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CONNECTION ASSESSMENT & APPROVAL PROCESS

SYSTEM IMPACT ASSESSMENT REPORT

For the incorporation of a new 500kV double-circuit line between the Bruce Complex & Milton TS

Applicant: Hydro One Networks Inc.

CAA ID No. 2006-250

Transmission Assessments & Performance Department

FINAL Version

Date: 27th March 2007

System Impact Assessment Report

For the incorporation of a new 500kV double-circuit line between the Bruce Complex & Milton TS

Acknowledgement

The IESO wishes to acknowledge the assistance of Hydro One in completing this assessment.

Disclaimers

IESO

This report has been prepared solely for the purpose of assessing whether the connection applicant's proposed connection with the IESO-controlled grid would have an adverse impact on the reliability of the integrated power system and whether the IESO should issue a notice of approval or disapproval of the proposed connection under Chapter 4, section 6 of the Market Rules.

Approval of the proposed connection is based on information provided to the IESO by the Hydro One Networks Inc. at the time the assessment was carried out. The IESO assumes no responsibility for the accuracy or completeness of such information, including the results of studies carried out by the transmitter at the request of the IESO. Furthermore, the connection approval is subject to further consideration due to changes to this information, or to additional information that may become available after the approval has been granted. Approval of the proposed connection means that there are no significant reliability issues or concerns that would prevent connection of the proposed facility to the IESO-controlled grid. However, connection approval does not ensure that a project will meet all connection requirements. In addition, further issues or concerns may be identified by the transmitter during the detailed design phase that may require changes to equipment characteristics and/or configuration to ensure compliance with physical or equipment limitations, or with the Transmission System Code, before connection can be made.

This report has not been prepared for any other purpose and should not be used or relied upon by any person for another purpose. This report has been prepared solely for use by the connection applicant and the IESO in accordance with Chapter 4, section 6 of the Market Rules. The IESO assumes no responsibility to any third party for any use, which it makes of this report. Any liability which the IESO may have to the connection applicant in respect of this report is governed by Chapter 1, section 13 of the Market Rules. In the event that the IESO provides a draft of this report to the connection applicant, you must be aware that the IESO may revise drafts of this report at any time in its sole discretion without notice to you. Although the IESO will use its best efforts to advise you of any such changes, it is the responsibility of the connection applicant to ensure that the most recent version of this report is being used.

Hydro One

Special Notes and Limitations of Study Results

The results reported in this system impact assessment are based on the information available to Hydro One, at the time of the study, suitable for a system impact assessment of a new transmission facility.

HYDRO ONE NETWORKS Inc.

SYSTEM IMPACT ASSESSMENT REPORT

For the incorporation of a new 500kV double-circuit line between the Bruce Complex and Milton TS

1. Summary of Conclusions & Recommendations

This Assessment has concluded that, subject to all of the following facilities being in-service prior to the completion of a proposed new 500kV line between the Bruce Complex and Milton TS, the new line will have no materially adverse effect on the IESO-controlled grid. It has therefore been recommended that a Notification of Conditional Approval to Connect be issued for this Project:

- The installation of the following reactive compensation, in addition to the shunt capacitor banks that have already been committed for installation at Detweiler TS and Orangeville TS:

  - Buchanan TS — A 3rd 170MVAr shunt capacitor bank
  - Middleport TS — Two 400MVAr shunt capacitor banks
  - Nanticoke SS — At least one 250MVAr shunt capacitor bank
  - Nanticoke SS — Dynamic compensation with a capacity of at least +350/-120MVAr

  These facilities are required to be available before a new 500kV double-circuit line is placed in-service between the Bruce Complex and Milton TS to avoid the need to implement generation rejection in response to any recognised system contingency.

  However, to mitigate the operational issues that will arise once seven units are in-service at the Bruce Complex starting in 2009 it is expected that the facilities listed above will be installed well in advance of the completion of a new 500kV line between the Bruce Complex and Milton TS.

  It is therefore expected that this requirement will be met through separate Hydro One initiatives with earlier in-service dates than that for the proposed 500kV double-circuit line between the Bruce Complex and Milton TS.

- The enhancement of the Bruce Special Protection System to allow generation rejection to be initiated in response to an expanded set of recognised contingency during periods when transmission elements are out-of-service.

With all of the additional facilities listed above and with all transmission elements in-service pre-contingency, a new 500kV double-circuit line between the Bruce Complex and Milton TS would allow all eight units at the Bruce Complex, together with all of the committed wind-turbine projects, to be accommodated without the need to employ post-contingency generation rejection in response to a recognised first contingency.

It has also been concluded that the installation of a second 250MVAr shunt capacitor bank at Nanticoke SS, in addition to a new 500kV double-circuit line between the Bruce Complex and Milton TS, would allow 870MW of additional generating capacity to be incorporated via the 500kV busbars at the Bruce Complex, without the need to employ generation rejection in response to a recognised first contingency.

It has been recommended that the proposed layout of the 500kV switchyard at Milton TS should be reviewed with the objective of avoiding the simultaneous loss of a 500kV Milton-to-Claireville circuit and a 500kV Milton-to-Trafalgar circuit due to the failure of one of the critical breakers at Milton TS. In addition, it has been suggested that consideration be given to the installation of a second new 500kV breaker at the A-station to limit the facilities that would be automatically removed from service at this switchyard in the event of a breaker-failure condition.

2. *Proposed New Transmission Facilities*

The new facilities involve the construction of a 500kV double-circuit line along the right-of-way of the existing 500kV line from the Bruce Complex to Milton TS.

One circuit of the new line is to be terminated on to the existing 500kV busbar at the Bruce A switchyard, while the other circuit is to be terminated on to the 500kV busbar at the Bruce B switchyard. Both circuits are to be terminated on to the existing 500kV busbar at Milton TS.

The new line is to be equipped with quad-585kcmil conductors and the specification calls for its ratings to be at least equivalent to those of the existing 500kV line to Milton TS.

Diagram 1 shows the proposed location of the new line in relation to the existing transmission facilities.

Subject to the necessary approvals, the new line is scheduled to be in-service by **December-2011** to coincide with the period when all eight units at the Bruce Complex are expected to be in-service simultaneously.

Facilities to be installed at the terminal stations

Diagram 2 shows the proposed arrangement of the 500kV busbars at the Bruce A & Bruce B switchyards to accommodate the two new 500kV circuits to Milton TS.

The proposed work will involve installing an additional 500kV breaker in an existing diameter at the Bruce A switchyard, while a new 500kV diameter with two new 500kV breakers will need to be established at the Bruce B switchyard.

A further 500kV breaker has also been shown in the middle diameter of the 500kV Bruce A switchyard.

Since a failure of the 500kV breaker EL560 would result in the simultaneous loss of both the E-busbar and the existing 500kV circuit B560V to Claireville TS, this situation can result in both generating units at the A-station being isolated on to the 500kV circuit to Longwood TS whenever breaker AL569 is out-of-service. This will also apply to future outages involving the new breaker that it is proposed to install in the switchyard of the A-station for the termination of the new circuit to Milton TS. Under these outage conditions, transient stability limitations would require the output of the two generating units at the A-station to be restricted.

The IESO therefore suggests that consideration be given to the installation of the additional 500kV breaker at the A-station to avoid the loss of the E-busbar at this switchyard in response to a breaker-failure condition involving the breaker EL560.

Diagram 3 shows the proposed arrangement at Milton TS which will involve the installation of a new 500kV breaker in each of two of the existing diameters.

Obtaining the necessary outages to undertake the work at this TS is expected to be challenging, particularly once seven units are all in-service at the Bruce Complex. If there is an opportunity to advance any of the proposed work so that it can be completed while there are only six units in-service, then this is expected to have major benefits.

3. *Background*

Units 1 & 2 at the Bruce A nuclear generating facility are both scheduled to return to service during 2009. However, during the period 2009 to 2011 other units at the Bruce Complex are scheduled to be removed from service for maintenance. Consequently, during the period 2009-2011 the maximum number of units that are expected to be in-service simultaneously is seven. It is only after December-2011 that all eight units at the Bruce Complex are expected to be in-service coincidently.

In addition, new wind-turbine generating projects that will have a direct impact on the flows away from the Bruce Complex have been awarded contracts under the Renewables I & II Requests-for-Proposals. These new facilities, whose total capacity is approximately 725MW, are scheduled to be incorporated into the system during the next two years.

230kV circuits B4V & B5V

Analysis that was performed for the earlier System Impact Assessment[1] for this area showed that to avoid the post-contingency overloading of the existing 230kV circuits B4V & B5V between Hanover TS and Orangeville TS, the maximum operating (sag) temperature of the conductors on this section would need to be increased from the present 104^{o}C to 127^{o}C. This work is presently underway and is expected to be completed before May 2009, prior to the return to service of the seventh unit at the Bruce Complex.

Reactive Compensation

The earlier SIA Report also identified the need for additional reactive support, to be provided through a mixture of dynamic facilities (synchronous condensers and/or static VAr compensators - SVCs) and shunt capacitor banks to ensure post-contingency voltage stability.

The original proposal for providing the dynamic reactive support involved converting up to four of the existing generating units at Nanticoke GS to synchronous condenser operation. Each unit when operating as a de-coupled synchronous condenser was expected to provide approximately 375MVAr of reactive support at their HV terminals.

Although it is now expected that the required dynamic reactive capability will be provided by SVCs instead of through the conversion of the generating units at Nanticoke GS, it has been assumed, solely for the purpose of this Assessment, that four of the existing units at Nanticoke GS will be operated as synchronous condensers. This approach is intended to provide an indication of the amount of dynamic support that will be required at Nanticoke SS once the proposed 500kV line to Milton TS is in-service.

The earlier SIA Report also recommended that shunt capacitor banks should be installed at the following locations prior to 2009 when seven Bruce units are expected to be operational:

- Detweiler TS a 230kV 250MVAr bank
- Orangeville TS a 230kV 250MVAr bank (or preferably, two 125MVAr banks)
- Middleport TS two 230kV 400MVAr banks: one on each half of the split busbar
- Nanticoke SS two 230kV 250MVAr banks

Apart from the two shunt capacitor banks at Nanticoke SS, all of these capacitor banks have been included in the system model used for this Assessment

Cambridge-Kitchener-Waterloo-Guelph area

It was also decided, following consultation with the OPA, to install a nominal 450MW generating facility at Cambridge-Preston TS as a proxy for whatever plan is eventually recommended for enhancing the supply to the Cambridge-Kitchener-Waterloo-Guelph area. This facility would have 300MW of its capacity connected to the 230kV busbar, with the remaining 150MW connected to the 115kV busbar.

To limit the reactive support provided by this facility so that it would not unduly distort the results, the generators were set to regulate the voltage at both the 230kV and 115kV busbars at Cambridge-Preston TS to a reference voltage of 1.03 pu (226.6kV and 121.6kV, respectively).

The base case model also included the 250MVA 230/115kV auto-transformer that Hydro One is currently installing at Cambridge-Preston TS, together with a second auto-transformer at the same location. The two 250MVA 230/115kV auto-transformers that have been proposed for installation at Guelph-Campbell TS were also included in the model.

[1] SIA Report: Reference IESO_REP_0299 Issued 11th April 2006

Should this new generation capacity not be developed or delayed beyond 2011, then other facilities that would provide a comparable degree of voltage support and system reinforcement would need to be installed.

