Based on an investigation by the Ameren Transmission Line Design group, a new maximum allowable conductor temperature of 120°C has been established for ACSR line conductors. Use of this maximum conductor temperature would be for circuits that have undergone a verification that clearances are adequate and that the appropriate line hardware has been installed to allow for the high temperature operation.

Stranded Conductor Rating Parameters

Rating Parameter	Ameren
Coefficient of Emissivity	0.5
Solar Absorption Constant	0.5
Wind Velocity	2 ft/sec
Duration of Emergency Rating	8 hours continuous
Wind Angle	90° to conductor
Summer Ambient Temperature	40 °C
Winter Ambient Temperature	10 °C
Latitude	38° N
Elevation above Sea Level	470 ft
Time of Day – Summer	2:00 p.m.
Time of Day – Winter	12:00 p.m.
Direction of Line	East-West
Sun Angle of Declination - Summer	27°
Sun Angle of Declination - Winter	0°
Solar Heating Constant - Summer	93 Watts/sq. foot
Solar Heating Constant - Winter	82.2 Watts/sq. foot

4.5.2.2 Minimum Clearances for Transmission Lines

Prior to 2011, transmission lines were assigned a clearance rating based on design drawings and the minimum allowable clearances as dictated by the applicable National Electrical Safety Code (NESC) or other governing body in effect at the time that the line was constructed, or by Ameren transmission line design criteria. As of the date of this filing, this verification effort is scheduled to be completed by December 31, 2013, but could change based on a variety of factors and constraints. If the effort is expected to extend beyond the three year NERC-established period, a revised project plan will be submitted to SERC, Ameren’s Regional Entity.

4.5.2.3 Bundled Conductors

Bundled conductors in transmission lines are assigned ratings based on the sum of the individual conductor ratings for both normal and emergency conditions. No rating reduction is necessary to account for the “proximity effect” heating because the spacing between bundled conductors is at least 12 inches, and the current carrying requirements of the conductors are 3000 A or less. For additional information, refer to Item #6 and Table 11 of Ameren’s Transmission and Distribution Design Department Standard No. 8G, "Design Guide for Outdoor Substation Conductor Current Ratings", dated June 10, 2004.

4.5.2.4 Line Hardware

The appropriate line hardware is selected by the Ameren Transmission Line Design group to meet or exceed the operating temperature requirements of the line conductors. All ACSR lines would be limited to a maximum of 110 degrees C operation unless Transmission Line Design has reviewed the line construction and equipment to determine if the appropriate line hardware is adequate for a maximum operating temperature of 120 degrees C.

4.5.2.5 Line Switches

Unless specific values have been provided by transmission line design engineers, disconnect switches are rated at their manufacturer’s nameplate continuous current rating for all conditions. No allowance is made for seasonal temperature differences or emergency operation, even though most disconnect switches have some additional capability during winter peak conditions or less than 40 °C ambient temperatures. See Appendix I for those situations where rating above nameplate may be allowed.

4.5.3 Substation Equipment Ratings

Substation equipment ratings consider the minimum capabilities of the substation conductors, substation and terminal equipment, and relay limits based on seasonal ambient conditions. Manufacturer’s nameplate continuous ratings are generally used to rate substation equipment connected at the transmission voltage level. Unless otherwise stated, only the ambient temperature is adjusted for seasonal ratings for Ameren electrical substation equipment.

The general loading philosophy for Ameren's transmission substation equipment follows the same philosophy as transmission line and transformer loading.

4.5.3.1 Substation and Bus Conductor Ratings

In determining the current carrying capability of various types of conductors used in Ameren Substations, reliance is placed on Ameren’s Transmission and Distribution Design Department Standard No. 8G, "Design Guide for Outdoor Substation Conductor Current Ratings", dated June 10, 2004. The philosophy for rating stranded substation conductors follows the same philosophy for rating stranded line conductors (see section 4.5.2.1 above) except for differences in allowable conductor operating temperatures, as noted below:

Substation Conductor Operating Temperatures

Conductor Type	Ameren Normal	Ameren Emergency
Cu	90° C	100° C
Al	90° C	100° C

Ratings for rigid substation conductors are based on the IEEE Guide for the Design of Substation Rigid-Bus Structures 605-1998, and are also provided in Transmission and Distribution Design Department Standard No. 8G.

4.5.3.2 Circuit Breakers and Switchers

Unless specific values have been provided by substation design engineers, circuit breakers and switchers are rated at their nameplate continuous current rating for all conditions. No allowance is made for seasonal temperature differences or emergency operation even though most breakers have some additional capability during winter peak conditions or less than 40 °C ambient temperatures. See Appendix I for those situations where rating above nameplate may be allowed.

4.5.3.3 Disconnect Switches

Unless specific values have been provided by substation design engineers, disconnect switches are rated at their nameplate continuous current rating for all conditions. No allowance is made for seasonal temperature differences or emergency operation even though most disconnect switches have some additional capability during winter peak conditions or less than 40 °C ambient temperatures. See Appendix I for those situations where rating above nameplate may be allowed.

4.5.3.4 Wave (Line) Traps

Unless specific values have been provided by substation design engineers, wave (line) traps are rated at their nameplate continuous current rating for all conditions. No allowance is made for seasonal temperature differences or emergency operation even though most wave traps have some additional capability during winter peak conditions or less than 40 °C ambient temperatures. See Appendix I for those situations where rating above nameplate may be allowed.

4.5.3.5 Current Transformers

Unless specific values have been obtained from substation design or system protection engineers, current transformers are rated at their connected ratio for all conditions and considering the thermal rating factor. No allowance is made for seasonal differences even though most current transformers have some additional capability particularly during winter peak conditions or less than 40 °C ambient temperatures. See Appendix I for those situations where rating above nameplate may be allowed. CT ratings incorporate the associated thermal rating of all secondary connected wiring, metering, and protective devices. Ratios of current transformers used in protective relaying are selected so as not to overburden the secondary of the CTs or the protective relaying devices.

4.5.3.6 Series Reactors

Unless specific values have been obtained from substation design engineers, series reactors (inductors) are rated at their nameplate continuous current rating for all conditions. No allowance is made for seasonal differences even though most series reactors have some additional capability at less than 40 °C ambient conditions.

4.5.3.7 Relay Load Limits

Relay Load Limits (RLL) are provided by the System Protection group of Transmission & Distribution Design. Relay Load Limits consider the CT ratios in the protective relaying circuits and the trip settings are selected such that they would not exceed the thermal ratings of the relays (typically 10 A secondary), based on the following:

For the longest reaching distance relay used for step distance or pilot schemes, the Relay Load Limit is calculated as follows:

For non-critical facilities 200 kV and below, the Relay Load Limit is calculated as:

$$RLL = 0.7 * \text{I-base} / [\ \text{Zpu-reach} * \cos(\angle \text{Z-relay} - 26^\circ)\ ]$$

Where the 0.7 is a multiplier and 26° corresponds to a 90% lagging power factor.

For critical facilities, which include all 230 and 345 kV lines and other 138 and 161 kV lines listed with SERC Reliability Region, the Relay Load Limit is calculated per NERC criteria as:

RLL = 0.85 ∗ I-base / [1.5 ∗ Zpu-reach ∗ cos(/Z-line - 30°)]

Where the multiplier of 0.85 considers low system voltage, the multiplier of 1.5 considers overcurrent, and 30° corresponds to an 86.6% lagging power factor.

Technical exceptions to the above Relay Load Limit requirements for critical facilities are allowed per published NERC reliability standards. No allowances are made for seasonal differences or emergency operation. The Relay Load Limit methodology is further documented in Transmission and Distribution Design Department Standard No.15G.

4.5.3.8 Shunt Reactors

Unless specific values have been obtained from substation design engineers, shunt reactors (inductors) are rated at their nameplate rating, adjusted for nominal system voltage, for all conditions.

4.5.3.9 Shunt Capacitors

Unless specific values have been obtained from substation design engineers, shunt capacitors are rated at their nameplate rating, adjusted for nominal system voltage, for all conditions.

4.5.3.10 Protective Relaying Devices

Unless specific values have been obtained from System Protection engineers, protective relay devices are rated at their manufacturer specified rating for all conditions. Thermal limits of protective relaying devices are incorporated within the CT ratings.

5.0 GLOSSARY OF TERMS

Adequacy

Adequacy is the ability of the bulk electric power system to supply the aggregate electrical power and energy requirements of the customers at all times, considering scheduled and unscheduled outages of system components.

Bulk Substation

On the Ameren system, bulk substations provide transformation from transmission to subtransmission voltage levels. In general, these substations step the voltage down from 138 kV to 34.5 kV in the St. Louis Metropolitan area and close-in Regional areas, and from 161 kV to either 34.5 kV or 69 kV in the outer Regional areas.

Collapse

The uncontrolled loss of customer load over a widespread area (usually referred to in a system context). System collapse can generally be attributed to cascading transmission outages, islanding situations with a large imbalance between available generation and connected load, or excessive power imports without sufficient local area reactive support to maintain system voltages.

