Oswego Complex Export Transient Stability

Limit Analysis

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I. INTRODUCTION

The purpose of this study is to validate the existing operating guidelines and potentially establish additional guidelines for Oswego Complex generation export limitations for all lines in service and line outage conditions. This involves a comprehensive evaluation of system transient stability in the Central East/Oswego Complex area transmission system.

The last comprehensive transient stability limit analysis of the Oswego Export was performed in 2005 by ABB for the National Grid. This study was undertaken in anticipation of the system upgrade in the Oswego complex - the Nine Mile #2 up rate project which is scheduled for 2012. This project will increase the unit maximum power generation from 1203 to 1309 MW and significantly decrease reactive capability of the generator from 500 to 233 Mvar.

Additionally, there has been larger penetration of wind generation projects along the Willis – Plattsburgh 230 kV lines in the North Country region of New York. These upgrades/projects, therefore underscore the need to re-confirm the existing Oswego Export stability limits for all lines in service and line outage conditions.

The study was performed with 2011 summer operating peak load flow base case with Central East interface at or slightly above its margined stability limit of 3400 MW. Import from Hydro-Quebec (1190 MW all AC) is entirely derived from Beauharnais generation with the Chateauguay HVDC out-of-service. This is a conservative approach to decouple the damping effect of the HVDC control circuits. The following outage conditions were also evaluated:

- 9mile - Clay (Ln# 8) 345 kV
- Clay - Independence (Ln# 26)
- Edic - Clay (Ln# 1-16) 345 KV
- Fitz - Edic (Ln# FE1) 345 kV
- Marcy - Edic (Ln# UE 1-7)
- Marcy - Volney (Ln# 19)
- Oswego - Lafayette (Ln# 17)
- Oswego - Volney (Ln# 11)
- Scriba - Independence (Ln# 25)
- Scriba - Volney (Ln# 21)
- Marcy STATCOM - OS
- Volney - Clay (Ln# 6)

This report documents the result of the analysis for the system conditions listed in Table 1 and the recommendations are based on the results of the simulation of Central East and Oswego Complex criteria contingencies shown in Tables 3 and 4. All assumptions are documented in the base case development section of the report.

This report includes the result of the stability analysis, the list of contingencies, copies of the most severe stability plots, and base case assumptions made in developing the various Oswego Export cases for the all lines in-service and line outage conditions.

This report was reviewed by the NYISO Operating Studies Task Force (OSTF).

2. RECOMMENDATIONS

Based on the system responses to all the tested contingencies (see Tables 3 and 4) with Oswego Complex generation at **5250 MW**, for all lines-in-service and **4800 - 5250** MW for the line outage conditions (see Table 1), the resulting dynamic simulation demonstrated acceptable system performance. The results of the analysis showed that, there were no adverse impacts on the NYISO bulk power system for these levels of Oswego Export limit.

The Oswego Export Stability Operating Limit is set at the actual test level, since this is a generation pocket (Oswego Complex generation pocket) and flows cannot exceed the maximum output of the generation in the pocket. A 10% criteria margin was taken on Central East (CE) interface with a margined transfer of **3400** MW.

The Oswego generation export limit of **5250 MW** is therefore recommended for all lines in service and **4800 - 5250** MW for line outage conditions as shown in Table 1.

Table 1

OSWEGO EXPORT LIMIT - TRANSIENT STABILITY LIMIT			
	Tested Oswego Complex	Recommended Oswego	Date : 8/2011
Line Outage	Export Level (MW)	Complex Export Limit	Ref. Report #
All-Lines-in-Service (Seasonal Limit)	**5250**	**5250 MW**	**OEL-2011**
9mile - Clay (Ln# 8) 345 kV	**5158**	**5150 MW**	**OEL-2011**
Marcy - Edic (Ln# UE 1-7) 345 kV	**5265**	**5250 MW**	**OEL-2011**
Oswego - Lafayette (Ln# 17) 345 kV	**5250**	**5250 MW**	**OEL-2011**
Oswego - Volney (Ln# 11) 345 kV	**5260**	**5250 MW**	**OEL-2011**
Oswego - Volney (Ln# 12) 345 kV	**5260**	**5250 MW**	**OEL-2011**
Scriba - Independence (Ln# 25) 345 kV	**5260**	**5250 MW**	**OEL-2011**
Scriba - Volney (Ln# 21) 345 kV	**5260**	**5250 MW**	**OEL-2011**
Scriba - Volney (Ln# 20) 345 kV	**5260**	**5250 MW**	**OEL-2011**
Volney - Clay (Ln# 6) 345 kV	**5260**	**5250 MW**	**OEL-2011**
Marcy STATCOM - OS (Unavailble)	**5260**	**5250 MW**	**OEL-2011**
Clay - Independence (Ln# 26) 345 kV	**5004**	**5000 MW**	**OEL-2011**
Clay - Edic (Ln# 1-16) 345 KV	**4857**	**4850 MW**	**OEL-2011**
Clay - Edic (Ln# 2-15) 345 KV	**4857**	**4850 MW**	**OEL-2011**
Fitz - Edic (Ln# FE1) 345 kV	**4815**	**4800 MW**	**OEL-2011**
Marcy - Volney (Ln# 19) 345 kV	**4937**	**4900 MW**	**OEL-2011**
*****NOTE***** The All-Lines-in-Service and Line Outage Cases were solved and Simulated with Central East Transfer at it's Margined Level =>**3400 MW**			

