Central Hudson Gas & Electric Corporation

Transmission Planning Guidelines

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Introduction

The Transmission Planning & Design Section has, as part of its mission, responsibility for the preparation of a rational plan for the development of Central Hudson's Underlying Transmission System to meet electric load growth in an orderly, economic and reliable manner. In developing such plans, results of security analyses are considered to ensure adequate Load Serving Capability of Central Hudson's Underlying Transmission System as well as sub-areas within that system.

These planning guidelines state principles and policies rather than design specifications. Development of detailed designs generally require guidance form various industry or other standards. This includes consideration of planning and designing the system with ease of operation in mind. Such considerations include, but are not limited to: utilization of standard components to facilitate availability of spare parts; mitigation of complex post-contingency switching operations; and reduction of operational risks (including risks associated with any decreasing reliability of aging infrastructure).

These planning guidelines supplement the NYISO's planning processes for Central Hudson's Underlying Transmission System.

A. Central Hudson Bulk Power System

I. Definition

The system that includes all 230 kV and above lines, all transformers where both terminals are at least 230 kV, all shunt devices 230 kV and above and all generators 300 MW and above. Planning criteria and guidelines for these facilities are defined by the NERC, NPCC & NYSRC. Transmission planning of this system is performed within the NYISO's planning processes. Under these processes, the analyses preformed include, but are not limited to, analyses of: thermal limits; voltage limits; stability limits; and transfer limits.

This system, typically, is considered to be the Bulk Power System (BPS). The BPS is defined by NPCC Criteria[1]. Although application of the methodology defined in NPCC A-10 may result in these facilities not being included in the BPS, for the purpose of these guidelines, these facilities will continue to be considered part of the BPS.

II. Reliability

Reliability criteria and guidelines for these facilities are defined by the NERC, NPCC & NYSRC.

III. Contingencies

Contingencies for these facilities are defined by the NERC, NPCC & NYSRC.

IV. Under Frequency Load Shedding (UFLS) & Manual Load Shedding

The capability to shed load, both automatically and manually, are required by NPCC BPS Criteria. These systems, however, are installed on non-BPS systems. UFLS and Manual Load Shedding are described in Sections D. II and D. III.

[1] Reference NPCC A-10.

V. Special Protection Systems (SPS)

SPSs typically are control schemes that control (e.g., trip, runback) a power system element in response to an adverse system condition other than the isolation of faulted elements. UFLS systems are not considered SPSs.

The use of SPSs on the BPS portion Central Hudson's system, generally, is discouraged. SPSs would be considered as a temporary mitigation measure while facilities are being constructed for the long-term correction of any adverse system condition.

B. Central Hudson's Underlying Transmission System

I. Definition

Central Hudson's Underlying Transmission System consists of all electric facilities which are used to connect the NYCA BPS and Central Hudson Bulk Power System to the Distribution System. This system includes, but is not necessarily limited to, all facilities operated at voltages between, but not including, 230 kV and 34.5 kV and the supply transformers (e.g., 345/115 kV and generator step-up transformers) for those facilities.

II. Reliability

Generally, no loss of load should result for the More Probable Contingencies, as listed in Section IIIa, on Central Hudson's Underlying Transmission System with the exception of radial circuits.

Generally, new facilities should be designed to provide physical separation so that a single occurrence will not result in the simultaneous loss of two supplies to the same distribution substation.

System spare transformers will be maintained to replace each type of transformer owned by Central Hudson (e.g., 345/115 kV and 115/69 kV), within Central Hudson's Underlying Transmission System, should one fail.

III. Contingencies

Central Hudson's Underlying Transmission System should be designed to sustain the following contingencies, on all facilities exceeding 34.5 kV, during all load levels while meeting applicable voltage guidelines and limiting equipment loadings to within applicable ratings.

a. More Probable Contingencies

Central Hudson's Underlying Transmission System will be planned to sustain the following contingencies without loss of load, except for loss of those customers and substations which depend solely on the outaged circuit.