Flow-South Transfers

The recently completed SIA Report that assessed the effect of installing series capacitors in each of the 500kV Hanmer TS-to-Essa TS circuits at Nobel TS, together with SVCs at both Porcupine TS and Kirkland Lake TS, concluded that the new facilities, if augmented with additional shunt capacitor banks, would allow the Flow-South limit to be increased to 2500MW. This would then allow unrestricted operation of all of the existing facilities in the north-east (including the Sault Ste. Marie area) as well as the proposed 440MW expansion of the Mattagami River plants.

The additional shunt capacitor banks that were recommended in the Flow-South SIA Report for increasing the Flow-South transfers were as follows:

- Pinard TS — 1 x 100MVAr bank
- Porcupine TS — 2 x 125MVAr banks
- Hanmer TS — 2nd 149MVAr bank
- Essa TS — 2nd 182MVAr bank

The following additional facilities were also included in the model used for this current study, although they are to be the subject of separate SIA and Feasibility Reports:

- Little Long GS — 1 x 100MVAr shunt capacitor bank

  The need for this particular capacitor bank is addressed in the SIA Report for the expansion of the Mattagami River plants

- Mississagi TS — 1 x +300/-100MVAr SVC
1 x 100MVAr shunt capacitor bank

- Algoma TS — 2nd 75MVAr shunt capacitor bank

  The need for the SVC as well as the two new shunt capacitor banks is to be addressed in the Feasibility Report for the development of the system between Sault Ste. Marie and Sudbury.

With all of these facilities in-service, the transfer on the Flow-South Interface was increased to 2500MW in all of the studies performed for this Assessment.

4. Summary of the Facilities included in the Reference System Model

All of the following facilities were included In the reference base case for the condition without the proposed double-circuit 500kV line between the Bruce Complex and Milton TS:

- *Series Compensation*

  Series capacitors providing 50% compensation in each of the Hanmer x Essa 500kV circuits.

- *SVCs*

  Porcupine TS — One +300/-100MVAr 230kV-connected SVC
Kirkland Lake TS — One +200/-100MVAr 115kV-connected SVC
Mississagi TS — One +300/-100MVAr 230kV-connected SVC

- *Shunt Capacitor Banks*

  Little Long SS — 1 x 100MVAr shunt capacitor bank
Pinard TS — 1 x 100MVAr shunt capacitor bank
Porcupine TS — 2 x 125MVAr shunt capacitor banks
Hanmer TS — 2nd 149MVAr shunt capacitor bank

Essa TS	2^{nd}	182MVAr shunt capacitor bank
Mississagi TS	1 x	100MVAr shunt capacitor bank
Algoma TS	2^{nd}	75MVAr shunt capacitor bank
Detweiler TS	2^{nd}	250MVAr shunt capacitor bank
Orangeville TS	2 x	125MVAr shunt capacitor banks
Buchanan TS	3^{rd}	170MVAr shunt capacitor bank
Middleport TS	2 x	400MVAr shunt capacitor banks

- *230/115kV auto-transformers*

  Cambridge-Preston TS   Two 250MVA 230/115kV auto-transformers
  Guelph-Campbell TS   Two 250MVA 230/115kV auto-transformers

- *Generating Facilities*

  Cambridge-Preston TS   A 300MW facility connected to the 230kV busbar, and
  A 150MW facility connected to the 115kV busbar

  In addition, the following generating facilities that have recently been awarded contracts and are either under construction or scheduled to be completed by 2009, were included in the system model:

  - Calpine - Greenfield Energy Centre   1005MW
  - Invenergy - St Clair Power   570MW
  - Sithe - Goreway   1015MW
  - Portlands Energy Centre   658MW
  - Halton Hills   680MW

- *Synchronous Condensers*

  Four units, each rated at 400MVAr, were assumed to be converted to synchronous condenser operation at Nanticoke GS, with two units connected to the 500kV & the 230kV busbars, respectively.

5. Forecast Primary Demand

The primary demand used in the model was 28400MW, representing the value that has been forecast for the extreme weather condition for the summer-2010.

6. Transmission Line Ratings

The long-term emergency ratings for the critical transmission circuits that were used in this Assessment are summarised in Table 1.

7. Study Criteria

Load Flow Analysis

- A constant-MVA representation was used for all system loads in both the pre-and post-contingency load flow analysis.
- All under-load tap-changers (ULTCs) that are under automatic control were allowed to move post-contingency.
- All switched shunt devices that are under automatic control were allowed to move post-contingency.
- To represent the new generation capacity that could be incorporated once the new line is operational, two fictitious generating units were assumed at the Bruce Complex: one connected to the 500kV busbar at the Bruce A switchyard and the other to the 500kV busbar at the Bruce B switchyard.

  Each generator was assumed to have the same characteristics as the Bruce B units and to be connected to their respective 500kV busbars via similar step-up transformers.

TABLE 1	***Long-Term Emergency Ratings for the 'Critical' Circuits in the Study Area*** *for an ambient temperature of 35^{o}C and with a wind speed of* ***0 to 4km/hr****.*		
Circuits	***Sag Temp***	***Long-Term Emergency Rating at 127^{o}C or Sag Temperature, if lower***	***MVA Rating***
500kV Circuits			*at 520kV*
B560V & B561M: *Bruce x Milton*			
Quad - 585kcmil	127^{o}C	3660A	3296MVA
B560V & M571V: *Milton x Claireville*			
Quad - 585kcmil	B560V 127^{o}C M571V 130^{o}C	3660A	3296MVA
M570V & V586M: *Milton x Claireville*			
Quad - 585kcmil	127^{o}C	3660A	3296MVA
B562L & B563L: *Bruce x Longwood*			
Quad - 585kcmil	127^{o}C	3660A	3296MVA
N582L: *Longwood x Nanticoke*			
Quad - 585kcmil	127^{o}C	3660A	3296MVA
230kV Circuits			*at 240kV*
B4V & B5V: *Bruce x Orangeville*			
1277.5kcmil Bruce to Hanover	127^{o}C**	1430A**	594MVA
1192.5kcmil Hanover to Orangeville	127^{o}C***	1400A	582MVA
B22D & B23D: *Bruce x Detweiler*			
1192.5kcmil Bruce to Seaforth	150^{o}C	1400A	582MVA
932.7kcmil Seaforth to Stratford	150^{o}C	1200A	582MVA
932.7kcmil Stratford to Detweiler	120^{o}C	1150A	582MVA
115kV Circuits			*at 121kV*
S2S: *Owen Sound x Stayner*			
477.0kcmil Owen Sound to Meaford	150^{o}C	770A	161MVA
477.0kcmil Meaford to Stayner	128^{o}C	770A	161MVA

Note: * Hydro One is planning to increase the sag temperature of this line to from 78^{o}C to 100^{o}C

** For planning purposes, operation at this current is to be limited to 8 hours per year because the conductors are classified as of 'high-aluminum content'

*** Hydro One plans to increase the sag temperature of this section of the line from 104^{o}C to 127^{o}C

Power-Voltage (PV) Analysis

For the condition with a new 500kV double-circuit line between the Bruce Complex and Milton TS

- A constant-MVA representation was used for all system loads
- For each of the system arrangements that were studied, the *post-contingency condition* following the loss of the 500kV Bruce-to-Claireville (B560V) and the Bruce-to-Milton (B561M) circuits was used as the reference. All ULTCs and switch shunts that are under automatic control were allowed to move prior to starting the PV analysis.
- To increase the Flow Away from the Bruce Complex (FABC), the outputs of the two fictitious generators were increased in unison.
- To compensate for the increase in generation output at the Bruce Complex, the output of those generating facilities at Darlington GS were reduced accordingly.
- In accordance with the IESO's criteria, the limiting transfer would correspond to a value 5% less than the voltage instability point (or knee) of the PV curve.

Stability Analysis

Fault clearance times

The following times were used for the contingency involving the 500kV circuits B560V & B561M:

		Elapsed Time
• Clearance of the fault at the terminals at the Bruce Complex		66msec
• Clearance of the fault at the Milton TS & Claireville TS terminals	+ 26msec	92msec

Provision of a margin of 10% on the Limiting Transfers

- To provide the required 10% margin, negative load was added to the busbars at the Bruce Complex to increase the Flow Away From the Bruce Complex (FABC) by 10%.

8. Reference Load Flow Diagrams with all eight Bruce units in-service

For these studies, the transfers across the Flow-South Interface and across the Negative-BLIP Interface (with a flow towards the GTA) were adjusted to 2500MW and 1500MW, respectively.

Diagram 4 shows the flow distribution that would occur on the existing transmission facilities, without the new 500kV line to Milton TS in-service, for the condition with all eight units at the Bruce Complex together with all of the committed wind-turbine projects, in operation.

In particular, the following should be noted:

i. That with no shunt capacitor banks at Nanticoke SS, the total reactive power output from the synchronous condensers at Nanticoke GS is shown as 763MVAr. This suggests that at least two 250MVAr shunt capacitor banks would need to be included at this location to minimise the pre-contingency output from the four synchronous condensers.

ii. That the transmission losses on the Ontario System, for this particular operating scenario, are shown to total 1355MW.

iii. That the flows on the principal circuits would be as shown in the following Table:

Circuit *500kV*		*Recorded Flows*			*Continuous Ratings at 93°C*
B560M	Bruce to Milton TS	1875MW	: 267MVAr	2014A	2815A
B561V	Bruce to Claireville TS	2146MW	: 372MVAr	2311A	2815A
B562L	Kingsbridge II to Longwood TS	644MW	: 98MVAr	688A	2815A
B563L	Kingsbridge II to Longwood TS	594MW	: 177MVAr	628A	2815A
N582L	Longwood TS to Nanticoke SS	1492MW	: 37MVAr	1579A	2815A
230kV					
B4V & B5V	Leader Wind to Hanover TS	388MW	: 34MVAr	907A	1080A
	Melancthon Wind to Orangeville	420MW	: 46MVAr	1000A	1060A
B22D & B23D	Ripley Wind to Seaforth	311MW	: 55MVAr	734A	1060A

Diagram 5 shows the corresponding flow distribution for the same operating scenario but with the proposed Bruce-to-Milton 500kV line in-service.

Similarly, the following should be noted from this Diagram:

i. That with no shunt capacitor banks at Nanticoke SS, the total MVAr output from the synchronous condensers at Nanticoke GS is shown as 380MVAr. This represents a reduction of over 380MVAr as a result of installing the new line: equivalent to the output of one of the synchronous condensers.

   It also suggests that at least one 250MVAr shunt capacitor bank should be included in the system model to minimise the pre-contingency output from the synchronous condensers. This would allow the maximum support to remain available from these devices for the post-contingency condition.

ii. That with the new 500kV line in-service, the flows on the principal circuits would be as follows:

Circuit *500kV*		*Flow*			*Continuous Rating : 93°C*
B560M	Bruce (A) to Milton TS	1228MW	: 56MVAr	1302A	2815A
B561V	Bruce (B) to Claireville TS	1267MW	: 84MVAr	1342A	2815A
B(A) x M	Bruce (A) to Milton TS - *NEW*	1244MW	: 66MVAr	1319A	2815A
B(B) x M	Bruce (B) to Milton TS - *NEW*	1264MW	: 80MVAr	1338A	2815A
B562L	Kingsbridge II to Longwood TS	324MW	: 101MVAr	357A	2815A
B563L	Kingsbridge II to Longwood TS	271MW	: 187MVAr	290A	2815A
N582L	Longwood TS to Nanticoke SS	1065MW	: 13MVAr	1120A	2815A
230kV					
B4V & B5V	Leader Wind to Hanover TS	297MW	: 20MVAr	685A	1080A
	Melancthon Wind to Orangeville	333MW	: 77MVAr	806A	1060A
B22D & B23D	Ripley Wind to Seaforth	253MW	: 31MVAr	594A	1060A

Comparing the results in the two preceding Tables shows that the new line would result in a reduction of approximately 640MVA in the combined flow on the 500kV Bruce-to-Longwood TS circuits. It would also reduce the flow on the 500kV circuit between Longwood TS and Nanticoke SS by approximately 430MVA.

