

NYSEG and RG&E TRANSMISSION PLANNING CRITERIA

**System Planning
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NYSEG and RG&E Transmission Planning Criteria

1). Introduction

The assignment of the System Planning department is to determine what, where, and when additional transmission system facilities are recommended to ensure adequate electric delivery service to all NYSEG and RG&E customers. The ultimate goal is to design a safe, reliable, and economical transmission system that works effectively to meet customer needs. This document establishes the planning criteria and guidelines for an effective transmission network, and the basis to identify cost effective and competitive transmission system reinforcements.

2). Definition of the Transmission System

The transmission system consists of Bulk Power, Local transmission (non Bulk Power), and within the City of Rochester, 11 kV Network facilities.

Bulk Power facilities are defined as those facilities whose performance affects the reliability of supply to other utilities and customers beyond the local area. The Bulk Power System consists primarily of generating plants usually greater than 300 MW and transmission facilities operating at 230 kV, and above. Smaller generating plants and lower voltage transmission may also be considered part of the Bulk Power System if the loss of such facilities may result in a measurable negative impact on the reliability outside of the local area. The Bulk Power System is designed and operated to the latest specifications contained in the New York State Reliability Council (NYSRC) *Reliability Rules for Planning and Operating the New York State Power System*, the Northeast Power Coordinating Council (NPCC) *Basic Criteria for Design and Operation of Interconnected Power Systems* (NPCC A-2) and *Bulk Power System Protection Criteria* (NPCC A-5), and the North American Electric Reliability Council (NERC) Planning and Reliability Standards.

Local transmission facilities are defined as those facilities that are primarily used to supply local area load or large industrial customers. The local transmission system generally consists of facilities that operate between 115 kV and 34.5 kV. However, some 34.5 kV is dedicated to serving customers. Facilities like these are referred to as 'Grounded Distribution' and are not considered part of the transmission system.

RG&E supplies a portion of the City of Rochester from Network facilities that are operated at distribution-level voltages (11 kV). However, since these Network facilities are operated in parallel with the 115 kV and 34.5 kV transmission systems, they are considered an extension of the transmission system.

3). Transmission System Conditions

The transmission system is susceptible to facilities being removed from service for circumstances such as equipment failure, weather-related damages, and accidents. Our plans identify the reinforcements that would allow the transmission system to operate under system normal conditions and most single contingency scenarios.

System Normal

System normal refers to the state of the transmission system under which all existing transmission network elements are available for service. Under system normal conditions, the transmission system shall be designed to ensure:

- 1) Adequate voltage is provided to all customers, as defined within ANSI standard C84.1-1989 (Range A) and any subsequent revisions.
- 2) All transmission lines operating between 345 kV and 69 kV do not exceed their respective seasonal Normal ratings according to the most recent NYSEG and RG&E respective "Tie Line Rating" sheets.
- 3) All transmission lines operated at 46 kV or 34.5 kV do not exceed their respective seasonal Normal ratings according to the NYSEG "Conductor Safe Ampere Rating" sheet dated July 25, 1978.
- 4) All transmission system transformers (34.5 kV and above on the low side or 11 kV on the low side for all Network transformers located within the City of Rochester) are within their respective zero percent loss of life, twenty-four hour continuous ratings.

An extended outage of a single generating unit or a single Bulk Power transformer (115 kV and above on the low side) is also considered to be a system normal state.

Single Contingency

Single contingency refers to the state of the transmission system when one element is removed from service from the system normal state. A transmission element can consist of a transmission line, a transformer, a generator, a double circuit transmission tower, a capacitor bank, or a static VAR compensator. A double circuit transmission tower outage should be considered as a single contingency if the multiple circuit towers are used for more than station entrance and/or exit purposes and exceed more than five towers in length. Multiple contingency outages that could result in the widespread loss of load may also be considered for the primary purpose of identifying their impact on the transmission system.

Under single contingency conditions, the transmission system shall be designed to ensure:

- 1) Adequate voltage is provided to all customers, as defined in ANSI standard

C84.1-1989 (Range B).

- 2) All transmission lines operating between 345 kV and 69 kV do not exceed their respective seasonal Long Term Emergency (LTE) or Short Term Emergency (STE) ratings according to the most recent NYSEG and RG&E "Tie Line Rating" sheets.
- 3) All transmission lines operating at 46 kV or 34.5 kV shall not exceed their respective seasonal LTE or STE ratings according to the NYSEG "Conductor Safe Ampere Rating" sheet dated July 25, 1978.
- 4) All transmission system transformers (34.5 kV and above on the low side or 11 kV on the low side for all Network transformers located within the City of Rochester) shall not exceed their respective seasonal LTE or STE ratings.