<table>
<tr><th colspan="6">More Probable Contingencies
With Applicable Ratings</th></tr>
<tr><th rowspan="2"></th><th colspan="3" rowspan="2">Contingency Description</th><th colspan="2">All Facilities within</th></tr>
<tr><th>Normal Limits</th><th>Long Term Emergency Limits</th></tr>
<tr><td rowspan="2">1</td><td colspan="2" rowspan="2">Loss of any one transmission line</td><td>Cable</td><td>X</td><td></td></tr>
<tr><td>Overhead</td><td></td><td>X</td></tr>
<tr><td>2</td><td colspan="3">Loss of any one transformer</td><td></td><td>X</td></tr>
<tr><td>3</td><td colspan="3">Loss of any one bus section</td><td></td><td>X</td></tr>
<tr><td>4</td><td colspan="3">Loss of any one generating unit</td><td>X</td><td></td></tr>
<tr><td rowspan="2">5</td><td rowspan="3">Overlapping outage of any generating unit and</td><td rowspan="2">any transmission circuit</td><td>Cable</td><td>X</td><td></td></tr>
<tr><td>Overhead</td><td></td><td>X</td></tr>
<tr><td>6</td><td colspan="2">any transformer</td><td></td><td>X</td></tr>
<tr><td>7</td><td colspan="3">Overlapping outage of any two generating units (scheduled or unscheduled)</td><td></td><td>X</td></tr>
<tr><td colspan="6">The intent of the following contingencies are to determine the impact of BPS Criteria contingencies on Central Hudson's Underlying Transmission System.</td></tr>
</table>

More Probable Contingencies With Applicable Ratings (continued)			
8	BPS Contingencies called for by NPCC A-02 Criteria and not covered by 1-7, above. For the purpose of this contingency analyses, the BPS is defined in Section I by voltage level and not by any other classification methodology (e.g., NPCC's A-10).		
8a	BPS Breaker Failure		X
8b	BPS Common Tower Failure (If multiple circuit towers are used only for station entrance and exit purposes, and if they do not exceed five towers at each station, then this condition is an acceptable risk and therefore can be excluded)		X
8c	BPS HVDC Bi-pole loss		X
8d	The failure of a circuit breaker to operate when initiated by an SPS following loss of any element or bus.		X

b. Less Probable Contingencies

Occurrence of the following specific contingencies are to be examined for consequences and possible solutions. In no case, however, should they result in a system outage greater than 20% of the total system load for a duration greater than one hour, or 10% for four hours. The transfer of load by rearrangement of lines and buses and the readjustment of generator outputs following outages are acceptable means to restore service.

Less Probable Contingencies	
1	Overlapping outage of any transmission line and any transformer
2	Overlapping outage of any generating unit and any bus section
3	Overlapping outage of any two transmission lines
4	Overlapping outage of all transmission lines on a single right-or-way[2]
5	Overlapping outage of any two transformers
6	Overlapping outage of any two adjacent bus sections
7	Overlapping outage of any three generating units

[2] The effected load shall be limited to no more than the total load of the substations that are supplied by the transmission lines.

IV. Voltage

Central Hudson's Underlying Transmission System shall have controls capable of maintaining voltages at levels which will not exceed the limits of the connected equipment during both normal and contingency conditions and will allow for meeting the criteria for customer voltage as specified in Central Hudson's Distribution Engineering Guides. Generally, the voltages on Central Hudson's Underlying Transmission System will be maintained within ±5% of nominal voltage under normal conditions. The minimum acceptable post-contingency voltage on Central Hudson's Underlying Transmission System, prior to the operation of load tap changing (LTC) transformers, is 90% of nominal voltage. The maximum voltage is 105% of nominal voltage.