3. DISCUSSION

3.1 Base Case Development and Assumptions

The Study was performed on a 2011 NYISO summer peak load dynamics base case with a NYISO load of **32,720 MW** and Central East transfer at its margined stability limit of **3400 MW**. All the Oswego Nuclear Units were dispatched at full load and generation dispatch within the complex was adjusted using Oswego 5 and 6 units.

Hydro Quebec-NYISO import (1190 MW all AC) is entirely derived from Beauharnois generation with the Chateauguay HVDC out-of-service. This is a conservative approach to decouple the damping effect of the HVDC control circuits.

Baseline assumption/starting base case for the 2011 dynamics setup is the 2010 series NERC/MMWG dynamics case. The NYISO Area representation for summer 2011 Operations base case was merged into the 2010 Series MMWG base case and NERC/SDDWG dynamics model.

Some of the base case conditions include:

- 200 MVAr Capacitor bank at Edic 345 kV
- 9 Mile #2 Uprate project: Pmax = 1309 MW, (Qmax) = 233 Mvar
- About 390 MW of North Country wind generation dispatched.

The line-Outage cases developed and evaluated in this analysis include:

- 9mile - Clay (Ln# 8) 345 kV
- Clay - Independence (Ln# 26)
- Edic - Clay (Ln# 1-16) 345 KV
- Fitz - Edic (Ln# FE1) 345 kV
- Marcy - Edic (Ln# UE 1-7)
- Marcy - Volney (Ln# 19)
- Oswego - Lafayette (Ln# 17)
- Oswego - Volney (Ln# 11)
- Scriba - Independence (Ln# 25)
- Scriba - Volney (Ln# 21)
- Marcy STATCOM - OS
- Volney - Clay (Ln# 6)

Table 2 below shows Oswego Complex generation dispatch at a total output of **5254 MW for all lines in service.**

Table 2

Unit	**MW**
Nine Mile Point #1	644
Nine Mile Point #2	1309
Oswego #5	610
Oswego #6	875
Fitzpatrick	865
Sithe-Independence	950
	5253

3.2 STUDY CRITERIA

The analysis for this evaluation was done in accordance with the "NYSRC Reliability Rules, Standards for Planning and Operation the New York ISO Bulk Power System" and the NYISO Transmission Planning Guideline #2.0. These Guidelines conform to NPCC A-2 "Basic Criteria for the Design and Operation of Interconnected Power Systems".

The NYISO stability transfer limit, obtained from a stable simulation of the most severe contingencies, is obtained by reducing the test level of the interface in question by the larger of either 10% of the pre-contingency transfer on the interface, or 200 MW.

3.3 STUDY METHODOLOGY

Contingency analysis included the NYISO contingency deck for Central East and Volney East. Faults within the Oswego complex vicinity, which included 3-phase faults and 1-phase-to-ground faults with delayed clearing, were tested against the all-lines-in-service case and the line outage conditions with Central East transfer and Oswego complex generation as described in the section above. Simulations were performed in accordance with the study criteria. If any of the simulated faults were found to violate stability performance criteria, then the simulation will be repeated at a reduced Oswego Complex generation level.

The Oswego Export Stability Operating Limit is set at the actual test level, since this is a generation pocket (Oswego Complex generation pocket) and flows cannot exceed the maximum output of the generation in the pocket. A 10% criteria margin normally applied to transmission interfaces was taken on Central East (CE) interface.

