Kansas City Power & Light Company

Transmission Facility Rating Methodology

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1. Purpose
This document provides the Transmission Owner Facility Rating Methodology (FRM) used for developing and communicating Facility Ratings (capitalized terms use NERC Glossary of Terms definitions) of solely and jointly owned transmission facilities for Kansas City Power & Light (KCP&L) and Transource Energy, LLC. The document also defines the basis for the calculation of normal and emergency ratings of KCP&L transmission facilities at 100 kV and above to satisfy the requirements of NERC Reliability Standard FAC-008-3 applicable to the Transmission Owner.

Documentation of Generator Facility ratings are maintained by the KCP&L Generator Owner entity as separate documents.

2. Generator Rating Methodology
This document describes FRM for KCP&L transmission facilities. FRM for generator facilities is maintained as a separate document by the KCP&L Generator Owner entity. The interconnection point between Generator Owner facilities and Transmission Owner transmission facilities shall be the high side bushings of the main step up transformer.

3. Transmission Facility Rating Methodology
KCP&L shall design and operate its part of the transmission network in a safe and reliable manner. In order to accomplish this goal, it is necessary to determine safe-operating limits for the facilities involved. This document provides a general discussion of the practices used in developing ratings for the equipment used on the transmission system as well as a description of KCP&L’s practices for developing loading limitations for the facilities (transmission lines and transformers), based upon these ratings.

3.1. Equipment Rating Methodology
Equipment ratings are determined for the maximum and minimum voltage, current, frequency, real and reactive power flows on individual transmission equipment. These ratings are based on a combination of;

- Ratings provided by equipment manufacturers or obtained from equipment manufacturer specifications such as nameplate rating;
- Industry standard(s) developed through an open process such as Institute of Electrical and Electronics Engineers (IEEE) or International Council on Large Electric Systems (CIGRE); or
- Practice(s) verified by testing, performance history or engineering analysis.

Transmission facilities constructed under regional transmission design criteria that receive Notification to Construct (NTC) letters may be rated at the appropriate minimum design standard or the minimum capacity required per the NTC.
KCP&L follows the legacy practice of rating transmission facilities as though all equipment were in service, in its normal operating state, and capable of normal operation. For some transmission facilities with multiple breaker substation configurations, such as ring bus and breaker & half, this practice may lead to situations that require a temporary derating of a transmission facility for an open breaker/bus condition. The rating of a transmission facility may be permanently set at the open bus limit for all applicable seasons in any of the following situations:

3.1.1 The open bus limit would result in a decrease in the summer emergency rating of less than 10 MVA for a facility; or
3.1.2 The facility is radial with a maximum possible current flow less than the open bus limit; or
3.1.3 The transmission facility’s phase conductor summer emergency rating is at least 30 percent above the Southwest Power Pool (SPP) minimum design standard for that voltage level.

3.2. **Items considered in equipment ratings**

KCP&L has considered the following items in the development of its transmission equipment ratings.

3.2.1. **Design Criteria based in industry rating practices**

KCP&L uses IEEE and ANSI standards for rating some of its transmission equipment. References for these industry rating practices are identified when used to rate transmission equipment.

3.2.2. **Manufacturer equipment ratings**

KCP&L uses manufacturer’s equipment ratings for most of its substation terminal equipment such as breakers, switches and wavetraps as well as for rating of power transformers.

3.2.3. **Ambient conditions**

KCP&L uses ambient weather conditions such as air temperature and wind speed to rate equipment such as conductors, switches and wavetraps. This is the basis for seasonal equipment ratings for summer, spring/fall, and winter seasons.

3.2.4. **Operating limitations**

KCP&L identifies changes in transmission equipment ratings due to reconfiguration of the transmission network and makes rating changes where applicable. An example of this would be a rating decrease due to operating a substation ring bus with an open breaker.

3.3. **Statement on Facility Rating limits**

For KCP&L the Facility Rating for transmission facilities shall equal the most limiting applicable Equipment Rating of the individual equipment that comprises that Facility.
For jointly owned transmission facilities KCP&L will coordinate its equipment ratings with the other facility owner’s equipment ratings to determine the most limiting applicable Equipment Rating of the individual equipment that comprises that Facility.