V. Transformers Connected for Phase Angle Control (i.e., Phase Angle Regulators)

For both normal and emergency conditions, use of up to 100% of the phase shift capability will be acceptable.

VI. Maintenance of Central Hudson's Underlying Transmission System and Generator Outages

The system design must provide for outages associated with the scheduled maintenance of lines, transformers, and substation equipment as well as for generator outages. In cases where substations serving the Distribution System have only two transmission supplies, Central Hudson will accept loss of load for the more probable contingencies (as listed in Section IIIa) when one supply is out of service for maintenance. During such maintenance and generator outages, the transition from the normal condition to contingency conditions will not result in any equipment loadings exceeding the applicable short time rating nor will the voltage be outside of the post-contingency voltage limits.

C. Ratings

The methodologies and criteria Central Hudson uses in rating Central Hudson's Bulk Power System and Underlying Transmission System facilities largely are described in the NYPP Tie-Line Ratings Task Force's Final Report on Tie Line Ratings (dated November 1995) as supplemented by Central Hudson's "Transmission Ratings Methodology" (dated May 31, 2007) . The following Final Report on Tie Line Ratings definitions are repeated here to promote a common understanding of rating terms:

<table>
<tr><td>Assumed Hours of Operation at Rated Temperatures[3]</td><td>It is assumed that only when the rated limiting temperatures are reached will annealing and loss of strength occur. In general, an environment more favorable than assumed result in a system whose line conductors are rarely operating near their thermal limit under normal operation. No more than 10 percent loss of life/strength is assumed over the life of the equipment. The estimated number of hours of operation at rated temperatures for each mode of operation over the 40 year assumed life of conductor are:
<table>
<tr><th>Rating</th><th>Operating Hours over life of conductor</th></tr>
<tr><td>Normal</td><td>7655</td></tr>
<tr><td>LTE</td><td>300</td></tr>
<tr><td>STE</td><td>12.5</td></tr>
</table>
To estimate loss of strength of overhead conductors, annealing is assumed to occur only during operation at one of the three limiting (rated) temperatures that correspond to Normal, LTE, STE ratings for an assumed number of hours</td></tr>
<tr><td>Normal Rating[4]</td><td>Capacity (Amps or MVA as applicable) which may be carried through consecutive twenty-four load cycles without exceeding agreed upon conductor or hottest spot equipment temperatures for this mode of operation.</td></tr>
<tr><td>LTE Rating[5]</td><td>Capacity (Amps or MVA as applicable) which may be carried through infrequent non-consecutive, appropriate four hour periods without exceeding agreed-upon maximum conductor or hottest spot equipment temperatures for this mode of operation.</td></tr>
<tr><td>STE Rating[6]</td><td>Capacity (Amps or MVA as applicable) which may be carried during very infrequent contingencies of fifteen minutes or less duration without exceeding agreed upon maximum conductor temperatures for this mode of operation.</td></tr>
</table>

3 This definition applies to overhead conductors.
4 This definition applies to all equipment.
5 This definition applies to all equipment.
6 This definition applies to all equipment.

In practice, these definitions result in the following rating periods:

Rating	**Transformers**[7]	**All**[8] **Other Equipment**
Continuous	Defined by Equipment Nameplate	Defined by Equipment Nameplate
Normal	Peak flow of a typical 24 hour load cycle	Daily peak flow (the maximum flow that can be carried normally, but not continuously)
LTE	Peak flow of a typical 24 hour load cycle	4 hour Continuous Flow during a 24 hour period
STE	15 minutes (from time Normal Rating was exceeded)	

D. System Frequency & Load Control

I. Standard Frequency

The standard frequency on the Central Hudson system is nominally 60 Hertz. A sustained frequency excursion of ±0.2 Hertz is an indication of a major load-generation unbalance and possible formation of an island. The load shedding program has been developed in order to provide selectivity and flexibility. Most generators are incapable of sustained operation below individually specified minimum frequencies, typically less than 58.5 Hertz.