In addition, the new 500kV line would reduce the flows on the 230kV circuits, particularly on that section of circuits B4V & B5V between the Melancthon Wind Projects and Orangeville TS. Without the new line in-service, these circuits are shown to be loaded to 1000A, which would be close to their continuous rating of 1060A. With the new 500kV line in-service, the flows on this section are reduced by approximately 200A to 806A.

iii. That the two 230/115kV auto-transformers that it is proposed to install at Guelph-Campbell TS would supply approximately 200MW to the 115kV system. This would have the effect of increasing the loading on the 230kV circuits D6V & D7V between Detweiler TS and Orangeville TS while unloading the 230/115kV auto-transformers at Burlington TS by approximately 210MW (the difference reflects the reduction in the transmission losses).

iv. That with the proposed 115kV-connected generation at Cambridge-Preston TS, the transfers through the two 230/115kV auto-transformers at that TS would be reduced to approximately 80MW.

v. That the new 500kV line between the Bruce Complex and Milton TS would result in circuit M585M between Middleport TS and Milton TS ‘floating’ i.e. carrying close to zero power. However, because of the line capacitance there would be a significant reactive power flow from this circuit into Milton TS, providing valuable voltage support. The companion circuit V586M, because it is terminated directly into Claireville TS, is shown to carry approximately 300MW.

vi That the transmission losses for the Ontario System, for the same operating scenario, but with the new 500kV line in-service, are shown to total 1236MW. This would represent a reduction in the system losses of 119MW.

8.1 FABC (Flow Away from the Bruce Complex) transfer

The FABC transfer shown in Diagram 5 is 6461.9MW. Since this corresponds to the actual flows that would be monitored in the operational environment it therefore reflects the local transmission losses as well as the load at Douglas Point TS.

This transfer corresponds to the following theoretical output from the Bruce Complex:

4 units at the Bruce A Station, each with a rated output of 805MW	3220MW
less a station service supply of 55MW for each unit	- 220MW
Net Output from the A station	*3000MW*
4 units at the Bruce B station, each with a rated output of 940MW	3760MW
less a station service supply of 50MW for each unit	- 200MW
Net Output from the B station	*3560MW*
Combined net output from the A & B Stations	*6560MW*

The transmission losses, together with the load at Douglas Point TS, therefore total approximately 100MW (6560MW - 6461.6MW).

For the purpose of this Assessment, except for the load flow studies where the actual flows are available for determining the FABC transfer, all other references to the FABC transfer use the combined net output from the A & B stations. To distinguish between the two values, the following convention has been adopted:

FABC *refers to the actual transfer away from the Bruce Complex, calculated by summing the appropriate flows.*

*FABC** *refers to the combined net output from the A & B stations, ignoring both the local transmission losses and the load at Douglas Point TS*

As shown above, with all eight units in-service at the Bruce Complex, the difference between the two values will be approximately 100MW.

8.2 Contingency Conditions

With a new 500kV double-circuit line constructed between the Bruce Complex and Milton TS and terminated into Milton TS as shown in Diagram 3 (Proposed Additions to the Milton 500kV Switchyard), the following would represent the more critical contingency conditions that could then occur:

- A double-circuit contingency involving either the existing 500kV line to Milton TS and Claireville TS (circuits B560V & B561M) or the new 500kV line to Milton TS
- A double-circuit contingency involving the existing 500kV Milton-to-Claireville line (circuits B560V & M571V)
- A breaker-failure condition involving breaker L61L71, breaker KL570 or the new H-busbar breaker that would result in the simultaneous loss of a Bruce-to-Milton & a Milton-to-Claireville circuit (circuits B561M & M571V; circuits BxxxM & M570V; or circuits ByyyM & M571V)
- A breaker-failure condition involving either breaker L70L73 or breaker HL573 that would result in the simultaneous loss of a Milton-to-Claireville & a Milton-to-Trafalgar circuit (circuits M570V & M573T or circuits M571V & M573T)

Analysis was performed to determine the effect of each of these contingency conditions:

Post-contingency Results: *for the case with 8 Bruce units, together with all of the committed wind-projects, and with the new 500kV Bruce-to Milton line in-service*

i. For a contingency involving the existing 500kV double-circuit line from the Bruce Complex to Milton TS & Claireville TS

The results from the study for this contingency condition have been summarised in Diagram 6.

This shows approximately 60% (1492MW) of the pre-contingency flow on the faulted circuits being transferred to the new 500kV line into Milton TS with a further 27% (675MW) appearing on the 500kV circuits into Longwood TS. The remaining 13% appears primarily as increased transfers over the 230kV circuits from the Bruce Complex to Detweiler TS and to Orangeville TS.

With lower post-contingency transfers to Nanticoke SS, via Longwood TS, the resulting net increase in the reactive power demand at Nanticoke SS is therefore only 208MVAr and this would be well within the capability of a single synchronous condenser at Nanticoke GS.

The increase in the transmission losses for this condition with no additional generation capacity incorporated is shown to be approximately 119MW (1355MW - 1236MW).

ii. For a double-circuit contingency involving the existing 500kV double-circuit line between Milton TS & Claireville TS: circuits B560V & M571V

The results from this study, which have been summarised in Diagram 7, show a post-contingency flow of 2526MVA on the remaining 500kV Milton x Claireville circuit. Although this is relatively high at 2790A, this flow would still be within the *continuous* rating of 2815A for this circuit, and well within its long-term emergency rating of 3660A.

iii. For a breaker failure condition that would result in the simultaneous loss of a 500kV Bruce x Milton circuit & a 500kV Milton x Claireville circuit

Since this contingency condition would result in the loss of only a single 500kV circuit from the Bruce Complex, the post-contingency flows on each of the remaining circuits, as summarised in Diagram 8, are shown to increase to a maximum of approximately 1670A, which would be well within their continuous ratings of approximately 2800A. Similarly, the post-contingency flows on the circuits between Milton TS and Claireville TS are also shown to remain well within their continuous ratings.

iv. For a breaker failure condition that would result in the simultaneous loss of a 500kV Milton x Claireville circuit & a 500kV Milton x Trafalgar circuit

The results for this contingency condition have been summarised in Diagram 9 and these show that the transfers through the T14 unit that would remain in-service connected to circuit M572T post-contingency (1088MVA), would be only marginally within its 10-day long-term emergency rating of 2625A or approximately 1090MVA.

Diagram 10 shows the results for the same contingency condition but with a reduced transfer across the QFW Interface. These results show that the 10-day long-term emergency rating would be exceeded. Similar results would be expected for the condition with a reduced transfer across the Negative-BLIP Interface.

It is therefore recommended that the proposed layout of the 500kV busbar at Milton TS be reviewed to avoid the simultaneous loss of the 500kV circuit M573T and either of the 500kV Milton-to-Claireville circuits due to a breaker-failure condition involving either of the 500kV breakers L70L73 or HL573.

Outage Conditions involving the 500kV Milton x Claireville circuits

Diagram 11 shows the flows with one of the Milton TS to Claireville TS circuits (M571V) out-of-service, either for maintenance or because of a fault.

In this Diagram, the flow on each of the 500kV circuits to Trafalgar TS is shown to remain within the 10-day limited-time-rating (~1090MVA) of the auto-transformer on to which each circuit is terminated.

Diagram 12 shows the corresponding flows should the companion circuit (M570V) suffer a contingency. This would result in flows through the 500/230kV auto-transformers at Trafalgar TS that would exceed their 10-day limited-time ratings, although they would remain within the 15-minute limited-time-ratings of these units.

Analysis has shown that to achieve the required reduction in the flows through the auto-transformers to respect their 10-day limited-time-ratings, the output from the Bruce complex would need to be reduced by approximately 650MW.

9. *Capability to incorporate additional generating capacity*

The construction of a new 500kV transmission line between the Bruce Complex and Milton TS is intended to allow additional generating capacity to be incorporated into the system beyond the eight units at the Bruce Complex and all of the committed wind-turbine projects, without the need to initiate generation rejection in response to any recognised first contingency.

Analysis was therefore performed to quantify the enhanced incorporation capability that the new line would be expected to provide.

In the absence of any definitive information as to where any new generation capacity is likely to be located and the manner in which it would be incorporated, it was decided to concentrate all the new generation capacity directly on to the 500kV busbars at the Bruce Complex. The intent was to avoid introducing unintentional circuit loading issues on the 230kV system that could indirectly influence the results.

9.1. Study Results

With a new 500kV line between the Bruce Complex and Milton TS and with additional generating capacity incorporated via the 500kV busbars at the Bruce Complex

9.1.1 Power-Voltage Analysis

PV-analysis was performed for the arrangement shown in Diagrams 5 & 6 to determine its voltage stability limit, following the loss of the existing 500kV double-circuit line, B560V & B561M. The FABC* transfer was increased by adjusting the output of the two fictitious generators that were added at the Bruce Complex; with one unit connected to the 500kV busbar at the A station and the other unit to the 500kV busbar at the B station.

Diagram 13 shows the resulting voltage curves together with a curve showing the available reactive power from the generating units in south-western Ontario.

The FABC* Transfer at which the study terminated was 7821MW and this corresponded to the situation where the generating units within the GTA (at Pickering GS, Darlington GS and the Sithe-Goreway facility) reached their maximum MVAr outputs.

Applying a 5% margin to this transfer would therefore give a voltage instability limit of **7430MW** for the FABC* Transfer with the new 500kV line in-service.

This would allow approximately **870MW** of additional generating capacity to be incorporated (7430MW - the FABC transfer for the existing 8 units at the Bruce Complex of 6560MW).

9.1.2 Load Flow Analysis

Pre-contingency

Diagram 14 shows the results of the pre-contingency analysis for the condition with the new 500kV line in-service and with the additional 870MW of generating capacity incorporated via the 500kV busbars at the Bruce Complex.

This shows an increase of 57MW (1292.9MW - 1236.3MW from Diagram 5) in the system losses as a result of incorporating the additional 870MW of generating capacity. In addition, the reactive power output from the synchronous condensers at Nanticoke GS is shown to have increased to 475MVAr; once again confirming the need for at least one 250MVAr shunt capacitor bank at Nanticoke SS.

The following Table shows the changes recorded in the circuit flows resulting from the addition of 870MW of new generating capacity at the Bruce Complex.

This shows that approximately 75% of the output from the new generating facilities would appear as increased flows on the four 500kV circuits from the Bruce Complex to Milton TS and Claireville TS. A further 16% would appear as increased flows on the two 500kV circuits from the Bruce Complex to Longwood, while the majority of the remainder (8%) would appear as increased flows on the 230kV circuits to Orangeville TS and Detweiler TS.

With such a high proportion of the output from the Bruce Complex flowing directly over the Bruce-to-Milton corridor, these results clearly demonstrate the benefit of installing a new transmission line into Milton TS from the Bruce Complex.