Emergency Operation

Emergency Operation is the period of time when one or more transmission elements (line, generator, or transformer) would experience a forced outage. Emergency ratings, based on eight hours duration, would be applied to equipment loadings and all system voltages should fall within emergency ranges.

Facility

A collection of electrical components, such as breakers, disconnect switches, CTs, wavetraps, overhead line conductors and substation conductors, which, when assembled together, function as a single unit.

FCITC

First Contingency Incremental Transfer Capability (FCITC) is the maximum amount of power in excess of the base case interchange schedule that can be safely transferred in a specific direction under peak load conditions without any facility becoming loaded above its emergency rating following the outage of the most critical element.

FCTTC

First Contingency Total Transfer Capability (FCITC) is the algebraic sum of the FCITC and the base interchange schedule in the direction of interest.

IITC

Incremental Transfer Capability is the amount of power, in excess of the base case interchange schedule that can be transferred over the transmission network without giving consideration to the effect of transmission facility outages.

Interconnection Reliability Operating Limit (IROL)

The value (such as MW, Mvar, Amperes, Frequency or Volts) derived from, or a subset of the System Operating Limits (SOL), which if exceeded, could expose a widespread area of the Bulk Electric System to instability, uncontrolled separation(s) or cascading outages.

MISO

Midwest Independent System Operator

NERC

NERC is the North American Electric Reliability Corporation, an organization consisting of eight regional reliability councils and one affiliate, which encompasses all of the power systems of the continental United States, the seven bordering provinces of Canada, and the Baja California area of Mexico.

Normal Operation

Normal Operation is the period of time when all transmission facilities are either in service or one or more scheduled outages are in effect. Continuous or normal ratings would be applied to equipment loadings and all system voltages should fall within normal ranges.

One-in-Ten Load Level

One-in-ten load levels are based on the statistical probability of the Ameren system load reaching or exceeding this level only once in ten years. This load level is used to model Ameren system loads for some short-term operational studies, and for specific local area bulk supply studies. This is also referred to as the 90/10 forecast load level.

One-in-Two Load Level

One-in-two load levels are based on the statistical probability of the Ameren system load reaching or exceeding this level once in two years. This load level is typically used for Ameren miscellaneous transmission planning studies, SERC studies, and other transfer capability studies. This is also referred to as the 50/50 forecast load level.

Operating Guide

An Operating Guide is an operating procedure that is considered available for use in determining transfer capabilities if implemented on a precontingency basis or on a post-contingency basis without operator intervention. In addition to this, an operating guide requiring operator intervention on a post-contingency basis would also be considered if the affected system will withstand any resulting overloads until the operating guide is implemented and no undue burden is placed on neighboring systems. An Operating Guide could involve the redispatch of local generation or the manual switching of transmission elements. An operating guide would only be considered as a short-term solution to a transmission loading problem as a result of single contingency conditions until additional facilities can be constructed. For beyond single contingency conditions, the use of an operating guide would be permitted for an extended period until system reinforcement is implemented.

Reliability

Reliability in a bulk electric power system is the degree to which the performance of the elements of that system results in power being delivered to customers within accepted standards and in the amount desired. The degree of reliability may be measured by the frequency, duration, and magnitude of adverse effects on consumer service. Bulk electric power system reliability can be addressed by considering two basic and fundamental aspects of the bulk power system - Adequacy and Security.

RFC

Reliability*First* Corporation -- A regional reliability organization (RRO) formed in June, 2005 by the combination of many of the members of the East Central Area Reliability Coordination Agreement (ECAR), Mid-Atlantic Area Council (MAAC), and Mid-America Interconnected Network (MAIN), three regional reliability organizations (RROs) of the North American Electric Reliability Corporation (NERC). The purpose of Reliability*First* is to preserve and enhance electric service reliability and security of the interconnected electric system and to be a regional entity under the framework of NERC or other entity established under the recently signed U.S. federal energy legislation.

Safe Loading Limit

The safe loading limit is the limit to which a particular line or transformer may be loaded under a specific set of circumstances so that, if another facility is suddenly outaged, the facility in question would load to no higher than its emergency rating. Ameren's Transmission Planning generally recognizes this philosophy.

Security

Security is the ability of the bulk electric power system to withstand sudden disturbances such as electric short circuits or the unanticipated loss of system components.

SERC

SERC is the Southeastern Electric Reliability Council, Inc., one of the eight reliability organizations of NERC, and it is composed of members from Alabama, Arkansas, the Carolinas, Georgia, Illinois, Iowa, Kentucky, Mississippi, Missouri, Oklahoma, Tennessee, Texas, and Virginia. SERC is divided into five subregions: Entergy, Gateway, Southern, TVA, and Virginia-Carolinas area. Its primary purpose is to promote, coordinate, and insure the reliability and adequacy of the bulk power supply systems in the area served by its Member Systems.

Subtransmission

On the Ameren system, subtransmission is the portion of the power delivery system from the dead-end insulators or potheads at the bulk substation feeder positions to the high-side bushings at the distribution substation transformers. Subtransmission also includes the taps to large customers supplied directly from the 34.5 kV or 69 kV systems.

System Operating Limit (SOL)

The value (such as MW, Mvar, Amperes, Frequency or Volts) that satisfies the most limiting of the prescribed operating criteria for a specified system configuration to ensure operation within acceptable reliability criteria. System Operating Limits are based upon certain operating criteria. These include, but are not limited to:

- Facility Ratings (Applicable pre- and post-Contingency equipment or facility ratings)

- Transient Stability Ratings (Applicable pre- and post-Contingency Stability Limits)

- Voltage Stability Ratings (Applicable pre- and post-Contingency Voltage Stability

- System Voltage Limits (Applicable pre- and post-Contingency Voltage Limits)

Transmission Line Loading Limit

The transmission line loading limit of each transmission line is determined by a review of the thermal capability of each component of the circuit and its terminals, as well as a review of any relay or sag limitations. Through this review, the element which is the most limiting is determined for each of the following conditions: Summer Normal, Summer Emergency, Winter Normal, and Winter Emergency.

Transmission Substation

In Transmission Planning, transmission substation is a station in which two or more transmission circuits (138 kV or above) connect, or where voltage transformation takes place between transmission voltage levels.

Transmission System

The document uses “transmission system” to refer to all bulk power supply system facilities 100 kV and above, including radial facilities.

6.0 LIST OF DOCUMENTED SOURCES OF OTHER PLANNING CRITERIA

6.1 North American Electric Reliability Council (NERC) Reliability Standards .
65.2 Federal Energy Regulatory Agency (FERC) Order 661A "Interconnection for Wind Energy", Issued December 12, 2005

Appendix II for Table I from NERC Reliability Standards TPL-001 through TPL-004

Appendix IV for "Guide to Wind Power Facility Interconnection Studies", dated March 7, 2011.

Justification for Rating Assumptions

I.1.1 Transmission Transformers

Ameren uses manufacturer's nameplate ratings for network power transformers for both normal and emergency conditions. Ameren has attempted to develop ratings beyond nameplate for these large autotransformers, but the manufacturers typically have not agreed to any extended ratings. If a transformer would become limiting on the Ameren system, a short-term emergency rating may be developed as described in section 4.4.3. The IEEE Guide for Loading Mineral-Oil-Immersed Transformers (IEEE Standard C57.91-1995) may be consulted to help determine an appropriate rating.

I.1.2 Line Conductors

Ameren line conductor rating assumptions are based on the House and Tuttle method of calculating heat transfers and ampacities assuming common weather parameters for all Ameren companies. The values for the rating parameters used by Ameren are generally accepted in the industry, and modified only slightly to fit the geographical location. An internal computer program calculates the conductor ampacities based on the parameters provided using the same thermal equations used in IEEE Standard 738-1993 for calculation of the current-temperature relationship of bare overhead conductors.

I.1.3 Bus Conductors

For Ameren stranded bus conductors, the rating assumptions are based on the House and Tuttle method of calculating heat transfers and ampacities. Ratings for rigid-bus conductors are based on the IEEE Guide for the Design of Substation Rigid-Bus Structures 605-1998. Tables of conductor ratings are included in Transmission and Distribution Design Department Standard No. 8G.

I.1.4 Circuit Breakers

Ameren uses manufacturer nameplate ratings for circuit breakers for both normal and emergency conditions. If a circuit breaker becomes limiting on the Ameren system, an extended rating may be applied based on ANSI standard C37.010b (1985).

I.1.5 Disconnect Switches

Ameren uses manufacturers nameplate ratings for disconnect switches for both normal and emergency conditions. An extended rating, particularly for conditions with lower ambient temperatures, may be applied based on ANSI standard C37.37 (1979) if a disconnect switch becomes limiting on the Ameren system. The use of an extended rating will depend on the condition of the switch.

