NYPP STABILITY ANALYSIS CONSIDERING IMPORT FROM HYDRO-QUEBEC OVER THE MSC-7040 LINE AT 2370MW

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INTRODUCTION

NYPA Operations Planning has performed extensive stability testing, utilizing the new IREQ HVdc modifications at Chateauguay, with the goal of acquiring approval for an increase in the limit on imports from Hydro-Quebec via the MSC-7040 line to the 2370MW level. At this level of MSC-7040 MW flow, all available Beauharnois generating units are connected to the NYPA system, including four machines (approximately 200MW) normally connected to Niagara Mohawk as part of the Cedars import. Thus, for this configuration, Niagara Mohawk's import via Cedars is lowered to approximately 110MW (as measured at Cedars).

This study was undertaken for the following reasons:

1) Provide the NYPP with operating flexibility;

2) Provide the NYPP with an additional path to import the 200MW of Beauharnois generation normally connected to Cedars for an outage of the Beauharnois-Cedars circuits.

Note that this configuration represents a shift in generation within the Moses-South interface. The level of Moses-South remains at 2900MW, which is the level currently approved by the NYPP (associated with the MSC-7040 import limit of 2170MW).

RECOMMENDATIONS

1) Increase the limit on import from Hydro-Quebec via the MSC-7040 line to 2370MW

2) Require that both Chateauguay second harmonic filters be in-service at MSC-7040 MW levels above 2170MW.

RESULTS

All stability simulations were stable with both Chateauguay second harmonic filters in-service. Both Chateauguay second harmonic filters are required for MSC-7040 flow levels above 2170MW.

DISCUSSION

The dynamics testing included in this report incorporates all the recent improvements to the Chateauguay HVdc controls. These improvements include the following:

- The 1989 IREQ HVdc control optimizations
- The recently improved LVCL control
- An expanded CSP control range
- A reduced power regulator control range

- The automatic trip of a second harmonic filter when both second harmonic filters are in-service should one of the following automatic HVdc control actions occur : low voltage block, third bang, commutation failure protection or transformer overload protection.

Each of these improvements provides system stability benefits. In particular, the revised LVCL control and expanded CSP range are extremely beneficial at the higher levels of MSC-7040 MW flow.

Dynamic simulations were conducted in accordance with standard methods used for establishing NYPP operating limits, including Transmission Planning Guideline #2 and the use of several approved NYPP base cases. A complete listing of PSAS files appears in Appendix A.

These base cases were developed from the NYPP 1991 Summer Peak Operations Engineering case, and were converted for Dynamics with the following load model:

AREA	REAL	REACTIVE
NYPP	KZ	KZ
NEPEX	KZ	KZ
PJM	KI	KZ
Hydro-Quebec	KI	V^3I
New Brunswick	KI	KZ
Nova Scotia	50% KI, 50% KZ	KZ
Ontario-Hydro	50% KI, 50% KZ	KZ
Michigan	50% KI, 50% KZ	KZ
REST	KZ	KZ

The entire Central-East and Moses-South fault "Books" were simulated, as well as three contingencies in the Ontario-Hydro 500kV system (a three phase normally cleared fault at Milton on the Milton Claireville 500kV circuit, a double line to ground normally cleared fault at Cherrywood on the Cherrywood-Claireville 500kV double circuit and a double line to ground fault at Willow Creek Junction on the Bruce-Milton 500kV double circuit). For Central-East faults, a ten percent margin was applied on the Central-East interface. For Moses-South and OH faults, a ten percent margin was applied to both the Moses-South and the Central-East interfaces. Thus, margin was applied for three (3) Oswego complex machines in-service as follows:

Faulted Interface	MSC-7040 MW FLOW	Test Level For Moses-South	Test Level For Central-East
Central-East	2370MW	2900MW	2944MW
Moses-South and OH	2370MW	3223MW	2944MW

The following conditions were assumed constant except as noted for sensitivity analyses:

1. Four Chateauguay 765kV/120kV Transformers;
2. Chateauguay operated in split 120kV bus configuration;
3. Chateauguay HVdc terminal flow of 1000MW;
4. Thirty two (32) Beauharnois Machines connected to MSC-7040 line;
5. Two full Chateauguay SVC's;
6. Chateauguay Bang Ramp, LVCL and CSP Control Systems in-service;
7. Beauharnois Generating Units operated at their minimum permissible operating voltage;
8. A Marcy 345kV pre-contingency voltage of 348kV;
9. Cedars to Niagara Mohawk Interface flow of 110MW (measured at Cedars).