3.4. Method to determine Most Limiting Facility

KCP&L has developed a rating methodology for each major component of bulk electric system equipment that comprises a transmission facility. All series equipment that together make up a line section, bulk power substation transformer circuit, or shunt reactive device are reviewed to determine the item of equipment that has the most limiting rating, which is then used as the most limiting component in determining the normal and emergency ratings for the transmission facility.

3.4.1. Scope of equipment ratings

KCP&L has developed a rating methodology for transmission conductors, transformers, relay protective devices, terminal equipment, and series and shunt compensation devices as defined in Section 9. Facility Rating Methodology for generators is documented in a standalone document maintained by KCP&L’s Generator Owner entity.

3.4.2. Use of normal and emergency ratings

KCP&L has developed a normal and emergency rating methodology for each major component of bulk electric system equipment that comprises a transmission facility. In some cases, the normal and emergency rating may be the same.

4. Availability of KCP&L Transmission FRM

KCP&L shall make this document available for inspection and technical review by those Reliability Coordinators, Transmission Operators, Transmission Planners, and Planning Coordinators that have responsibility for the area in which the associated Facilities are located, within 21 calendar days of receipt of a request. Furthermore, this document will be posted on the KCP&L OASIS site for public viewing.

5. Response to reviews of KCP&L FRM

KCP&L will also respond in writing to written comments from NERC registered responsible entities within 45 days per NERC Reliability Standard FAC-008 requirements. KCP&L’s response will indicate whether a change will be made to the FRM and, if no change will be made, the reason why a change is not necessary.
6. Establishment of Facility Ratings
KCP&L establishes 100 kV and above facility ratings consistent with its FRM as described in Section 9.

7. Communication of Generator Facility Ratings
KCP&L submits then-current ratings information to the SPP model building processes on a periodic basis as required by the NERC MOD standards and annual SPP model building requirements. KCP&L will communicate facility ratings information to its Regional Reliability Organization (Midwest Reliability Organization (MRO)), its Reliability Coordinator (SPP) and to other Transmission Owners or Operators upon request. When KCP&L has confirmed that updated ratings of its facilities are applicable, it will communicate those new ratings to the SPP, and KCP&L Transmission System Operators via appropriate mechanisms such as by submitting updated ratings to model data bases, by electronic mail, by web-based tools, or, in the event of real-time system loading issues, by telephone. KCP&L will maintain records of updated facility ratings submittals for documentation purposes for the applicable FAC-008-3 retention period.

8. Communication of Transmission Facility Ratings
KCP&L shall provide requested information as specified below (for its solely and jointly owned Facilities that are existing Facilities, new Facilities, modifications to existing Facilities and re-ratings of existing Facilities) to its associated Reliability Coordinator(s), Planning Coordinator(s), Transmission Planner(s), Transmission Owner(s) and Transmission Operator(s):

8.1. As Scheduled by NERC Entity
KCP&L submits then-current ratings information to the SPP model building processes on a periodic basis as required by the NERC MOD standards and annual SPP model building requirements.

8.1.1. Facility Ratings
KCP&L will provide all current facility ratings for transmission lines, power transformers, and shunt reactive devices.

8.1.2. Identification of Facility Rating limits
KCP&L will identify the most limiting equipment for all current facility ratings for transmission lines, power transformers, and shunt reactive devices.

8.2. As Requested by NERC Entity
KCP&L will communicate facility ratings information to its Regional Reliability Organization (MRO), its Reliability Coordinator (SPP) and to other Transmission Owners or Operators upon request within 30 calendar days (or a later date if specified by the requester), for any requested Facility with a Thermal Rating that limits the use of Facilities under the requester’s authority by causing any of the following: 1) An
Interconnection Reliability Operating Limit, 2) A limitation of Total Transfer Capability, 3) An impediment to generator deliverability, or 4) An impediment to service to a major load center:

8.2.1. **Identity of next most limiting equipment in Facility Rating**

KCP&L will identify the existing next most limiting equipment of the Facility ratings for transmission lines, power transformers, and shunt reactive devices.

