DEDSTF – Lines Subgroup

Clearance Requirements DRAFT

Bob May – BGE

Phase to phase and phase to ground clearances shall be set to accommodate live line maintenance. Discussed at 10/5 teleconference and since this does not address possibility of other designs which may not meet Live Line requirements but could meet all applicable regulations, it was decided to use similar language that is incorporated in the SPP Minimum Transmission Design Standards for Competetive Upgrades:

"Sufficient space to maintain OSHA minimum approach distances in place at the date of project approval, either with or without tools, shall be provided. When live-line maintenance is anticipated, designs shall be suitable to support the type of work that will be performed (e.g., insulator assembly replacement) and the methods employed (i.e., hot stick, bucket truck, or helicopter work, etc.)."

~~Clearances between subconductors of a bundle are not defined in this section.~~

Clearance Requirements

The clearance requirements presented in this section of the standards will be maintained with the reference conductor at maximum sag and after experiencing the maximum loading conditions ("final" conditions). Maximum sag conditions may be experienced at maximum conductor operating ~~elevated~~ temperatures or under NESC heavy ice~~d conductor~~ conditions. For conductor-to-conductor clearances between different circuits, the upper conductor shall be at maximum sag and the lower conductor at "minimum" sag. Minimum sag is defined as -10°F, no wind, no ice, initial conditions. In the absence of the necessary data to perform this analysis, the lower conductor's position may be approximated by a straight line interpolation between the attachment points. Additional review of this criteria needed to address crossings on different structures verses conductors on same structure.

Clearances shall assume maximum operating voltages as defined in PJM Manual 3. These are nominally 5% overvoltage for the high voltage lines (<=345kV) and 10% for extra-high voltage lines (>345kV). The system transient overvoltages (TOV) shall then be applied and any elevation factors added. Is this specifically addressed in NESC?

~~The clearance requirements relating to the National Electrical Safety Code (NESC) shall be based on the version specified by local ordinance. If no such version is specified, the latest effective version at the beginning of design shall apply (based on NESC Rule 016 "effective date").~~ Addressed in the NESC forward?

~~The DE is responsible for ensuring the correct conditions are applied.~~ eliminate

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Comment [TDP1]: This may add confusion as it is commonly associated with switching surges. 765kV is 5% but I don't know how it is listed in Manual 3. Should we eliminate all but the reference?

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Clearances between phase and grounded metal Values in table are greater than NESC and PJM TSDS.

If a "buffer" is recommended, what should the buffer be and why. It may be less contentious to identify why a buffer should be considered as opposed to agreeing to a specific buffer? Homework topic

This requirement defines clearance minimums between the phase conductor and any grounded metal surface, such as the structure or shield wire.

Voltage	69kV	115kV & 138kV	230kV	345kV	500kV	765kV
Phase-ground clearance (in)		52	97		132	

Maintain avian clearances – For clearances between the phase conductor and the arm of the phase below, additional clearance shall be maintained to prevent electrocutions to perching birds. An additional 7 feet of clearance shall be maintained based on the wing span of a bald eagle or turkey vulture. Group felt that the Avian clearance should be taken into consideration – additional work required to determine if there is a guideline or best practice in use today. ie, EPRI.

Comment [TDP2]: Could we make it conditional based on special studies when required by siting authorities?

Clearances between phases of the same circuit

Maintain avian clearances see above.

Clearances to ground – Based on NESC Rule 232

All clearances over ground shall be set to accommodate vehicle access, plus a 3 foot clearance buffer at maximum sag. All terrain points shall be considered vehicle-accessible regardless of terrain changes or the presence of access roads. In addition, the requirements of Rule 232C1.c (5mA rule) must be factored in to all designs exceeding 98kV AC to ground to limit the steady state current to 5mA rms of the largest vehicle anticipated under the lines were short circuited to ground. – this is stated in NESC.

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~~When a subject line has a known or controlled switching surge, the alternate clearances described in Rule 232D may be used as a base value, with the 3 foot clearance buffer applied above that value.~~

Clearances to waterways – Based on NESC Rule 232 recommendation to re-word as a requirement

Clearances over Waters of the United States shall be based, at a minimum, on the NESC requirements in Rule 232, plus a 3 foot buffer. In the event that the Army Corps of Engineers (ACOE) determines higher clearances are required, the ACOE requirements shall be held, plus a 3 foot buffer. It is important that the navigable waterways are CHARTED by the National Oceanic and Atmospheric Administration (NOAA)

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and the US Coast Guard to include the appropriate electrical clearances between the conductor position and the highest passable vessel under the conductors.