All standard MP-6 Central East and Moses-South faults were simulated (Appendix B & C). The Central-East fault "Book" consists of CE01 through CE28, CE32 and CE33, including all appropriate reclosing. The Moses-South fault "Book" consists of MS01 through MS13 and MS15. As stated previously, the Ontario Hydro OH09, OH140 and OH364 faults were also simulated. All cases without reclosing were checked for stability at fifteen seconds. Of these, simulations that exhibited an oscillatory response were run to 30 seconds. Simulations with reclosing were run to 30 seconds. Dynamic run summaries were examined for HVdc control operation and relay messages.

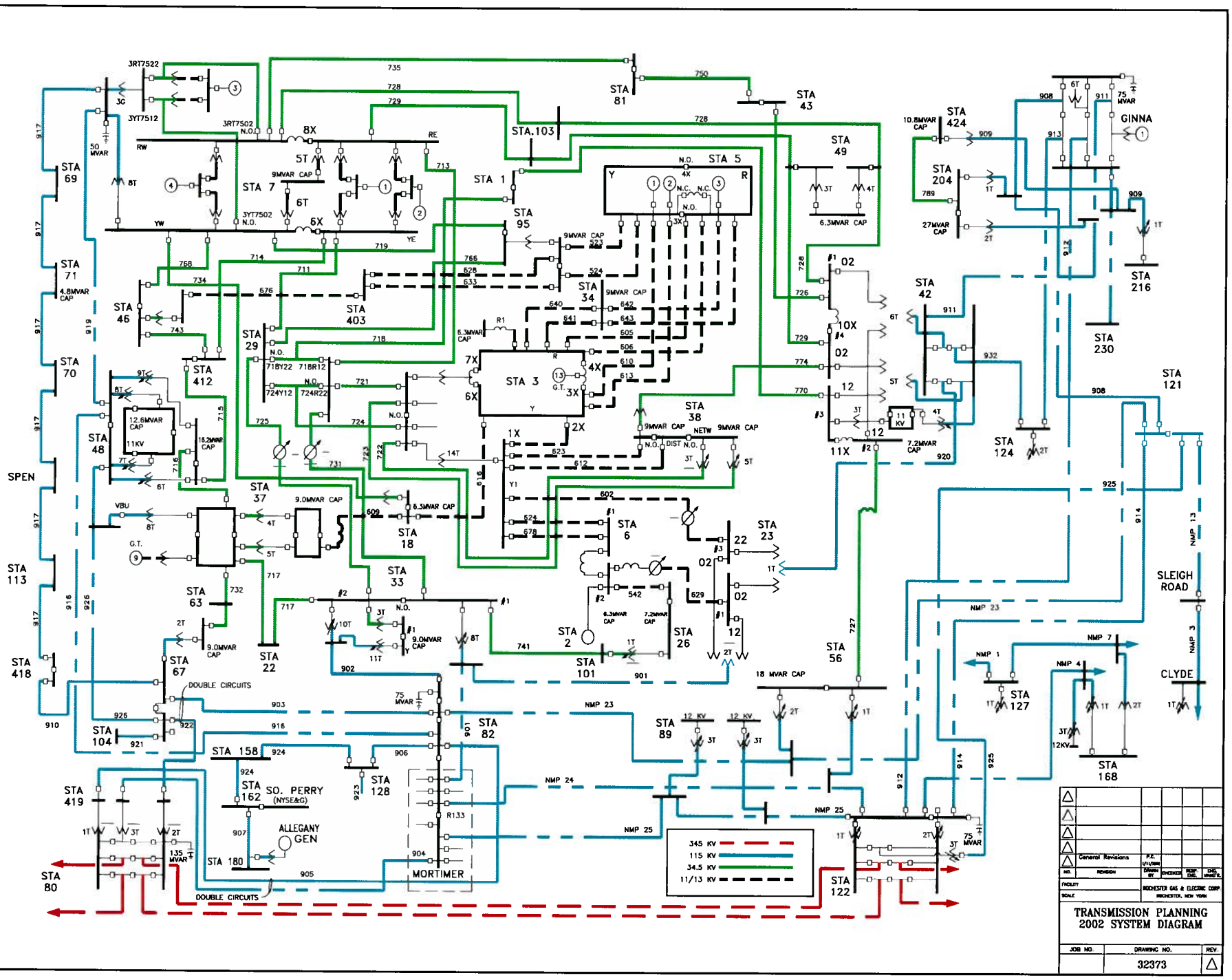
In all cases, the Chateauguay SVC's were producing the maximum pre-contingency capacitive MVAR output while respecting all Chateauguay/Beauharnois and NYPP voltage and MVAR constraints.