3.4 SVCs/STATCOM Normal Operating Mode

The Leeds/Fraser SVCs and Marcy STATCOM are modeled in service. The base case load flows were solved with the SVCs/STATCOM set to minimum (0Mvar) output by adjusting their respective voltage schedules in the pre-contingency case.

3.5 Contingency Analysis

Tables 3 and 4 below outline the design criteria faults for Central East, Volney East and Oswego Complex contingencies which include 3-phase faults and Single-phase-to-ground faults with delayed clearing tested for this analysis. Descriptions of all the contingencies evaluated are listed in Table 3 and 4. Selected resulting critical simulation plots are attached in the appendices.

The contingencies simulated for this analysis, were tested and evaluated in accordance with the "Standards for Planning and Operating the New York ISO Bulk Power System" and the NYISO Transmission Planning Guideline #2.

Table 3	CENTRAL EAST CONTINGENCIES
CE01	3PH@EDIC 345KV on EDIC-N.SCOT#14, NORM.CLR. W/RCL@NS
CE02	3PH@MARCY 345KV on MARCY-N.SCOT18, NORM.CLR. W/RCL@NS
CE03	SLG/STK@EDIC345kV on EDIC-N.SCOT#14;BKUP CLR@FITZ 345kV
CE04	SLG/NC@EDIC 345kV on EDIC-NEW SCOTLAND #14 W/HS&AUTO RCL
CE05	3PH@EDIC 345KV on EDIC-MARCY UE1-7 NORM.CLR
CE06	3PH@MARCY345KV on EDIC-MARCY UE1-7 NORM.CLR
CE07AR	LLG@MARCY/EDIC 345kV on MARCY-COOPERS & EDIC-FRASER DBL CKT
CE08	LLG @COOPERS ON MARCY-COOPER/FRASER-COOPERS
CE08AR	LLG @COOPERS ON MARCY-COOPER/FRASER-COOPERS w/ RCL
CE09	SLG/STK@EDIC345KV on FITZ-EDIC #FE-1/BKUP CLR@N.SCOT345
CE10	SLG/STK@MARCY345kV on MARCY-N.SCOT UNS18/STK@MARCY 345kV
CE11	SLG/STK@FRASER 345kV on FRASER-GILBOA & CLR FRASER SVS
CE12	3PH-NC@NSCOT 345kV on EDIC-N.SCOT #14 W/HS RCL@ N.SCOT
CE13	3PH@VOLNEY 345KV on VOLNEY-MARCY VU-19 NORM.CLR.
CE14	3PH@ MARCY 345KV on VOLNEY-MARCY VU-19 NORM.CLR.
CE15	SLG/STK@MARCY345kV on VOLNEY-MARCY VU-19/STK@MARCY 345
CE16	SLG/STK @EDIC 345kV on EDIC-FRASER
CE17	SLG/STK @MARCY ON MARCY-COOPERS CORNERS/ CLEAR AT#1
CE18/18AR	LLG@ROCK TAVN 345kV on COOPERS CORNERS-ROCK TAVERN D/C
CE19/18AR	LLG@COOPERS ON COOPERS CORNERS-ROCK TAVERN D/C
CE20	SLG/STK@EDIC345kV on EDIC-MARCY UE1-7/CLR PORTER 230&115#4
CE21	SLG/STK @FRASER 345kV on FRASER-COOPERS 33/CLR#32@OAKDALE
CE22/22AR	3PH-NC@EDIC 345kV EDIC-FRASER EF-24/40
CE23/23AR	LLG@FRASER ON MARCY-COOPERS/EDIC-FRASER D/C
CE24/24AR	3PH-NC@FRASER 345kV ON FRASER - COOPERS CONRNERS FCC-33
CE25/25AR	3PH-NC@COOPERS on FRASER-COOPERS CORNERS FCC-33
CE26/26AR	3PH-NC@COOPERS on MARCY-COOPERS CONRNERS UCC-2/41
CE27/27AR	3PH-NC@COOPERS 345kV on COOPERS CORNERS-ROCK TAVERN CCRT-34
CE28/28AR	3PH-NC@COOPERS 345kV on COOPERS CORNERS-ROCK TAVERN CCRT-42
CE32/32AR	3PH-NC@FRASER on EDIC - FRASER EF-24/40
CE33	3PH-NC@FITZ on EDIC - FITZPATRICK FE-1
CE99	SLG/STK@SCRIBA345/SCRIBA-VOLNEY 21/FITZ-SCRIBA #10

