GridLiance
Reliability Criteria

Planning Department

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Blackstone Portfolio Company

FOREWORD

The GridLiance system is planned, designed, constructed, and operated to assure continuity of service during system disturbances and to be consistent with sound economic planning principles. GridLiance complies with reliability standards set forth by North American Electric Reliability Corporation (NERC) as a basis for the Reliability Criteria. As a member of various RTOs/ISOs, GridLiance also observes the reliability criteria set forth by the respective entities.

The Reliability Criteria defines the maximum effects system disturbances should have on transmission service to general service areas and radial service areas. The creation and application of these criteria is specific to GridLiance's system. The Reliability Criteria is intended to be used as design guidelines for new construction and system upgrades. In instances where portions of the existing system do not yet meet these criteria a mitigation plan have been identified.

1.0 Reliability Criteria Scope

At a minimum, GridLiance's system performance shall be in compliance with NERC Reliability Standard TPL-001-4 (see Appendix A). GridLiance Planning Criteria may go beyond NERC standards and RTO/ISO criteria/protocols to address the unique needs and conditions of the GridLiance system.

System performance, as specified in this section, is a guide to system design. From the planning perspective, it is easiest to describe system performance by listing those desired conditions that exist when the system is 1) normal, and 2) when the system is subject to various system disturbances. It is also necessary to specify what remedial measures may be taken to preserve the required conditions.

The expected system performance will vary depending upon the type and severity of the disturbance and also upon the "grade" of service expected. Transmission service areas can be grouped into two broad classifications.

General Service Area – (A) All stations that are not in radial service areas and are served from multiple busses or lines (B) Same as above except that stations are served from a single bus and multiple lines.

Radial Service Area – A station or area served by a single line or tap from the main grid.

The expected service to these two areas differs and, consequently, the level of performance may differ when these areas are exposed to system disturbances.

The following terms relate to system performance and evaluation:

1.1 Required Conditions

Abnormal weather peak load – Refers to a design load consisting of the forecasted normal peak load for an average year plus 10%.

Conductor within normal limit – Conductor loadings are within normal loading limits per GridLiance's ratings methodology.

Maintain integrity of all load area – Grid is intact between load areas.

Conductor within emergency limit – Conductor loadings are within emergency limits per GridLiance's ratings methodology.

Maintain minimum voltage – System bus voltages are not less than minimum voltages as defined in

Table 1 and

Table 2, and the variation in voltage as a result of the disturbance does not exceed the set limits.

Prevent Cascading – Cascading refers to the uncontrolled and successive loss of system elements (normally, successive overloading and relaying out of lines). This condition is unacceptable even under the most severe credible disturbance.

1.2 Planning Remedial Measures

Line switching, generation adjustments – Refers to the transfer of loads and the balance of generation to match system loads to minimize the effects of system disturbances.

Drop firm load – Refers to the disconnections of customer load when proper voltages cannot be maintained to an area or customer, or when area load exceeds available generation or capacity due to a system disturbance.

Controlled Opening of Area Ties – Refers to the opening of internal grid connections to a portion of the system during a system disturbance when:

1) Area voltage requirements cannot be maintained.
2) Area load exceeds available capacity or generation.
3) System load exceeds available generation.
4) Area ties become overloaded due to a disturbance in another area.
5) When frequency deviation occurs.

2.0 System Voltage Limits

2.1 These guidelines specify the minimum and maximum voltage levels along with maximum variation allowed for each voltage class. The following tables depict the voltage limits for normal and contingency outage conditions. Limits are determined with the various system conditions in mind and therefore vary by region.

Nominal Voltage	Steady State Pre-Contingency		Steady State Post-Contingency			Maximum Variation Outage
	High (kV/p.u.)	Low (kV/p.u.)	High (kV/p.u.)	Low LSB[1] (kV/p.u.)	Low NLSB[1] (kV/p.u.)	
34.5 kV[2]	36/1.05	33/0.95	36/1.05	32/0.93	31/0.90	0.07
69 kV	72/1.05	66/0.95	72/1.05	64/0.93	62/0.90	0.07
115 kV	121/1.05	109/0.95	121/1.05	107/0.93	104/0.90	0.07
138 kV	145/1.05	131/0.95	145/1.05	128/0.93	124/0.90	0.07
161 kV	169/1.05	153/0.95	169/1.05	150/0.93	145/0.90	0.07
230 kV	242/1.05	219/0.95	242/1.05	214/0.93	207/0.90	0.07
345 kV	362/1.05	328/0.95	362/1.05	321/0.93	311/0.90	0.07
500 kV	525/1.05	475/0.95	525/1.05	465/0.93	450/0.90	0.07

Table 1: SCMCN Voltage Limits

[1] Load Serving Bus (LSB) and Non-Load Serving Bus (NLSB) low voltage limits
[2] This includes SPP transmission facilities in Kansas.