It should be noted that all LTE ratings are based on a duration of 4 hours and STE ratings are based on a duration of 15 minutes. Generally, the LTE rating will be used as the limiting rating to identify thermally limited facilities.

When the contingency is in addition to a generating unit or Bulk Power transformer being out of service, potential solutions could include voltage reduction, load transfers, interruptible load curtailment, public appeals, voluntary load curtailment, and/or load shedding.

4). Voltage

When analyzing the transmission system, voltage is one of the most critical parameters that must be considered. Submarginal voltages can result in damage to utility and customer equipment, and decrease the reactive power supply capability of switched capacitors. The transmission system shall be designed to maintain steady state voltages between 105% and 90% of nominal for service to regulated distribution facilities and between 105% and 95% of nominal for service to unregulated distribution facilities during system normal and most single contingency conditions. Transmission system voltages may be allowed to deviate outside the above ranges if it can be determined that the voltage provided to affected customers is acceptable.

5). Equipment Ratings

To maintain a reliable and enduring transmission system, equipment must be sized and operated according to manufacturer's specifications, industry and national standards, and Company guidelines. These guidelines specify everything from maximum operating temperatures, to energy dissipation, to mechanical operation times.

Substation equipment and transmission lines are designed to accommodate specific ratings when operating under normal or emergency conditions. A transformer's "Normal" rating is intended to protect the unit from premature aging caused by excessive heating. The seasonal LTE rating specifies the amount of load the transformer can potentially carry for up to 4 hours while suffering no more than a 0.25%

loss of life. The seasonal STE rating allows the transformer to operate at two times its nameplate rating for no longer than 15 minutes. Most overhead transmission lines and substation equipment also have seasonal normal, LTE, and STE ratings. The ratings for transmission circuits and transformers are based on the most limiting element in the path.

The transmission engineering group is responsible for providing thermal ratings for overhead transmission lines and cables.

Overhead Transmission Lines

Thermal ratings for all of the Bulk Power System overhead transmission lines are based on the 1995 report entitled "Tie-Line Ratings Task Force Final Report on Tie-Line Ratings" from the New York Power Pool and IEEE Standard 738-1993. The following criteria and assumptions are used to establish the ratings for Bulk Power System overhead transmission lines:

- A) A 40-year life is assumed for each line.
- B) A maximum ambient temperature of 35°C, with an average daily maximum temperature of 30°C is used for summer.
- C) A maximum ambient temperature of 10°C, with an average daily maximum temperature of 5°C is used for winter.
- D) An ambient wind speed of 3 ft/sec is used for summer and winter.
- E) All LTE ratings are established assuming a maximum time period of 4 hours but totaling not more than 300 hours over the life of the line.
- F) All STE ratings are established assuming a maximum time period of 15 minutes but totaling not more than 12.5 hours over the life of the line. A normal preload is also used in establishing the STE rating.

Thermal ratings for all of the Local system overhead transmission lines are based on three New York Power Pool Tie-Line Ratings Task Force reports on ratings for electric transmission lines 115 kV and above from 1970, 1982, and 1995. All Local system transmission lines built before 1982 are rated using the 1970 ratings. If a transmission line was built between 1982 and 1995, the line is rated using the 1982 ratings. If a line was built before 1982 and has been checked against the 1982 criteria and passed, then it is rated using the 1982 ratings. Finally, all lines built after 1995 are rated using the 1995 ratings.

Transmission Cables

Underground, aerial, and submarine cables are rated per manufacturer's specifications and recommendations.

The substation engineering group is responsible for providing the thermal ratings for transformers, circuit breakers, air disconnect switches, substation bus facilities, line traps, series reactors, and series capacitors.

Transformers

Transformer ratings are specified according to ANSI Standard No. C57.91-1995, "IEEE Guide for Loading Mineral Oil-Immersed Transformers". The chart below describes the system conditions used to determine loading capability. When available, actual daily load curves and ambient temperatures should be used instead of the listed standard values. The Planned Loading Beyond Nameplate rating can be applied when the pre-load of the transformer is less than 70% and the peak load duration does not exceed 8 hours. The maximum Top Oil Temperature and Hotspot Temperature, as recommended in ANSI C57.91 for each system condition, limit the loading capability of each transformer.

Transformer Overload Criteria Standard System Conditions

Description	Normal		Planned Loading Beyond Nameplate		Long Term Emergency		Short Term Emergency	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Ambient Temperature In Degrees C	30	5	30	5	35	10	35	10
Pre-Load % Of Top Nameplate	100%	100%	70%	70%	100%	100%	100%	100%
Load Duration	24 hrs	24 hrs	8 hrs	8 hrs	4 hrs	4 hrs	15 min	15 min

Circuit Breakers

The rating for circuit breakers is based on ANSI standard C37.010-1979, "Application Guide for AC High Voltage Circuit Breakers" and its supplement C37.010b-1985 on "Emergency Load Current – Carrying Capability which covers the LTE and STE conditions.

