NYISO FAULT CURRENT ASSESSMENT

2016

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INTRODUCTION

The following report highlights the significant results of the fault current screening analysis completed for the 2016 period. The purposes of this analysis are to document significant changes in fault current levels statewide, identify selected critical substations with potentially overdutied circuit breakers, refer these substations to the respective owners, and recommend remedial actions.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

Fault current assessments are intended to be conservative in nature in order to provide an adequate margin of design safety and reliability. For example, this assessment has assumed that all generation and transmission are in service, while in actual operations it is highly likely that some generation and transmission facilities are out of service due to transmission constraints, economic generation dispatch, or forced outages. For this assessment the NYISO has not taken into account other factors such as reclosing, circuit breaker age, or fault current asymmetry which may lower breaker ratings or increase fault levels interrupted by the breakers. Facility owners have the responsibility for rating their equipment correctly, and as such shall routinely evaluate the interrupting capability of the circuit breakers using their own methods or industry standards. The following findings and recommendations are presented based on the analysis and results documented in this report:

NYISO performed a sensitivity analysis for various possible Astoria configurations. The sensitivity analysis shows that when Astoria 3 and 5 dual yard steam units are operating on the Astoria East bus together with all other Astoria East units running, the Astoria East 138 kV circuit breakers 5W, 6W, 7W, 8W, 2E, 3E, 7E, and 8E would be overdutied.

The NYISO recommends the continued application of the Interim Operating Protocol for Astoria East and West Stations Fault Current Mitigation approved by the Operating Committee on May 6, 2010 to prevent overduty conditions at the Astoria East 138 kV station. The Interim Operating Protocol indicates that the acceptable Astoria West station configuration will be all three (3) units of the NYPA 500 MW combined cycle plant, two (2) Astoria Generating Company L.P. dual yard units (Astoria 3, 4 or 5), and the NRG GT 10-13 units, and the acceptable Astoria East station configuration will be all three (3) units of the Astoria East Energy 500 MW combined cycle plant, one (1) Astoria Generating Company L.P. dual yard unit (Astoria 3, 4 or 5), the Astoria Generating Company L.P. Astoria 2 unit, and the NRG GT 2, 3, 4, 5, 7 and 8 units, unless for reliability reasons a different configuration for each station is required. Astoria 4, one of the dual yard units, has deactivated since the approval of the Interim Operating Protocol.

SYSTEM REPRESENTATION AND BASE STUDY ASSUMPTIONS

I. System Representation

The NYISO 2016 Statewide Short Circuit representation captured in the Aspen Oneliner file, NYISO_SPRING_UPDATE_2016_SC_REV5.OLR, dated April 26, 2016, was used as the model for this study. This representation includes all system changes through the Summer Capability

Period[1] ending October 31, 2016. The starting point for this representation was the NYISO 2015 Statewide Short Circuit representation, with updates to reflect the planned system listed in the NYISO 2016 Load and Capacity Data Report ("Gold Book"), as well as other updates as provided by the New York Transmission Owners to appropriately reflect the conditions expected for the 2016 Summer Capability Period.

The adjacent control area data for PJM, ISO-NE, and Ontario used in this representation is the latest available data as of April 11, 2016.

Significant changes in the 2016 NYISO Statewide Short Circuit Representation from 2015 include:

- Dunkirk unit 2 mothballed
- Astoria GT 05, 07, 12, 13 ICAP Ineligible Forced Outage (IIFO)
- Astoria GT 08, 10, 11 mothballed
- Ravenswood GT 4-6 mothballed
- Huntley G67 & G68 retired
- New Rock Tavern – Sugarloaf – Ramapo 345 kV line
- New Packard – Huntley 77 & 78 230 kV series reactors
- New Five Mile Road 345/115 kV station
- New Marcy – Coopers Corners 345 kV series compensation
- New Edic – Fraser 345 kV series compensation
- New Fraser – Coopers Corners 345 kV series compensation

II. Base Study Assumptions

The short circuit levels for the initial screening analysis were calculated using the ASPEN OneLiner® program and the "NYISO Guideline for Fault Current Assessment." The short circuit levels presented have been determined for all facilities scheduled in-service during 2016.