I.1.6 Wave Traps

Ameren uses manufacturer nameplate ratings for rating wave traps under normal conditions. An extended rating, particularly for conditions with lower ambient temperatures, may be applied based on ANSI standard C.93.3 (1981) Appendix Table A1. This table shows emergency loading multipliers of 120% for one hour and 110% for four hours based on a 40 degree C ambient temperature.

I.1.7 Current Transformers

Ameren uses manufacturer nameplate ratings, including the continuous thermal current rating factor, for current transformers for both normal and emergency conditions.

An extended rating, particularly for conditions with lower ambient temperatures, may be applied based on ANSI Standard C57.13 (1978) Figure 1. This figure shows a rating multiplier of 125% can be used for an average ambient temperature of 0 degrees C with a thermal rating factor of 1.0.

I.1.8 Series Reactors

Ameren uses manufacturer nameplate ratings for series reactors for both normal and emergency conditions.

I.1.9 Shunt Reactors

Ameren uses manufacturer nameplate ratings adjusted for nominal system voltage to rate shunt reactors connected to the transmission system. These voltage adjusted ratings are used for both normal and emergency conditions.

I.1.10 Shunt Capacitors

Ameren uses manufacturer nameplate ratings adjusted for nominal system voltage to rate shunt capacitors connected to the transmission system. These voltage adjusted ratings are used for both normal and emergency conditions.

I.1.11 Protective Relaying Devices

Ameren uses manufacturer nameplate ratings for protective relaying devices for both normal and emergency conditions. Thermal limits of protective relaying devices are incorporated within the CT ratings.

Table I. Transmission System Standards – Normal and Emergency Conditions

Category	**Contingencies**	**System Limits or Impacts**		
	Initiating Event(s) and Contingency Element(s)	System Stable and both Thermal and Voltage Limits within Applicable Rating [a]	Loss of Demand or Curtailed Firm Transfers	Cascading Outages
A No Contingencies	All Facilities in Service	Yes	No	No
B Event resulting in the loss of a single element.	Single Line Ground (SLG) or 3-Phase (3Ø) Fault, with Normal Clearing: 1. Generator 2. Transmission Circuit 3. Transformer Loss of an Element without a Fault	Yes Yes Yes Yes	No [b] No [b] No [b] No [b]	No No No No
	Single Pole Block, Normal Clearing[e]: 4. Single Pole (dc) Line	Yes	No[b]	No
C Event(s) resulting in the loss of two or more (multiple) elements.	SLG Fault, with Normal Clearing[e]: 1. Bus Section 2. Breaker (failure or internal Fault)	Yes Yes	Planned/ Controlled[c] Planned/ Controlled[c]	No No
	SLG or 3Ø Fault, with Normal Clearing[e], Manual System Adjustments, followed by another SLG or 3Ø Fault, with Normal Clearing[e]: 3. Category B (B1, B2, B3, or B4) contingency, manual system adjustments, followed by another Category B (B1, B2, B3, or B4) contingency	Yes	Planned/ Controlled[c]	No
	Bipolar Block, with Normal Clearing[e]: 4. Bipolar (dc) Line Fault (non 3Ø), with Normal Clearing[e]: 5. Any two circuits of a multiple circuit towerline[f]	Yes Yes	Planned/ Controlled[c] Planned/ Controlled[c]	No No
	SLG Fault, with Delayed Clearing[e] (stuck breaker or protection system failure): 6. Generator 7 Transformer 8. Transmission Circuit 9. Bus Section	Yes Yes Yes Yes	Planned/ Controlled[c] Planned/ Controlled[c] Planned/ Controlled[c] Planned/ Controlled[c]	No No No No

D [d] Extreme event resulting in two or more (multiple) elements removed or Cascading out of service.	3Ø Fault, with Delayed Clearing [e] (stuck breaker or protection system failure): 1. Generator 2. Transmission Circuit 3. Transformer 4. Bus Section 3Ø Fault, with Normal Clearing[e]: 5. Breaker (failure or internal Fault) 6. Loss of towerline with three or more circuits 7. All transmission lines on a common right-of way 8. Loss of a substation (one voltage level plus transformers) 9. Loss of a switching station (one voltage level plus transformers) 10. Loss of all generating units at a station 11. Loss of a large Load or major Load center 12. Failure of a fully redundant Special Protection System (or remedial action scheme) to operate when required 13. Operation, partial operation, or misoperation of a fully redundant Special Protection System (or Remedial Action Scheme) in response to an event or abnormal system condition for which it was not intended to operate 14. Impact of severe power swings or oscillations from Disturbances in another Regional Reliability Organization.	Evaluate for risks and consequences. ▪ May involve substantial loss of customer Demand and generation in a widespread area or areas. ▪ Portions or all of the interconnected systems may or may not achieve a new, stable operating point. ▪ Evaluation of these events may require joint studies with neighboring systems.

a) Applicable rating refers to the applicable Normal and Emergency facility thermal Rating or system voltage limit as determined and consistently applied by the system or facility owner. Applicable Ratings may include Emergency Ratings applicable for short durations as required to permit operating steps necessary to maintain system control. All Ratings must be established consistent with applicable NERC Reliability Standards addressing Facility Ratings.

b) Planned or controlled interruption of electric supply to radial customers or some local Network customers, connected to or supplied by the Faulted element or by the affected area, may occur in certain areas without impacting the overall Security of the interconnected transmission systems. To prepare for the next contingency, system adjustments are permitted, including curtailments of contracted Firm (non-recallable reserved) electric power Transfers.

c) Depending on system design and expected system impacts, the controlled interruption of electric supply to customers (load shedding), the planned removal from service of certain generators, and/or the curtailment of contracted Firm (non-recallable reserved) electric power Transfers may be necessary to maintain the overall Security of the interconnected transmission systems.

d) A number of extreme contingencies that are listed under Category D and judged to be critical by the transmission planning entity(ies) will be selected for evaluation. It is not expected that all possible facility outages under each listed contingency of Category D will be evaluated.

e) Normal clearing is when the protection system operates as designed and the Fault is cleared in the time normally expected with proper functioning of the installed protection systems. Delayed clearing of a Fault is due to failure of any protection system component such as a relay, circuit breaker, or current transformer, and not because of an intentional design delay.

f) System assessments may exclude these events where multiple circuit towers are used over short distances (e.g., station entrance, river crossings) in accordance with Regional exemption criteria.

Schedules of Ameren Normally Open Transmission Circuit Breakers and Disconnect Switches

The Ameren operating utilities have installed a number of circuit breakers and disconnect switches at the transmission level that are operated normally open to limit fault levels, to control power flow, to enhance reliability to the customer load, and to provide for operating flexibility during maintenance, construction, or outage of transmission facilities. These normally open devices are identified below and are noted on the various system operating and one-line diagrams. This information is also used to model the Ameren transmission system in powerflow, short circuit, and stability simulations.

A. Schedule of Ameren 138 kV Bus Splits

The following transmission circuit breakers and disconnect switches are operated normally open to limit short circuit currents and/or transmission flows on the Ameren system.

138 kV Bus Split	Open Circuit Breaker or Switch	Fault or Powerflow Control	Suggested Allowable Closing/Reclosing
Berkeley (UE)	Bus-Tie 1-2 Breaker	Fault	Automatic closure when Bus-Tie 1-4, Bus-Tie 2-3, or a Berkeley 138 kV line breaker opens
Cahokia (CIPS) *	Position H25 Breaker	Fault	None Recommended
Centerville	Line Switch 1497	Powerflow	None Recommended until line is reconductored
Euclid (UE)	Bus-Tie 2-3 Breaker	Fault (Page) and Powerflow	Close if Page-Euclid-1 or Campbell-Euclid-4 Out of Service
Laclede - Alton Steel (CIPS)	Bus-Tie Switch	Fault (Wood River)	Close if Line 1436 or Line 1456 Out of Service
Mason (UE)	Bus-Tie 2-3 Breaker	Fault	None Recommended
Meramec (UE)	Bus-Tie 3-4 Breaker	Fault	Close if no Meramec units synchronized
North Decatur (IP)	Bus-Tie 1351 Breaker	Fault	None Recommended
Sioux (UE) **	Position 23H Breaker	Fault	Close if no Sioux units synchronized
Taum Sauk (UE)	Position 3H Breaker (no relaying)	Fault and Powerflow	Close if one Taum Sauk unit is not synchronized

* The Cahokia 230/138 kV transformer should be connected to Cahokia 138 kV Bus 2 (breaker H17 closed and breaker H23 opened) for the conditions with all facilities in service. For conditions with Cahokia 345/138 kV transformer #9 out of service, the Cahokia 230/138 kV transformer may be connected to Cahokia 138 kV Bus 3 (breaker H25 closed and breaker H17 opened) to provide for a stronger source with Pinckneyville generation on.

** The Sioux 345/138 kV transformer should be connected to Sioux 138 kV Bus 1A (breaker 15H closed and breaker 23H opened) for the conditions with all facilities in service. For conditions with Sioux generator #2 off, the Sioux 345/138 kV transformer may be connected to Sioux 138 kV Bus 2 (breaker 23H closed and breaker 15H opened) to provide for a stronger source.

