NorthWestern Energy Transmission Planning Criteria

Steady-State & Post-Fault Voltage Criteria for 230 kV & Below

The steady-state voltage criteria listed in the tables below are based on the assumption that all switching has taken place, all generators and transformer Load Tap Changers (LTCs) have regulated voltages to set values, and capacitors or reactors are switched. The basis for the percent voltages is the designed operating voltage.

Table 1 – Maximum Upper Voltage Criteria

At Unregulated Load-Serving Bus

	Upper Operating Limit
Voltages	105%

As shown in Table 1 – Maximum Upper Voltage Criteria, the recommended upper voltage limit for a load-serving bus is 105% unless equipment rating dictates a different limit. For example, equipment used on 100 kV systems is typically rated for a nominal voltage of 102 kV or higher, so 107 kV or 105% of 102 kV nominal is permitted on 100 kV systems. NWMT follows the limit as outlined in the American National Standards Institute standards (i.e., ANSI C84.1). It is possible that a load-serving bus voltage may exceed the table value if conditions allow a higher voltage without harm to NWMT or customer equipment.

The allowable minimum percent voltage for any load-serving bus that is within a network configuration is shown in Minimum Allowable Percent Voltage at NWMT Unregulated Load-Serving Bus. It is possible that a load-serving bus voltage may fall below the table value if conditions allow a lower voltage without harm to NWMT or customer equipment. This table considers FERC/NERC and WECC criteria as applied to the bulk electric system buses (100 kV and above). This table is also applied on lower voltage transmission buses that are not part of the bulk electric system (50 kV & 69 kV).

The minimum allowable percent voltage for a load serving bus that is on a radial transmission system for an event on the radial line must only meet the existing system performance (N-0) shown in Minimum Allowable Percent Voltage at NWMT Unregulated Load-Serving Bus. Any unacceptable voltage performance must be mitigated in accordance with the criteria described below. The use of a Special Protection Scheme (SPS) is evaluated on a case-by-case basis, with no assurance that NWMT will accept or use a SPS. The values in Minimum Allowable Percent Voltage at NWMT Unregulated Load-Serving Bus assume that all other methods to control voltage have been explored (such as capacitors, reactors, and line switching, etc.).

Under emergency conditions, bus voltage between 90% and 110% of nominal is permitted for up to 30 minutes.

Table 2 - Min. Allowable % Voltage at NWMT Unregulated Load-Serving Bus

Minimum Allowable Percent Voltage at NWMT Unregulated Load-Serving Bus			
Nominal Voltage	Existing System (N-0)	First Contingency (N-1)	Second Contingency (N-2)
230 kV and 161 kV	95%	95%	93%
115 kV and 100 kV	95%	93%	90%
69 kV and 50 kV	93%	93%	90%

Note:
1. Percent voltage is measured from the nominal voltage.
2. 50 kV, 69 kV and radial 100 kV segments are not bulk electric system elements.

Steady-state & Post-fault Voltage Criteria for 500 kV

The allowable operating voltage range for the 500 kV transmission system is 100% to 110% of nominal, or 500 to 550 kV. This range is different from other voltage levels because equipment used on the 500 kV system is nominally rated at 525 kV. These criteria apply to both steady-state and post-fault conditions.

Thermal Ratings

Transmission conductor continuous summer ratings are based on 25°C (77°F) ambient air at 1.4 mph (2 ft/sec), 50°C conductor temperature rise, and 75°C (167°F) maximum operating temperature unless conditions dictate otherwise (e.g., some conductors and lines may be specifically designed for higher operating temperatures). Winter transmission conductor continuous thermal ratings are 125% of the summer rating, during the winter months November – February, or any time ambient temperatures are below 0°C (32°F).This rating is entered as Rate A in the power flow base cases. Unacceptable conductor loading can be mitigated by system improvements or, in some cases, a Special Protection Scheme (SPS) that changes system conditions to mitigate the overload. The use of an SPS to alleviate conductor overloading is evaluated on a case-by-case basis, with no assurance that NWMT will accept or use an SPS.