III. Operating Guidelines

Attachment II contains the operating guidelines for the operation of series reactors required for fault current mitigation, as provided by the Transmission Owner of the equipment that the series reactors protect. Attachment II is Critical Energy Infrastructure Information (CEII) and is available subject to an approved CEII request form and executed non-disclosure agreement.[2]

DISCUSSION AND RESULTS

I. Fault Current Calculation

As stated above, the baseline fault levels were calculated in accordance with the methodology in the "NYISO Guideline for Fault Current Assessment" (Guideline #4-1) set forth in the NYISO Transmission Expansion and Interconnection Manual, version 2.1, Attachment I.

[1] Capitalized terms not otherwise defined herein have the meaning set forth in the NYISO's Tariffs – NYISO's Market Administration and Control Area Services Tariff (Services Tariff) and NYISO's Open Access Transmission Tariff (OATT).
[2] The NYISO CEII Request Form is available at: http://www.nyiso.com/public/webdocs/markets_operations/services/customer_relations/CEII_Request_Form/CEII_Request_Form_and_NDA_complete.pdf

Consistent with generally accepted practices for short circuit studies, Guideline #4-1 requires that transmission lines and transformers be modeled in their normal operating condition, with all generating units modeled as in-service. This configuration, regardless of whether or not the system can actually be operated in such a manner, provides an adequate design margin of safety and reliability by yielding the worst case and most conservative fault levels.

II. Circuit Breaker Rating

The lowest circuit breaker ratings for each of the selected substations were obtained from the applicable transmission and generation owners. The ratings are the nameplate symmetrical rating, the de-rated symmetrical value as determined by the owner, or the approximate symmetrical value converted from a total current basis.

Circuit breakers rated on a total current basis were converted to an approximate symmetrical current rating by using the nominal voltage of the substation.

Advanced circuit breaker rating techniques such as asymmetrical current analyses, de-rating for reclosing and de-rating for age were not considered by the NYISO for this screening analysis, although each circuit breaker owner should consider these when performing their own analysis.

III. Analysis

A. Bus Fault Summary

The first step in the procedure for identifying potentially overdutied circuit breakers is to generate a bus fault summary. The bus fault summary yielded the three-line-to-ground (3LG), double-line-to-ground (2LG), and single-line-to-ground (SLG) fault values at each selected substation. The results of the bus fault summary were compared to the lowest rated breaker within the substations, and if any of the bus faults exceeded the lowest rated breaker, an individual breaker analysis (IBA) was performed to determine if any circuit breakers were actually overdutied.

In many situations, a high fault duty does not automatically mean that each circuit breaker at that bus rated lower than the bus fault will be over-duty. Only an IBA can provide the true fault current at a particular breaker. The NYISO does not have a universal IBA methodology defined; therefore, each Transmission Owner uses its own internal IBA methodology. When no internal IBA methodology is defined, the NYISO uses the standard, conservative methodology in which the breaker in question is the last breaker opened to clear the fault regardless of the voltage level.

The complete results of the bus fault summary for the 142 stations that the NYISO studied are shown in Attachment 1. Of the 142 stations, two (2) were identified as having a bus fault in excess of the lowest circuit breaker rating, and required a more detailed analysis as outlined in the next section.

B. Detailed Analysis of Stations Identified in the Bus Fault Summary

The next step in the procedure for identifying potentially overdutied circuit breakers is for the facility owners to perform an IBA at each of the identified substations to determine if any of the circuit breakers were indeed overdutied.

The results of the IBA showed no stations with bus fault levels greater than their lowest breaker rating.

The NYISO performed a sensitivity analysis for various possible Astoria configurations. The sensitivity analysis shows that when Astoria G3 and G5 dual yard steam units are operating on the Astoria East bus together with all other Astoria East units running, Astoria East 138 kV circuit breakers 5W, 6W, 7W, 8W, 2E, 3E, 7E, and 8E would be overdutied.

The Interim Operating Protocol for Astoria East and West Stations Fault Current Mitigation approved by the Operating Committee on May 6, 2010 prevents overduty conditions at Astoria East 138 kV stations.