II. Under Frequency Load Shedding (UFLS)[9]

Under frequency relays are required by NPCC BPS Criteria but are installed on non-BPS systems to provide additional insurance against widespread system disturbances. Step 1 automatic UFLS sheds 10% of system load at a nominal set point of 59.3 Hertz. Step 2 automatic UFLS sheds an additional 15% of system load at a nominal set point of 58.8 Hertz. These load shedding steps are designed to return the system frequency to at least

[7] Includes, but not necessarily limited to: step-down transformers; step-up transformers; voltage regulators; PARs.
[8] Includes, but not necessarily limited to: conductors (overhead & underground); circuit breakers; bus conductors; Current Transformers; line traps; switches (air, oil, vacuum, etc.); series reactors.

58.5 Hertz in 10 seconds or less and to at least 59.5 Hertz in 30 seconds or less for a generation deficiency of up to 25% of the load.

III. Manual Load Shedding[10]

Each area in NPCC must be capable of shedding at least 50% of its load in ten minutes or less. Insofar as practical, the first half of the load shed manually should not include that load which is part of any automatic load shedding plan. Care should be taken that manual load shedding plans do not interrupt transmission paths.

E. System Reactive Requirements

On the distribution system, Central Hudson installs capacitor banks, for both voltage support and loss reduction, to correct typical distribution circuits as follows:

- Summer Peaking: correct on-peak load to a power factor of approximately 0.98 to 0.99+
- Winter Peaking: correct on-peak load to a power factor of approximately 1.0-.

On the transmission system, Central Hudson installs capacitors banks to provide voltage support for post-contingency conditions.

F. Stability

Similar to planning for the BPS, system stability analyses generally are performed at the NYISO level. Stability issues regarding individual generators within Central Hudson's Underlying Transmission system are evaluated as necessary (e.g., associated with significant changes in network topology or supply).

[9] Section 4.6 from NPCC "Emergency Operating Criteria," Document A-03. August 31, 2004.
[10] Section 4.8 from NPCC "Emergency Operating Criteria," Document A-03. August 31, 2004.

G. Load Serving Capability

Load Serving Capability (LSC) analyses are performed for Central Hudson's Underlying Transmission System as a whole as well as for sub-areas within that system, as necessary.

The LSC of Central Hudson's Underlying Transmission System is defined as the ability to serve load without violating a thermal or voltage limit following the contingencies specified in these guidelines. Generally, this is the import capability of Central Hudson's Underlying Transmission System plus the available generation (mostly at Danskammer). The import capability of Central Hudson's Underlying Transmission System is determined by summing algebraically the MW flows on the following lines and transformers[11]:

East Fishkill			345/115 kV	Transformer 1
East Fishkill			345/115 kV	Transformer 2
Hurley Avenue			345/115 kV	Transformer 1
Pleasant Valley			345/115 kV	Transformer S1
Rock Tavern			345/115 kV	Transformer 1
Rock Tavern			345/115 kV	Transformer 3
Feura Bush (N.G.)	to	North Catskill	115 kV	2 Line
Blue Circle (N.G.)	to	Pleasant Valley	115 kV	8 Line
Hudson (N.G.)	to	Pleasant Valley	115 kV	12 Line
Churchtown (NYSEG)	to	Pleasant Valley	115 kV	13 line
Sylvan Lake (NYSEG)	to	Fishkill	115 kV	FP (990) Line
Sugarloaf			69/115 kV	Transformer 6108
West Woodbourne (NYSEG)			115/69 kV	Transformer 1
Vinegar Hill			115/34.5 kV	Transformer 1
Salisbury (NU)	to	Smithfield	69 kV	FV (690) Line
Walden (NYSEG)	to	East Walden	69 kV	WM (862) Line
Walden (NYSEG)	to	Montgomery	69 kV	WM (862) Line
Blooming Grove (O&R)	to	WM Line Tap	69 kV	WM Line
Amenia (NYSEG)	to	Smithfield	69 kV	SA (825) Line

[11] This definition may change from time-to-time as Central Hudson's Underlying Transmission System changes.