Changes in the Flow Distribution arising from the 870MW of New Generating Capacity at the Bruce Complex						
Circuit			*New Generation Capacity*		*Increase*	
			None Diagram No. 5	870MW Diagram No. 14		
500kV	B560V	Bruce x Claireville	1228.1MW	1396.1MW	167.7MW	19.2%
	B561M	Bruce x Milton	1267.2MW	1427.9MW	160.7MW	18.5%
	New BxM Circuit from the ‘A’ station		1244.0MW	1403.1MW	159.1MW	18.3%
	New BxM Circuit from the ‘B’ station		1264.1MW	1424.6MW	160.5MW	18.4%
	B562L	Bruce x Longwood	324.3MW	394.8MW	70.5MW	8.1%
	B563L	Bruce x Longwood	270.9MW	342.9MW	72.0MW	8.3%
230kV	B4V & B5V	Bruce x Orangeville	590.5MW	634.2MW	43.7MW	5.0%
	B22D & B23D	Bruce x Detweiler	505.5MW	531.7MW	26.2MW	3.0%
115kV	S2S Owen	Sound x Stayner	66.9MW	75.3MW	8.4MW	1.0%
				Total	*868.8MW*	*99.8%*

Analysis was also performed to determine the effect that each of the same contingency conditions that were examined previously for the scenario with no additional generating capacity incorporated, would have.

Post-contingency Results: *for the case with 8 Bruce units, together with an additional 870MW of new generation capacity as well as all of the committed wind-projects, and with the new 500kV Bruce-to Milton line in-service*

i. For a contingency involving the existing 500kV double-circuit line from the Bruce Complex to Milton TS & Claireville TS

Diagram 15 shows the load flow results following a double-circuit contingency involving the loss of circuits B560V & B561M. This shows a combined output from the synchronous condensers at Nanticoke GS of 751.6MVAr; representing an increase over their pre-contingency output of 277MVAr. The increase in transmission system losses between the pre- and post-contingency conditions is shown to total 152MW (1444.8MW - 1292.9MW).

The post-contingency flows on the 500kV & 230kV circuits are all shown to remain well within their long-term-emergency ratings.

This is also true with respect to the 115kV line between Owen Sound TS and Stayner TS. The post-contingency flow on the section into Stayner TS is shown as 558A which would be well within its LTE rating of 770A. Consequently, automatic cross-tripping of this circuit, as recommended in the Assessment Report for the Bruce series compensation, would not be required with this amount of new generating capacity incorporated.

ii. For a double-circuit contingency involving the existing 500kV double-circuit line between Milton TS & Claireville TS: circuits B560V & M571V

The results from this study have been summarised in Diagram 16. These show that as a result of incorporating the additional generating capacity, the post-contingency flow on the remaining 500kV Milton-to-Claireville circuit would increase to 3210A (from 2815A). However, this would still be within its long-term emergency rating of 3660A.

iii. For a breaker failure condition that would result in the simultaneous loss of a 500kV Bruce x Milton circuit & a 500kV Milton x Claireville circuit

The results from this study, as summarised in Diagram 17, show that although the incorporation of the new generating capacity at the Bruce Complex would result in increased post-contingency flows, all of the flows, including those on the 230kV circuits from the Bruce Complex, would remain within their *continuous* ratings.

iv. For a breaker failure condition that would result in the simultaneous loss of a 500kV Milton x Claireville circuit & a 500kV Milton x Trafalgar circuit

Diagram 18 shows the results from this study. These show a post-contingency transfer of approximately 1160MVA through the remaining 500/230kV auto-transformer at Trafalgar TS, which would exceed its 10-day limited-time-rating of 1090MVA.

Furthermore, as discussed in Section 8.2 iv. for the same contingency condition but with no additional generating capacity incorporated at the Bruce Complex, the transfer through the remaining auto-transformer would be expected to increase in response to lower transfers across the QFW and/or Negative-BLIP Interfaces than were assumed in this analysis.

The recommendation to review the proposed layout of the 500kV busbar at Milton TS so as to avoid the simultaneous loss of the 500kV circuit M573T and either of the 500kV Milton-to-Claireville circuits due to a breaker-failure condition involving either of the 500kV breakers L70L73 or HL573, would therefore be even more relevant with the added generation capacity.

Outage Conditions involving the 500kV Milton x Claireville circuits

Diagram 19 shows the flows with one of the Milton TS to Claireville TS circuits (M571V) out-of-service, either for maintenance or because of a fault.

In this Diagram, the transfer through each of the 500kV auto-transformers at Trafalgar TS is shown to be approximately 910MVA, which would be within their 10-day limited-time-rating (~1090MVA). However, as before, these transfers would be expected to increase with lower transfers across the QFW and/or Negative-BLIP Interfaces, and could therefore exceed the emergency ratings of the auto-transformers.

Diagram 20 shows the corresponding flows should the companion circuit (M570V) suffer a contingency. This would result in transfers of approximately 1370MVA through each of the 500/230kV auto-transformers at Trafalgar TS, and these would be well in excess of their 10-day limited-time ratings.

These results show that with additional generation capacity incorporated via the 500kV busbars at the Bruce Complex, outages involving the transmission facilities that form the Milton-to-Claireville corridor would be especially challenging operationally. This corridor would therefore benefit from the implementation of measures that would limit the severity of the critical outage conditions.

9.2 Transient Stability Analysis

A transient stability study was performed for the arrangement with the new 500kV line in-service to confirm that the corresponding transient stability limit would be less restrictive than the voltage stability limit that has been determined from the PV-analysis.

For this study, rather than attempting to establish an actual transient stability limit for the FABC* Transfer, it was considered sufficient to demonstrate that the system would remain stable at an FABC* Transfer (after applying the required 10% margin) that was higher by an appropriate margin than the voltage stability limit determined from the PV-analysis.

Since the voltage stability limit for this condition (after applying the 5% margin) corresponded to an FABC* Transfer of 7430MW, then the transient stability analysis would need to demonstrate that the generating units would remain stable for an FABC* Transfer of *at least* 8173MW (7430MW x 1.1) in order to provide the required margin of 10% as stipulated in the IESO's criteria.

Diagram 20 shows the results obtained with an FABC Transfer of 8610MW. This shows that the units remain stable with an initial angular swing of less than 30^o. It is therefore expected that the FABC Transfer at which stability would be lost would be substantially higher.

After applying the required 10% margin, this FABC Transfer would be equivalent to a 'limit' of 7827MW. However, since this Transfer corresponds to the actual flows and not the net output of the generating units at the Bruce Complex, this 'limit' would therefore correspond to an FABC* Transfer at least 100MW higher, or approximately 7930MW. This would therefore be 500MW or at least 6.7% higher than the corresponding voltage stability limit of 7430MW.

This study therefore confirms that the voltage stability limit for the FABC* Transfers would be more restrictive than the transient stability limit.

10. Summary of the studies for the new 500kV line between the Bruce Complex and Milton TS

The studies have shown that, under the following operating conditions,

- With a transfer of 2500MW across the Flow-South Interface
- With a transfer of 1500MW across the Negative-BLIP Interface, and
- With a primary demand of 28400MW

and with *a new 500kV double-circuit line between the Bruce Complex and Milton TS,* the amount of new generating capacity that could be incorporated into the system via the 500kV busbars at the Bruce Complex, in addition to the following generating facilities,

- All eight units at the Bruce Complex, and
- All 725MW of the committed wind-turbine Projects

would be limited to a maximum of **870MW** to avoid the onset of voltage instability at the busbars within the GTA.

11. Reactive Compensation Requirements

This Assessment has confirmed that apart from the four synchronous condensers that were assumed to be in-service at Nanticoke GS, all of the following reactive compensation facilities will be required to be in-service once the new line is completed.

Detweiler TS	A 2^{nd} 250MVAr shunt capacitor bank
Orangeville TS	Two 125MVAr shunt capacitor banks
Buchanan TS	A 3^{rd} 170MVAr shunt capacitor bank
Middleport TS	Two 400MVAr shunt capacitor banks

The reactive power requirements at Nanticoke GS, *with all transmission elements in-service*, have been summarised in Table 3. This shows that, with no additional generating capacity incorporated, at least one 250MVAr shunt capacitor bank will be required at Nanticoke SS to limit the amount of dynamic reactive support that would need to be installed.

TABLE 3	***Reactive Power Requirements at Nanticoke SS with a new 500kV line to Milton TS***				
Additional Generating Capacity Incorporated at the Bruce Complex	***Diagram No.***	***System Condition***	***Reactive Power Output from the Synchronous Condensers***		
			Recorded Value	***Increase***	***Effective Output with shunt capacitor banks at Nanticoke***
None	5	*Pre-contingency*	379.6MVAr		*129.6MVAr + 1 x 250MVAr*
	6	*Post-contingency*	587.8MVAr	*208.2MVAr*	*337.8MVAr + 1 x 250MVAr*
870MW	8	*Pre-contingency*	498.0MVAr		*-2.0MVAr + 2 x 250MVAr*
	9	*Post-contingency*	682.8MVAr	*184.8MVAr*	*182.8MVAr + 2 x 250MVAr*

The above Table shows that with no additional generating capacity incorporated, approximately 600MVAr of reactive support would be required at Nanticoke SS to maintain acceptable post-contingency voltages. This is shown to increase to approximately 700MVAr for the condition with 870MW of new generation capacity incorporated into the system via the 500kV busbars at the Bruce Complex. However, the portion of these requirements that would need to be provided by dynamic reactive power devices could be reduced by placing shunt capacitor banks in-service at Nanticoke SS pre-contingency.

The final column of the above Table shows that with one 250MVAr capacitor bank in-service pre-contingency, the amount of dynamic reactive support that would be required post-contingency to maintain acceptable voltages for the condition with no additional generating capacity incorporated would be approximately 340MVAr.

Similarly, for the condition with 870MW of additional generating capacity in-service, placing two 250MVAr shunt capacitor banks in-service pre-contingency would reduce the amount of dynamic reactive support that would be required post-contingency to approximately 185MVAr.

However, with lesser amounts than the 870MW of additional generating capacity that has been assessed, the devices that provide the dynamic reactive power would need to have a VAr absorption capability to allow the second 250MVAr shunt capacitor bank to be placed in-service pre-contingency.

It is therefore recommended that with the new 500kV line to Milton TS in-service, the *minimum* amount of reactive compensation that will be required at Nanticoke SS to allow up to 870MW of additional generating capacity to be incorporated will be as follows:

- Two 250MVAr shunt capacitor banks, and
- Dynamic reactive power device(s) with a reactive power capability range of at least +350MVAr and -120MVAr

It should also be stressed that with any transmission facilities out-of-service that result in increased post-contingency transfers via those facilities between Longwood TS/Buchanan TS and Nanticoke SS/Middleport TS, the reactive power requirements in the Nanticoke area will increase beyond those shown in Table 3.

Operation during the interim period once seven units are in-service at the Bruce Complex

Although this is considered to be outside the scope of this Assessment, analysis has shown that the reactive power requirements at Nanticoke SS during this period prior to the new 500kV line being completed when seven units are in-service at the Bruce Complex will be significantly greater than those summarised in Table 3.

It is therefore assumed that the reactive compensation requirements detailed above will be met through a separate Hydro One initiative with an earlier in-service date than that for the new 500kV line.

Furthermore, on the assumption that the reactive power facilities that will be installed at Nanticoke SS to limit the extent of any operational constraints that might need to be imposed during the interim period will exceed the requirements detailed above, it is recommended that consideration be given to retaining at least some of these additional facilities in-service once the new line becomes available. With additional reactive support available at Nanticoke SS, it would therefore be possible to limit the extent of any operational restrictions that could be required during periods when transmission facilities are out-of-service following the completion of the new 500kV line.

12. Bruce Special Protection System

Although the analysis has shown that all of the committed generating facilities as well as further new generating capacity could be incorporated without having to initiate generation rejection in response to a contingency while all transmission elements are in-service, generation rejection will still be required whenever transmission elements are out-of-service.