Air Disconnect Switches

The standard requirements for high voltage air disconnect switches are covered in ANSI Standards C37.30 to C37.37. These standards specify, in addition to other requirements, the rated current, the conditions under which the rated current is determined and the maximum allowable temperature rise limitations of the various components in the switch. A formula is provided in ANSI Standard C37.30 for the calculation of the allowable continuous current at ambient

temperature at which the switch can operate without exceeding its temperature rise limitations.

Substation Bus Facilities

Ampacity rating factors for rigid bus conductors are based on information provided in ANSI/IEEE Standard 605-1987 (Reference #1). Ampacity rating factors for bare cable bus conductors are determined using the rating factors for transmission line conductors, except that for ampacity calculations of the substation bus conductors, a wind velocity of 2 ft/sec must be considered.

Line Traps

A line trap usually consists of an air-core inductance coil in series with a power line conductor. It is tuned to parallel resonance by means of a tuning pack. The ANSI Standard for line traps is titled "Requirement for Power Line Carrier Line Traps" ANSI C93.3-1981, dated September 12, 1980. Prior to 1981, the line trap requirements were specified in NEMA Standard SG-11-1955.

Series Reactors

The standard covering the use of series reactors is the American Standard Requirement, Terminology, and Test Code for Current-Limiting Reactors, C57.16-1958. The ANSI's Appendix C57.99, The Guide for Loading Dry-Type and Oil-Immersed Current-Limiting Reactor published in 1965 is currently being used by the industry.

Series Capacitors

The standard requirements for series capacitors are covered in ANSI Standards 824-1985. This standard applies to capacitors and assemblies of capacitors, insulation means, switching and protective equipment, and control accessories that form a complete installation for inserting in series with a transmission or distribution line.

Current Transformers/Relays

Current transformers and relays are rated per manufacturer specifications and design recommendations. The System Protection and Control group of the System Engineering Department is responsible for providing these ratings.

6). Voltage Flicker

The maximum allowable flicker on the transmission system (Bulk Power and Local transmission facilities) caused by the starting of large motors, the switching of capacitor banks, etc., is defined by the IEEE flicker curve (see attachment A). The "Borderline of Visibility" curve, which is used as the design criteria for the transmission system, shows that when large reactive loads (capacitor banks, electric motors, etc.) are switched, steady-state bus voltages must not change by more than 3% and the number of

switching events must be limited to less than one per hour. Additionally, as seen on the curve, voltage flicker in the frequency range of 2 to 8 dips per second (characteristics of an arc furnace) shall be less than 0.5%.

7). Capacitor Sizing and Switching

- A) The voltage flicker on transmission facilities caused by the normal operation of an automatically controlled switched capacitor bank shall not exceed the “Borderline of Visibility”. When a capacitor bank is switched under normal system conditions, steady state bus voltages shall not change by more than 3% and the maximum number of switching events shall be less than one per hour.
- B) To ensure the best possible voltages to all customers during contingency conditions, voltage flicker on transmission facilities caused by the operation of an automatically or a manually controlled switched capacitor bank may be allowed to exceed 3%.
- C) Whenever possible, switched capacitor banks shall be sized and operated in a manner that will minimize system losses and/or optimize the area power factor.
- D) In most design situations, switched capacitor banks shall be equipped with automatic controls, typically with “CAP ON”, “CAP OFF”, Time Clock, Voltage Override, and time delay controls.
- E) Switched capacitor bank control settings should be calculated to ensure proper operation under normal and first contingency conditions to minimize the need for intervention by operating personnel.
- F) Whenever possible, switched capacitor banks shall be sized to avoid potential harmonic resonance during normal system operation, particularly at the 3rd, 5th, 7th, and 11th harmonics. This requirement does not usually apply to capacitor banks that are only used to provide voltage during first contingency conditions.

8). Harmonics

Harmonic distortion caused by customer load characteristics and capacitor banks shall be limited such that harmonic voltage distortion on the system shall not cause any applicable ANSI standards for equipment connected to the system to be exceeded, shall not exceed 3% for any single frequency or 5% total harmonic distortion, and shall not injuriously affect equipment or its service to others. However, it is recognized that

reasonable engineering judgment must be used in the application of these limits to balance compliance costs against adverse consequences of excess harmonic distortion.

9). Stability

Steady State Conditions

Transmission system studies shall be conducted such that system voltages and transmission line and equipment loadings shall be within normal limits during all predisturbance conditions and within applicable emergency limits during all system load and generation conditions that exist following the disturbances discussed below.

System/Unit Stability

Stability of the Bulk Power and Local transmission systems shall be maintained during and after the most severe contingencies stated below.