Nominal Voltage	Steady State Pre-Contingency		Steady State Post-Contingency		Maximum Variation Outage
	High (kV/p.u.)	Low (kV/p.u.)	High (kV/p.u.)	Low (kV/p.u.)	
69 kV	72/1.05	66/0.95	76/1.10	62/0.90	0.08
115 kV	121/1.05	109/0.95	127/1.10	104/0.90	0.08
138 kV	145/1.05	131/0.95	152/1.10	124/0.90	0.08
161 kV	169/1.05	153/0.95	177/1.10	145/0.90	0.08
230 kV	242/1.05	219/0.95	253/1.10	207/0.90	0.08
345 kV	362/1.05	328/0.95	380/1.10	311/0.90	0.08
500 kV	525/1.05	475/0.95	550/1.10	450/0.90	0.08

Table 2:GWT Voltage Limits

2.2 The system shall be capable of maintaining bus voltage between minimum and maximum voltage when serving normal peak and abnormal weather peak loads with all lines in service.

2.3 The system shall be capable of maintaining transmission voltages between maximum and minimum voltage when serving normal peak and abnormal weather peak loads with:

1) one line out of service.
2) one transformer, load, generator, or bus out of service to all except radial service areas and general service areas served from a single bus.

In addition, these outages shall not cause system voltage to vary more than the set limits.

2.4 The system shall be capable of maintaining system voltages between maximum and minimum voltage during normal peak loading with:

1) one substation out of service.
2) two elements out of service.

3.0 Transmission Line Limits

Line thermal ratings are determined by the most limiting element including terminal equipment, conductor, and sag limits. Under normal conditions, the thermal loading shall not exceed 100% of the normal thermal rating. Likewise, in the event of an outage, the thermal loading shall not exceed 100% of the emergency thermal rating.

3.1 No line shall be operated at a load such that it exceeds its sag limit as prescribed by that line design.

3.2 Planning studies shall utilize conductor loading limits per GridLiance's ratings methodology. Line loadings shall not be permitted to exceed conductor loading limits except under abnormal or emergency conditions.

3.3 Maximum emergency conductor loading shall not exceed emergency loadings limits per GridLiance's ratings methodology.

4.0 Transformer Capacity

4.1 Loss of a power transformer shall not cause loss of service to customers.

4.2 Transformer loadings encountered shall not be permitted to exceed maximum transformer ratings per GridLiance's ratings methodology.

5.0 Disturbance Performance Requirements

5.1 Faults

A fault is normally assumed to be a three phase or single line to ground fault with normal clearing. Studies shall use the following guidelines for typical fault clearing times:

Nominal System Voltage	Clearing Time
500 kV	3 Cycles
345 kV	3 Cycles
230 kV	3 Cycles
161 kV	5-8 Cycles[3]
138 kV	5-8 Cycles[3]
115 kV	5-8 Cycles[3]
69 kV	8 Cycles

Table 3:System Fault Clearing Times

Certain studies may require examining the effects of other outages, faults, and clearing times. The loss of a system element is assumed to be a permanent or sustained outage that provides time for automatic and manual adjustments to the system.

5.2 Expected Performance

The expected level of system performance should be evaluated based on the effects of the following factors:

1) The faulted or lost element causing the disturbance.
2) The type of service area (general service area or radial service area).
3) The location of the disturbance with respect to the service area whose system performance is being evaluated.
4) The ability to readjust the system between multiple disturbances if the disturbances are not simultaneous.

5.3 Interconnections

Present agreements with other utilities will be used for a basis for evaluating the loss of an interconnection. The interconnected electric transmission grid is planned and operated following the NERC and RTO/ISO criteria, protocol, and standards.

[3] Clearing times will depend upon the relay protective zone in which the fault occurs.

5.4 Transmission Islanding

Maintaining the integrity of the interconnected network is GridLiance's first priority. Islanding will only be used as a last resort to maintain local generation or when area frequency cannot be maintained at the appropriate levels.

6.0 Transmission Service to Distribution Substations

Load service substations served at a transmission voltage level shall have at least two sources of transmission service if meeting one or a combination of the criteria set in **Table 4**. Any planned enhancements must be economically feasible.