8.2.2. **Identification of Facility Rating limits**

KCP&L will identify the thermal limit of the existing next most limiting equipment of the Facility ratings for transmission lines, power transformers, and shunt reactive devices.

9. **Transmission Equipment Rating Methodology**

KCP&L shall design and operate the transmission network in a safe and reliable manner. In order to accomplish this goal, it is necessary to determine safe-operating limits of the equipment involved. This document provides a general discussion of the practices used in developing ratings for the equipment used on the transmission system as well as a description of KCP&L’s practices for developing loading limitations for the facilities (transmission lines and transformers), based upon these ratings. Equipment ratings are determined for the maximum and minimum voltage, current, frequency, real and reactive power flows on individual transmission equipment.

9.1. **Development of Equipment Current Ratings**

A maximum current capacity rating (in amperes) is assigned to all equipment on the KCP&L bulk electric system. The development of the current ratings for each type of equipment is discussed below. KCP&L has not established a minimum current capacity rating for transmission equipment.

9.1.1. **Overhead Conductors**

Maximum current ratings are calculated for ACSR (aluminum conductor steel reinforced) overhead conductors based upon maintaining conductor temperature limits of 90°C and 100°C. The current ratings developed for these conductor temperatures represent the Normal and the Emergency ratings of the conductors, respectively. Each of these ratings is developed for the Summer Peak (Jun, Jul, Aug, Sep), Winter Peak (Dec, Jan, Feb, Mar), and Spring/Fall (Apr, May, Oct, Nov) seasons of the year.

Beginning in 2003, KCP&L began using ACSS (aluminum conductor steel supported) overhead conductor in certain situations where contingent overloads on ACSR conductors would limit transfer capability. For this conductor, the normal and emergency ratings will be based on allowing a maximum conductor temperature of up to 200°C dependent upon adequate clearance levels.
For transmission lines where conductor sag conditions do not permit the conductor to operate at the temperatures defined above, clearance limitations will be noted in the rating of the facility.

The maximum current ratings for each of these conductor temperatures are calculated using EPRI’s DYNAMP computer model. These ratings are static ratings based upon the anticipated system conditions as defined in Table 1:

**Table 1: System Design Variables Modeled in DYNAMP**

<table>
<thead>
<tr>
<th>Data Items</th>
<th>Input Conditions</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Summer Peak</strong></td>
<td><strong>Winter Peak</strong></td>
<td><strong>Spring/Fall</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Conditions</strong></td>
<td><strong>Conditions</strong></td>
<td><strong>Conditions</strong></td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>June 15</td>
<td>January 1</td>
<td>April 1</td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>12:00 Noon</td>
<td>12:00 Noon</td>
<td>12:00 Noon</td>
<td></td>
</tr>
<tr>
<td>Latitude</td>
<td>38.5° N</td>
<td>38.5° N</td>
<td>38.5° N</td>
<td></td>
</tr>
<tr>
<td>Longitude</td>
<td>94.0° W</td>
<td>94.0° W</td>
<td>94.0° W</td>
<td></td>
</tr>
<tr>
<td>Inclination Angle</td>
<td>0°</td>
<td>0°</td>
<td>0°</td>
<td></td>
</tr>
<tr>
<td>Ambient Air Temperature</td>
<td>37.7°C</td>
<td>0°C</td>
<td>20°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100°F</td>
<td>32°F</td>
<td>68°F</td>
<td></td>
</tr>
<tr>
<td>Line Axis Azimuth</td>
<td>90°</td>
<td>90°</td>
<td>90°</td>
<td></td>
</tr>
<tr>
<td>Elevation</td>
<td>950 feet</td>
<td>950 feet</td>
<td>950 feet</td>
<td></td>
</tr>
<tr>
<td>Absorptivity</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Emissivity</td>
<td>0.85</td>
<td>0.85</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>Wind Direction</td>
<td>180°</td>
<td>180°</td>
<td>180°</td>
<td></td>
</tr>
<tr>
<td>Wind Speed</td>
<td>2 ft/sec</td>
<td>2 ft/sec</td>
<td>2 ft/sec</td>
<td></td>
</tr>
</tbody>
</table>

Ratings for the conductor on the St. Joseph – Cooper 345kV line utilize differing system design variables based on performance history and engineering analysis specific to the line.