ONE CHATEAUGUAY SECOND HARMONIC FILTER

One Chateauguay second harmonic filter was considered in service for the system conditions previously described.

The results of all dynamic simulations were all stable with the exception of CE08, a normally cleared double line to ground fault at Coopers Corners on the Marcy-Coopers Corners and Fraser-Coopers Corners circuits. While the CE08 fault provided an overall, marginally damped, system response, the Chateauguay-Beauharnois complex was oscillatory at 30 seconds.

The CE08 simulation for the previously described system conditions results in a Bang-Ramp operation during the initial fault, a second Bang-Ramp operation during a reclose at ten seconds, and a third Bang-Ramp operation during a reclose at 18 seconds. The Bang-Ramp control is designed to keep the HVdc at a power level of 50MW/converter if three "Bangs" occur within 60 seconds. Thus for this simulation, the HVdc remains at 50MW/converter after the reclose at 18 seconds, eliminating the stabilization the HVdc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STA 162 SO. PERRY (NYSE&G)
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STA 180
ALLEGANY GEN
MORTIMER
STA 113
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SPEN
SLEIGH ROAD
CLYDE
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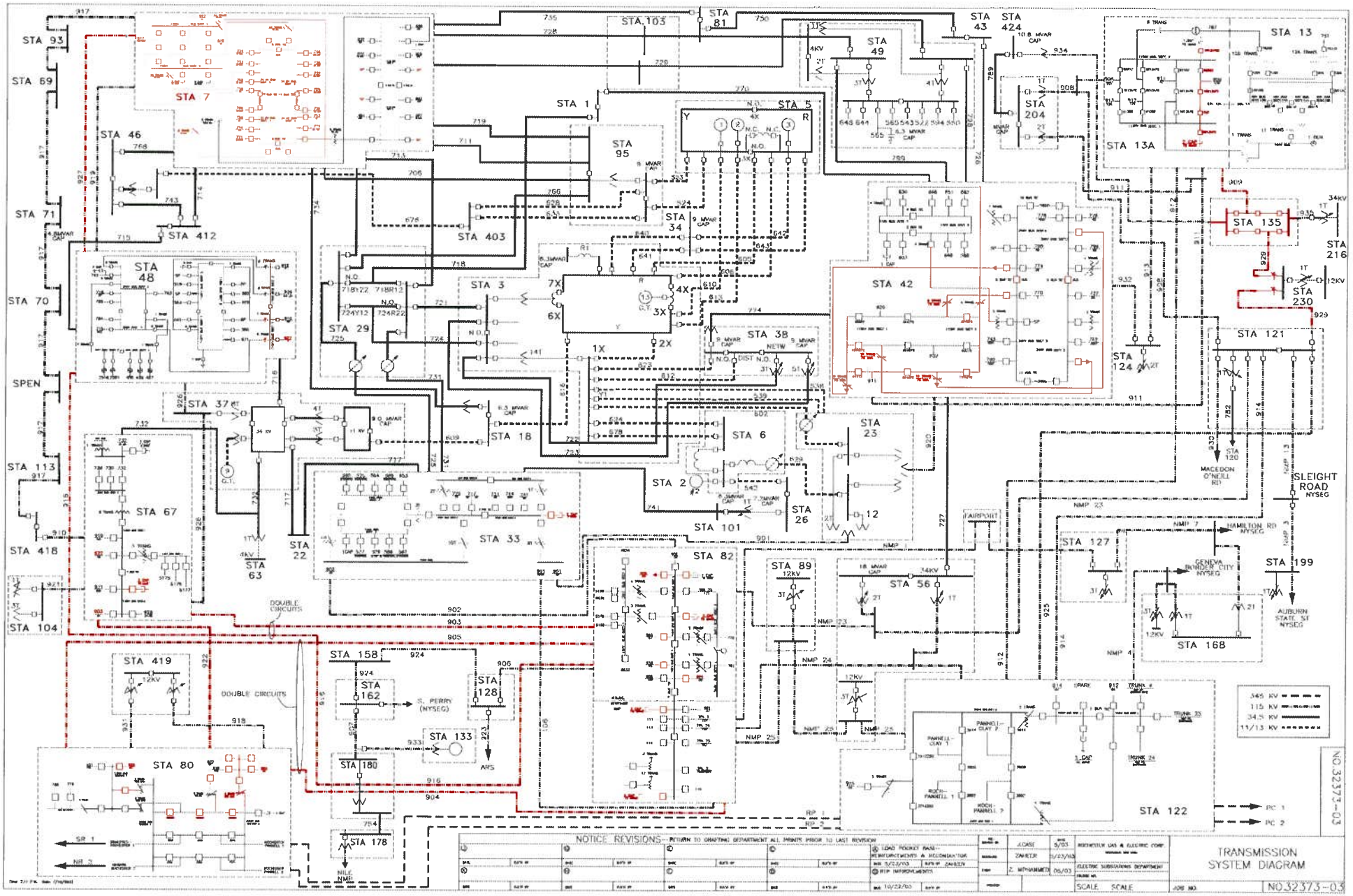
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STA 121
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SLEIGHT ROAD NYSEG
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HAMILTON RD NYSEG
GENEVA BOWKER CITY NYSEG
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DOUBLE CIRCUITS