NOTE: Example – can't have a 40ft conductor height and chart it for a 40ft sailboat. The sailboat can't be higher than 34ft or you introduce a risk of flashover.

Clearances to crossing lines – Based on NESC Rule 233

Clearances shall assume a 180° phase relationship between the conductors.

Vertical: As stated previously, clearances between crossing lines shall be measured with the upper conductor at maximum sag and the lower conductor at minimum sag. Lines of higher voltage shall always cross above lines of lower voltage. A 3 foot buffer shall be used above the clearances required in the NESC Rule 233. Homework – review this section in NESC

~~Horizontal: Horizontal clearances shall be calculated using NESC rule 233 with a 3 foot buffer.~~

~~When a subject line has a known or controlled switching surge, the alternate clearances described in Rule 233B3 and 233 C3 may be used as base values with the respective vertical and horizontal buffers applied above those values.~~

Clearances to other obstacles – Based on NESC Rule 234

The horizontal, vertical, and transitional clearances specified under NESC Rule 234 shall all have a 3 foot buffer added to the clearance requirement. Vertical clearances shall be measured with the conductor at maximum sag. Horizontal clearances shall be measured with the conductor at 60°F with 6psf wind. Is this specified in NESC? In addition, the requirements of Rule 234G3 (5mA rule) must be factored in to all designs exceeding 98kV AC to ground to limit the steady state current to 5mA rms in any ungrounded portion of or attachment to a metal fence, building, sign, billboard, chimney, antenna, tank, or other installation under the lines were short circuited to ground.

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~~When a subject line has a known or controlled switching surge, the alternate clearances described in Rule 234H may be used as base values with the respective vertical and horizontal clearance buffers applied above those values.~~

Clearances to co-located lines – Based on NESC Rule 235

Clearances in this section are required between the phase conductors of one circuit and the phase conductors of another circuit attached to the same structure. These are required for double circuit transmission structures (typical double circuit arrangements) or structures with transmission and distribution on the same structure (i.e. underbuild). Clearances shall assume a 180° phase relationship between the conductors.

The clearances calculated based on Rule 235 shall all have a 3 foot buffer added to the horizontal and vertical clearance requirement. What does NESC specify – is the 3 foot buffer in PJM TSS applied to vertical only?Vertical clearances shall be measured using the clearance criteria of Rule 233 (top wire at max sag, bottom at "cold" or straight line). What is specified in NESC? Horizontal clearance requirements shall be measured assuming suspension insulator swing

~~When a subject line has a known or controlled switching surge, the alternate clearances described in Rule 235B3 and 235C3 may be used as base values with the respective vertical and horizontal clearance buffers applied above those values.~~

Additional clearance topics to include or specifically call out?

- Clearance requirements within controlled switchyards?
  - Clearances over crossing equipment, fences, etc. M. Herman to check with Sub Station group.
- Application of clearance requirements with bundled conductors?
  - Assume nearest sub-conductor position or centroid of bundle?
  - Nearest energized conductor not centroid of bundle
- Clearance alternatives with respect to compact line design or control of field effects?
  - E-field, B-field, corona, TVI, RFI, audible noise, etc. captured in previous discussions of these topics. However, discussion was that any design had to meet all applicaple codes/regulations, etc. we may want to add some language to our standards to alert the DE to these design phenomenon.
- Clearances with respect to minimum insulation levels?
  - Leakage distance, dry arc distance?
  - Shielding angles? Group felt these criteria were too specific

It was discussed at the meeting that a the common approach of calling out specifics that are not covered in a code or regulation was more productive than trying to be too specific about the individual engineering "factors" that are used by TO's.

TDP Comments:

After a quick review of the NESC, it seems that it covers everything contained within our draft except the following:

- Design clearance buffers
- These definitions of maximum and minimum sag
- Maximum operating voltage

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Comment [TDP3]: NESC states that clearances are measured to the nearest surface and spacing is measured center to center.

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Comment [TDP4]: If addressed, should they be in different sections?

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- Clearances between conductor and grounded metal surfaces
- Avian clearances
- ACOE requirement statement

- Suggest we avoid repeating code provisions. For simplicity, "the DE shall meet the NESC clearances, with any noted exceptions"? Should we avoid altering the conditions for calculating the clearances from those defined within the NESC as much as possible (these are the industry agreed-upon minimums). The design buffers would provide any safety margin the group feels is needed.

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