The normal and emergency ratings determined for overhead transmission conductors are treated in the following manner in planning and operating the transmission system.

**Normal Rating:** Under normal operating conditions, with no contingencies in effect, the normal rating of the conductor may not be exceeded.

**Emergency Rating:** Under contingency conditions, an overhead transmission line may be operated up to its emergency rating for a period not to exceed
hours. KCP&L Transmission Line Engineering approved this emergency rating limit.

9.1.2. Underground Pipe-Type Cable
The KCP&L transmission system utilizes several sections of buried oil-filled, pipe-type cable operated at a voltage of 161 kV. The factor that limits the current-carrying capability is the maximum permissible insulation temperature, which was determined by the manufacturer. Their current-carrying capability is not affected by ambient air temperature due to the fact that the cable is located underground. Therefore, seasonal ratings are not assigned to the cables.

Due to the nature and location of the underground transmission cables, the maximum current ratings determined by the manufacturers are treated as firm limits and may not be exceeded under any circumstances. Normal and Emergency ratings will be the same.

9.1.3. Bus Pipe Conductor
Bus pipe conductor ampacity rating is provided by the manufacturer with conditions of 30°C rise over a 40°C ambient temperature. KCP&L has determined to rate tubular bus it uses for substations at a 50°C rise over ambient temperature (~90°C bus bar max temperature), therefore the conservative multiplier for a 50°C rise is 130%. Seasonal ratings are not assigned for bus pipe conductor, and Normal and Emergency ratings will be the same.

9.1.4. Wavetraps
Wavetraps are assigned maximum current ratings by the manufacturers based upon design criteria. KCP&L has two types of wavetraps in service; 1) the older wavetrap in which the main coil is designed as a single phase, air-cored inductor of dry type, and 2) the newer designs that consist of a wire coil encapsulated in an epoxy resin. These wavetraps have no overload capability when the ambient air temperature is 40°C (104°F) or higher and the wavetrap have been carrying current. If the ambient air temperature is less than 40°C or if the wavetrap has not been carrying rated current, some overload capacity does exist. KCP&L has adopted the SPP normal loading guidelines (Planning Criteria section 7.2.5 and appendix PL-2.D) for wavetraps. To arrive at the seasonal ratings, multiply the designed ampere rating at 40°C by the loadability factor shown in Table 2 for dry type wavetraps, or Table 3 for epoxy wavetraps.
Table 2: Seasonal Loadability Factors for dry type Wavetraps

<table>
<thead>
<tr>
<th>Ambient Air Temperature</th>
<th>Season</th>
<th>Loadability Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>37.7°C/100°F</td>
<td>Summer</td>
<td>1.0058</td>
</tr>
<tr>
<td>20°C/68°F</td>
<td>Spring/Fall</td>
<td>1.05</td>
</tr>
<tr>
<td>0°C/32°F</td>
<td>Winter</td>
<td>1.10</td>
</tr>
</tbody>
</table>

Table 3: Seasonal Loadability Factors for epoxy type Wavetraps

<table>
<thead>
<tr>
<th>Ambient Temperature</th>
<th>Season</th>
<th>Loadability Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>37.7°C/100°F</td>
<td>Summer</td>
<td>1.0058</td>
</tr>
<tr>
<td>20°C/68°F</td>
<td>Spring/Fall</td>
<td>1.13</td>
</tr>
<tr>
<td>0°C/32°F</td>
<td>Winter</td>
<td>1.25</td>
</tr>
</tbody>
</table>

The seasonal maximum current ratings determined for wavetraps are treated as firm limits and may not be exceeded under any circumstances (Normal and Emergency rating are same).