- A) A permanent 3-phase fault on any generator, transmission line, transformer, or bus section with normal fault clearing.
- B) A permanent phase to ground fault on a circuit breaker with normal fault clearing.
- C) Simultaneous permanent phase to ground faults on different phases of each of two adjacent transmission lines on a multiple circuit tower with normal fault clearing. If multiple circuit towers are used only for station entrance and/or exit purposes, and they do not exceed five towers at each station, this condition can be considered as an acceptable risk.
- D) A permanent phase to ground fault on any transmission line, transformer, or bus section with delayed fault clearing.
- E) Loss of any single system element without a fault.

NOTE: Extreme contingencies are generally not analyzed. Extreme contingencies include the following: 1) a permanent 3-phase fault on any generator, transmission line, transformer, or bus section with delayed fault clearing, 2) the loss of right of way, 3) the loss of a transmission substation, or 4) the loss of all of the units at a generating plant.

10). System Frequency

Since the transmission network in the northeastern United States and Canada is well interconnected, frequency deviation is not usually a significant concern. The interconnected transmission systems of eastern North America typically have a frequency variation of a fraction of 1%. The Bulk Power transmission system is designed to comply with NERC/NPCC criteria for under-frequency load-shedding and generator frequency or speed protection. These criteria are designed to help survive islanding and stabilize system frequency at 60 Hz. The under-frequency load-shedding plan is a joint effort between the System Planning and System Operations Departments.

A Normal Operating State exists when the frequency is not less than 59.95 Hz or not greater than 60.05 Hz. An Alert State exists when the frequency is between 60.05 Hz and 60.10 Hz or between 59.90 Hz and 59.95 Hz. Finally, a Major Emergency exists when the frequency increases to 60.10 Hz and is sustained at that level or continues to increase, or declines to 59.90 Hz and is sustained at that level or continues to decline. The New York Independent System Operator (NYISO) is responsible for informing all New York utilities when Alert States and Major Emergencies are being experienced on the Bulk Power transmission system.

11). Risk Assessment

Ideally, it is desirable to meet all of the previously mentioned planning criteria to provide an adequate continuous supply to all customers. However, the benefit to cost analyses to achieve this may not be justified. Therefore, situations may arise under which customer loads cannot be adequately served during certain contingencies. When these situations are identified, selected areas of impact will be evaluated and available resources will be allocated in a manner that will benefit our customers. The variables to be evaluated include, but are not limited to the following:

- 1) The probability of the event occurring and its associated risk
- 2) The frequency and duration of the outage
- 3) The number of customers and amount of customer load affected
- 4) Lost revenue
- 5) Damage claims
- 6) The cost of transmission system upgrades

While no single variable can usually justify an upgrade on its own, the effective combination of all the variables can provide important insights into assessing system problems and determining the solutions.

Attachment A

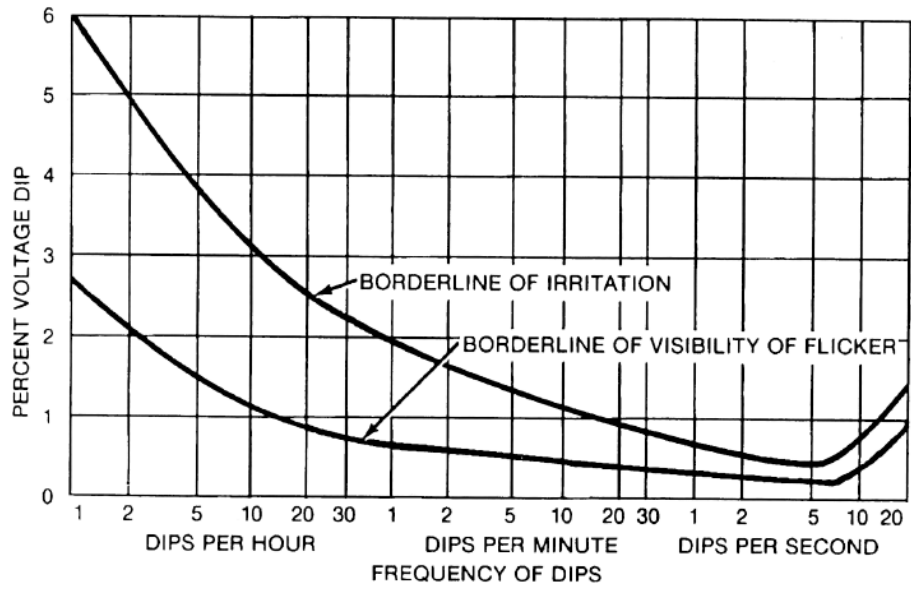


Figure A.1—Flicker tolerance curve from IEEE Std 141-1993/IEEE Std 519-1992