345 KV
115 KV
34.5 KV
11/13 KV
NOTICE REVISIONS — RETURN TO DRAFTING DEPARTMENT ALL PRINTS PRIOR TO LAST REVISION
TRANSMISSION SYSTEM DIAGRAM
NO.32373-03

provides to the Beauharnois generators. The third bang occurs because there is insufficient MVAR reserve in the Chateauguay/Beauharnois complex.

TWO SECOND HARMONIC FILTERS

The third Bang-Ramp operation associated with the CE08 simulation can be eliminated by placing an additional second harmonic filter in-service. This filter provides 135MVAR to the Chateauguay complex, raising the 120kV voltage so that a Bang-Ramp operation does not occur for the reclose at 18 seconds. The result is a damped response of the Chateauguay-Beauharnois complex (Appendix D).

To guard against potential high voltage conditions after HVdc control actions, Hydro-Quebec has recently added a protection scheme to trip one of the second harmonic filters, if both are in-service, after a permanent reduction in HVdc power level (third bang, low voltage block, commutation failure protection, etc.) Implementation of this protection scheme now allows the simultaneous use of both second harmonic filters.

Sensitivity analysis was performed with two second harmonic filters in-service in the three Oswego machine cases previously tested. The following simulations were performed.

CE03: Single line-to-ground stuck breaker at Edic on ENS-14 trapping EF-24.

CE04: Single line-to-ground normally cleared fault at Edic on ENS-14 with reclosing.

CE07: Two simultaneous single line-to-ground normally cleared faults at Marcy on different phases of UCC2-41 and EF-24.