9.1.5. Disconnect Switches

Disconnect switches are assigned maximum current ratings by the manufacturers based upon design criteria. The switches are rated according to their Allowable Continuous Current Class (ACCC) designation (ANSI STD. 37.37-1979). KCP&L utilizes switches with an ACCC rating of A01 or D06. The design of the switches is such that they have no overload capability when the ambient temperature is 40°C (104°F) and the switch is carrying rated current. If the ambient temperature is less than 40°C or the switch has not been carrying rated current, some overload capability does exist. The loadability factors used in developing the normal seasonal ratings for the KCP&L system are taken from SPP Criteria (Planning Criteria section 7.2.4 and appendix PL-2.C) and shown in Table 4. To arrive at the seasonal ratings, multiply the designed ampere rating at 40°C by the loadability factor.
Table 4: Seasonal Loadability Factors for Disconnect Switches

<table>
<thead>
<tr>
<th>Ambient Temperature</th>
<th>Season</th>
<th>Loadability Factor A01</th>
<th>Loadability Factor D06</th>
</tr>
</thead>
<tbody>
<tr>
<td>37.7°C/100°F</td>
<td>Summer</td>
<td>1.04</td>
<td>1.10</td>
</tr>
<tr>
<td>20°C/68°F</td>
<td>Spring/Fall</td>
<td>1.29</td>
<td>1.27</td>
</tr>
<tr>
<td>0°C/32°F</td>
<td>Winter</td>
<td>1.53</td>
<td>1.41</td>
</tr>
</tbody>
</table>

The seasonal maximum current ratings determined for disconnect switches are treated as firm limits and may not be exceeded under any circumstances. Normal and Emergency ratings are the same.

9.1.6. Current Transformers and Relays

KCP&L uses two types of current transformers (CT); separately mounted type or bushing type. The basis for CT ampere rating is ANSI/IEEE C57.13-1978, IEEE Standard Requirements for Instrument Transformers.

Separately mounted CTs (i.e. Slip Over CT’s and Free Standing CT’s) will have ratings based on the primary current rating for the tap ratio being used and the continuous thermal current rating factor (RF) supplied by the specific CT manufacturer. All unknown full ratio RF values will be assumed to be 1.0.

\[
\text{Max CT rating} = \text{CT primary tap ratio setting times RF} \\
RF = RF_{\text{Full Ratio}} \text{ or } RF_{\text{Tap}} \text{ if known}
\]

Bushing type CTs mounted inside of breakers and transformers may have ratings calculated in one of two ways:

1) Where specific manufacturer data on the RF for each tapped ratio is available and greater than 1.0, KCP&L will use the formula below to define maximum allowable CT ampere rating.

\[
\text{Max CT rating} = \text{CT primary tapped ratio setting times RF of specific tapped ratio used.}
\]

2) Where specific manufacturer data (RF) for each tapped setting is unavailable or listed at 1.0, KCP&L may use either 1.0 or the rating formulas below based on a Westinghouse Electric technical paper 8/18/1969 entitled “Memorandum on Thermal Current Characteristics of Current Transformers Used with Power Circuit Breakers and Power Transformers”. All unknown full ratio RF values will be assumed to be 1.0.

\[
RF_{\text{Tap}} = \left(\frac{I_b}{I_{ct}}\right)^{1/2} \times RF_{\text{Full Ratio}}, \text{ RF}_{\text{Tap}} \text{ not to exceed 2.0}
\]
I_b = Breaker (or Transformer) continuous current rating
I_{ct} = CT primary ratio tap setting
Max CT rating = I_{ct} * RF_{Tap}, rating not to exceed continuous
current rating of breaker or transformer.

No seasonal ratings are developed for current transformers.

Due to the operating characteristics of relays, the maximum current ratings
specified for this type of equipment are treated as firm limits. Normal and
Emergency ratings are the same. As these ratings are relatively independent of
temperature, no seasonal ratings are developed for relays.