CONCLUSIONS AND RECOMMENDATIONS

The 2016 Fault Current Assessment has identified the following significant changes in fault current, statewide, in comparison to 2015:

- Fault currents significantly increased at Farragut 345 kV bus due to transmission modifications in the New Jersey portion of PJM.
- Fault currents significantly increased at Middletown Tap, Ramapo, Rock Tavern, Roseton, and South Mahwah 345 kV buses due to the Rock Tavern – Sugarloaf – Ramapo 345 kV new line.
- Fault currents significantly increased at Stolle Road 345 kV due to the new Five Mile Road station.
- Fault currents significantly decreased at Niagara 345 kV bus and Dunkirk, Gardenville, Huntley, Niagara, Packard, and Stolle Road 230 kV buses due to the mothball of Dunkirk unit 2 and the retirement of the Huntley units.
- Fault currents significantly decreased at Astoria-West-N, Hellgate 6, and Queensbridge 138 kV buses due to the deactivation of Astoria GT units 05, 07, 08, 10, 11, 12, 13.
- Fault currents significantly increased at Clay and Porter 115 kV buses due to station reconfigurations and other local area upgrades.
- Fault currents significantly increased at Coopers Corners, Edic, Fraser, and Marcy 345 kV buses do to the Marcy – Coopers Corners, Edic – Fraser, and Fraser – Coopers Corners series compensation.

Fault current assessments are intended to be conservative in nature in order to provide an adequate margin of design safety and reliability. No breakers were found overdutied.

The NYISO recommends continued application of the Interim Operating Protocol for Astoria East and West Fault Current Mitigation approved by the Operating Committee on May 6, 2010 to prevent overduty conditions at Astoria East station for certain Astoria East and West configurations.

Attachment I – 2016 Bus Fault Summary

Substation Name	Nominal kV	Lowest Rated CB (kA)	TO #	2016 Max Bus Fault (kA)	2015 Max Bus Fault (kA)	2016-2015 Delta (kA)	IBA Required	Breaker(s) Overdutied
MARCY 765	765	63	7	9.9	9.7	0.2	N	N
MASSENA 765	765	63	7	8.2	7.9	0.4	N	N
ACADEMY	345	63	2	32.7	32.8	-0.1	N	N
AES SOMERSET	345	40	4	17.6	17.8	-0.2	N	N
ALPS	345	40	5	17.5	17.5	-0.1	N	N
ASTORIA ANNEX	345	63	7	45.7	45.2	0.6	N	N
ATHENS	345	48.7	5	34.1	34.2	0.0	N	N
BOWLINE1	345	40	6	27.4	27.2	0.2	N	N
BOWLINE 2	345	40	6	27.3	27.0	0.3	N	N
BUCHAN N	345	63	2	29.6	29.4	0.2	N	N
BUCHAN S	345	63	2	39.1	39.1	0.1	N	N
CLARKS CNRS	345	40	4	11.7	11.7	0.0	N	N
CLAY	345	49	5	33.1	32.7	0.3	N	N
COOPERS CRN	345	40	4	18.2	15.7	2.5	N	N
DEWITT	345	39.9	5	18.9	18.8	0.1	N	N
DUNWOODIE	345	63	2	50.7	50.9	-0.1	N	N
E FISHKILL	345	50	2	39.9	39.6	0.3	N	N
EDIC	345	40	5	33.3	32.0	1.3	N	N
EGC PAR	345	63	7	25.4	25.5	-0.1	N	N
ELBRIDGE	345	39.9	5	16.1	16.0	0.1	N	N
FARRAGUT	345	63	2	58.6	57.5	1.2	N	N
FITZPATRICK	345	37	GO	41.5	41.3	0.2	Y	N
FRASER	345	40	4	19.1	17.4	1.6	N	N
FR KILLS	345	63	2	26.9	27.2	-0.3	N	N
GILBOA 345	345	50	7	25.0	24.8	0.2	N	N
GOETHL N	345	63	2	29.2	29.6	-0.4	N	N
GOW N	345	63	2	28.0	28.3	-0.3	N	N
HURLEY	345	40	9	17.3	17.3	0.1	N	N
INDEPENDENCE	345	41.9	5	38.5	38.4	0.1	N	N
LADENTOWN	345	63	6	40.3	39.5	0.8	N	N
LAFAYETTE	345	40	5	17.9	17.8	0.1	N	N
LEEDS	345	36.6	5	34.8	34.8	0.0	N	N
MARCY 345	345	63	7	32.6	31.3	1.3	N	N
MIDDLETN TAP	345	63	7	19.0	17.2	1.7	N	N
MILLWOOD	345	63	2	45.0	45.1	-0.1	N	N
MOTT HAVEN	345	63	2	48.9	48.6	0.3	N	N
NEWBRIDG	345	57.3	3	8.6	8.7	0.0	N	N
NIAGARA 345	345	63	7	32.9	33.9	-1.0	N	N
NMP#1	345	50	5	43.5	43.3	0.2	N	N
NSCOT 77B	345	38.8	5	31.2	31.4	-0.1	N	N
NSCOT 99B	345	38.8	5	31.3	31.4	-0.1	N	N
OAKDALE 345	345	40	4	12.7	12.6	0.1	N	N