It will therefore be necessary to enhance the Bruce SPS to expand the number of contingency conditions, including those involving the new 500kV line, to which it can respond.

13. Customer Impact Assessment

Hydro One Networks Inc. has completed a Customer Impact Assessment for this Project and concluded that the proposed facilities will have no adverse impact on any of their customers.

14. Notification of Approval of the Connection Proposal

This Assessment has concluded that, subject to all of the following facilities being in-service prior to the completion of the new 500kV line, this proposal will have no materially adverse effect on the IESO-controlled grid:

- The installation of the following reactive compensation, in addition to the shunt capacitor banks that have already been committed for installation at Detweiler TS and Orangeville TS:
  - Buchanan TS — A 3rd 170MVAr shunt capacitor bank
  - Middleport TS — Two 400MVAr shunt capacitor banks
  - Nanticoke SS — At least one 250MVAr shunt capacitor bank
  - Nanticoke SS — Dynamic compensation with a capacity of at least +350/-120MVAr

  However, while the facilities listed above must be available once the new 500kV line is in-service to avoid the need to implement generation rejection in response to any recognised system contingency, it is expected that they will be installed prior to the new line being placed in-service to mitigate the operational issues that will arise once seven units are in-service at the Bruce Complex starting in 2009.

  This requirement is therefore expected to be met through separate Hydro One initiatives with earlier in-service dates than that of the new 500kV line.

- The enhancement of the Bruce Special Protection System.
- A review of the proposed layout of the 500kV switchyard at Milton TS to limit the effect of breaker-failure conditions at that station.

It is therefore recommended that a Notification of Conditional Approval to Connect be issued for this Project.

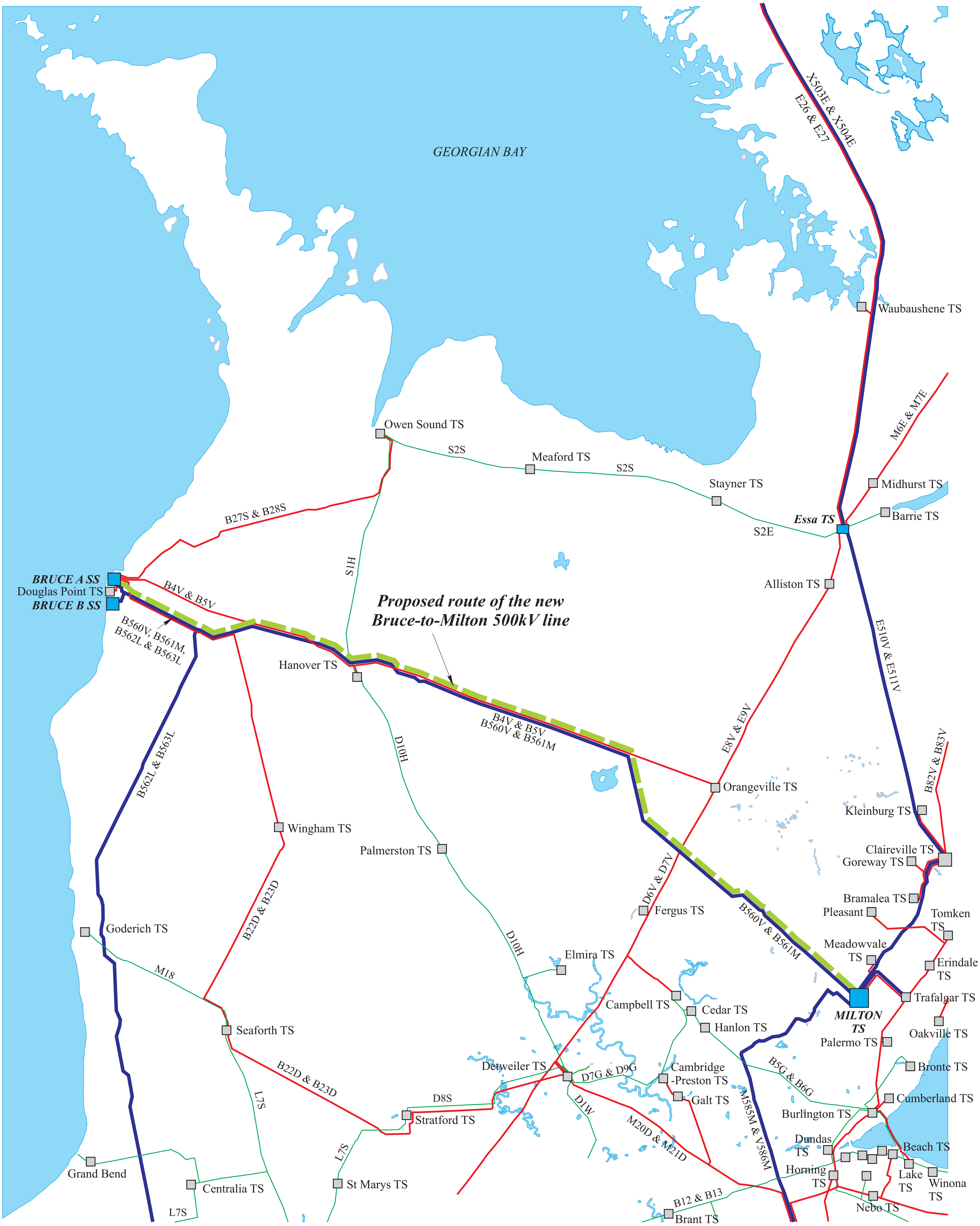
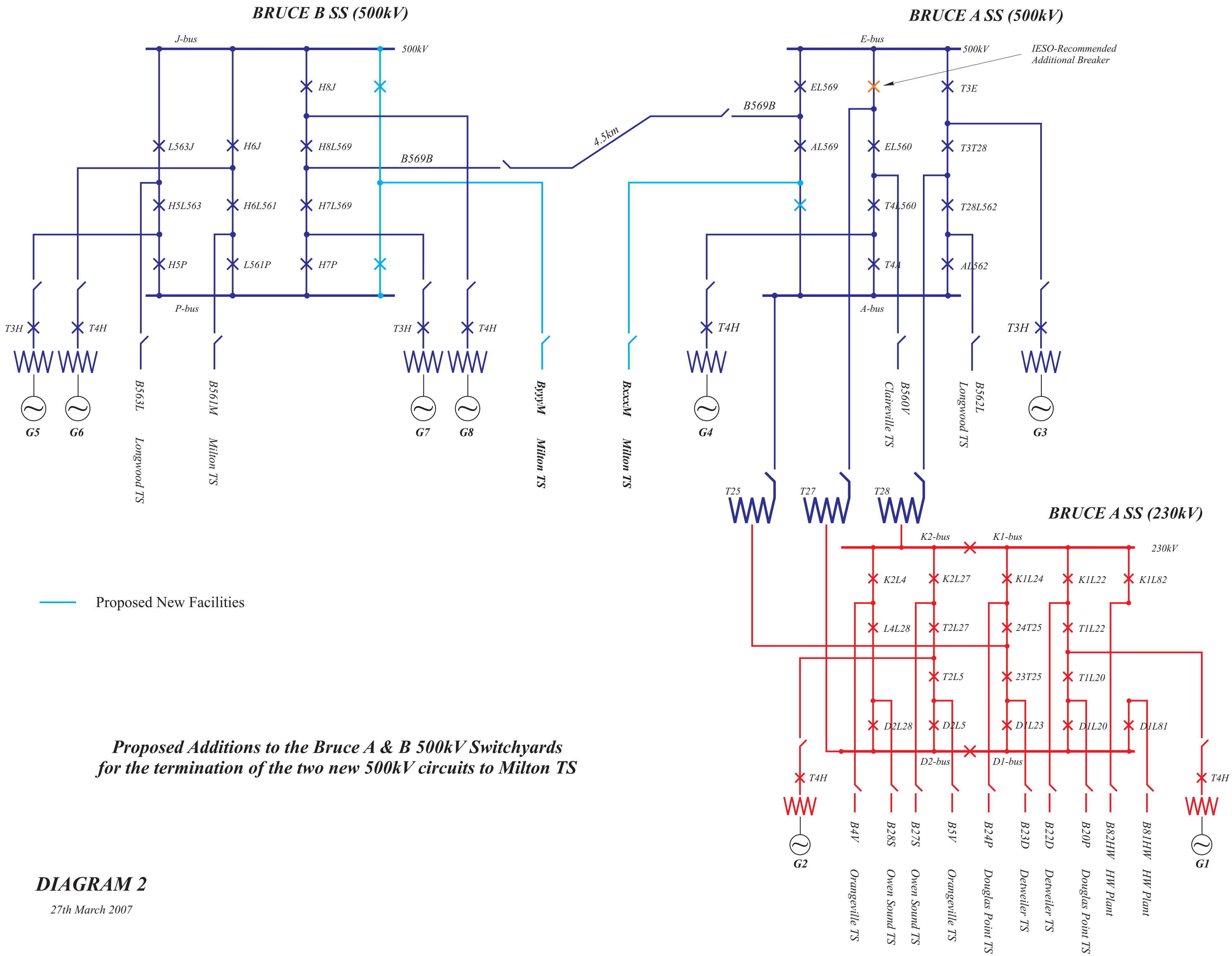


DIAGRAM 1

2nd February 2007

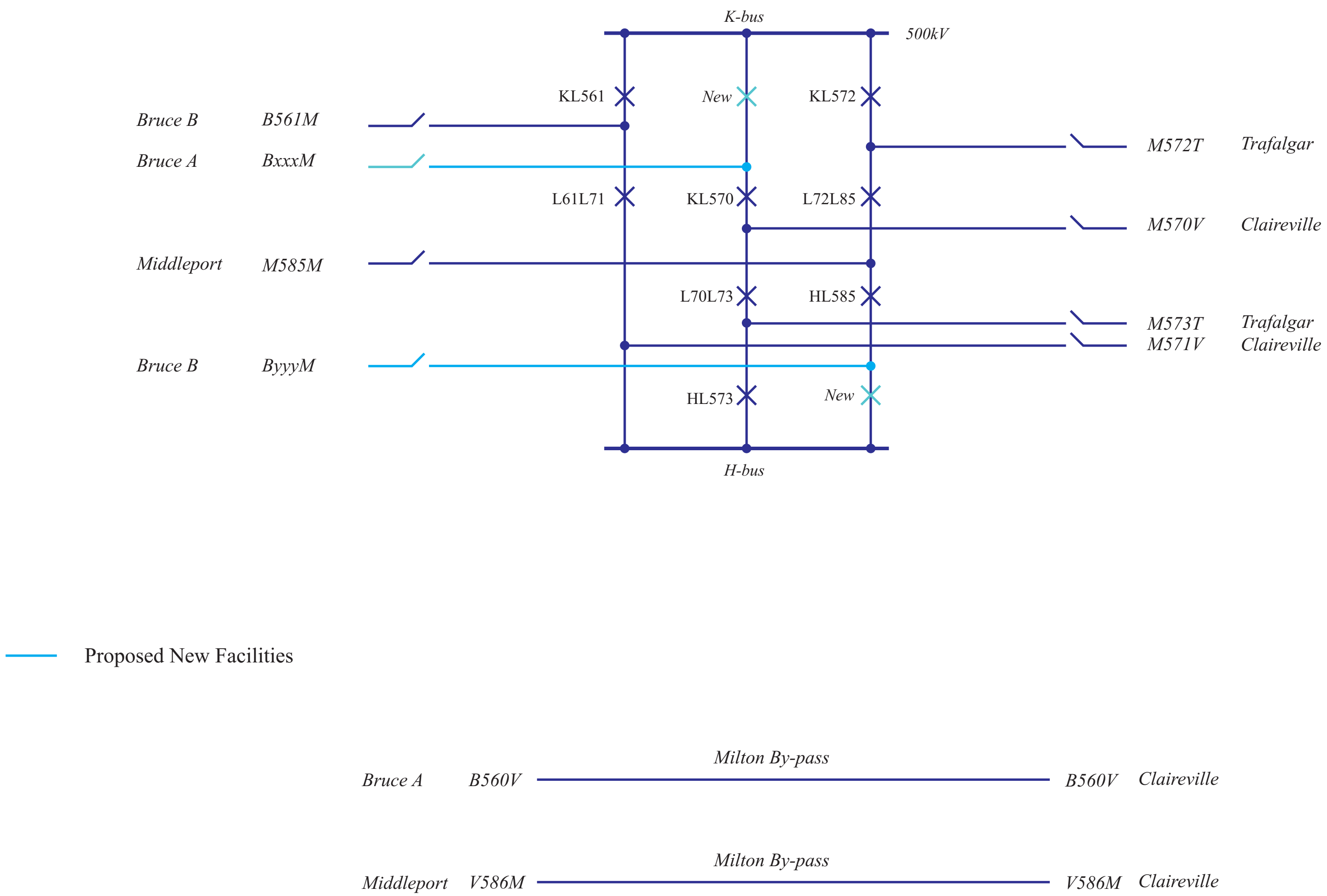


Proposed Additions to the Bruce A & B 500kV Switchyards for the termination of the two new 500kV circuits to Milton TS