9.1.7. Bulk Power Transformers

The bulk power transformers used by KCP&L consist of 345/161 kV
autotransformers, and 161/69 kV and 161/34.5 kV transformers. Power
transformer ratings are discussed in IEEE Standard C57.115-1991, IEEE Guide
for Loading Mineral-Oil-Immersed Power Transformers Rated in Excess of 100
MVA (65°C Winding Rise). Every transformer has a distinct temperature rise
capability used in setting its nameplate rating (either 55°C or 65°C). These
temperature rise amounts reflect the average winding temperature rise over
ambient that a transformer may operate on a continuous basis and still provide
normal life expectancy. Average ambient temperature is an important factor in
determining the load capability of a transformer since the temperature rise for any
load must be added to the ambient to determine operating temperature.
Transformers designed according to ANSI standards use a 30°C average ambient
temperature (average temperature for 24 consecutive hours) when setting
nameplate rating. Transformer overloads can be increased at lower average
ambient temperatures and still experience the same loss of life. KCP&L has
chosen to follow SPP rating practices, which did not use seasonal transformer
ratings.

The normal circuit rating for power transformers shall be its highest nameplate
rating. The nameplate rating shall include the effects of forced cooling equipment
if it is available. For multi-rated transformer (OA/FA, OA/FA/FA,
OA/FOA/FOA, OA/FA/FOA) with all or part of forced cooling inoperative,
nameplate rating used is based upon the maximum cooling available for
operation. Normal life expectancy will occur with a transformer operated at
continuous nameplate rating.

When operated for one or more load cycles above nameplate rating, the
transformer insulation deteriorates at a faster rate than normal. The emergency
circuit rating for power transformers shall be 110% of its highest nameplate
rating.
9.1.8. Circuit Breakers

Circuit breaker ratings are discussed in ANSI/IEEE C37.010-1979, IEEE Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis and in ANSI/IEEE C37.010b-1985, IEEE Standard for Emergency Load Current-Carrying Capability. These standards discuss the development of ratings from the standpoint of the manufacturers. From a practical standpoint, the application of the methods discussed in these standards to circuit breakers in operation will be very difficult, due to the fact that this application would require contacting the manufacturer for detailed design information for each circuit breaker being rated. Therefore, the nameplate rated continuous current will be used as the circuit breaker’s normal and emergency circuit ratings.

9.1.9. Series & Shunt Reactive Devices

KCP&L utilizes series reactors, shunt reactors, and shunt capacitors in a number of locations in its transmission system. Normal and emergency ratings for these devices will be based on manufacturers’ continuous current rating. This rating should not be exceeded under any circumstance.

9.1.10. Substation Infrastructure Facilities

For substations with straight bus configurations, the ratings of substation infrastructure (bus section, bus switches, breakers, bus jumpers, CTs) will be included in the development of ratings for transmission line/transformer/generator/shunt device terminal equipment.

For Multi-Breaker configuration (breaker-and-half, Ring Bus, or double breaker/double bus), the equipment rating on the substation side of the terminal shall be rated based on one-breaker open when determining an “open bus limit” (OBL). If the ratings of terminal equipment (such as breakers, switches, etc.) are not identical at one end of the transmission line or transformer, then the equipment with the higher rating is assumed to be open when developing the “open bus” facility rating. Where appropriate a note will be added in the Transmission Line Ratings book to reflect a reduced rating, equal to the most limiting infrastructure rating, for “open” bus operation. The note will identify the specific piece of equipment causing the open bus limit. Normal and Emergency ratings are the same.

9.2. Transmission Equipment Current Limits

There are several different types of equipment that could limit the load-carrying capability of a single transmission line or bulk power transformer. The limiting element could be the transmission line’s conductor, a wavetrap, a disconnect switch, a current transformer, a relay, a transformer, or a circuit breaker. The current carrying limitation of a transmission line segment or bulk power transformer will be the most limiting equipment in the path of current flow. The limiting element must be determined separately for both normal and emergency conditions, as well as on a seasonal basis. The information on limiting element for transmission lines is maintained in the KCP&L
Transmission Line Ratings book. Minimum facility ratings are converted to MVA values and provided to KCP&L Transmission Operations (electronic copy & EMS limits), SPP RC (e-mail), and other NERC entities through the SPP model development process. Transmission facilities will be reviewed for upgrades or mitigating actions when the normal or emergency ratings are exceeded as determined from SPP or KCP&L planning studies. KCP&L will also review upgrading circuit breakers when the short circuit interrupting capability is expected to exceed 100% of its rating.