Substation Name	Nominal kV	Lowest Rated CB (kA)	TO #	2016 Max Bus Fault (kA)	2015 Max Bus Fault (kA)	2016-2015 Delta (kA)	IBA Required	Breaker(s) Overdutied
OSWEGO	345	40.6	5	32.5	32.4	0.1	N	N
PLEASANT VAL	345	63	2	41.2	41.2	0.0	N	N
PVILLE-2	345	63	2	22.0	22.1	-0.1	N	N
RAINEY	345	63	2	55.1	54.6	0.5	N	N
RAMAPO	345	63	2	45.5	43.4	2.1	N	N
REYNOLDS	345	40	5	14.7	14.8	0.0	N	N
ROCK TAVERN	345	63	9	32.3	26.7	5.6	N	N
ROSETON	345	63	9	36.1	35.0	1.1	N	N
SCRIBA	345	48.3	5	47.0	46.7	0.2	N	N
SHORE RD	345	63	3	27.9	28.0	-0.1	N	N
S.MAH-A	345	40	6	35.2	34.2	1.0	N	N
S.MAH-B	345	40	6	34.8	33.8	1.0	N	N
SPRN BRK	345	63	2	52.1	52.2	-0.1	N	N
S080 345KV	345	40	8	16.8	17.1	-0.3	N	N
S122	345	40	8	16.7	17.1	-0.4	N	N
STOLLE ROAD	345	40	4	5.0	4.0	1.0	N	N
VOLNEY	345	44.8	5	36.7	36.5	0.2	N	N
WATERCURE345	345	40	4	8.3	8.4	0.0	N	N
W 49 ST	345	63	2	50.5	49.8	0.7	N	N
ADIRONDACK	230	25	5	9.4	9.4	0.0	N	N
CANANDAIGUA	230	40	4	6.3	6.3	-0.1	N	N
CHASES LAKE	230	40	5	8.9	8.9	0.0	N	N
DULEY	230	40	7	7.4	7.4	0.0	N	N
DUNKIRK	230	29.5	5	9.4	15.1	-5.7	N	N
GARDENVILLE1	230	32.2	5	18.8	23.1	-4.3	N	N
HIGH SHELDON	230	40	4	9.6	10.0	-0.4	N	N
HILLSIDE 230	230	28.6	4	12.5	12.6	-0.1	N	N
HUNTLEY 70	230	31.8	5	17.2	27.1	-10.0	N	N
MEYER	230	40	4	6.8	6.9	-0.1	N	N
NIAGRA E 230	230	63	7	54.1	57.1	-3.0	N	N
NIAGRA W 230	230	63	7	54.1	57.1	-3.0	N	N
PACKARD 6	230	47.8	5	39.7	43.9	-4.2	N	N
PATNODE	230	63	7	9.3	9.4	-0.1	N	N
PORTER	230	21	5	19.5	19.2	0.3	N	N
ROBINSON RD.	230	43	4	14.0	14.5	-0.4	N	N
ROTTERDAM66H	230	39.9	5	13.2	13.8	-0.6	N	N
ROTTERDAM77H	230	23.6	5	13.1	13.8	-0.6	N	N
ROTTERDAM99H	230	23.2	5	13.2	13.8	-0.6	N	N
RYAN	230	40	7	10.5	10.5	-0.1	N	N
S RIPLEY	230	40	5	9.0	9.9	-0.8	N	N
ST LAWRN 230	230	33.1	7	33.1	33.8	-0.7	N	N
STOLLE ROAD	230	40	4	13.2	14.2	-1.1	N	N
STONEYRIDGE	230	40	4	6.9	7.0	-0.1	N	N
STONY CREEK	230	40	4	8.2	8.5	-0.2	N	N