To determine the LSC, first, two load flow cases with different load levels are solved[12] with all lines in service. These cases are then used to test the contingencies defined in these Transmission Planning Guidelines. The LSC then is determined by using the minimum limits that appear for the set of contingencies considered. This, generally, is performed for several different Danskammer generation levels although the specific study being performed may necessitate analyses of additional levels or configurations:

1. No Danskammer Generation in service
   Analysis of this Danskammer level, typically is performed with ALL generation connected to Central Hudson's Underlying Transmission System & Distribution System modeled out of service. This analysis determines the capability of Central Hudson's Underlying Transmission System to supply load under a "Load Pocket" scenario.
2. Danskammer 3 in service (i.e., 130 MW at Danskammer)
3. Danskammer 1, 2, & 3 in service (i.e., 250 MW at Danskammer)
4. Danskammer 3 & 4 in service (i.e., 360 MW at Danskammer)
5. All Danskammer in service (i.e., 480 MW at Danskammer)
   In evaluating the LSC for this Danskammer level, it is recognized that post-contingency generator reduction and/or transmission topology changes (e.g., Danskammer Split Bus scheme) may be necessary to mitigate some overloads.

Any limits shown through the analyses of LSC may be removed by several methods including: up-rating or upgrading the limiting facility; reconfiguring the system to eliminate the contingency; or adding shunt devices to control voltage. The judicious use of SPSs may be appropriate in certain limited cases.

Proposed reinforcements that significantly reduce any portion of the LSC curve should be modified to mitigate those reductions in LSC.

[12] AC solution techniques are used for all pre and post contingency analyses.

Appendix -- List of Acronyms and Definitions

Acronyms	
BES	The NERC Bulk Electric System
BPS	The NPCC Bulk Power System
CHG&E	Central Hudson Gas & Electric
LSC	Load Serving Capability
LTC	Load Tap Changing
LTE	Long Term Emergency
NERC	North American Electric Reliability Corporation
NPCC	Northeast Power Coordinating Council
NYCA	New York Control Area
NYISO	New York Independent System Operator
NYPP	New York Power Pool
NYSRC	New York State Reliability Council
PAR	Phase angle Regulator
RPWG	Reactive Power Working Group
SPS	Special Protection System
STE	Short Term Emergency
UFLS	Under-Frequency Load Shedding

1. Cleared in Normal Time

   Fault clears consistent with correct operation of the protective relay scheme designed to clear the fault without unnecessary delay and with correct operation of all circuit breakers or other automatic switching devices intended to operate in conjunction with that relay scheme and without the operation of other protective or switching equipment.

2. Contingency

   An event, usually the loss of one or more elements, which affects the power system at least momentarily.

3. Delayed Clearing

   Delayed clearing of a fault consistent with correct operation of a breaker failure scheme and its associated breakers or of a backup relay scheme with an intentional time delay. This delayed clearing could be due to circuit breaker, relay systems or signal channel malfunction.

4. Delayed Reclosing

   Is manual, supervisory or any non-high speed automatic reclosing (autoreclosing).

5. Emergency

   An Emergency is considered to exist in the NYCA if firm load may have to be reduced because sufficient capacity or energy is unavailable in NYCA or in a portion of it after due allowance for purchases. Emergency transfers are applicable under such conditions. Emergency transfers may be invoked to provide transmission capability to deliver Operating Reserve to a member deficient in Operating Reserve.

6. Normal Transfer Limit

   The maximum allowable transfer is calculated based on thermal, voltage and stability testing, considering contingencies, ratings and limits specified for normal conditions. The normal transfer limit is the lowest limit based on the most restrictive of these three maximum allowable transfers.