Table 4	VOLNEY EAST/ OSWEGO COMPLEX CONTINGENCIES
VE01	SLG-STK R935 @ CLAY 345KV on EDIC-CLAY-PANNELL 345kV
VE02	SLG-STK R935 @ CLAY 345KV on PANNELL-CLAY-EDIC 345kV
VE03	SLG-STK R220 @ LAFAYETTE on DEWITT-LAFAYETTE-OSWEGO 345KV
VE04	SLG-STK R925 @ CLAY 345KV on DEWITT-CLAY-9 MILE 345
VE05	SLG-STK@OAKDALE 32B222 on OAKDALE-FRASER 345KV
CE101	3PH-NC@SCRIBA 345kV on SCRIBA-VOLNEY #21
CE102	3PH-NC@INDEP 345kV on INDEPENDENCE-CLAY #8
CE103	3PH-NC@INDEP 345kV on INDEPENDENCE-SCRIBA #25
CE104	3PH-NC@CLAY 345kV on CLAY-EDIC #1-16
CE105	3PH-NC@EDIC 345kV on EDIC-CLAY #1-16
CE106	3PH-NC@OSWEGO 345/ OSWEGO-VOLNEY #11
MS150	LLG@MOSES 230/MOSES-ST.LAWRENCE L33/34P

4. RESULTS

4.1 Stability Analysis

The results of the transient stability analysis indicate that the Oswego Export Limit **5250 MW** for all lines in service case and **4800 - 5250** MW for line outage conditions are transiently stable and showed acceptable system performance. The simulation plots of most severe contingencies are contained in the appendixes A – M.

The stability results were analyzed by examining the following plots:

- Rotor angles for generating units in Oswego complex and some select units in the rest of NY.
- Bus voltages in the Oswego Complex and select bus voltages in the rest of NY and OH.
- Power transfers across Central East and some select NYISO interfaces.
- NY SVC's and STATCOM output in response to changes in bus voltages in central NY.

The all-lines-in-service case and line outage conditions were subjected to the contingencies listed in Tables 3 and 4. There were no unstable system responses in all the cases simulated. A couple of the line outage cases exhibited relatively higher oscillations and lower transient voltages which eventually damped out. The most severe line outage cases and most severe fault are discussed in section 4.2.

The Oswego Export limits were evaluated in accordance with the NYISO Transmission Planning Guideline #3 "Guideline for Stability Analysis and Determination of Stability-Based Transfer Limits".

4.2 Outage Analysis:

The simulation plots of the most critical contingencies for all the line outage cases are in the attached Appendixes A-M.

4.2.1 Marcy – Volney 345 kV (VU-19)_Outage

With VU-19 out of service, the worst dynamic response was noted for the SLG/STK@Scriba on Scriba -Volney/Fitz-Scriba (CE99) and 3-Phase@Fitzpatrick on Fitz–Edic 345kV (CE33). For these faults (CE99 & CE33), there was a noticeable transient voltage dip and sustained oscillation which eventually damped out. With this Outage, the Oswego Export limit is 4900 MW. The Fitzpatrick plant has an operating limitation for this outage scenario which was modeled and accounted for in this analysis. This is a critical Central East contingency since it separates the Marcy 345 kV substation from the Oswego Complex with Volney – Marcy out of service.