Substation Name	Nominal kV	Lowest Rated CB (kA)	TO #	2016 Max Bus Fault (kA)	2015 Max Bus Fault (kA)	2016-2015 Delta (kA)	IBA Required	Breaker(s) Overdutied
WATERCURE230	230	40	4	12.4	12.4	-0.1	N	N
WETHERSFIELD	230	40	4	7.9	8.2	-0.2	N	N
WILLIS 230	230	33.1	7	12.5	12.6	-0.1	N	N
AST-EAST-E	138	63	2	53.3	54.0	-0.7	N	N
AST-WEST-N	138	45	2	44.3	46.7	-2.4	N	N
BARRETT2	138	57.8	3	48.6	48.8	-0.1	N	N
BRKHAVEN	138	37	3	26.8	27.2	-0.4	N	N
BUCHANAN	138	40	2	15.7	16.0	-0.2	N	N
CORONA N.	138	63	2	52.4	53.1	-0.7	N	N
DUN NO	138	40	2	34.3	34.7	-0.4	N	N
DUN SO	138	40	2	30.6	30.8	-0.2	N	N
E 13 ST	138	63	2	47.4	47.4	0.0	N	N
E 179 ST	138	63	2	48.6	48.9	-0.3	N	N
E 75 ST TAP	138	63	2	9.1	9.1	0.0	N	N
EASTVIEW	138	63	2	36.9	37.1	-0.2	N	N
EGC-1	138	80	3	70.3	70.5	-0.2	N	N
ELWOOD 1	138	63	3	38.4	38.5	-0.1	N	N
ELWOOD 2	138	63	3	38.1	38.2	-0.1	N	N
FOXHLS 2	138	40	2	33.7	33.8	-0.1	N	N
FREEPORT	138	63	3	35.9	36.0	-0.1	N	N
FR KILLS	138	40	2	36.1	36.2	-0.2	N	N
GREENLWN	138	63	3	29.1	29.2	-0.1	N	N
GRENWOOD	138	63	2	49.7	49.9	-0.2	N	N
HAUPAGUE	138	63	3	22.0	22.1	-0.1	N	N
HG 6	138	63	2	40.8	42.9	-2.0	N	N
HOLBROOK	138	57.8	3	48.5	48.9	-0.3	N	N
HOLTSGT-GTS	138	63	3	44.8	45.3	-0.6	N	N
HUDSON E	138	63	2	39.4	39.6	-0.1	N	N
JAMAICA	138	63	2	49.3	49.5	-0.2	N	N
LKE SCSS2	138	63	3	38.8	38.9	-0.1	N	N
MILLWOOD	138	40	2	19.3	19.5	-0.2	N	N
MOTT HAVEN	138	50	2	13.3	13.4	-0.1	N	N
NEWBRID	138	80	3	69.0	69.2	-0.2	N	N
NRTHPRT1	138	56.2	3	59.5	59.7	-0.2	Y	N
OAKWOOD	138	57.8	3	28.2	28.3	-0.1	N	N
PILGRIM	138	63	3	59.3	59.5	-0.3	N	N
PT JEFF	138	63	3	32.1	32.7	-0.6	N	N
QUEENSBG	138	63	2	42.6	44.9	-2.3	N	N
RIVERHD	138	63	3	17.4	17.5	-0.1	N	N
RULND RD	138	63	3	45.7	45.9	-0.2	N	N
SB TR N7	138	63	2	26.9	27.1	-0.1	N	N
SB TR S6	138	63	2	29.0	29.3	-0.3	N	N
SHM CRK	138	63	2	45.5	45.8	-0.3	N	N
SHORE RD1	138	57.8	3	48.2	48.4	-0.2	N	N

Substation Name	Nominal kV	Lowest Rated CB (kA)	TO #	2016 Max Bus Fault (kA)	2015 Max Bus Fault (kA)	2016-2015 Delta (kA)	IBA Required	Breaker(s) Overdutied
SHOREHAM1	138	52.2	3	27.7	27.9	-0.2	N	N
SYOSSET	138	63	3	34.1	34.3	-0.2	N	N
TREMNT11	138	63	2	42.7	43.0	-0.3	N	N
TREMNT12	138	63	2	42.6	42.9	-0.3	N	N
VLY STRM2	138	63	3	53.8	54.0	-0.2	N	N
VERNON E	138	63	2	43.8	44.3	-0.4	N	N
VERNON W	138	63	2	34.7	34.9	-0.2	N	N
WADNGRV1	138	56.4	3	25.8	25.9	-0.2	N	N
WILDWOOD	138	63	3	27.6	27.8	-0.2	N	N
CLAY	115	44.4	5	37.8	36.0	1.9	N	N
PORTER	115	55.5	5	41.5	40.2	1.3	N	N
E RIVER	69	50	2	49.7	49.9	-0.1	N	N