DIAGRAM 2

27th March 2007

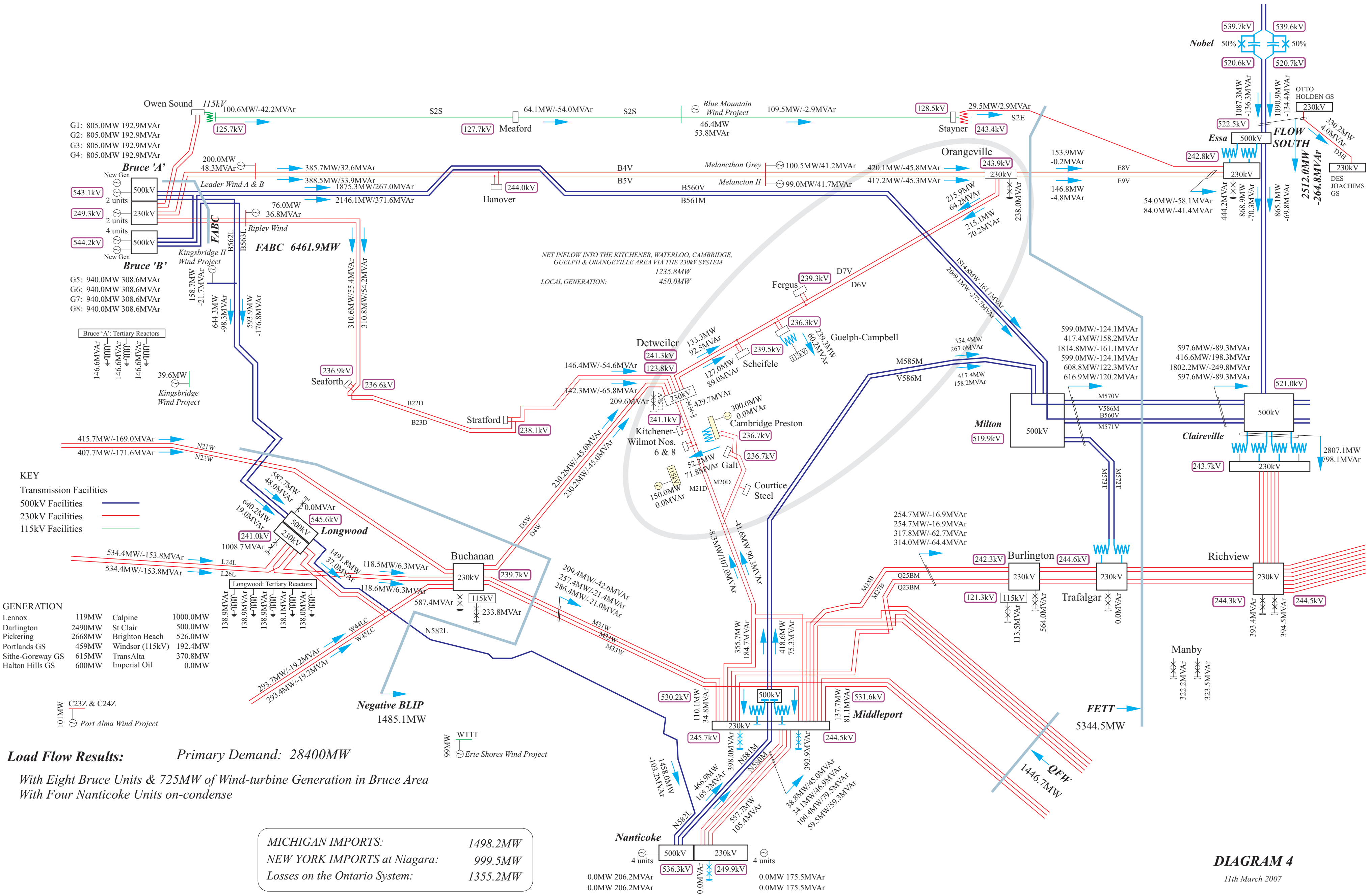
MILTON TS (500kV)



Proposed Additions to the Milton 500kV Switchyard for the termination of the two new 500kV circuits to the Bruce Complex

DIAGRAM 3

10th March 2007



Load Flow Results:
Primary Demand: 28400MW
With Eight Bruce Units & 725MW of Wind-turbine Generation in Bruce Area
With Four Nanticoke Units on-condense
MICHIGAN IMPORTS: 1498.2MW
NEW YORK IMPORTS at Niagara: 999.5MW
Losses on the Ontario System: 1355.2MW
DIAGRAM 4
11th March 2007
KEY
Transmission Facilities
500kV Facilities
230kV Facilities
115kV Facilities
GENERATION
Lennox 119MW
Darlington 2490MW
Pickering 2668MW
Portlands GS 459MW
Sithe-Goreway GS 615MW
Halton Hills GS 600MW
Calpine 1000.0MW
St Clair 500.0MW
Brighton Beach 526.0MW
Windsor (115kV) 192.4MW
TransAlta 370.8MW
Imperial Oil 0.0MW
Bruce 'A'
G1: 805.0MW 192.9MVAr
G2: 805.0MW 192.9MVAr
G3: 805.0MW 192.9MVAr
G4: 805.0MW 192.9MVAr
Bruce 'B'
G5: 940.0MW 308.6MVAr
G6: 940.0MW 308.6MVAr
G7: 940.0MW 308.6MVAr
G8: 940.0MW 308.6MVAr
FABC 6461.9MW
Negative BLIP 1485.1MW
FETT 5344.5MW
QFW 1446.7MW
FLOW SOUTH 2512.0MW -264.8MVAr
NET INFLOW INTO THE KITCHENER, WATERLOO, CAMBRIDGE, GUELPH & ORANGEVILLE AREA VIA THE 230kV SYSTEM 1235.8MW
LOCAL GENERATION: 450.0MW
Nobel
Essa
Otto Holden GS
Des Joachims GS
Owen Sound
Meaford
Stayner
Orangeville
Hanover
Blue Mountain Wind Project
Melancthon Grey
Melancton II
Leader Wind A & B
Ripley Wind
Kingsbridge II Wind Project
Kingsbridge Wind Project
Seaforth
Stratford
Detweiler
Fergus
Guelph-Campbell
Scheifele
Kitchener-Wilmot Nos. 6 & 8
Cambridge Preston
Galt
Courtice Steel
Milton
Claireville
Longwood
Buchanan
Burlington
Trafalgar
Richview
Manby
Middleport
Nanticoke
Port Alma Wind Project
Erie Shores Wind Project

