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WFEC Planning and Design Criteria

The WFEC criteria described below supplements the North American Electric Reliability Corporation (NERC) Reliability Standards, SPP Planning Criteria Section 5: Regional Transmission Planning, and SPP Disturbance Performance Requirements. Additional design criteria and planning goals incorporated in the long-range planning performed by WFEC are as follows:

1. Power Factor - Transmission system power factor, including the reactance and susceptance (B) the imaginary part of admittance in transmission lines, should be maintained at 98% or better by the use of switched capacitors and/or reactors. Generator reactive power will be used to provide system voltage control, but will not be available to supply reactive power to remote loads with lagging power factor.

2. System Voltage - Transmission level buses above 60kV shall maintain 0.95 per unit to 1.05 per unit during a pre-contingency operating condition in category P0 of the NERC Reliability Standard TPL-001-4. Capacitor switching and adjustment of de-energized tap changers (DETC) will be permitted to meet these voltage criteria for normal system operation. Transmission level buses above 60kV shall maintain 0.90 per unit to 1.05 per unit during a contingency operating condition in category P1 through P7 of the NERC Reliability Standard TPL-001-4. Transmission level buses above 100kV with a post-contingency voltage deviation greater than 0.10 pu shall be flagged and serve as informational purpose only.

3. Equipment ratings - Thermal ratings define transmission facility loading limits. Normal ratings are generally based upon no abnormal loss of facility life or equipment damage. Emergency ratings accept some loss of life or strength, over a defined time limit for operation at the rated loading level. The thermal rating for a transmission line is defined by the most limiting element, be it a conductor capability, sag clearance, or terminal equipment rating. Thermal limits establish the maximum amount of electrical current that a transmission circuit or electrical facility can conduct over a specified time period before it sustains permanent damage by overheating or before it violates public safety requirements. Normal and emergency transmission equipment ratings are documented by WFEC's Transmission and Generation Facility Ratings Methodology. No facility may exceed its normal rating in the pre-contingency state following the occurrence of any operating condition in category P0 of the NERC Reliability Standard TPL-001-4. No facility may exceed its emergency rating in the post-contingency state following the occurrence of any operating condition in categories P1 through P7 of the NERC Reliability Standard TPL-001-4

4. Radial Service Conversion - Radial served loads (i.e. - one source) will qualify for improved service (i.e. - loop or multiple source, improved line construction, etc.) when the radial load exposure factor exceeds predefined limits, typically 500MW-miles, defined as the length of the tap line times total loading on the radial. The radial load exposure factor was developed to provide a systematic approach to evaluating radial loop conversion. This was necessary to avoid overly subjective evaluation of conversion resulting in inconsistent system improvements.

5. Outages - Outage records for WFEC transmission facilities are reviewed for a 5 year period. System modifications or additions are recommended if any line or substation has an outage record of more than 10 hours average per year, or more than one outage every year of five hours duration or more.

6. Maximum Service Level - No more than 50 MW of load or 10,000 consumers will be served on any single line segment between major switching points. Switching stations and/or looped lines will be added as necessary to meet this criterion.

7. Multiple Terminal Lines - No four terminal lines will be used. Multiple terminal lines are permitted up to three terminals. However, due to the challenges they impose to protective relaying three terminal lines are not the preferred option.

8. Multiple Transformers - For loads up to 28,000 kVA, a single transformer per substation will be used. For loads above 28,000 kVA, separately protected transformers will be used or additional substations will be considered. Multiple transformers within the same substation will not have paralleled low side buses.

9. Transformer Protection - Primary fuses will be used for transformers rated up to 10,500 kVA. Circuit Switchers, vacuum interrupters or similar devices will be used for transformers rated above 10,500 kVA. New stations will have Circuit Switcher on 10,500 kVA and above. Rehabs generally will have circuit switcher if transformer has CTs on it. New stations will be designed (i.e. foundations and conduit installed) with the capability of installing a future circuit switcher even if fuses are utilized.

10. All new switch stations will be built in a ring bus configuration wherever possible to improve fault isolation and system reliability. Minimum 2000 amp bus in any new switch station.

11. Newly constructed and rebuilt transmission lines will be designed and insulated for 138 kV even if operated at 69 kV. Newly constructed and rebuilt transmission lines will also include Optical Ground Wire (OPGW). They will use Class II or better wood poles for all tangent structures. Steel poles will be used for all turns and dead-end structures. Steel poles may be substituted for wood poles in areas with historic woodpecker damage. 336.4ACSR Linnet will be the minimum size conductor allowed for new construction. A guyed double-deadend or self-supporting "storm structure" will be installed at a minimum of 5 miles and both sides of all railroad and highway crossings. Running angles may be designed as double-deadends to meet the "storm structure" criteria.

12. Dynamic Criteria – Requirements for Rotor Angle Damping and Transient Voltage Recovery are defined in SPP's Disturbance Performance Requirements and are applicable to the Bulk Electric System within WFEC's planning area.

13. Transmission Line Rebuilds – Upgrading of transmission lines will most commonly occur for those cases described in Section 3, 4, and 5 above. However, it is possible that a transmission line may approach the end of its lifespan without qualifying for an upgrade based on the requirements of section 3, 4, and 5 in the WFEC planning criteria. Age alone is not enough to prioritize line replacement as pole condition, such as woodpecker damage, my warrant a line rebuild before a predefined number of years. WFEC will maintain a line replacement decision matrix, taking into account and applying weighting factors for categories such as age, conductor size, pole condition, etc. that will identify those lines most in need of replacement.

14. Switchstation Upgrades – The switchgear in WFEC switchyards should be designed for a 30-year lifespan. When switchgear has surpassed this age it will be marked for replacement. This will improve reliability by upgrading equipment that has become old, worn out, obsolete, and prone to failure. This will also allow easier accessibility to replacement parts, which may become difficult to find with older equipment.

15. Substation Transformer Upgrades – Per WFEC Policy 9-1 substation transformers will be marked for replacement when they have reached 90% utilization. Typically this will result in the upgrade of an existing transformer, but a 2nd transformer in the same substation may also be installed to meet the requirements of Section 8 in WFEC's Planning Criteria.

Approval

Kalun Kelley
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3/21/17
Date

Revision History

Date	Revised/Reviewed By:	Revision:
03/20/2017	Joe Williams Travis Gouche Shaun Golden Cobey Bean	Document Creation; consolidation of WFEC's planning criteria

3/21/2017	Kalun Kelley	Review and approval by Manager, Transmission & Distribution Engineering