# NYISO Guideline for Fault Current Assessment

## Introduction

This document outlines a recommended approach for fault current assessments using ASPEN One Liner$^{TM}$/Batch Short-Circuit program and the NYISO short circuit representation base case. Use of programs other than ASPEN One Liner$^{TM}$ is not recommended at this time as the NYISO representation uses equipment short-circuit models (in ASPEN format) that are not readily available in other program(s) at this time. Fault current assessment is necessary in several areas of power system analysis including:

- breaker adequacy assessment
- assessment of fault levels for use in dynamics analysis
- fault levels to assess reclosing cycles and impact of the reclosing on breaker duty.

Operation of circuit breakers within specified fault interruption capabilities is essential for safe and reliable production, transmission, and delivery of electrical energy within the NYISO Interconnected bulk power system. This need has been heightened in recent years by the evolution of the open and competitive market structure and operation and the numerous requests from market participants and developers for interconnection to the grid.

Breaker adequacy assessments involve two complementary evaluations:

(i) that of fault interrupting duties expected to exist at stations due to prospective developer sites and other locations associated with planned system changes, and

(ii) appraisal of present operating capabilities of the affected circuit breakers, including associated relay times.

Both evaluations involve judgment and, therefore, are guided by long-standing industry practices and standards.

The NYISO short circuit representation base case was developed with the assistance and cooperation of the transmission owner representatives on the NYISO System Protection Advisory Subcommittee (SPAS), and is maintained by the NYISO Operations Engineering Staff in accordance with the "Procedure for Developing and Maintaining the NYISO Short Circuit Representation" and the NYISO "Manual for System Analysis Data". The base case representation is maintained in ASPEN One Liner$^{TM}$ format and provides a uniform representation to perform fault current studies of the NYISO bulk power system as required by the NYISO "Transmission Expansion and Interconnection Manual".

## Fault Current Calculations

The NYISO shall employ the methodology detailed below, consistent with the system conditions being studied, when evaluating short circuit currents on New York State transmission system facilities.

A. The following system-wide assumptions shall normally be applied to the base case representation for NYISO analysis:

1. All generating units are in service.[1] Synchronous machines (e.g., generators, synchronous condensers, and large motor groups) are modeled using subtransient saturated reactance ($X_{dv}$”). Machine zero-sequence reactance ($X_{0v}$) generally is not required in short-circuit studies because the GSU transformer HV/LV windings are normally specified with YG/D connections, blocking the flow of machine zero-sequence currents during system faults; generator $X_{0v}$ can be omitted or set to the actual value, if readily available.
2. Transmission line models include positive- and zero-sequence inductive impedances. Negative-sequence impedance is equal to the positive-sequence impedance and hence not entered separately. Zero-sequence mutual impedances between mutually-coupled line sections, such as those on common rights-of-way, are also included. Positive-sequence mutuals are normally ignored, but can be combined with line impedance in some situations, if needed. Capacitive admittances of lines (line charging), both positive- and zero-sequence, are omitted.
3. Initially, fault levels will be determined with all transmission lines that are normally in service represented as such, and those transmission lines that are normally open (e.g. a “normally open” bus tie) shall be represented as such. However, all reasonably realizable system configurations that yield the highest fault current shall be considered, consistent with local operating practice and procedure as determined by the NYISO. System facilities represented in the studies reflect information obtained from equipment vendors, design records, and operating data (or best estimates) processed into suitable models using proven tools and techniques. Since resistance values are generally more difficult to secure than reactance values, although both are important in breaker duty assessments, References 1-3 can be used to estimate typical X/R ratios for principal system components.
4. All transformers are modeled using leakage reactance and load-loss based resistances corresponding to the present or planned operating tap positions, as appropriate. Tap ratios for load-tap changing transformers are assumed to be 1:1 (or center tap); phase-angle regulating transformers are assumed on the lowest impedance setting (typically center tap and / or 0-degree shift), and magnetizing branches are omitted. Impedances of mismatched, single-phase transformers operating in a common bank are averaged. Transformer positive- and negative-sequence impedances are identical, and zero-sequence impedances are assumed identical to positive-sequence impedances unless test data indicate otherwise. All

windings are modeled with proper winding/grounding connections, keeping in mind that some GSU transformers operate with ungrounded neutrals to reduce fault duties. Fixed tap and GSU transformers should be represented on the tap ratio consistent with the connecting transmission owner practice, or the normal operating condition if tap and impedance data are readily available; otherwise they shall be represented on nominal.

5. All fault current-limiting series reactors are in service. Load current-limiting series reactors are represented only if switched permanently into service. Series capacitors are bypassed during close-in faults that exceed the capacitor normal rating (consistent with the series element protection); otherwise, they remain in service.
6. All loads, shunt capacitors, and shunt reactors are ignored except those shunts used in the representation of three winding transformers. Static VAr Compensators, Static Shunt or Series Compensators (FACTs devices), traditional HVdc converters, and other power-electronic devices are normally omitted, except that any transformers integrating these facilities into a power system are included. Voltage Source Converter HVdc is represented as an equivalent generator source, where appropriate.
7. All generator internal voltages are set at 1.0 p.u. and no phase displacement due to load (i.e., Flat Gen pre-fault starting conditions are assumed[2]).

B. The following types of faults shall be considered:

- Three Line to Ground
- Double Line to Ground
- Single Line to Ground

All faults are assumed to be a zero-impedance (bolted) fault with no current limiting effect due to the fault itself.

C. Fault currents through each interrupting device shall be analyzed for the following fault conditions under all normal system and single contingency system configurations:

- Bus Fault
- Close-in Line-end Open Fault

Individual breaker analysis will be performed consistent with the station breaker arrangement.

## References

*[1] ANSI/IEEE C37.5-1979, "IEEE Guide for Calculation of Fault Currents for Application of AC High-Voltage Circuit Breakers Rated on a Total Current Basis."*

*[2] ANSI/IEEE C37.04-1979, "IEEE Standard Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis."*

*[3] ANSI/IEEE C37.010-1979 and -1999, "IEEE Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis."*

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Footnotes:

1. All generating units shall be in service, unless they are retired or are not commercially viable (e.g. stand-by black-start diesel generators reserved for system restoration).
2. Flat gen starting conditions are defined as all generator internal voltages at unity (1.0 p.u.), and all transformer taps set per this Guideline.

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