Looping Requirements	
Load Level Between Breakers	20 MW
Stations Between Breakers	3
MW-Mile Measuring Load Loss Exposure	200 MW-mi
Operational Performance Metrics	Outage index < 98.5%
Cost of Transmission Solution	<$5M

Table 4:Looping Requirements Matrix

7.0 Bus Arrangements

GridLiance recommends the following breaker configurations to allow for system flexibility while ensuring reliability on the system. Other configurations will be considered on a case by case basis.

Bus Voltage Level	**Breaker Configuration**
69 kV	Ring Bus
115 kV	Ring Bus
138 kV	Ring Bus
161 kV	Ring Bus
230 kV	Ring Bus or Breaker-and-Half
345 kV	Ring Bus or Breaker-and-Half
500 kV	Ring Bus or Breaker-and-Half

Table 5:Breaker Configuration Guidelines

Existing stations may not meet these recommended arrangements.

8.0 Performance Requirements

Performance Level				
A	**B**	**C**	**D**	**REQUIRED CONDITIONS**
X	X			Serve abnormal weather peak loads
X				Conductor within normal limits
X	X	X		Maintain integrity of load areas
X	X	X	X	Conductor within emergency limits
X	X	X	X	Maintain minimum voltage
X	X	X	X	Prevent cascading
X	X	X	X	Serve normal peak loads
				REMEDIAL MEASURES PERMITTED
		X	X	Line switching, generation adjustments
		X	X	Controlled dropping of area ties
			X	Drop firm load

Table 6:System Performance Levels

LOST OR FAULTED FACILITY	**GENERAL SERVICE AREA**		**RADIAL SERVICE AREA**	
SYSTEM NORMAL	A		A	
SINGLE CIRCUIT	B		B*	
DOUBLE CIRCUIT	C			
LOAD	A			
TRANSFORMER	B			
GENERATOR	B			
BUS	B			
MULTIPLE DISTURBANCE	**Adj**	**Sim**	**Adj**	**Sim**
SUBSTATION	D**			
BREAKER FAILURE		C		
TWO ELEMENTS	C	D		
ALL LINE ON ROW	C	D		

Table 7:Disturbance Performance

Adj: System adjusted after first outage.

Sim: Simultaneous outages.

*: One area grid line out of service.

**: Only allows for consequential load loss.

Appendix A- NERC TPL-001-4 Standard

Standard TPL-001-4 — Transmission System Planning Performance Requirements

Table 1 – Steady State & Stability Performance Planning Events

Steady State & Stability:

a. The System shall remain stable. Cascading and uncontrolled islanding shall not occur.
b. Consequential Load Loss as well as generation loss is acceptable as a consequence of any event excluding P0.
c. Simulate the removal of all elements that Protection Systems and other controls are expected to automatically disconnect for each event.
d. Simulate Normal Clearing unless otherwise specified.
e. Planned System adjustments such as Transmission configuration changes and re-dispatch of generation are allowed if such adjustments are executable within the time duration applicable to the Facility Ratings.

Steady State Only:

f. Applicable Facility Ratings shall not be exceeded.
g. System steady state voltages and post-Contingency voltage deviations shall be within acceptable limits as established by the Planning Coordinator and the Transmission Planner.
h. Planning event P0 is applicable to steady state only.
i. The response of voltage sensitive Load that is disconnected from the System by end-user equipment associated with an event shall not be used to meet steady state performance requirements.

Stability Only:

j. Transient voltage response shall be within acceptable limits established by the Planning Coordinator and the Transmission Planner.

Category	Initial Condition	Event [1]	Fault Type [2]	BES Level [3]	Interruption of Firm Transmission Service Allowed [4]	Non-Consequential Load Loss Allowed
P0 No Contingency	Normal System	None	N/A	EHV, HV	No	No
P1 Single Contingency	Normal System	Loss of one of the following: 1. Generator 2. Transmission Circuit 3. Transformer [5] 4. Shunt Device [6]	3Ø	EHV, HV	No[9]	No[12]
		5. Single Pole of a DC line	SLG			
P2 Single Contingency	Normal System	1. Opening of a line section w/o a fault [7]	N/A	EHV, HV	No[9]	No[12]
		2. Bus Section Fault	SLG	EHV	No[9]	No
				HV	Yes	Yes
		3. Internal Breaker Fault [8] (non-Bus-tie Breaker)	SLG	EHV	No[9]	No
				HV	Yes	Yes
		4. Internal Breaker Fault (Bus-tie Breaker) [8]	SLG	EHV, HV	Yes	Yes

