Dispatch local generation
3	Harmony, Lamar, Fulton, Saunders Creek, Dana Corp, Sheepskin and Evansville 69-kV buses	–	83.6% - 91.8%	–	90.5% - 91.5%	–	86.8% - 91.5%	McCue-Harmony 69-kV line Harmony-Lamar 69-kV line Lamar-Fulton 69-kV line	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
3	Lakehead Cambridge Tap, Fort Atkinson, Jefferson, Crawfish, Concord ,Hubbard, Hustisford, Rubicon and Butler Ridge 138-kV buses	–	86.4% - 91.5%	–	–	–	88.3% - 91.8%	Rockdale to Lakehead Cambridge Tap 138-kV line Lakehead Cambridge Tap-Jefferson4 138-kV line Jefferson4-Jefferson 5 Bus outage Jefferson5-Crawfish 138-kV line Crawfish-Concord4 138-kV line Plus other less severe outages	Dispatch local generation

TABLE ZS-1 (continued)
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2009 Summer Peak, 70% High Transfer and 90% East-to-West Bias Cases

Planning Zone	Criteria Exceeded/Need	2009 Summer Peak Case		2009 High Transfer Case		2009 90% E-W Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
3	Brodhead Muni 3, Brodhead Muni 2, Brodhead, Brodhead Muni 1, RCEC Orfordville, Orfordville, Bass Creek, Footville, RCEC Center, Evansville 69-kV bus voltages	–	88.2% - 91.7%	–	–	–	90.7% - 92%	Brodhead Switching Station-Brodhead Muni 3 69-kV line Brodhead Muni 2 – Brodhead Muni 3 69-kV line Brodhead Muni 2-Brodhead 69-kV line	Upgrade Sheepskin capacitor bank from 10.8 MVAR to 16.2 MVAR and Install 5.7 MVAR distribution capacitor bank at Union Townline 69-kV Substation
3	Aaker, Oregon and Brooklyn 69-kV buses	–	88.2% - 89.5%	–	–	–	–	Stoughton-Aaker 69-kV line	Rebuild the Y-119 Verona to Oregon 69-kV line
3	Spring Green, Arena, Mazomanie, Mazomanie Industrial, Lone Rock, Muscododa, Avoca, Blue River, Boscobel, Boscobel Muni 69-kV bus voltages	–	88.5% - 91.4%	–	–	–	90.5% - 91.7%	Spring Green 138/69-kV transformer	Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation
3	Hubbard and Hustisford 138-kV buses	–	89.1% - 89.7%	–	88.5% -89.3%	–	–	Rubicon-Hustisford 138-kV line Hubbard-Hustisford 138-kV line	Adjust load tap changer at Hubbard
3	Dickinson, Global Renewable Energy, William Bay and Brick Church 138-kV buses	–	90.0% - 91.2%	–	89% - 91.5%	–	89.1% - 91.7%	Colley Road – Dickinson 138-kV line Dickinson-Global Renewable Energy 138-kV line Global Renewable Energy-Brick Church 138-kV line	Install a total of 6.3 MVAR distribution capacitor banks at Dickinson Substation and Install one temporary 12.45 MVAR 69-kV mobile capacitor bank at Brick Church Substation
3	Eden and Lancaster 138-kV buses	–	90.4% - 91.7%	–	–	–	–	Nelson Dewey-Lancaster 138-kV line Lancaster-Eden 138-kV line	Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation
3	N Stoughton, Stoughton E, Stoughton and Aaker 69-kV buses	–	91.2% - 91.5%	–	–	–	–	N Stoughton-Kegonsa 69-kV line	Rebuild the Y-119 Verona to Oregon 69-kV line and Construct new Oak Ridge-Verona 138-kV line and install a 138/69-kV transformer at Verona with a 100 MVA summer normal rating
3	Muscododa and Avoca 69-kV buses	–	91.3% - 91.7%	–	–	–	91.9%	Spring Green-Lone Rock 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	Paddock 345/138 kV transformer	–	–	107.7%	–	–	–	Base case	Dispatch local generation
3	Paddock-Townline 138-kV line	–	–	103.1%	–	–	–	Base case	Dispatch local generation
3	Paddock-Townline 138-kV line	–	–	123.3% - 113.8%	–	–	–	Paddock-NW Beloit 138-kV line NW Beloit-Blackhawk 138-kV line Blackhawk-Colley Road 138-kV line	Dispatch local generation
3	Paddock-NW Beloit-Blackhawk-Colley Road 138-kV line	–	–	116.8% - 105.5%	–	–	–	Paddock-Townline 138-kV line	Dispatch local generation

