



## Reliability Criteria and Assessment Practices for Transmission Studies

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**Purpose:**

To outline Platte River’s reliability criteria and assessment practices used in transmission system studies for the operating and planning horizons.

### **I. Reliability Criteria**

Platte River adheres to the NERC Reliability Standards and the WECC Reliability Criteria, as well as internal company criteria for operating and planning studies. Criteria used by affected parties in neighboring systems are to be considered during the reliability assessments. The following criteria are used in steady-state, short-circuit, and stability analyses for the Platte River system.

#### **Steady-State**

Steady-state criteria are specified for the following scenarios:

**Switching – System Normal**

Switching criteria require all reactive control devices (shunt capacitor banks, shunt reactors, etc.) to result in a steady-state voltage change of 2% or less.

### **Category P0 –**

“N-0” System Performance Under Normal (No Contingency) Conditions (Category P0) as referenced in Table 1 of NERC Standard TPL-001-4

Voltage:	0.95 to 1.05 per unit
Line Loading:	100 percent of continuous rating
Transformer Loading:	100% of highest 65 °C rating

### **Category P1-P2 Events –**

“N-1” System Performance Following Loss of a Single Element (Category P1-P2) as referenced in Table 1 of NERC Standard TPL-001-4

Voltage:	0.92 to 1.10 per unit
Line Loading:	100 percent of continuous rating or emergency rating if applicable
Transformer Loading:	100% of highest 65 °C rating

### **Category P3-P7 Events –**

“N-1-1 or N-2 or More” System Performance Following Loss of Two or More Elements (Category P3-P7) as referenced in Table 1 of NERC Standard TPL-001-4

Voltage and Thermal:	Allowable short-term and/or emergency rating(s) will be considered for achieving acceptable system performance as determined by the affected parties along with any available emergency mitigation plans. System adjustments – including interruption of firm transmission service and non-consequential load shedding will be considered for achieving acceptable system performance, where allowed in Table 1 of TPL-001-4.
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### **Category Extreme Events (EE) -**

“N-1-1 or N-2 or More” System Performance Following Extreme Events (Category EE) as referenced in Table 1 of NERC Standard TPL-001-4

Voltage and Thermal:	Evaluate for risk of widespread instability, cascading or uncontrolled islanding in the BES. Identify possible actions to reduce the likelihood of, or mitigate the adverse consequences of, any occurrence of cascading. Use all available system adjustments, emergency facility rating(s) and/or emergency voltage limits, to evaluate possible actions to mitigate consequences of the event.
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## **Short-Circuit**

Short-circuit criteria require the maximum available fault current for either a 3-phase or single-line-to-ground fault to not exceed 95% of the fault interrupting capability rating of all equipment. The maximum available fault current is determined for the worst case scenario with all generation and transmission facilities in-service.

## **Transient Stability**

Transient stability criteria require that all generating machines remain in synchronism and all power swings should be well damped.

Transient voltage performance should meet the following criteria:

- Following fault clearing for Category P1 events, voltage may not dip more than 25% of the pre-fault voltage at load buses, more than 30% at non-load buses, or more than 20% for more than 20 cycles at load buses.
- Following fault clearing for Category P2-P7 events, voltage may not dip more than 30% of the pre-fault voltage at any bus or more than 20% for more than 40 cycles at load buses.

Transient frequency performance should meet the following criteria:

- Following fault clearing for Category P1 events, frequency should not dip below 59.6 Hz for 6 cycles or more at a load bus.
- Following fault clearing for Category P2-P7 events, frequency should not dip below 59.0 Hz for 6 cycles or more at a load bus.

Load buses include generating unit auxiliary loads.

A transient stability simulation will be deemed to exhibit positive damping if a line defined by the peaks of the machine relative rotor angle swing curve tends to intersect a second line connecting the valleys of the curve with the passing of time. Corresponding lines on bus voltage swing curves will likewise tend to intersect. A stability simulation which satisfies these conditions will be defined as stable. A case will be defined as marginally stable if it appears to have zero percent damping and transient voltage dips are within or at their criteria limits.

## **Voltage Stability**

Voltage stability criteria establish the acceptable real power (MW) margins as:

- 5% for system conditions in a Category P0-P1 event.
- 2.5% for system conditions in a Category P2-P7 event.

## **Cascading**

NERC Standards require that the system remain stable and no Cascading occurs for Category P0-P7 and EE events. Cascading is defined in the NERC Glossary as “The uncontrolled successive loss of system elements triggered by an incident at any location. Cascading..... cannot be restrained from sequentially spreading beyond an area predetermined by studies.”

A potential triggering event for Cascading will be investigated upon one of the following results:

- A generator pulls out of synchronism in transient stability simulations. Loss of synchronism occurs when a rotor angle swing is greater than 180 degrees. Rotor angle swings greater than 180 degrees may also be the result of a generator becoming disconnected from the BES; or
- A transmission element experiences thermal overload and its transmission relay loadability is exceeded.
- Negative margin occurs in a voltage stability simulation

## **II. Assessment Practices for Transmission Studies**

### **Tools Used to Perform Analyses**

Platte River uses the Power System Simulator for Engineering (PSS/E) software from Siemens for powerflow and dynamics studies, the ASPEN OneLiner software from Advanced Systems for Power Engineering for short-circuit studies, and the RateKit software from The Valley Group for steady-state and emergency ratings of overhead lines. Platte River may choose to contract with a consultant for studies using the PSS/E software or an Electromagnetic Transient Program (EMTP) analysis. SCADA system snapshots are periodically used to validate the powerflow model and disturbance event reports from SEL relays and DFRs are used to validate the short-circuit model.