Standard TPL-001-4 — Transmission System Planning Performance Requirements

Category	Initial Condition	Event [1]	Fault Type [2]	BES Level [3]	Interruption of Firm Transmission Service Allowed [4]	Non-Consequential Load Loss Allowed
P3 Multiple Contingency	Loss of generator unit followed by System adjustments[9]	Loss of one of the following: 1. Generator 2. Transmission Circuit 3. Transformer [5] 4. Shunt Device [6]	3Ø	EHV, HV	No[9]	No[12]
		5. Single pole of a DC line	SLG			
P4 Multiple Contingency *(Fault plus stuck breaker[10])*	Normal System	Loss of multiple elements caused by a stuck breaker [10](non-Bus-tie Breaker) attempting to clear a Fault on one of the following: 1. Generator 2. Transmission Circuit 3. Transformer [5] 4. Shunt Device [6] 5. Bus Section	SLG	EHV	No[9]	No
				HV	Yes	Yes
		6. Loss of multiple elements caused by a stuck breaker[10] (Bus-tie Breaker) attempting to clear a Fault on the associated bus	SLG	EHV, HV	Yes	Yes
P5 Multiple Contingency *(Fault plus relay failure to operate)*	Normal System	Delayed Fault Clearing due to the failure of a non-redundant relay[13] protecting the Faulted element to operate as designed, for one of the following: 1. Generator 2. Transmission Circuit 3. Transformer [5] 4. Shunt Device [6] 5. Bus Section	SLG	EHV	No[9]	No
				HV	Yes	Yes
P6 Multiple Contingency *(Two overlapping singles)*	Loss of one of the following followed by System adjustments.[9] 1. Transmission Circuit 2. Transformer [5] 3. Shunt Device[6] 4. Single pole of a DC line	Loss of one of the following: 1. Transmission Circuit 2. Transformer [5] 3. Shunt Device [6]	3Ø	EHV, HV	Yes	Yes
		4. Single pole of a DC line	SLG	EHV, HV	Yes	Yes

Standard TPL-001-4 — Transmission System Planning Performance Requirements

Category	Initial Condition	Event [1]	Fault Type [2]	BES Level [3]	Interruption of Firm Transmission Service Allowed [4]	Non-Consequential Load Loss Allowed
P7 Multiple Contingency *(Common Structure)*	Normal System	The loss of: 1. Any two adjacent (vertically or horizontally) circuits on common structure [11] 2. Loss of a bipolar DC line	SLG	EHV, HV	Yes	Yes

Standard TPL-001-4 — Transmission System Planning Performance Requirements

Table 1 – Steady State & Stability Performance Extreme Events	
Steady State & Stability For all extreme events evaluated: a. Simulate the removal of all elements that Protection Systems and automatic controls are expected to disconnect for each Contingency. b. Simulate Normal Clearing unless otherwise specified.	
Steady State 1. Loss of a single generator, Transmission Circuit, single pole of a DC Line, shunt device, or transformer forced out of service followed by another single generator, Transmission Circuit, single pole of a different DC Line, shunt device, or transformer forced out of service prior to System adjustments. 2. Local area events affecting the Transmission System such as: a. Loss of a tower line with three or more circuits.[11] b. Loss of all Transmission lines on a common Right-of-Way[11]. c. Loss of a switching station or substation (loss of one voltage level plus transformers). d. Loss of all generating units at a generating station. e. Loss of a large Load or major Load center. 3. Wide area events affecting the Transmission System based on System topology such as: a. Loss of two generating stations resulting from conditions such as: i. Loss of a large gas pipeline into a region or multiple regions that have significant gas-fired generation. ii. Loss of the use of a large body of water as the cooling source for generation. iii. Wildfires. iv. Severe weather, e.g., hurricanes, tornadoes, etc. v. A successful cyber attack. vi. Shutdown of a nuclear power plant(s) and related facilities for a day or more for common causes such as problems with similarly designed plants. b. Other events based upon operating experience that may result in wide area disturbances.	**Stability** 1. With an initial condition of a single generator, Transmission circuit, single pole of a DC line, shunt device, or transformer forced out of service, apply a 3Ø fault on another single generator, Transmission circuit, single pole of a different DC line, shunt device, or transformer prior to System adjustments. 2. Local or wide area events affecting the Transmission System such as: a. 3Ø fault on generator with stuck breaker[10] or a relay failure[13] resulting in Delayed Fault Clearing. b. 3Ø fault on Transmission circuit with stuck breaker[10] or a relay failure[13] resulting in Delayed Fault Clearing. c. 3Ø fault on transformer with stuck breaker[10] or a relay failure[13] resulting in Delayed Fault Clearing. d. 3Ø fault on bus section with stuck breaker[10] or a relay failure[13] resulting in Delayed Fault Clearing. e. 3Ø internal breaker fault. f. Other events based upon operating experience, such as consideration of initiating events that experience suggests may result in wide area disturbances