9.3. Transmission Equipment Voltage Limits

KCP&L substation equipment design practice defines the lightning arrester as the limiting element for maximum allowable operating voltage for transmission equipment. The continuously applied voltage is the most important application criterion for a metal oxide arrester. The maximum continuous operating voltage (MCOV line to ground) for the different voltage classes is shown in Table 5. The maximum normal and emergency operating voltage for KCP&L transmission equipment will be the MCOV line to line voltage. This is approximately 105% of nominal voltage. The arrester manufacturer does provide a temporary overvoltage (TOV) capability equal to approximately an additional 1.25% of the MCOV for approximately 15 minutes.

| Table 5: Metal Oxide Lightning Arrester maximum voltage in kV |
|-----------------|-----------------|-----------------|-----------------|
| kV level        | MCOV L-G        | MCOV L-L        | 15 minute TOV   |
| 345             | 209             | 362             | 371             |
| 161             | 98              | 169             | 173             |
| 69              | 42              | 72              | 74              |

The minimum normal operating voltage for KCP&L transmission equipment will be 95% of nominal voltage and the minimum emergency operating voltage will be 90% of nominal voltage. These values are consistent with SPP Planning Criteria.

KCP&L has 138kV rated oil circuit breakers that are operated at 161kV based on performance history.

9.4. Transmission Real & Reactive Power Flow Limits

KCP&L real power flow will be constrained by the maximum current that a piece of transmission equipment can carry. For this reason KCP&L has not established a separate maximum real power flow limit for its transmission equipment. Similarly, reactive power flow will be constrained by the minimum and maximum voltage levels that a piece of transmission equipment can operate at. For this reason KCP&L has not established a separate minimum or maximum reactive power flow limit for its transmission equipment.

9.5. Transmission Equipment Frequency Limits

Because the normal operating range for system frequency for the Eastern Interconnection is relatively small, the impact of frequency deviations on transmission equipment is insignificant. For this reason, KCP&L has not established minimum and maximum frequency limits for its transmission equipment.
## Document version history

The following table documents changes to this document and its predecessors.

<table>
<thead>
<tr>
<th>Date</th>
<th>Document</th>
<th>Description</th>
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<tbody>
<tr>
<td>7-16-19</td>
<td>KCP&amp;L Transmission FRM 7-16-19 Final.pdf</td>
<td>Reviewed and updated document with administrative updates and formatting; removed references to GMO and Aquila; updated sections 2, 9.3, 9.1.1, 9.1.6; added section 9.1.3; removed section 9.6.</td>
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<tr>
<td>12-6-18</td>
<td>KCP&amp;L Transmission FRM 12-6-18 Final.pdf</td>
<td>Annual document review, no changes made</td>
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<tr>
<td>12-6-17</td>
<td>KCP&amp;L Transmission FRM 12-6-17 Final.pdf</td>
<td>Updated Sections 3.1 and 9.1.5</td>
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<tr>
<td>12-31-16</td>
<td>KCP&amp;L Transmission FRM 12-31-16.pdf</td>
<td>Reviewed and updated document</td>
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<tr>
<td>12-31-15</td>
<td>KCP&amp;L Transmission FRM 12-31-15.pdf</td>
<td>Reviewed and updated document to reflect recommendations for August 2015 audit</td>
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<tr>
<td>4-1-15</td>
<td>KCP&amp;L Transmission FRM 4-1-15.pdf</td>
<td>Reviewed and updated document</td>
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<tr>
<td>12-1-13</td>
<td>KCP&amp;L Transmission FRM 12-1-13.pdf</td>
<td>Reviewed and updated document to reflect FAC-008-3 requirements</td>
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<tr>
<td>3-1-10</td>
<td>2010 KCP&amp;L Planning Criteria.pdf</td>
<td>Reviewed and updated Bulk Electric System Planning Criteria; included addition of section 5.1.9 clarifying rating of substation infrastructure facilities.</td>
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<tr>
<td>4-1-08</td>
<td>2008 KCP&amp;L Planning Criteria.doc</td>
<td>Reviewed and updated Bulk Electric System Planning Criteria.</td>
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