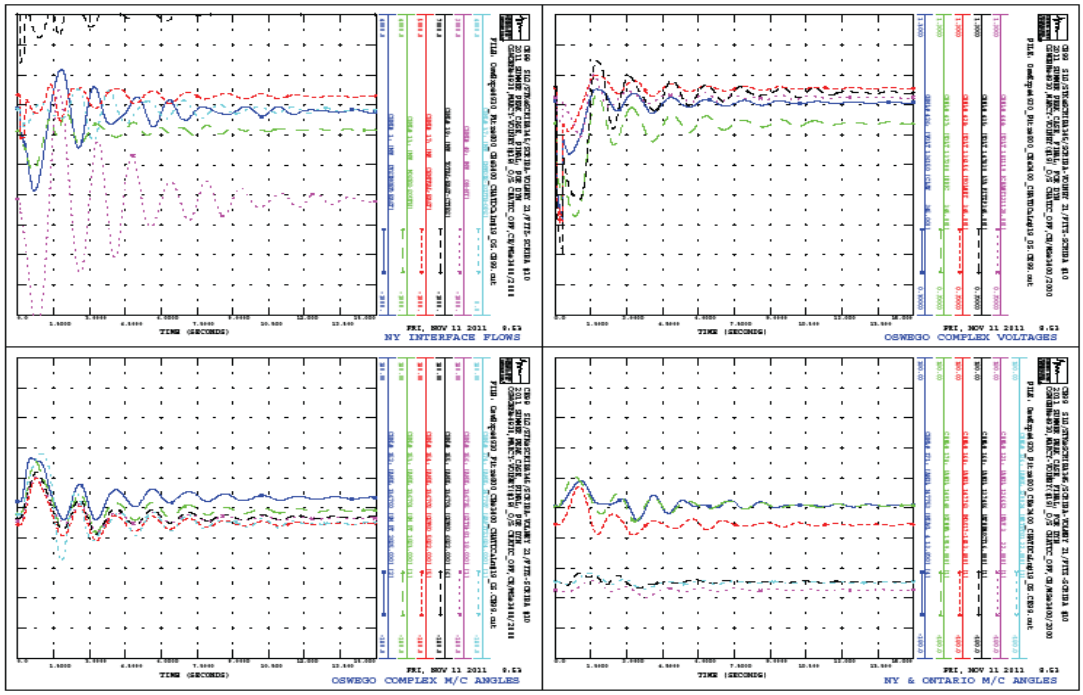


Fig 1 Marcy–Volney (VU-19)_OS; SLG/STK@Scriba/Scriba-Volney/Fitz-Scriba

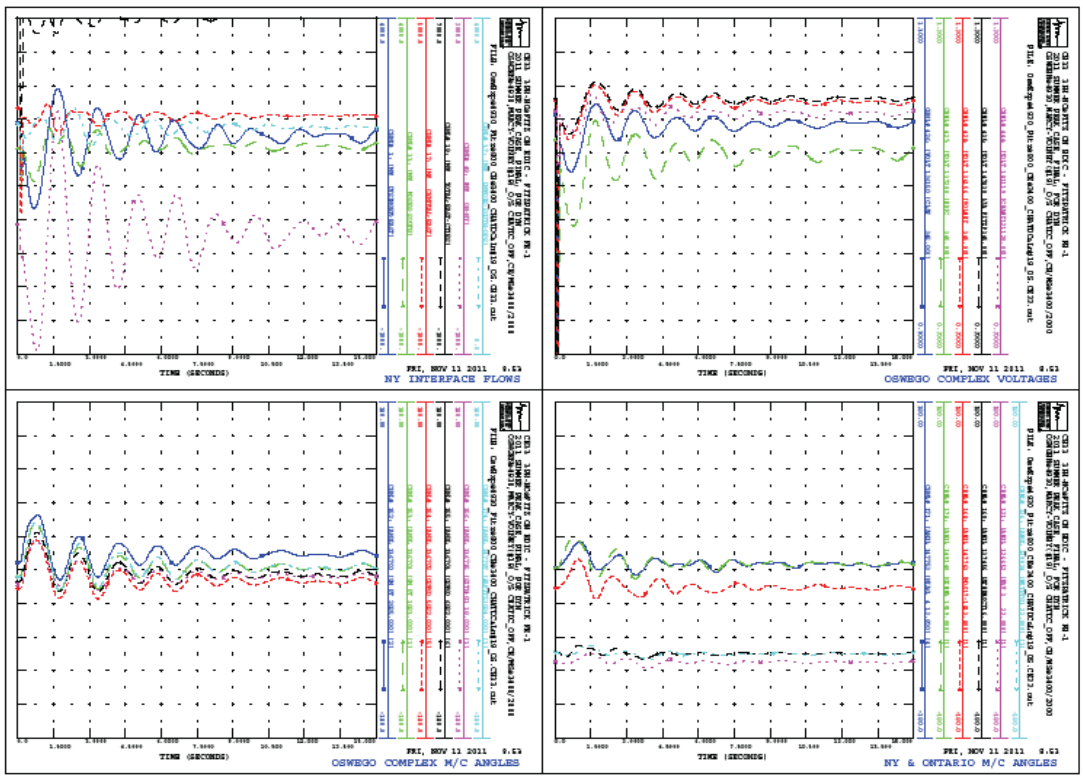


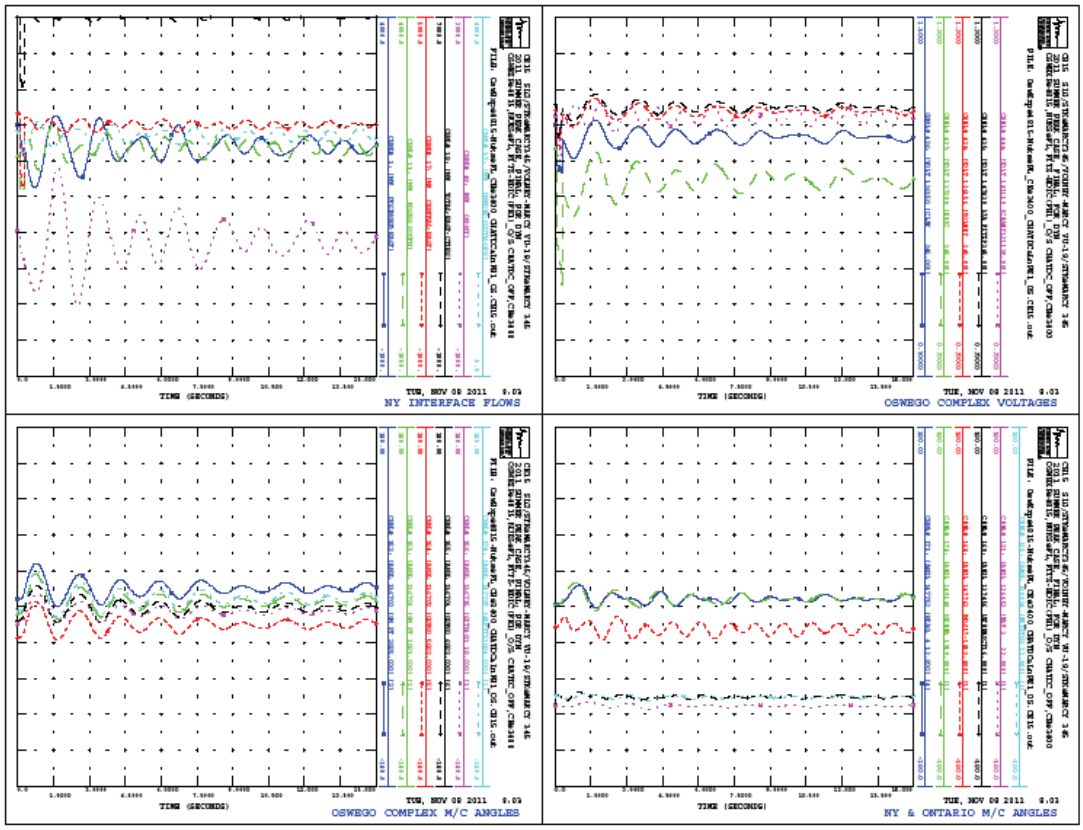
Fig 2 Marcy–Volney (VU-19)_OS; 3-Phase@Fitzpatrick on Fitz–Edic 345kV (CE33)

4.2.2 Fitzpatrick – Edic (FE-1) -Outage

With FE-1 out of service, one of the worst dynamic responses noted was the CE15 - SLG/STK@Marcy345 kV on Volney - Marcy (VU-19). For this fault, there was a noticeable sustained oscillation which damped out after about 10 seconds. This is a critical Central East contingency (especially with the outage of Fitzpatrick – Edic line) since it separates the Marcy 345 kV substation from the Oswego Complex by tripping Volney – Marcy and Edic – Marcy 345 kV lines.

An evaluation of some generating units elsewhere in NY (Niagara, Moses) showed the presence of an oscillating mode that damps out over time.

Fig 3: SLG/STK@Marcy345 kV on Volney - Marcy (VU-19).



5. CONCLUSIONS

Table 1 shows the line outage conditions evaluated in this analysis, the actual Oswego generation output levels, and the Oswego complex export operating limit. .

The system demonstrated stable performance for all the tested contingencies (see Tables 3 and 4) with Oswego Complex generation at **5250 MW**, for the all lines-in-service case and **4800 - 5250** MW for line outage conditions. The results of the analysis showed that there were no adverse impacts on the NYISO bulk power system for this level of Oswego Export.

The limits stated below are consistent with the 2005 ABB report on the Oswego Export Limit and a confirmation of the existing limits. The guidelines developed from this study for Oswego Complex generation Export, are based on the assessment of system dynamic performance for the tested cases and conditions.