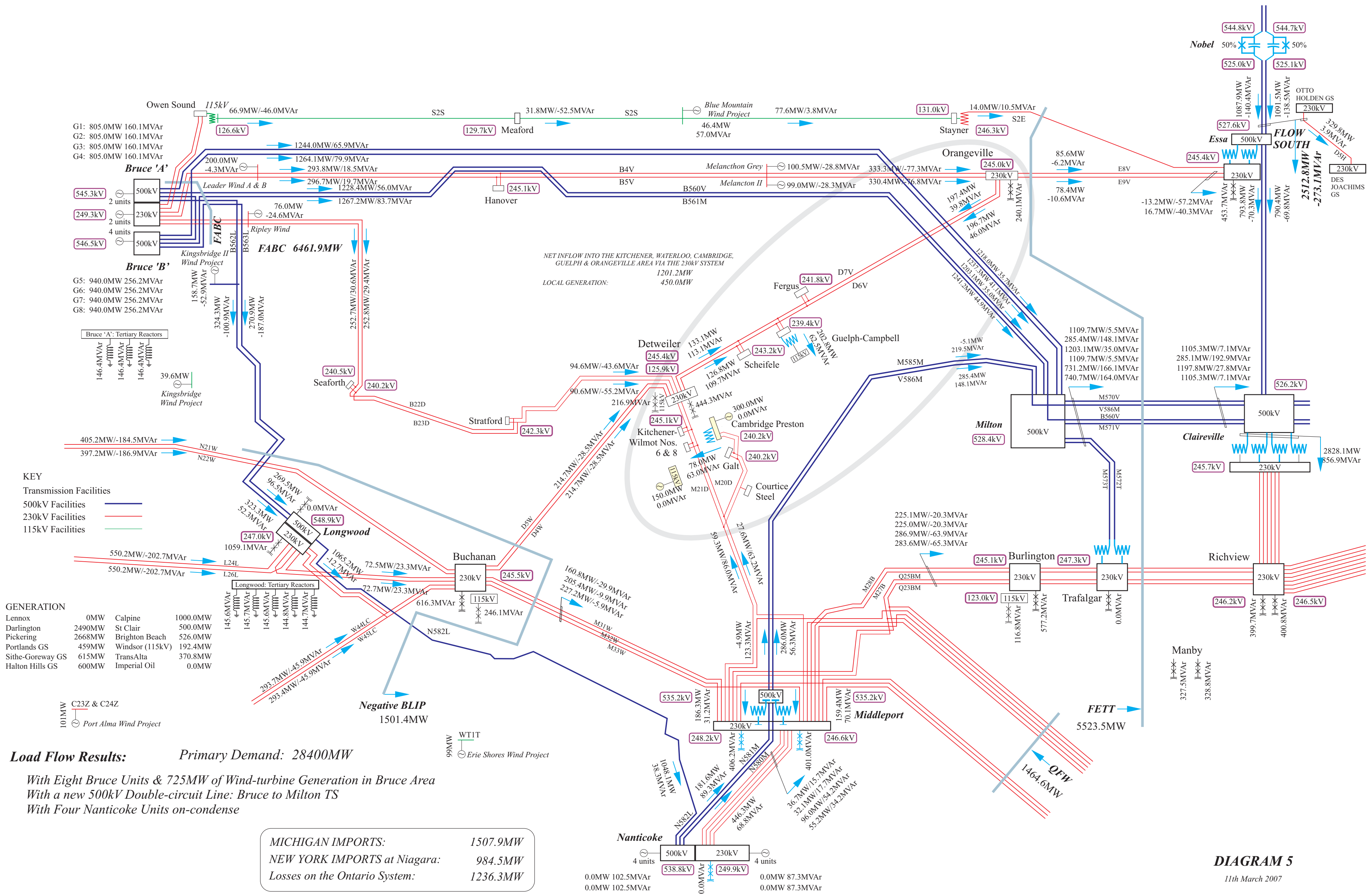
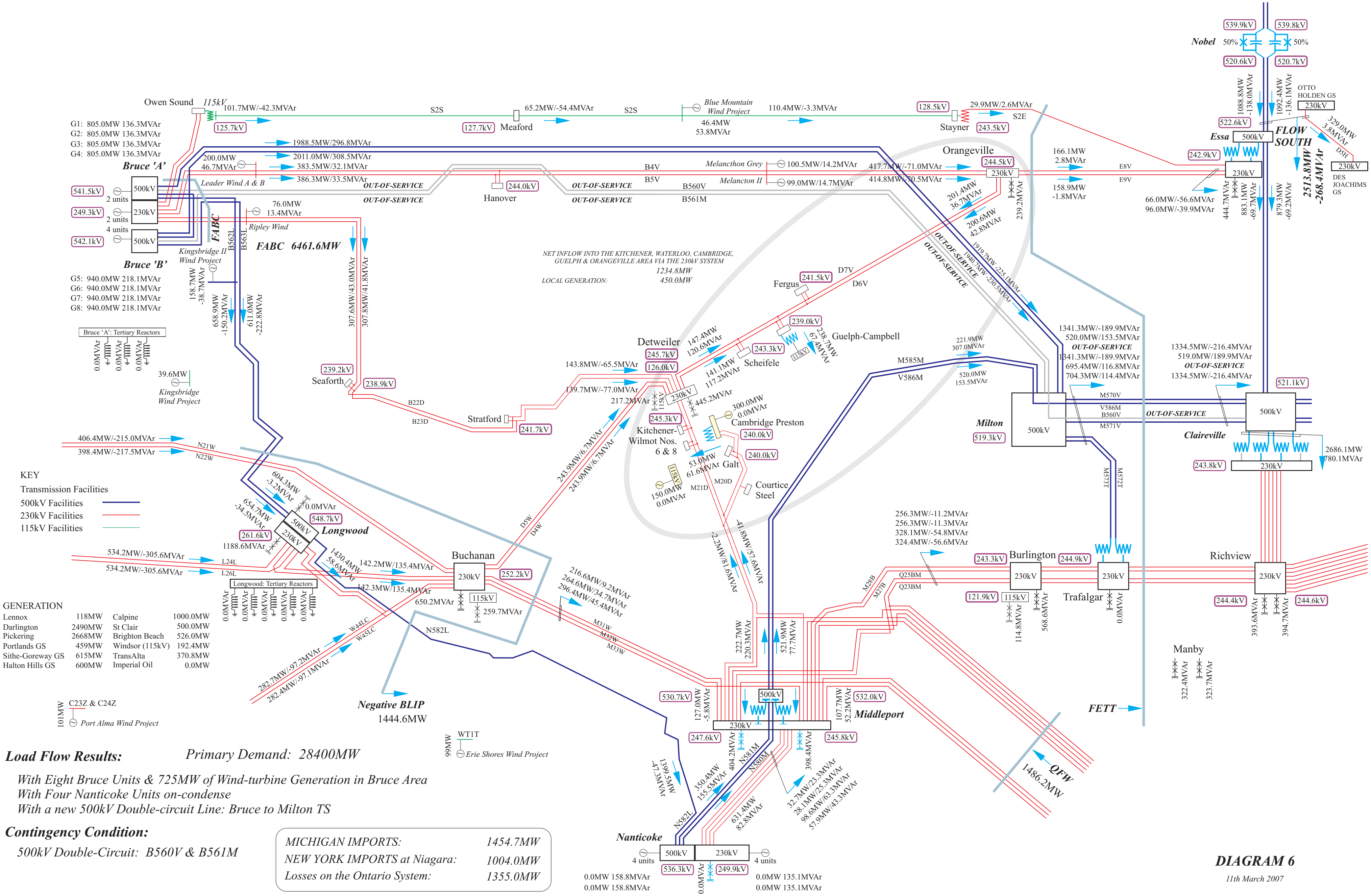
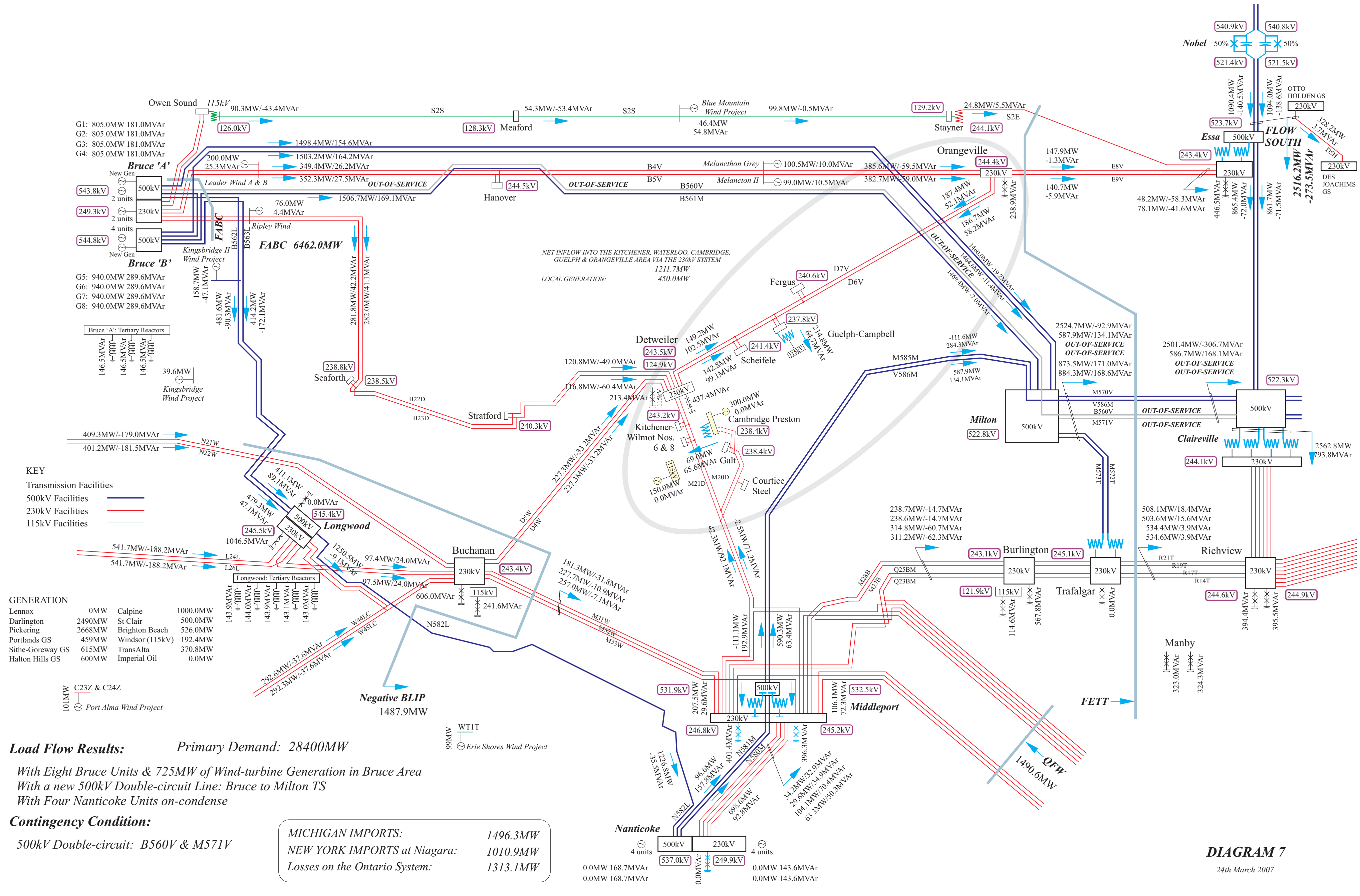