B. Schedule of Ameren Substations with Normally Open Transmission Bus-Tie Switches

The following distribution and bulk substations are connected to the Ameren transmission system with two or three supply lines, but with normally open bus-tie disconnect switches at the transmission level. The line and bus-tie disconnect switches at many of these two unit distribution substations are equipped with motor operators to allow both transformers to be supplied from the remaining transmission line following a transmission line outage. The line and bus-tie disconnect switches at the bulk and larger distribution substations typically do not have motor operators and these switches must be operated manually to allow a transmission line to supply more than one transformer.

Substation	Open Switch	Facility
Barrett Station (UE)	1462	Bus-Tie 1-2
Brennen (UE)	998	Bus-Tie 1-2
Buick Mine (UE)	B6250	Bus-Tie 1-2
Buick Smelter (UE)	B6850	Bus-Tie 1-2
Chrysler (UE)	1240	Bus-Tie 1-2
Clarkson (UE)	1257	Bus-Tie 1-2
Diamond Star (IP)	1303	Bus-Tie 1-2
Dorsett (UE)	1204	Bus-Tie 1-2
Eatherton (UE)	1438	Bus-Tie 1-2
Florissant (UE)	1167	Bus-Tie 1-2
Fort Zumwalt (UE)	Pos H7	Bus-Tie 1-3
Gratiot (UE)	89 1-2	Bus-Tie 1-2
Gratiot (UE)	89 2-3	Bus-Tie 2-3
North Park (UE)	1650	Bus-Tie 1-2
Orchard Gardens (UE)	1174	Bus-Tie 1-2
Ringer (UE)	1172	Bus-Tie 1-2
Robinson-Marathon N (CIPS)	1326	Bus-Tie 1-2
Rudder (UE)	1143	Bus-Tie 1-2
Russell (UE)	89 1-2	Bus-Tie 1-2
Russell (UE)	89 2-3	Bus-Tie 2-3
Schuetz (UE)	1190	Bus-Tie 1-2
State Farm (IP)	1305	Bus-Tie 1-2

C. Schedule of Ameren Emergency Transmission Supplies

Normally open transmission line or substation switches have been installed at the following substations to allow for the manual reestablishment of a transmission supply line for a river crossing or other major transmission line outage(s) for an extended period of time. Except for the Miller-Zion 161 kV line, all of the other transmission facilities are in service. The Miller–Zion 138 kV line would be able to supply the Zion dual high-side 161-138 x 69 kV transformer for extended outages of the 161 kV Mariosa-Zion-Apache Flats 161 kV line.

Substation	Open Switch	Facility
Lemay (UE)	21 (line)	Meramec-Watson-2
Lemay (UE)	22 (line)	Meramec-Watson-2
Miller (UE)	13062	Miller-Zion-1
Mississippi (CIPS)	Pos H13	Wood River-N Staunton 1436
Russell (UE)	Pos W	Cahokia-Poplar-5
Turris Coal (IP)	8003 (line)	N Decatur-Latham 1342C

D. Schedule of Ameren Substations with Preferred /Reserve Connection Arrangements

The following distribution and bulk substations connected to the Ameren transmission system have preferred/reserve connection arrangements where the preferred connection is to be used to supply the substation load for all times except during transmission contingencies. The reserve connection is operated as normally open and is used for those conditions when the preferred connection transmission is unavailable.

Substation	Preferred Supply (Normally Closed)	Reserve Supply (Normally Open)
Belle (UE)	Tegeler-Osage-1	Gasco-Osage-2
Calumet (UE)	Pike-Dundee-3	Pike-Dundee-4
Centerville (IP)	Cahokia-Turkey Hill 1492A	S Belleville-Centerville 1586
Fountain Lakes (UE)	Sioux-Huster-3	Sioux-Huster-1
Gasco (UE)	Gasco-Osage-2	Tegeler-Osage-1
Meta (UE)	Gasco-Osage-2	Tegeler-Osage-1
Miller (UE)	Tegeler-Osage-1	Gasco-Osage-2
North Decatur (IP)	West Bus (breaker 1566-W)	East Bus (breaker 1566-E)
Taum Sauk (UE)	Rivermines-Taum Sauk-2	Rivermines-Taum Sauk-1

E. Schedule of Other Ameren Connection Arrangements

A number of substations in the IP and CILCO areas were built with substation bus arrangements, including multiple sets of disconnect switches, that allow generators, transmission lines and transformers to connect to either one or both 138 kV substation busses. As the transmission system was developing in the 1950s and early 1960s, this operating flexibility allowed for a high level of reliability in the event of breaker failures, transmission bus outages, or other conditions with multiple transmission facilities out of service at the same time. However, as the transmission system has developed since that time with the 345 kV network feeding into the 138 kV system via multiple 345/138 kV transformers, the need to transfer transmission facilities from one substation bus to another to maintain reliability has diminished significantly. The following 138 kV disconnect switches are operated normally open with no suggested closing.

Substation	Open Switch	Facility
East Galesburg (IP)	1316	Xfmr #2 Connection to North Bus
East Springfield (CILCO)	98-31	Line 1398 Connection to West Bus
East Springfield (CILCO)	22-32	Line 1422 Connection to East Bus
East Springfield (CILCO)	68-14	Xfmr #1 Connection to East Bus
East Springfield (CILCO)	38-31	Xfmr #3 Connection to West Bus
Havana (IP)	1329	Xfmr B060 Connection to East Bus
Havana (IP)	1332	Unit #6 Connection to West Bus
Havana (IP)	1337	Bus Tie
Hennepin (IP)	1313	Bus Tie
Hennepin (IP)	1316	Unit 1 Connection to North Bus
Hennepin (IP)	1322	Line 1512 Connection to South Bus
Hennepin (IP)	1326	Line 1516 Connection to South Bus
Hennepin (IP)	1329	Bus Tie
Midway (IP)	1412	Line 1626 Connection to East Bus
Midway (IP)	1409	Bus Tie
Midway (IP)	1405	Bus Tie
Midway (IP)	1417	Line 1466 Connection to West Bus
Mt. Vernon West (IP)	1417	Bus Tie
Mt. Vernon West (IP)	1412	Line 1546 Connection to West Bus
Mt. Vernon West (IP)	1410	Line 1336 Connection to East Bus
Mt. Vernon West (IP)	1422	Xfmr 4 Connection to East Bus
North Champaign (IP)	1314	Line 1396 Connection to East Bus
North Champaign (IP)	1309	Line 1386 Connection to West Bus
North Champaign (IP)	1305	Bus Tie
North Decatur (IP)	B059	Xfmr 5 Connection to East Bus
North Decatur (IP)	B089	Xfmr 8 Connection to West Bus
Oglesby (IP)	1499	Line 1496 Connection to Bus 2
Oglesby (IP)	7719	Line 7713 Connection to Bus 2
Oglesby (IP)	1555	Line 1556 Connection to Bus 1
Oglesby (IP)	1381	Line 1382 connection to Bus 1
Oglesby (IP)	387	PT Connection to bus 1
Oglesby (IP)	1519	Line 1516 Connection to Bus 2

South Centralia (IP)	1306	Xfmr 1 Connection to South Bus
South Centralia (IP)	1310	Line 1546 Connection to South Bus
Stallings (IP)	1322	Xfmr 5 Connection to North Bus
Stallings (IP)	1304	Xfmr 3 Connection to South Bus
Stallings (IP)	1316	Xfmr 6 Connection to South Bus
Wood River (IP)	1313	Bus Tie
Wood River (IP)	1318	Line 1456 Connection to Northeast Bus
Wood River (IP)	1322	Line 1502 Connection to Northeast Bus
Wood River (IP)	1324	Xfmr 5 Connection to Southwest Bus
Wood River (IP)	1329	Line 1506 Connection to Southwest Bus

F. Schedule of Ameren Bypass Disconnect Switches

Past practices by some of the operating utilities in the late 1950s and early 1960s resulted in the installation of normally open circuit breaker and meter bypass switches. These switches would only be used in the event of a circuit breaker or metering element outage to be able to restore customer load more quickly to minimize the outage time to the customer. However, system protection was often compromised by using these devices as required relaying changes were often not implemented or not reset when the outaged equipment was returned to service. As the 138 kV transmission network developed, with transmission supplies to substations from more than one source, the installation of these bypass disconnect switches became unnecessary. Further, the infrequent use of these bypass switches resulted in reliability concerns. Therefore, the practice of installing bypass disconnect switches was discontinued, and more recently, the practice has been changed to remove the disconnect switches (the live parts as a minimum) whenever other construction work in a substation is performed. Below is a list of the bypass disconnect switches that are candidates for removal or disabling. Note that there are just a few of these bypass disconnect switches located on the Ameren Missouri transmission system.