TABLE ZS-1 (continued)
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2009 Summer Peak, 70% High Transfer and 90% East-to-West Bias Cases

Planning Zone	Criteria Exceeded/Need	2009 Summer Peak Case		2009 High Transfer Case		2009 90% E-W Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
3	Huiskamp-Mendota-Ruskin 69-kV line	–	–	106.5% - 98.9%	–	–	–	North Madison-Vienna 138-kV line Vienna-Yahara River 138-kV line Yahara River-American Center 138-kV line American Center-Sycamore 138-kV line	Dispatch local generation
3	N Stoughton-Stoughton E-Stoughton 69-kV line	–	–	113.9% - 104.4%	–	–	–	Paddock 345/138 kV transformer Paddock-Wempletown 345-kV lines	Dispatch local generation
3	North Monroe-Darlington 138-kV line	–	–	100.8%	–	–	–	Paddock 345/138 kV transformer Paddock-Wempletown 345-kV lines	Dispatch local generation
3	Brick Church 138-kV bus	–	–	–	94.9%	–	–	Base case	Dispatch local generation
3	Brick Church, Global Renewable Energy, North lake Geneva, William Bay, Elkhorn, Bristol, Sugar Creek and Bluff Creek 138-kV buses	–	–	–	90.8% - 91.8%	–	–	Burlington 138-kV Bus tie outage	Dispatch local generation
3	Potosi, Hillman, Lafayette wind, Darlington, Albany and North Monroe 138-kV buses	–	–	–	87.3% - 91.8%	–	–	Nelson Dewey-Potosi 138-kV line Potosi-Hillman 138-kV line Hillman-Lafayette Wind 138-kV line	Dispatch local generation
3	Entire Rock County and Walworth County 138-kV bus voltages	–	–	–	86.8% - 91%	–	–	Paddock 345/138 kV transformer Byron-Wempletown 345 kV line Paddock-Wempletown 345-kV line	Dispatch local generation
3	McCue-Harmony 69-kV line	96.5%	--	--	--	--	--	Columbia generator unit 1 or 2	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
4	West Marinette 138/69-kV transformer #1	96.6-95.1%	–	–	–	–	–	Wells St-Roosevelt 69-kV line Roosevelt 138/69-kV transformer	- Expand the Menominee 69-kV Substation and install 138-kV terminals. Loop the West Marinette-Bay De Noc 138-kV line into the Substation - Install 138/69-kV transformer at the expanded Menominee Substation
4	Sunset Point-Pearl Ave 69-kV line	104.8%	–	–	–	–	–	Ellinwood-Twelfth Ave 69-kV line	- Rebuild 2.37 miles of 69 kV from Sunset Point to Pearl Ave with 477 ACSR
4	Pioneer-Sobieski 69-kV line	99.6%	–	–	–	–	–	Pulliam-Suamico 69-kV line outage followed by Sobieski-Pioneer 69-kV line close	Rebuild/Convert Bayport-Suamico-Sobieski-Pioneer 69-kV line to 138 kV
4	Sobieski 69-kV bus	–	93.9%	–	–	–	94.8%	Base Case	Rebuild/Convert Bayport-Suamico-Sobieski-Pioneer 69-kV line to 138 kV

TABLE ZS-1 (continued)
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2009 Summer Peak, 70% High Transfer and 90% East-to-West Bias Cases