Emergency ratings for transmission conductors are developed on a case-by-case basis, and are dependent on conductor size, line voltage and available ground clearance under elevated conductor temperature conditions. Under emergency conditions for standard conductors (e.g. not "high temp" conductors), conductor temperatures are limited to 100°C (212°F) or less, and thermal ratings are limited to 125% of the seasonal rating for up to 30 minutes.

Transformer ratings are based on the following:

- For standard service conditions (24-hour average ambient air temperature of 30°C or 86°F, or less), the continuous rating is 100% of the highest operational nameplate rating. This rating is entered as Rate A in the power flow base case.
- For winter service conditions (November – February, or any time 24-hour ambient air temperature is less than 0°C, or 32°F), loading to 125% of the standard service condition rating may be allowed.
- Under emergency operating conditions, loading to 125% of the standard service condition rating may be allowed for up to 30 minutes during any season. Note this is the same as the winter rating, and under winter conditions this load level is permitted continuously.

Unacceptable transformer loading can be mitigated by transformer replacement, system improvements or, in some cases, an SPS that changes system conditions to mitigate the overload. The use of an SPS to alleviate transformer overloading is evaluated on a case-by-case basis, with no assurance that NWMT will accept or use an SPS.

General Minimum Equipment Specifications

The general minimum specifications for North Western Energy Transmission and Substation equipment are listed in Table 3 – T&S Equipment: General Minimum Specifications.

This table also summarizes the MVA or capacity, voltage, current, equipment Basic Impulse Level (BIL), Maximum Continuous Over Voltage (MCOV) for lightning arresters, and interrupt ratings of equipment as applicable and associated grounding requirements.

Voltage criteria for 500 kV, General Minimum Equipment specifications, Transmission Equipment Rating and Loading, Special Protection Scheme (SPS) Application, Voltage Ride Through, Harmonics, and Subsynchronous Resonance are outlined in NWMT's ETP Method Criteria and Process Business Practice 08-21-14 which is posted on NWMT's OASIS website.

Table 3 – T&S Equipment: General Minimum Specifications

Transmission and Substation Equipment: General Minimum Specifications						
	Nominal System voltages - kV					
	230 kV	161 kV	115 kV	100 kV	69 kV	50 kV
MVA and Current Ratings *(1)	As Req'd	As Req'd	As Req'd	As Req'd	As Req'd	As Req'd
Equipment BIL (kV) *(2)	900	750	550	550	350	350
Maximum Design Voltage (kV) *(3)	242	169	121	121	72.5	72.5
Breaker Interrupt Current (kA)	40	40	40	40	40	40
Breaker and Switch Continuous Current (A) *(4)	1200	1200	1200	1200	1200	1200
Arrester Duty Rating/MCOV (kV) *(5)	172/140	120/98	90/70	90/70	54/42	39/31.5
Substation Insulator Class	TR-304	TR-291	TR-286	TR-286	TR-216	TR-214
Transmission Line BIL, wood (kV) *(6)	1105	780	610	525	440	355
Transmission Line BIL, steel (kV) *(7)	1265	945	695	610	525	440

Notes:
(1) Project and equipment specific as required to avoid thermal overloads
(2) 1050 kV BIL is also used on some 230 kV equipment
(3) At least 5% over nominal
(4) 2000 amp equipment is used in some applications
(5) For effectively grounded systems
(6) Insulator support hardware ungrounded
(7) Insulator support hardware grounded

Base Case Planning Scenarios

Base Case Planning Scenarios (Scenarios) are developed based on the goal of the local transmission system plan and to examine different load, generation, and dispatch patterns in the future to identify conditions that stress the transmission system in planning models and simulations. Public policy requirements would be considered as well. Through simulations potential problems in system adequacy or security are revealed under normal or abnormal system conditions. Scenarios are determined per the goals of the transmission plan and look at a 15-year planning study period: current year, five years, ten years, and fifteen years into the future. NWMT uses scenario planning and not probabilistic planning for developing the local area transmission plan. NWMT may, however, use probabilistic assessment methods within a defined scenario to evaluate uncertainty.

Base case scenarios are used to examine the transmission system under a variety of future assumptions for a specific period of time. The scenario assumptions may include, but are not limited to, the following: