Selected Contingencies

The planning studies for the transmission system are performed for normal and contingency conditions. The thermal and voltage guidelines should not be violated for either normal operations or under the loss of:

a) A single transmission circuit
b) A single transformer
c) A single generating unit
d) A single reactive power source or sink
e) Combination of a single generating unit and a single transmission circuit, capacitor bank, or transformer
f) Combination of two generating units

These contingency conditions are evaluated in accordance with NERC Reliability Standards TPL-001 through 004.. Duke's philosophy on each of these standards is explained below.

TPL 001-002 – Categories A and B

The following was taken from Table IA of the NERC Reliability Standards. Notes were added by members of the System Planning Department for the purpose of clarifying and documenting results. *Notes are in italics.*

A – No Contingencies/All facilities in service – *base case is screened for thermal and voltage violations*

B – Event resulting in the loss of a single element

SLG or 3-Phase Fault, Normal Clearing

1. Generator – *Duke will evaluate the loss of the largest generating unit at each station.*
2. Transmission Circuit - *Duke will evaluate the loss of every 44 kV, 100 kV, 161 kV, 230 kV and 500 kV transmission circuit on the system.*
3. Transformer – *Duke will evaluate the loss of every 230-100 kV txs, 230-161 kV txs, 500-230 kV txs, and 100-44 kV txs on the system*

Although Duke doesn't plan to take out bulk equipment or generation on summer peak, the demand condition we assess, Duke plans the system to accommodate the maintenance of the largest unit at any generating station on the system.

TPL 003 – Category C

The following was taken from Table IA of the NERC Reliability Standards. Notes were added by members of the System Planning Department for the purpose of clarifying and documenting results. *Notes are in italics.*

C Event(s) resulting in the loss of two or more (multiple) elements.

4. Bus Section – *Duke will evaluate the loss of every 161 kV, 230 kV or 500 kV bus; 100kV stations that have more than 4 double circuit lines emanating from it will we assessed. This criteria is based upon engineering judgment and system knowledge (previous studies show*

higher voltage contingencies generally have a more detrimental impact on the bulk electric system).

5. Breaker - *Duke will evaluate the loss of every 100 kV, 161 kV, 230 kV or 500 kV breaker at a station that has the most detrimental impact on the system.*
6. Category B (B1, B2, B3 or B4) contingency, manual system adjustments, followed by another Category B (B1, B2, B3 or B4) contingency – *Duke will evaluate double contingencies that do not result as a function of Category C events #1 or #2. Studies will encompass a subset of the Duke 100 kV lines, 161 kV lines, 230 kV lines, 500 kV lines, 230-100 kV txs, 230-161 kV txs, 500-230 kV txs, generators and tie lines.*
7. Bipolar (dc) line fault (non 3-ph) with normal clearing – *Duke has none.*
8. Any two circuits of a multiple circuit tower line- *Covered in # 3.*

The Bulk System (500 kV and 230 kV) is a highly inter-connected group of high-voltage and extra-high voltage electric transmission lines and tie-stations whose purpose is to enable the movement or transfer of electric energy in bulk between generators and major points of delivery. This definition can be found in both the Duke Power Facility Connections Requirements manual and the agreements Duke has made with the North Carolina Stakeholders concerning coordinated transmission planning. The Regional System (161 kV and below) is a group of electric transmission lines and tie-stations whose primary function is the distribution of energy to large industrial and large commercial customers and to retail stations in its geographical area.

In order to ensure a comprehensive evaluation of 100 kV Category C events, any station that has more than four network double circuit lines is studied.

C1,C2 will cover everything C6-C9

Because the probability of Category C events is much lower than Category B, these contingencies will be run only against the base case. Duke doesn't plan to take out bulk equipment or generation on summer peak, which is the demand condition we assess.

TPL-004 Category D (SEVERE CONTINGENCY)

The following was taken from Table IA of the NERC Reliability Standards. Notes were added by the Severe Contingency Team (SCT) for the purpose of clarifying and documenting results of the first SCT meeting. *Notes are in italics.*

D e – Extreme event resulting in two or more (multiple) components removed or cascading out of service

Evaluate for risks and consequences.

- May involve substantial loss of customer demand and generation in a widespread area or areas.
- Portions or all of the interconnected systems may or may not achieve a new, stable operating point.
- Evaluation of these events may require joint studies with neighboring systems.
- Document measures or procedures to mitigate the extent and effects of such events.
- Mitigation or elimination of the risks and consequences of these events shall be at the discretion of the entities responsible for the reliability of the interconnected transmission systems.

It was decided not to do # 1-5 since Duke is planning on performing # 8 which is more severe.

3Ø Fault, with Delayed Clearing (stuck breaker or protection system failure):

1. Generator
2. Transmission Circuit
3. Transformer
4. Bus section

3Ø Fault, with Normal Clearing:

5. Breaker (failure or internal fault). *Duke will evaluate the loss of every 100 kV, 161 kV, 230 kV or 500 kV breaker at a station that has the most detrimental impact on the system.*

Other:

6. Loss of towerline with three or more circuits – *None exist on the Duke Electric Transmission System.*
7. All transmission lines on a common right-of way- *Duke will evaluate the loss of the following:*
   any 500 kV Line that shares a common r/w with a line(s) rated 100 kV or higher for more than one mile,
   any 230 kV Line that shares a common r/w with a line(s) rated 100 kV or higher for more than one mile, and
   any 161 kV Line that shares a common r/w with a line(s) rated 100 kV or higher for more than one mile.
8. Loss of a substation (one voltage level plus transformers) – *Duke will evaluate the loss of the following:*
   500 kV busses and 500-230 kV txs at 500-230 kV stations,
   230 kV busses and 500-230 kV txs at 500-230 kV stations,
   230 kV busses and 230-100-(44) kV txs at a 230-100-(44) kV station,
   230 kV busses and 230-161 kV txs at 230-161 kV stations, and
   161 kV busses and 230-161 kV txs at 230-161 kV stations.
   100kV stations that have more than 4 double circuit lines emanating from it will we assessed. This criteria is based upon engineering judgment and system knowledge (previous studies show higher voltage contingencies generally have a more detrimental impact on the bulk electric system).
9. Loss of a switching station (one voltage level plus transformers) – *captured in 8.*
10. Loss of all generating units at a station – The stations where all units connect to the same voltage level are covered by 8. *Duke will now evaluate the loss of the following:*
    all generating units (trip only the breakers protecting each generator) that connect to 100 kV or higher via a generator step-up transformer and the loss of all units where units are connected at different voltage levels in the switchyard..
11. Loss of a large load or major load center - *None exist on the Duke Electric Transmission System.*
12. Failure of a fully redundant special protection system (or remedial action scheme) to operate when required. *None exist on the Duke Electric Transmission System.*
13. Operation, partial operation, or misoperation of a fully redundant special protection system (or remedial action scheme) for an event or condition for which it was not intended to operate. *None exist on the Duke Electric Transmission System.*
14. Impact of severe power swings or oscillations from disturbances in another Regional Council. *Not applicable to the thermal portion of the Severe Contingency Analysis.*