Standard TPL-001-4 — Transmission System Planning Performance Requirements

Table 1 – Steady State & Stability Performance Footnotes (Planning Events and Extreme Events)
1. If the event analyzed involves BES elements at multiple System voltage levels, the lowest System voltage level of the element(s) removed for the analyzed event determines the stated performance criteria regarding allowances for interruptions of Firm Transmission Service and Non-Consequential Load Loss.
2. Unless specified otherwise, simulate Normal Clearing of faults. Single line to ground (SLG) or three-phase (3Ø) are the fault types that must be evaluated in Stability simulations for the event described. A 3Ø or a double line to ground fault study indicating the criteria are being met is sufficient evidence that a SLG condition would also meet the criteria.
3. Bulk Electric System (BES) level references include extra-high voltage (EHV) Facilities defined as greater than 300kV and high voltage (HV) Facilities defined as the 300kV and lower voltage Systems. The designation of EHV and HV is used to distinguish between stated performance criteria allowances for interruption of Firm Transmission Service and Non-Consequential Load Loss.
4. Curtailment of Conditional Firm Transmission Service is allowed when the conditions and/or events being studied formed the basis for the Conditional Firm Transmission Service.
5. For non-generator step up transformer outage events, the reference voltage, as used in footnote 1, applies to the low-side winding (excluding tertiary windings). For generator and Generator Step Up transformer outage events, the reference voltage applies to the BES connected voltage (high-side of the Generator Step Up transformer). Requirements which are applicable to transformers also apply to variable frequency transformers and phase shifting transformers.
6. Requirements which are applicable to shunt devices also apply to FACTS devices that are connected to ground.
7. Opening one end of a line section without a fault on a normally networked Transmission circuit such that the line is possibly serving Load radial from a single source point.
8. An internal breaker fault means a breaker failing internally, thus creating a System fault which must be cleared by protection on both sides of the breaker.
9. An objective of the planning process should be to minimize the likelihood and magnitude of interruption of Firm Transmission Service following Contingency events. Curtailment of Firm Transmission Service is allowed both as a System adjustment (as identified in the column entitled 'Initial Condition') and a corrective action when achieved through the appropriate re-dispatch of resources obligated to re-dispatch, where it can be demonstrated that Facilities, internal and external to the Transmission Planner's planning region, remain within applicable Facility Ratings and the re-dispatch does not result in any Non-Consequential Load Loss. Where limited options for re-dispatch exist, sensitivities associated with the availability of those resources should be considered.
10. A stuck breaker means that for a gang-operated breaker, all three phases of the breaker have remained closed. For an independent pole operated (IPO) or an independent pole tripping (IPT) breaker, only one pole is assumed to remain closed. A stuck breaker results in Delayed Fault Clearing.
11. Excludes circuits that share a common structure (Planning event P7, Extreme event steady state 2a) or common Right-of-Way (Extreme event, steady state 2b) for 1 mile or less.
12. An objective of the planning process is to minimize the likelihood and magnitude of Non-Consequential Load Loss following planning events. In limited circumstances, Non-Consequential Load Loss may be needed throughout the planning horizon to ensure that BES performance requirements are met. However, when Non-Consequential Load Loss is utilized under footnote 12 within the Near-Term Transmission Planning Horizon to address BES performance requirements, such interruption is limited to circumstances where the Non-Consequential Load Loss meets the conditions shown in Attachment 1. In no case can the planned Non-Consequential Load Loss under footnote 12 exceed 75 MW for US registered entities. The amount of planned Non-Consequential Load Loss for a non-US Registered Entity should be implemented in a manner that is consistent with, or under the direction of, the applicable governmental authority or its agency in the non-US jurisdiction.
13. Applies to the following relay functions or types: pilot (#85), distance (#21), differential (#87), current (#50, 51, and 67), voltage (#27 & 59), directional (#32, &

Standard TPL-001-4 — Transmission System Planning Performance Requirements

Table 1 – Steady State & Stability Performance Footnotes (Planning Events and Extreme Events)
67), and tripping (#86, & 94).