Planning Zone	Criteria Exceeded/Need	2009 Summer Peak Case		2009 High Transfer Case		2009 90% E-W Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
4	Suamico 69-kV bus	-	91.6%	-	-	-	-	Pulliam-Suamico 69-kV line outage followed by Sobieski-Pioneer 69-kV line close	Rebuild/Convert Bayport-Suamico-Sobieski-Pioneer 69-kV line to 138 kV
4	Bluestone, Wesmark 69-kV buses	-	89.3-91.5%	-	-	-	-	Finger Rd-Bluestone 69-kV line outage	Construct a new 138-kV substation and loop Highway V-East Krok 138-kV line into the substation
5	Concord 138 kV bus Bark River 138 kV bus Cooney 138 kV bus Cottonwood 138 kV bus Germantown 138 kV bus Hartford 138 kV bus Merrill Hills 138 kV Maple 138 kV bus Summit 138kV bus	-	93.5 % 94.2 % 92.8 % 93.1 % 93.6 % 94.9 % 94.7 % 94.1 % 92.9 %	-	-	-	-	Intact System	Dispatch local generation
5	Concord, Cooney, Cottonwood, Summit, Bark River 138-kV bus voltages	-	90.6 – 91.8% 87.8 – 90.6 % 87.7 – 91.0 % 88.0 – 91.4 % 89.1 - 91.0 %	-	- - - - -	-	91.8 -- 91.9% 89.5 -- 91.9% 88.9 – 90.4 % 89.5 – 90.7 % 91.1 – 91.7 %	Jefferson–Lakehead – Rockdale 138-kV line Jefferson-Crawfish River – Concord 138-kV line Bark River – Cottonwood 138-kV line Bark River – Sussex 138-kV line Maple – Saukville 138kV line Plus other less severe outages	Dispatch local generation
5	Germantown and Maple 138-kV bus voltages	-	88.7% 83.8 – 84.1% 89.4 – 90.4%	-	-	-	91.1 % 87.3 – 87.6 % 91.1 – 91.9%	Germantown – Maple 138kV line Maple - Saukville 138kV line Bark River – Sussex 138kV line	Dispatch local generation
5	Hartford 138-kV bus voltage	-	86.8%	-	-	-	88.6 %	Hartford – St. Lawrence 138kV line	Load shifting
5	Bain 345/138-kV transformer	159.0%	-	130.7%	-	159.1%	-	Pleasant Prairie bus split between buses 3 and 4	Dispatch local generation
5	Albers – Bain 138-kV line	97.6%	-	-	-	102.7%	-	Bain – Kenosha 138-kV line	Dispatch local generation
5	Oak Creek 345/230-kV transformer (T884)	97.5%	-	-	-	-	-	Oak Creek 230-kV bus split between buses 6 & 7	Dispatch local generation
5	Arcadian4 – Waukesha1 138-kV line	-	-	-	-	98.2%	-	Arcadian6 – Waukesha3 138-kV line	Dispatch local generation
5	Arcadian6 – Waukesha3 138-kV line	-	-	-	-	97.4%	-	Arcadian4 – Waukesha1 138-kV line	Dispatch local generation
5	Albers – Paris 138-kV line	-	-	100.7%	-	-	-	Paddock 345/138-kV transformer	Dispatch local generation
5	Harbor – Kansas 138-kV line	-	-	92.6% 93.2% 93.6% 94.6%	-	-	-	Montana – Dewey 138-kV line Dewey 138-kV bus tie outage Dewey – Norwich 138-kV line Kansas – Norwich 138-kV line	Dispatch local generation
5	Tichigan and Burlington 138-kV buses	-	-	-	89.3-89.6%	-	91.6%	Burlington 138-kV bus split	Load shift
5	Albers- Kenosha 138-kV line	-	-	111.3%	-	113.3%	-	Albers – Bain 138-kV line	Dispatch local generation
5	Root River – Oak Creek 138-kV line	-	-	-	-	101.2%	-	Albers – Paris 138-kV line	Dispatch local generation
5	Tichigan, Burlington and Air Liquide 138-kV buses	-	-	-	91.3-92.0%	-	-	Paddock 345/138-kV transformer	Load shift

TABLE ZS-1 (continued)
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2009 Summer Peak, 70% High Transfer and 90% East-to-West Bias Cases

Planning Zone	Criteria Exceeded/Need	2009 Summer Peak Case		2009 High Transfer Case		2009 90% E-W Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
5	Arcadian 345/138-kV transformer #3	- 106.0%	-	108.0% 94.1%	-	100.2% 106.4%	-	Arcadian 345-kV bus and Arcadian transformer #2 Arcadian transformer #1	Dispatch local generation (temporary) Arcadian transformer (provisional permanent solution)
5	Arcadian 345/138-kV transformer #2	96.0 %	--	--	--	97.5%	-	Arcadian transformer #1	Generation redispatch (temporary) Arcadian transformer (provisional permanent solution)