CE08: Two simultaneous single line-to-ground normally cleared faults at Coopers Corners on different phases of UCC2-41 and EF-24.

CE13: Three phase normally cleared fault at Volney on VU-19.

CE15: Single line-to-ground stuck breaker at Marcy on VU-19 trapping UE1-7.

CE16: Single line-to-ground stuck breaker at Edic on EF-24 trapping CE2-15.

MS02: Three phase normally cleared fault at Moses on MAP-1.

MS03: Double line-to-ground normally cleared fault at Moses on MAP-1 and MAP-2.

MS05: Three phase normally cleared fault at Massena 765kV on MMS-1.

MS07: Single line-to-ground stuck breaker at Massena 765kV on MMS-1, 765kV bus clearing.

MS13: Double line-to-ground normally cleared fault at Moses on both MMS circuits.

MS15: Double line-to-ground normally cleared fault at Moses on L33P and L34P.

OH09: Double line-to-ground normally cleared fault at Cherrywood on the Cherrywood-Claireville 550 and 551 500kV circuits.

OH140: Three phase normally cleared fault on the Milton-Claireville 500kV circuit.

OH364: Double line-to-ground normally cleared fault at Willow Creek Junction on the Bruce-Milton 550/551 500kV circuits.

All simulation results were stable and well damped.

Four and Two Oswego Machine Sensitivities

NYPP stability testing as summarized in the report entitled "NYPP-Marcy South Summer 1988 Stability Analysis" has shown that there is a relation between the number of Oswego units in-service and the Central-East operating limit. Limits recommended by the NYPP study are:

Oswego Machine I/S	CE Limit
5	2850MW
4	2800MW
3	2650MW
2	2550MW
1	2200MW
0	1900MW

The 2370MW level of MSC-7040 import with two Chateauguay second harmonic filters in-service was tested with four and two Oswego machines in-service. The following simulations were performed (Appendix E&F, respectively):

CE03: Single line-to-ground stuck breaker at Edic on ENS-14 trapping EF-24.

CE04: Single line-to-ground normally cleared fault at Edic on ENS-14 with reclosing.

CE07: Two simultaneous single line-to-ground normally cleared faults at Marcy on

different phases of UCC2-41 and EF-24.

CE08: Two simultaneous single line-to-ground normally cleared faults at Coopers Corners on different phases of UCC2-41 and EF-24.

CE13: Three phase normally cleared fault at Volney on VU-19.

CE15: Single line-to-ground stuck breaker at Edic on EF-24 trapping CE2-15.

MS02: Three phase normally cleared fault at Moses on MAP-1.

MS03: Double line-to-ground normally cleared fault at Moses on MAP-1 and MAP-2.

MS05: Three phase normally cleared fault at Massena 765kV on MMS-1.

MS07: Single line-to-ground stuck breaker at Massena 765kV on MMS-1, 765kV bus clearing.

MS13: Double line-to-ground normally cleared fault at Moses on both MMS circuits.

MS15: Double line-to-ground normally cleared fault at Moses on L33P and L34P.

OH09: Double line-to-ground normally cleared fault at Cherrywood on the Cherrywood-Claireville 550 and 551 500kV circuits.

OH140: Three phase normally cleared fault on the Milton-Claireville 500kV circuit.

OH364: Double line-to-ground normally cleared fault at Willow Creek Junction on the Bruce-Milton 550/551 500kV circuits.

Similar to the three Oswego machine cases discussed earlier, appropriate margin was applied to the faulted interface as follows:

Four Oswego Machines In-Service

Faulted Interface	MSC-7040 MW Flow	Test Level For Moses-South	Test Level For Central-East
Central-East	2370MW	2900MW	3112MW
Moses-South and OH	2370MW	3223MW	3112MW

Two Oswego Machines In-Service

Faulted Interface	MSC-7040 MW Flow	Test Level For Moses-South	Test Level For Central-East
Central-East	2370MW	2900MW	2833MW
Moses-South and OH	2370MW	3223MW	2833MW

All simulation results were stable and well damped.

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