Substation	Open Switch	Facility
Cape Clark (UE)	163	Breaker 160 Bypass
Cat 1 (CILCO)	1361-27	Meter Bypass
Cat 1 (CILCO)	1362-15	Breaker 1362 and Meter Bypass
Cat 2 (CILCO)	1331-15	Meter Bypass
Cat Mapleton (CILCO)	4594-19	Meter Bypass
Cat Mossville (CILCO)	77-27	Meter Bypass
Cominco (UE)	B7791	Breaker B7714 Bypass
East Kewanee (IP)	B019	Breaker B010 Bypass
East Kewanee (IP)	1554	Breaker 1552 Bypass
Keystone (CILCO)	99-15	Meter and Breaker 1389 Bypass

Keystone (CILCO)	9697-28	Meter Bypass
Keystone (CILCO)	87-15	Meter and Breaker 1387 Bypass
Kickapoo (CILCO)	1325-15	Breaker 1325 Bypass
Midway (IP)	1544	Breaker 1542 Bypass
Midway (IP)	B019	Breaker B010 Bypass
Mt. Vernon West (IP)	B0139	Breaker B013 Bypass
Mt. Vernon West (IP)	1548	Breaker 1546 Bypass
Mt. Vernon West (IP)	1338	Breaker 1336 Bypass
South Centralia (IP)	1544	Breaker 1542 Bypass
South Centralia (IP)	1548	Breaker 1546 Bypass
Stallings (IP)	1458	Breaker 1456 Bypass
Stallings (IP)	1454	Breaker 1452 Bypass
Viaduct (UE)	5243	Breaker 5240 Bypass
Wood River (IP)	B403	Breaker B400 Bypass
Wood River (IP)	B503	Breaker B500 Bypass
Wood River (IP)	1454	Breaker 1452 Bypass
Wood River (IP)	1508	Breaker 1506 Bypass

Guide to Wind Power Facility Interconnection Studies

REVISION 2

Transmission Planning & Interconnections
Ameren
March 7, 2011

TABLE OF CONTENTS

1. INTRODUCTION

All Wind Power Facilities (**WPFs**) that connect to transmission system voltages on the Ameren Transmission System are required to comply with the Guide to Wind Power Facility Interconnection Studies (**GWPFIS**). The electrical behavior of Wind Turbine Generators (**WTG**) can be significantly different from the characteristics of synchronous generators. Therefore technical requirements for **WPFs** interconnection studies are defined which are applicable to **WPFs** interconnecting with the Ameren Transmission System.

The guide specified in this document incorporates Federal Electric Reliability Council (FERC) Order 661A rules and criteria, and could be subject to change in the event that North American Electric Reliability Council (NERC), Federal Electric Reliability Council (FERC), or Southeast Electric Reliability Council (SERC) Wind Power requirements are modified. The technical requirements also take into consideration that some issues need to be studied further before implementing specific technical requirements arising from the variability of wind power.

The purpose of this document is to define the required technical requirements from a **Wind Power Interconnection** perspective to ensure that wind power facilities contribute to continued safe and reliable operation of the Ameren Electric System

2. OBJECTIVE

The primary objective of the **GWPFIS** is to establish the technical rules and requirements that a WPF must comply with in relation to their connection to the Ameren Transmission System.

3. WIND POWER FACILITY DESCRIPTION

A WPF typically will have several Wind Turbine Generators (**WTGs**) connected to individual **WTG** step-up transformers. The **WTG** transformers will step-up voltages from a typical 600-volt level to a typical 25 kV to 34.5 kV level called the collector level. A **WPF** may have several collectors that will connect to the collector bus. The collector bus is connected to the low side of the transmission step-up transformer(s). Figure 3.0 shows the typical Wind Power Facility Configuration.

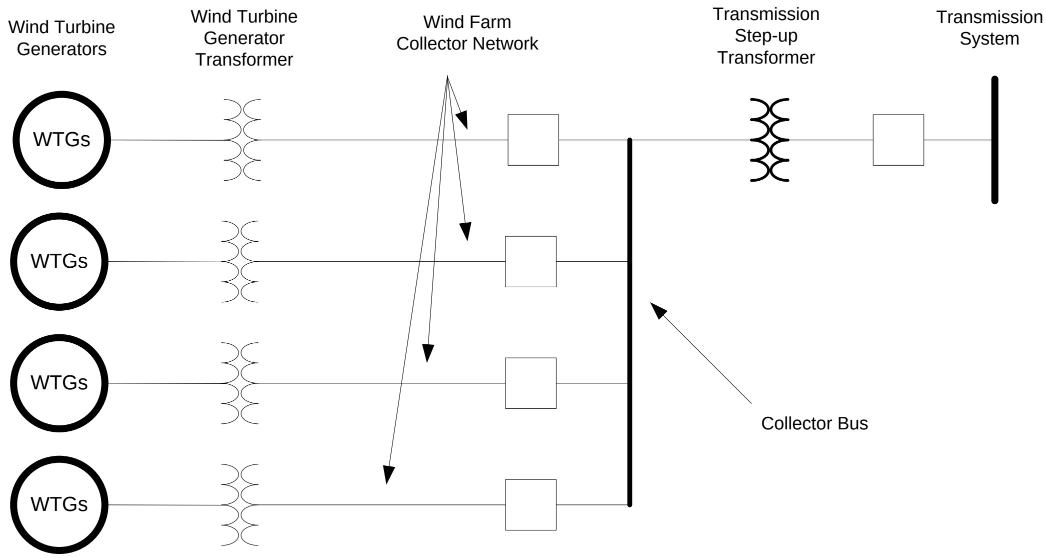

Figure 3.0 – Typical Wind Power Facility Configuration

4. MODELING REQUIREMENTS

   a) The procedures for studying generator connections to the Ameren transmission system are governed by MISO. The MISO Generator Interconnection Manual, MISO Attachment X: Generator Interconnection Procedures (GIP) would be applicable.

   b) Where an appropriate model is not available within PSS/E, the **WPF** Owner must supply a working user written PSS/E model.

   c) **WPF** Owners that provide user written model(s) must provide compiled code of the model and are responsible to maintain the user written model compatible with current and new release of PSS/E until such time as a standard model is provided.

5. TECHNICAL REQUIREMENTS FOR WIND POWER FACILITIES INTERCONNECTION STUDY

5.1. Wind Power Facility Aggregated MW Capability

A **WPF** owner must provide Ameren with the **WPF** aggregated MW capacity as determined at the collector bus(es). The **WPF** aggregated MW capacity shall be used to determine the **WPF** requirements associated with real and reactive power capability.

5.2. Low Voltage Ride Through (LVRT) Requirements

a) LVRT requirements are applicable to all transmission connected generating facilities where the **WPF** aggregated MW capability is greater than 5 MW. Ameren will continue to monitor development of facilities 5 MW and less and may revise the MW threshold.

b) **WPF**(s) are required to remain in-service during three-phase faults with normal clearing (which is a time period of approximately 4-9 cycles) and single line to ground faults with delayed clearing, and subsequent post-fault voltage recovery to **prefault voltage** unless clearing the fault effectively disconnects the generator from system.

c) The fault clearing time requirement for a three-phase fault will be specific to the **WPF** substation location, as determined by and documented by Ameren. The maximum clearing time the **WPF** shall be required to withstand for a three-phase fault shall be 9 cycles at a voltage as low as 0.15 p.u, for the transition period, and 0 p.u. for the post transition period, after which, if the fault remains following the location-specific normal clearing time for three-phase faults, the **WPF** may disconnect from the transmission system.

Note: The transition period covers wind generating plants subject to FERC Order 661A that have either: 1) interconnection agreements signed and filed with the Commission, filed with the Commission in unexecuted form, or filed with the Commission as non-conforming agreements between January 1, 2006 and December 31, 2006, with a scheduled in-service date no later than December 31, 2007, or 2) wind generating turbines subject to a wind turbine procurement contract executed prior to December 31, 2005, for delivery through 2007.

d) Voltage described in c) is measured at the **high side of the WPF step-up transformer** (i.e. the transformer that steps the voltage up to the transmission interconnection voltage).

e) Exceptions:

   i. **WPFs** are not required to ride through transmission system faults that cause a forced outage of a radial line to the **WPF**.

   ii. **WPFs** are not expected to ride through faults that would occur between the wind generator terminals and the high side of the GSU serving the facility (including GSU, Collector Bus(es), Collector Systems or **WTG(s)).**

   iii. **WPFs** may be tripped after the fault period if this action is intended as part of a special protection system.

f) WPFs may meet the LVRT requirements of this Guide through generator performance or by the installation of additional equipment (e.g., StatCom, Dvar, etc) within the WPFs or by a combination of generator performance and additional equipment.

5.3. Voltage Regulation / Reactive Power Requirements

All synchronous generator interconnections must be designed to operate across the power factor range of 0.95 leading (absorbing reactive power from the network) to 0.95 lagging (providing reactive power to the network) at the Point of Interconnection (**POI**). A non-synchronous generator, such as a **WPF**, is also required to operate across the power factor range of 0.95 leading to 0.95 lagging at the **POI**, if the System Impact Study related to the generator connection demonstrates this is necessary for the safety or reliability of the system (FERC Order 661A). Ameren's interpretation of FERC Order 661A requires a non-synchronous generator to be capable of assisting with system voltage control if the system impact study related to the generator connection shows the voltage at the **POI** will not stay within the voltage schedule specified by the Transmission Operator if the non-synchronous generator operates as var neutral.

The need for a **WPF** to have reactive capability in the system impact study is determined with the following methodology. The **WPF** is modeled as var neutral in both the summer peak and off-peak models. If the **POI** does not stay within the assigned voltage schedule for NERC Category A or B contingency conditions, or for Line + Generator contingency (Ameren Criteria) conditions, then the wind farm will be required to provide assistance in controlling voltage by being designed to operate from 0.95 lagging to 0.95 leading at the **POI**. If the voltage schedule is met with the WPF modeled as var neutral, then the **WPF** would be allowed to operate as var neutral at the **POI**.

Voltage regulation and reactive power capability from **WPF** can vary with technology. Some **WPFs** may utilize reactive capability from WTGs, other WPFs may use dynamic var devices, and some **WPFs** may be aggregated with synchronous generators.

Some **WPFs** may wish to connect to a common transmission substation and may wish to consider aggregating voltage regulation and reactive power from a single source for multiple **WPFs**. Such a proposal would be subject to review and approval by Ameren.

Voltage regulation is essential for reliable system operation and requires some reactive capability in order to perform. Voltage regulation and reactive power performance of a **WPF** will be assessed at the **POI** of a **WPF**. All reactive power requirements are based on the rated **POI** voltage. The **WPF** must be able to regulate the system voltage both under system non-disturbance and system disturbance conditions.

The Guide identifies a minimum requirement for dynamic vars and permits some controlled reactive devices such as capacitor banks to satisfy total reactive power requirements.

5.3.1. **WPF** Total Reactive Power Capability

a) A WPF shall maintain a power factor within the range of 0.95 leading to 0.95 lagging, measured at the point of interconnection, if Ameren's System Impact Study shows that such a requirement is necessary to ensure safety or reliability of the system (FERC Order 661A).

b) The power factor range requirement can be met by the automatic voltage regulation at the generator excitation system, or by using the dynamic reactive devices (e.g., StatCom, Dvar, etc) or by using non-dynamic reactive devices (e.g., fixed and switched capacitor banks), or a combination of these means of providing reactive power.

5.3.2. Dynamic Reactive Power Capability

a) A **WPF**'s lagging dynamic reactive power capability is determined by LVRT analysis in section 5.2, which is performed on a case by case basis.

b) A **WPF**'s leading dynamic reactive power capability is determined by High Voltage Ride Through (HVRT) analysis. Since there is no HVRT requirement For Wind Power in FERC Order 661A, for the time being, Ameren assume the leading dynamic reactive power to be zero.

c) A **WPF** shall be able to provide sufficient dynamic voltage support in lieu of the automatic voltage regulation at the generator excitation system if the System Impact Study shows this is to be required for system safety or reliability.

5.3.3. Non-Dynamic Reactive Power Capability

Within the total reactive power capability, the non-dynamic reactive power capability and dynamic reactive power capability are closely related with each other.

Figure 5.3.a illustrates the procedure to perform the WPF interconnection study, and Figure 5.3.b illustrates the procedure to perform a reactive power capability calculation, and it also illustrates the procedure to determine the optimal non-dynamic reactive power capability and dynamic reactive power capability for the particular location. The goal is to minimize the dynamic reactive capability, and meanwhile keep the system safe and reliable.