### **Transmission Studies**

Transmission studies evaluate all Category P0-P1 and certain Category P2-P7 and EE events. The Category P2-P7 and EE events studied are those that would produce more severe system results or impacts based on the Transmission System Planning and Operating Engineers knowledge of the system and engineering judgment. The rationale for selection considers facilities at significant substations, large generation stations, and lines involved with large bulk transfer paths, common rights-of-way, common structures, and shared circuit breakers. Platte River will monitor bus voltages, transmission lines, and transformers in the study area for criteria violations.

### **Base Cases and Study Scenarios**

Each City/Owner(s) prepares a ten-year load forecasts coincident with the Platte River peak on a delivery point basis for the operating season and the next ten years of summer and winter peak demands coincident with the Platte River system peak. Platte River prepares both “base” and “high” ten-year load forecasts of summer and winter peak demands on a Platte River system basis aggregating the City/Owner(s) loads. Platte River uses its “high” load forecast for transmission planning purposes to ensure transmission adequacy in the event actual loads exceed forecasted loads or new transmission construction is delayed.

The sum of the coincident City/Owner(s) load forecasts is scaled to match the Platte River “high” load forecast and the corresponding delivery point load projections are represented in the powerflow model for the operating and planning horizons. Loads are modeled at the high-voltage bus with the power factor adjusted from the low-side to the high-side of the distribution substation transformer. Platte River is a summer-peaking utility.

Network Customer ten-year load forecasts and delivery point plans are provided annually to Platte River and these representations are updated as necessary in the WECC base cases.

Platte River’s resource planning group provides the resource plans for the ten-year horizon.

Generation dispatch, system demand, and transmission topologies are coordinated with interconnected neighbors and representations are modeled in the WECC base cases and updated as necessary.

Platte River conducts studies using a combination of heavy summer (on-peak) cases and light load (off-peak) cases for the operating horizon and cases for the near-term and long-term planning horizons.

Studies are conducted using the Reliability Criteria described above to assess the system performance. Mitigation alternatives are developed and re-studied to verify their performance.

### **Operating Studies**

Platte River annually conducts operating assessments of its system. Platte River studies scheduled outages on its system and develops mitigation procedures if necessary.

Performance criteria violations that are extended before a project can be placed in-service are addressed with mitigation procedures developed in the annual operating season assessments conducted by Platte River.

Platte River coordinates its operating assessments and planned outage studies with interconnected neighbors, the Foothills Planning Group, and the Peak Reliability Coordinator.

### **Planning Studies**

Platte River has an annual process for updating its Ten-Year Transmission Plan as follows. Platte River and the City/Owner(s) coordinate their respective planning activities through the Joint Technical Advisory Committee, which consist of operations, engineering, and planning staff from each entity. The City/Owner(s) inform Platte River of their plans for new transmission delivery points, either a new substation or a new transformer at an existing substation, in the ten-year horizon. Platte River meets with the City/Owner(s) to present the planning study results with possible alternatives and to receive feedback on the proposed plan. After City/Owner(s) review and input, Platte River may refine the plan based on preferred alternatives and then develop a timeline for the projects. Preferred alternatives to mitigate transmission performance criteria are selected based on factors such as right-of-way (new vs. rebuild on existing), diversity of supply lines, feasibility to build, time to completion, system risks during construction, usefulness beyond ten years, and cost. In order to determine a time-line for projects, years between the operating scenario and the ten-year scenario are studied to determine by what year the problem needs correction. The Ten-Year Transmission Plan is then finalized with maps and a list of projects including in-service dates. In cases where it is not practical to complete projects by the year needed, the timeline will be adjusted to accommodate staffing limitations or anticipated siting or routing delays. These projects are then put into the budget process.

Platte River coordinates its planning assessments with interconnected neighbors, the Foothills Planning Group, the Colorado Coordinated Planning Group, WestConnect, and WECC.

### **Transfer Capability Studies**

Platte River conducts Transfer Capability studies in the operating and planning horizons to identify current or potential Platte River transmission system weaknesses and/or limiting Facilities which could impact the Bulk Electric System's ability to reliably transfer energy from one area to another. Platte River uses the Reliability Criteria and planning study practices described above, together with its Transfer Capability Methodology to identify Transfer Capabilities within the Platte River system.

### **System Impact Studies**

When studying an interconnection request, Platte River notifies neighboring and potentially impacted entities on the transmission system of proposed new or modified facilities being considered for interconnection in order to involve them in a coordinated joint study effort.

Platte River conducts System Impact Studies using the Reliability Criteria, base cases, study scenarios, and planning study practices described above to identify system impacts, constraints, and any necessary system upgrades.

## Version History

Version	Date	Action	Owner	Change Tracking
1.0	08/31/06	Combine and record planning outline into one summary document.	John Collins	New
2.0	05/29/07	Added resource planning section.	John Collins	Revision
3.0	02/06/12	Changed title and expanded descriptions of criteria and practices.	John Collins	Revision
4.0	02/12/13	Modified steady-state voltage criteria. Added section for contingencies evaluated in Transmission Studies.	Jeremy Brownrigg	Revision
5.0	3/19/13	Expanded Transmission Studies description to consider monitored facilities. Added Transfer Capability Studies section.	Jeremy Brownrigg	Revision
6.0	3/7/16	Modified Criteria to align with new NERC TPL-001-4 Standard, updated format	Jeremy Brownrigg	Revision