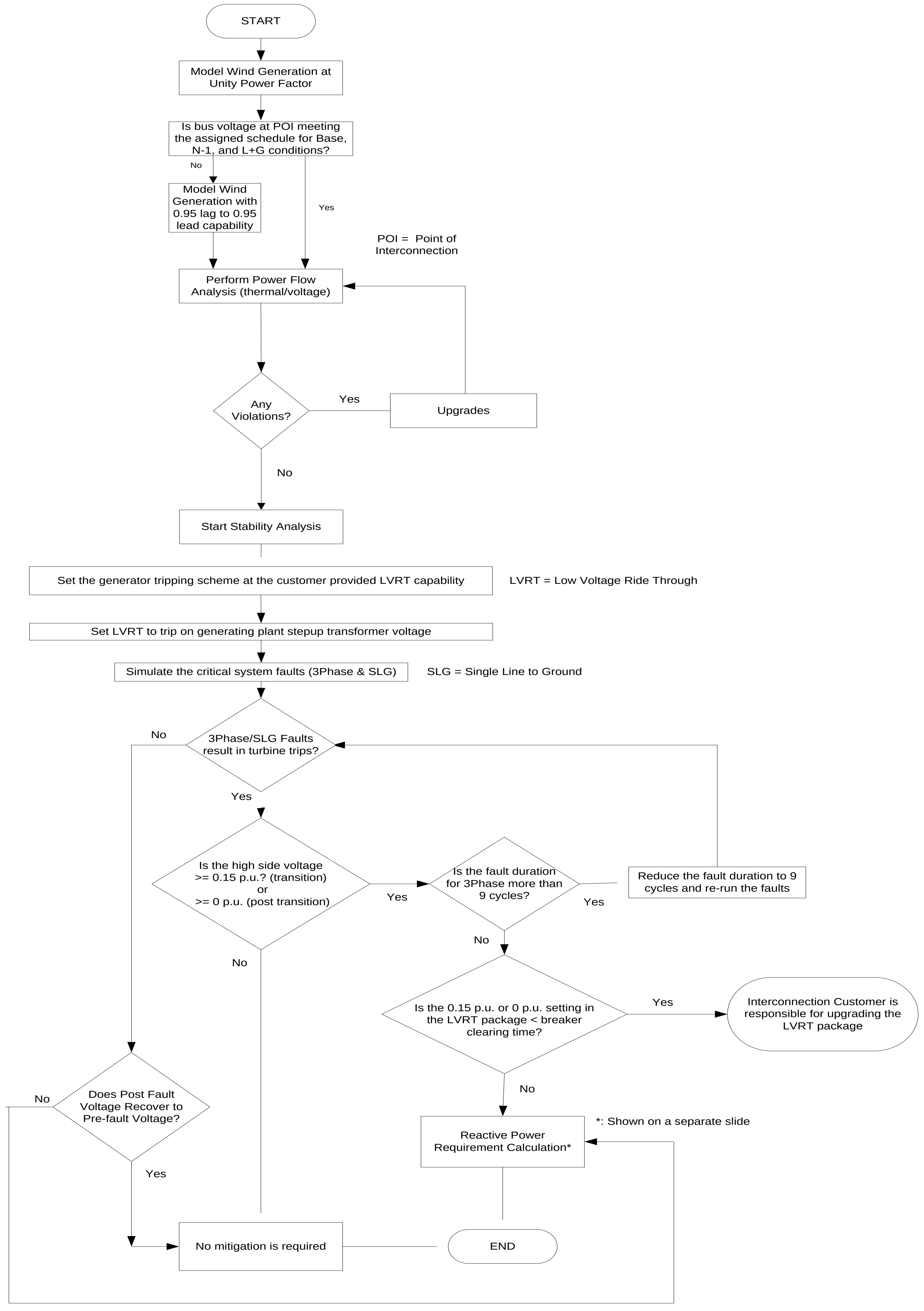

Figure 5.3.a – Wind Power Facility Connection Procedure

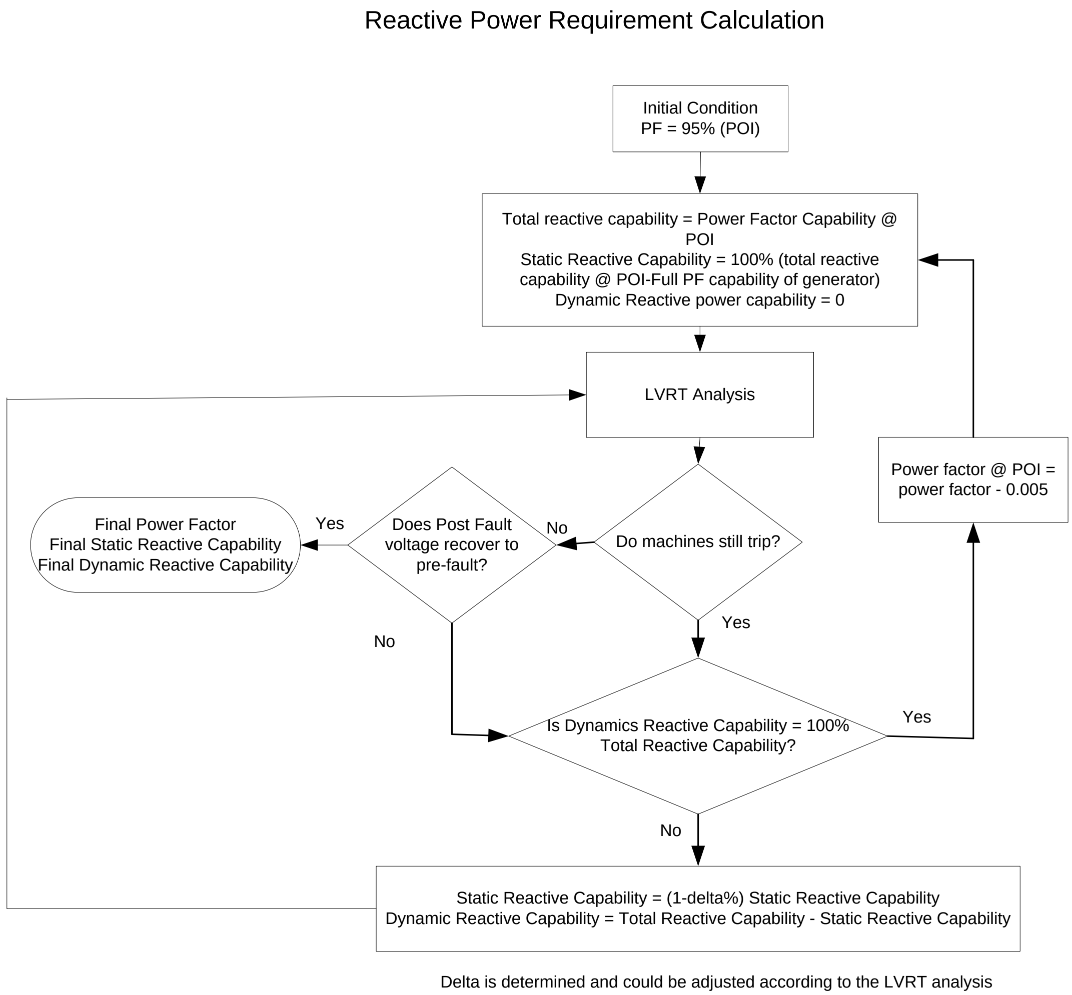

Figure 5.3.b – Reactive Power Capability Calculation

5.4. Power Quality

The **WPF** shall comply with industry standards and guidelines for power quality including but not limit to the following.

5.4.1. Voltage Flicker

Refer to Ameren's Transmission Planning Criteria and Guidelines document, Section 3.1.4.

5.4.2. Harmonics

Refer to Ameren's Transmission Planning Criteria and Guidelines document, Section 3.1.4.

a) Upon request from the WPF owner, Ameren will provide the WPF owner with information describing the specific harmonic-impedance envelope at the proposed Point of Connection.

b) The WPF owner is required to mitigate harmonic currents resulting from non-compliance with IEEE Standard 519.

5.4.3. Voltage Unbalance

The voltage unbalance on the electrical system under normal operating conditions may reach 3%. A WPF should not cause voltage unbalance to exceed 3%. The voltage unbalance is calculated using the following formula:

Unbalance (%) = 100* (deviation from average)/ (average)

The calculation is derived from NEMA MG 1-14.33.

5.4.4. Resonance

The WPF owner must design the facility to avoid introducing undue resonance on the Ameren system. Of particular concern are self-excitation of induction machines, transformer ferroresonance, and the resonant effects of capacitor additions and the capacitance of the WPF collector cables.

5.5 System Conditions for Modeling

For areas of the system with significant WPF, assessments to determine compliance with NERC Standards and other Ameren Criteria related to power flow on system elements will include at least the following critical system conditions:

5.5.1 WPF shown at 20% of the aggregated MW level and system loads at projected peak.

5.5.2 WPF shown at 100% of the aggregated MW level and system loads in the range of 70% to 80% of projected peak for wind generation in the immediate study area. To reflect the fact that all wind farms in a wide geographic area will rarely be operating at 100% of nameplate capacity at the same time, wind generation located outside the immediate study area should be represented at 90% of the aggregated MW level. General system studies would be performed with wind generation represented at 90% of aggregated MW level.

Ameren Missouri Plant Voltage Schedules

	Unit	Owner	Nominal Voltage (kV)	Primary Measurement Point	Secondary Measurement Point	Scheduled Voltage Range (kV)
	Callaway	Ameren Missouri	345	MTGY-CAL-7 PT	Bus A	358.8-365.5
	Fairgrounds	Ameren Missouri	69	69 kV Bus	------	71.1 - 72.5
	Howard Bend	Ameren Missouri	13.8	Howard Bend transformer	------	13.8-14.2
	Keokuk (all units)*	Ameren Missouri	69	Bus 1	Bus 3	71.1 - 72.5
	Kirksville	Ameren Missouri	34.5	34.5 kV Bus	------	35.5 - 36.2
	Labadie (all units)*	Ameren Missouri	345	Bus 4	Bus 3	358.8-365.5
	Meramec 1/4	Ameren Missouri	138	Bus 4	Bus 1	142 - 144.9
	Meramec 2/3*	Ameren Missouri	138	Bus 2	Bus 3	142 - 144.9
	Mexico	Ameren Missouri	69	TBD	TBD	71.1 - 72.5
	Moberly	Ameren Missouri	69	69 kV Bus	------	71.1 - 72.5
	Moreau	Ameren Missouri	69	Bus	------	71.1 - 72.5
	Osage*	Ameren Missouri	138	Bus 1	Bus 2	142 - 144.9
	Peno Creek	Ameren Missouri	161	Bus 1	GSU Transformer	166 - 169
	Rush Island (Both Units)	Ameren Missouri	345	Bus 1	Bus 2	358.8-365.5
	Sioux 1	Ameren Missouri	138	Bus 1	Bus 1A	142 - 144.9
	Sioux 2	Ameren Missouri	138	Bus 2	None	142 - 144.9
	Viaduct	Ameren Missouri	34.5	Bus 1	------	35.5 - 36.2
	Venice	Ameren Missouri	138	Bus 2	Bus 3	142 - 144.9
	Venice	Ameren Missouri	69	Bus 1	Bus 2	71.1 - 72.5
	Kinmundy (all units)	Ameren Missouri	138	North Bus	South Bus	142 - 144.9
	Pinckneyville (all units)	Ameren Missouri	230	Bus between V7 and V1	Bus between V7 and V5	236.9 - 241.5
	Audrain (all units)	Ameren Missouri	345	Bus	------	358.8-365.5
	Raccoon Creek	Ameren Missouri	345	Bus	------	358.8-365.5
	Goose Creek	Ameren Missouri	345	Bus between PCB 4545 and 4575	Bus between PCB 4555 and 4575	358.8-365.5
	Taum Sauk Unit 1	Ameren Missouri	138	Generator 1 Potential Transformer	Rivermines-Taum Sauk 1 CCVT	142-144.9
	Taum Sauk Unit 2	Ameren Missouri	138	Generator 2 Potential Transformer	Rivermines-Taum Sauk 2 CCVT	142-144.9
*	**Interim Schedule in effect as units are being operated controlled with attention to generator bus voltage.**					
1.	**Voltage schedules do not apply if no unit which affects the measurement point is online.**					
2.	**If all online units that affect a measurement point are operating to the limit of their unit specifications at .95 power factor lead or lag at the interconnection point, no further VAR contribution is required.**					
3.	**A unit will be considered off-line for the purposes of following voltage schedule when the unit is below its minimum operating output.**					
4.	**These voltage schedules constitute the normal operating voltages which the plant should follow. In all cases, generator operators are required to follow directives from the Reliability Coordinator or Transmission Operator as needed to meet situations on the bulk electric system.**					

AEG and AERG Plant Voltage Schedules

Unit	Nominal Voltage (kV)	Primary Measurement Point	Secondary Measurement Point	Scheduled Voltage Range (kV)
Coffeen (both units)	345	Bus between PCBs 3411 and 3414	Bus between PCBs 3412 and 3413	358.8 - 365.5
Gibson City (both units)	138	Bus at Gibson City Plant	West Bus at Gibson City Substation	142 - 144.9
Grand Tower (all units)	138	Bus between PCBs 1449 and 1459	Bus between PCBs 1409 and 1489	142 - 144.9
Hutsonville (all units)	138	Bus between PCBs 1407 and 1469	Bus between PCBs 1437 and 1477	142 - 144.9
Meredosia 1&2 (both units)	69	West Bus at Meredosia	East Bus at Meredosia	71.1 - 72.5
Meredosia 3&4 (both units)	138	West Bus at Meredosia East	East Bus at Meredosia East	142 - 144.9
Newton (both units	345	East Bus	West Bus	358.8 - 365.5
Duck Creek	345	North Bus	South Bus	358.8 - 365.5
Edwards 3	138	West Bus	East Bus	142 - 144.9
Edwards 1&2 (both units)	69	West Bus	East Bus	71.1 - 72.5
Tazewell (all units)	69	Transformer 4	Transformer 3	71.1 - 72.5

1. **Voltage schedules do not apply if no unit which affects the measurement point is online.**
2. **If all online units that affect a measurement point are operating to the limit of their unit specifications at .95 power factor lead or lag at the interconnection point, no further VAR contribution is required.**
3. **A unit will be considered off-line for the purposes of following voltage schedule when the unit is below its minimum operating output.**
4. **These voltage schedules constitute the normal operating voltages which the plant should follow. In all cases, generator operators are required to follow directives from the Reliability Coordinator or Transmission Operator as needed to meet situations on the bulk electric system.**

DMG Plant Voltage Schedules

Unit	Nominal Voltage (kV)	Primary Measurement Point	Secondary Measurement Point	Scheduled Voltage Range (kV)
Baldwin (all units)	345	West Bus	East Bus	358.8 - 365.5
Havana (all units)	138	West Bus	------	142 - 144.9
Hennepin (all units)	138	South Bus	North Bus	142 - 144.9
Oglesby (all units)	138	Bus #2	Bus #1	142 - 144.9
Stallings CTG (all units)	138	Line 1452	Line 1456	142 - 144.9
Vermilion 1*	**69**	**Bus between switches 613, 614, and 615**	------	71.1 - 72.5
Vermilion 2	**138**	**Hoopeston West Line**	------	142 - 144.9
Wood River 1&2*	**34.5**	**Southwest Bus**	**Northeast Bus**	34.5 - 35.5
Wood River 3,4&5 (all units)	**138**	**Southwest Bus**	**Northeast Bus**	142 - 144.9

*** SERC has agreed to remove Vermilion Unit 1 and Wood River Units 1 and 2 from the NERC Compliance Registry**

1. **Voltage schedules do not apply if no unit which affects the measurement point is online.**

2. **If all online units that affect a measurement point are operating to the limit of their unit specifications at .95 power factor lead or lag at the interconnection point, no further VAR contribution is required.**

3. **A unit will be considered off-line for the purposes of following voltage schedule when the unit is below its minimum operating output.**

4. **These voltage schedules constitute the normal operating voltages which the plant should follow. In all cases, generator operators are required to follow directives from the Reliability Coordinator or Transmission Operator as needed to meet situations on the bulk electric system.**

Holland Energy Plant Voltage Schedule

Unit	Nominal Voltage (kV)	Primary Measurement Point	Secondary Measurement Point	Scheduled Voltage Range (kV)
Holland (all units)	345	Plant 345 kV Bus between PCBs 52-1, 52-2, 52-3, and 52-4	--------	358.8 - 365.5

1. **Voltage schedules do not apply if no unit which affects the measurement point is online.**
2. **If all online units that affect a measurement point are operating to the limit of their unit specifications at .95 power factor lead or lag at the interconnection point, no further VAR contribution is required.**
3. **A unit will be considered off-line for the purposes of following voltage schedule when the unit is below its minimum operating output.**
4. **These voltage schedules constitute the normal operating voltages which the plant should follow. In all cases, generator operators are required to follow directives from the Reliability Coordinator or Transmission Operator as needed to meet situations on the bulk electric system.**

LS Power Plant Voltage Schedule

Unit	Nominal Voltage (kV)	Primary Measurement Point	Secondary Measurement Point	Scheduled Voltage Range (kV)
Tilton	138	Line 1572	Line 1576	142 - 144.9

1. **Voltage schedules do not apply if no unit which affects the measurement point is online.**
2. **If all online units that affect a measurement point are operating to the limit of their unit specifications at .95 power factor lead or lag at the interconnection point, no further VAR contribution is required.**
3. **A unit will be considered off-line for the purposes of following voltage schedule when the unit is below its minimum operating output.**
4. **These voltage schedules constitute the normal operating voltages which the plant should follow. In all cases, generator operators are required to follow directives from the Reliability Coordinator or Transmission Operator as needed to meet situations on the bulk electric system.**

RRI Energy Plant Voltage Schedule

Unit	Nominal Voltage (kV)	Primary Measurement Point	Secondary Measurement Point	Scheduled Voltage Range (kV)
Reliant/Neoga (all units)	138	Bus	--------	142 - 144.9

1. **Voltage schedules do not apply if no unit which affects the measurement point is online.**
2. **If all online units that affect a measurement point are operating to the limit of their unit specifications at .95 power factor lead or lag at the interconnection point, no further VAR contribution is required.**
3. **A unit will be considered off-line for the purposes of following voltage schedule when the unit is below its minimum operating output.**
4. **These voltage schedules constitute the normal operating voltages which the plant should follow. In all cases, generator operators are required to follow directives from the Reliability Coordinator or Transmission Operator as needed to meet situations on the bulk electric system.**

AmerGen Plant Voltage Schedules

Unit	Nominal Voltage (kV)	Primary Measurement Point	Secondary Measurement Point	Scheduled Voltage Range (kV)
Clinton	345	South Bus	------	358.8 - 362.2

1. **Voltage schedules do not apply if no unit which affects the measurement point is online.**

2. **If all online units that affect a measurement point are operating to the limit of their unit specifications at .95 power factor lead or lag at the interconnection point, no further VAR contribution is required.**

3. **A unit will be considered off-line for the purposes of following voltage schedule when the unit is below its minimum operating output.**

4. **These voltage schedules constitute the normal operating voltages which the plant should follow. In all cases, generator operators are required to follow directives from the Reliability Coordinator or Transmission Operator as needed to meet situations on the bulk electric system.**

Rail Splitter Wind Farm Voltage Schedule

Unit	Nominal Voltage (kV)	Primary Measurement Point	Secondary Measurement Point	Scheduled Voltage Range (kV)
Rail Splitter Wind Farm (all units)	138	Line Voltage at San Jose Rail Substation	Bus Voltage at San Jose Rail Substation	142 - 144.9

1. **Voltage schedules do not apply if no unit which affects the measurement point is online.**

2. **If all online units that affect a measurement point are operating to the limit of their unit specifications at .95 power factor lead or lag at the interconnection point, no further VAR contribution is required.**

3. **A unit will be considered off-line for the purposes of following voltage schedule when the unit is below its minimum operating output.**

4. **These voltage schedules constitute the normal operating voltages which the plant should follow. In all cases, generator operators are required to follow directives from the Reliability Coordinator or Transmission Operator as needed to meet situations on the bulk electric system.**

Trigen Voltage Schedule

Unit	Nominal Voltage (kV)	Primary Measurement Point	Secondary Measurement Point	Scheduled Voltage Range (kV)
Trigen (all units)	138	Between PCB 52L and Transformer	-------	142 - 144.9

1. **Voltage schedules do not apply if no unit which affects the measurement point is online.**
2. **If all online units that affect a measurement point are operating to the limit of their unit specifications at .95 power factor lead or lag at the interconnection point, no further VAR contribution is required.**
3. **A unit will be considered off-line for the purposes of following voltage schedule when the unit is below its minimum operating output.**
4. **These voltage schedules constitute the normal operating voltages which the plant should follow. In all cases, generator operators are required to follow directives from the Reliability Coordinator or Transmission Operator as needed to meet situations on the bulk electric system.**

Alsey Plant Voltage Schedule

Unit	Nominal Voltage (kV)	Primary Measurement Point	Secondary Measurement Point	Scheduled Voltage Range (kV)
Alsey (all units)	138	Alsey Bus between PCB AS8006, PCB AS8004, Switch AS8003, Switch AS8002, and AS8001	-------	142 - 144.9

1. **Voltage schedules do not apply if no unit which affects the measurement point is online.**
2. **If all online units that affect a measurement point are operating to the limit of their unit specifications at .95 power factor lead or lag at the interconnection point, no further VAR contribution is required.**
3. **A unit will be considered off-line for the purposes of following voltage schedule when the unit is below its minimum operating output.**
4. **These voltage schedules constitute the normal operating voltages which the plant should follow. In all cases, generator operators are required to follow directives from the Reliability Coordinator or Transmission Operator as needed to meet situations on the bulk electric system.**

Ameren
Transmission Line
Minimum Required Right-of-Way Widths

Ameren establishes its minimum right-of-way width requirement to provide a controlled area with certain restrictions that are designed to provide for public safety, proper NESC code clearances and reliable high voltage line operation.

Several factors are considered when establishing the minimum width criteria. These factors include:

1. Adequate construction area to build and maintain the line.
2. Provide adequate distance for public safety.
3. Provide proper distance to prevent tree contact with the energized wires that would disrupt electrical operation of the line, whether due to tree growth or falling trees.
4. Provide control for adequate NESC code clearances to various objects, like buildings, antennas, tanks, swimming pools, and future subdivision development.
5. Provide adequate horizontal distance from potential flammable objects (buildings, etc.) to prevent fire hazards to the line that can interfere with the electrical operation or mechanical stability.
6. Provide for proper NESC code clearances for long span wire blow out to adjacent objects.

On future projects the following are Ameren's minimum right-of-way widths:

- 138/161 kV ---- 100 ft.
- 345 kV ---------- 150 ft.