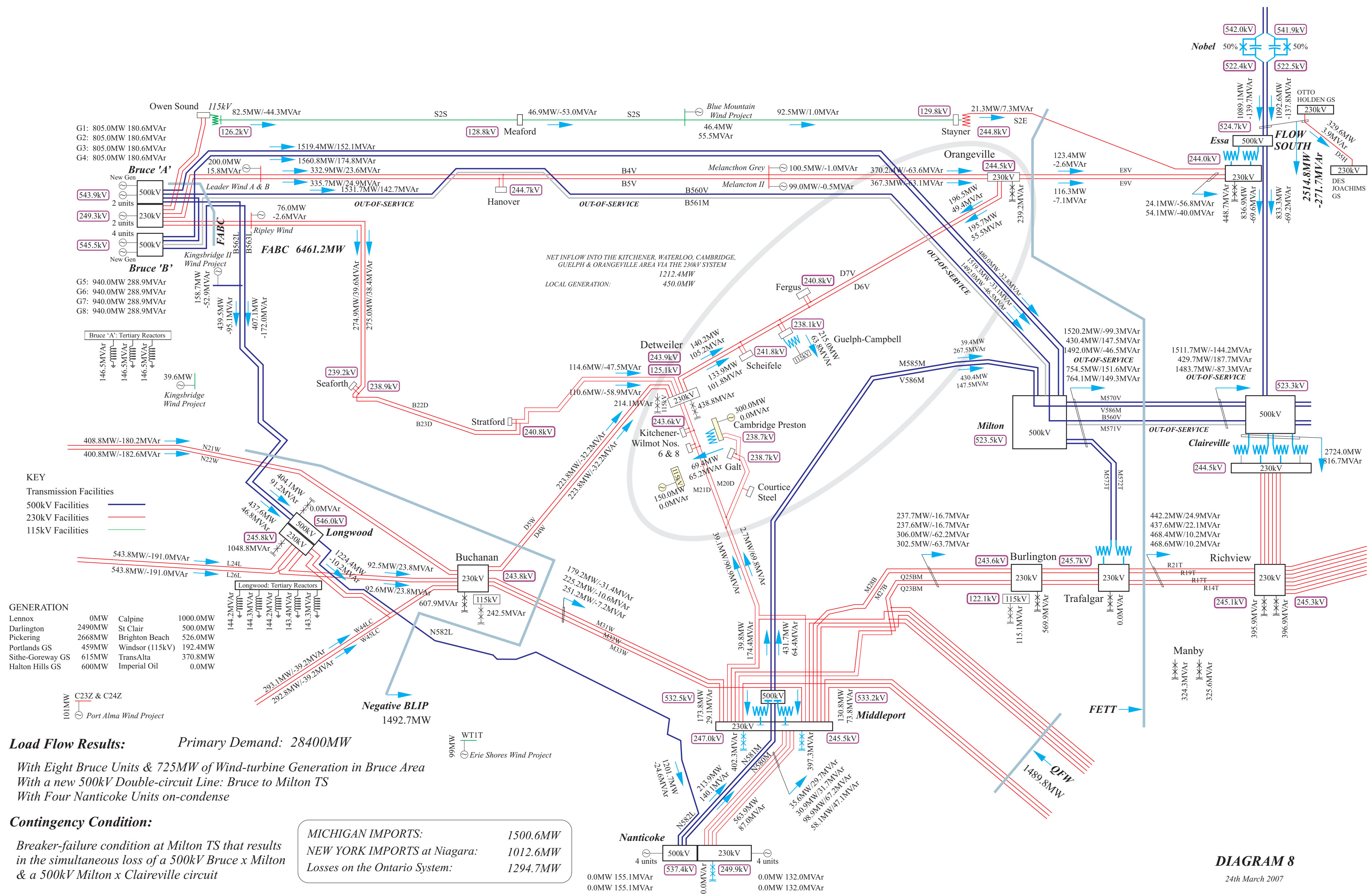
DIAGRAM 5

11th March 2007

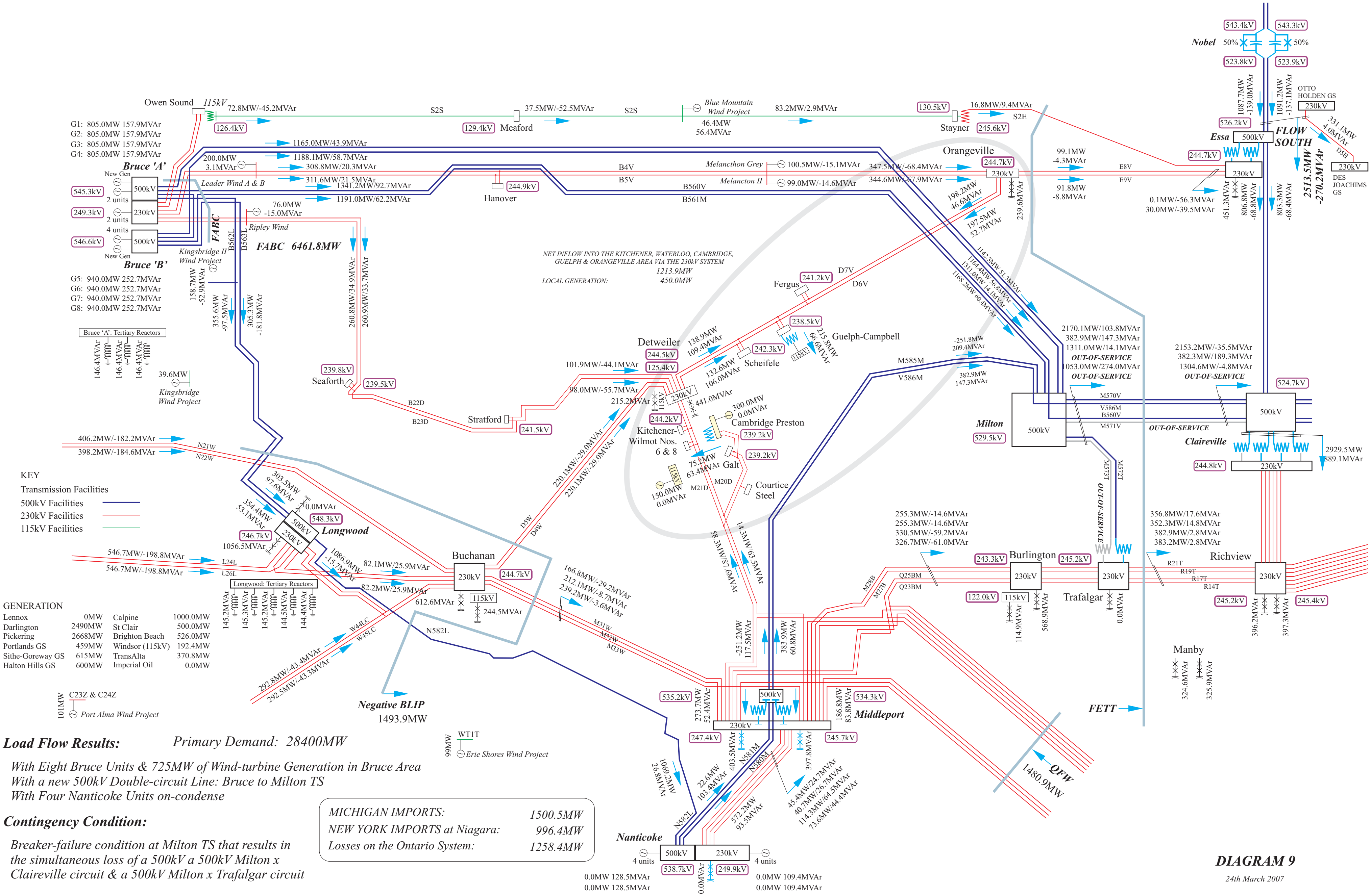

Load Flow Results:
Primary Demand: 28400MW
With Eight Bruce Units & 725MW of Wind-turbine Generation in Bruce Area
With Four Nanticoke Units on-condense
With a new 500kV Double-circuit Line: Bruce to Milton TS
Contingency Condition:
500kV Double-Circuit: B560V & B561M
MICHIGAN IMPORTS: 1454.7MW
NEW YORK IMPORTS at Niagara: 1004.0MW
Losses on the Ontario System: 1355.0MW
DIAGRAM 6
11th March 2007
KEY
Transmission Facilities
500kV Facilities
230kV Facilities
115kV Facilities
GENERATION
Lennox 118MW
Darlington 2490MW
Pickering 2668MW
Portlands GS 459MW
Sithe-Goreway GS 615MW
Halton Hills GS 600MW
Calpine 1000.0MW
St Clair 500.0MW
Brighton Beach 526.0MW
Windsor (115kV) 192.4MW
TransAlta 370.8MW
Imperial Oil 0.0MW
Bruce 'A'
G1: 805.0MW 136.3MVAr
G2: 805.0MW 136.3MVAr
G3: 805.0MW 136.3MVAr
G4: 805.0MW 136.3MVAr
Bruce 'B'
G5: 940.0MW 218.1MVAr
G6: 940.0MW 218.1MVAr
G7: 940.0MW 218.1MVAr
G8: 940.0MW 218.1MVAr
FABC 6461.6MW
FLOW SOUTH 2513.8MW -268.4MVAr
Negative BLIP 1444.6MW
QFW 1486.2MW
FETT
NET INFLOW INTO THE KITCHENER, WATERLOO, CAMBRIDGE, GUELPH & ORANGEVILLE AREA VIA THE 230kV SYSTEM 1234.8MW
LOCAL GENERATION: 450.0MW
Owen Sound
Meaford
Stayner
Orangeville
Hanover
Essa
Nobel
Claireville
Milton
Detweiler
Fergus
Guelph-Campbell
Scheifele
Seaforth
Stratford
Kitchener-Wilmot Nos. 6 & 8
Cambridge Preston
Galt
Courtice Steel
Longwood
Buchanan
Burlington
Trafalgar
Richview
Manby
Middleport
Nanticoke
OTTO HOLDEN GS
DES JOACHIMS GS
Leader Wind A & B
Ripley Wind
Kingsbridge II Wind Project
Kingsbridge Wind Project
Blue Mountain Wind Project
Melancthon Grey
Melancthon II
Port Alma Wind Project
Erie Shores Wind Project
Bruce 'A': Tertiary Reactors
Longwood: Tertiary Reactors
OUT-OF-SERVICE



Load Flow Results:
Primary Demand: 28400MW
With Eight Bruce Units & 725MW of Wind-turbine Generation in Bruce Area
With a new 500kV Double-circuit Line: Bruce to Milton TS
With Four Nanticoke Units on-condense
Contingency Condition:
500kV Double-circuit: B560V & M571V
MICHIGAN IMPORTS: 1496.3MW
NEW YORK IMPORTS at Niagara: 1010.9MW
Losses on the Ontario System: 1313.1MW
DIAGRAM 7
24th March 2007
KEY
Transmission Facilities
500kV Facilities
230kV Facilities
115kV Facilities
GENERATION
Lennox 0MW
Darlington 2490MW
Pickering 2668MW
Portlands GS 459MW
Sithe-Goreway GS 615MW
Halton Hills GS 600MW
Calpine 1000.0MW
St Clair 500.0MW
Brighton Beach 526.0MW
Windsor (115kV) 192.4MW
TransAlta 370.8MW
Imperial Oil 0.0MW
G1: 805.0MW 181.0MVAr
G2: 805.0MW 181.0MVAr
G3: 805.0MW 181.0MVAr
G4: 805.0MW 181.0MVAr
Bruce 'A'
Bruce 'B'
G5: 940.0MW 289.6MVAr
G6: 940.0MW 289.6MVAr
G7: 940.0MW 289.6MVAr
G8: 940.0MW 289.6MVAr
Bruce 'A': Tertiary Reactors
FABC 6462.0MW
NET INFLOW INTO THE KITCHENER, WATERLOO, CAMBRIDGE, GUELPH & ORANGEVILLE AREA VIA THE 230kV SYSTEM 1211.7MW
LOCAL GENERATION: 450.0MW
Owen Sound
Meaford
Stayner
Blue Mountain Wind Project
Hanover
Orangeville
Essa
Nobel
FLOW SOUTH
2516.2MW
-273.5MVAr
OTTO HOLDEN GS
DES JOACHIMS GS
Melancthon Grey
Melancthon II
Leader Wind A & B
Ripley Wind
Kingsbridge II Wind Project
Kingsbridge Wind Project
Fergus
Guelph-Campbell
Detweiler
Scheifele
Cambridge Preston
Kitchener-Wilmot Nos. 6 & 8
Galt
Courtice Steel
Seaforth
Stratford
Milton
Claireville
Longwood
Longwood: Tertiary Reactors
Buchanan
Burlington
Trafalgar
Richview
Manby
Middleport
Nanticoke
Negative BLIP
1487.9MW
FETT
QFW
1490.6MW
OUT-OF-SERVICE
Port Alma Wind Project
Erie Shores Wind Project



Owen Sound
115kV
82.5MW/-44.3MVAr
126.2kV
S2S
46.9MW/-53.0MVAr
128.8kV
Meaford
Blue Mountain Wind Project
46.4MW
55.5MVAr
92.5MW/1.0MVAr
129.8kV
Stayner
244.8kV
21.3MW/7.3MVAr
S2E
G1: 805.0MW 180.6MVAr
G2: 805.0MW 180.6MVAr
G3: 805.0MW 180.6MVAr
G4: 805.0MW 180.6MVAr
Bruce 'A'
Bruce 'B'
G5: 940.0MW 288.9MVAr
G6: 940.0MW 288.9MVAr
G7: 940.0MW 288.9MVAr
G8: 940.0MW 288.9MVAr
543.9kV
249.3kV
545.5kV
1519.4MW/152.1MVAr
1560.8MW/174.8MVAr
1531.7MW/142.7MVAr
Leader Wind A & B
Ripley Wind
Kingsbridge II Wind Project
Kingsbridge Wind Project
FABC 6461.2MW
B4V
B5V
B560V
B561M
OUT-OF-SERVICE
Hanover
244.7kV
Melancthon Grey
Melancton II
100.5MW/-1.0MVAr
99.0MW/-0.5MVAr
Orangeville
244.5kV
Bruce 'A': Tertiary Reactors
Seaforth
239.2kV
238.9kV
B22D
B23D
Stratford
240.8kV
NET INFLOW INTO THE KITCHENER, WATERLOO, CAMBRIDGE, GUELPH & ORANGEVILLE AREA VIA THE 230kV SYSTEM
1212.4MW
LOCAL GENERATION: 450.0MW
Fergus
240.8kV
D7V
D6V
Guelph-Campbell
238.1kV
241.8kV
Scheifele
Detweiler
243.9kV
125.1kV
243.6kV
Kitchener-Wilmot Nos. 6 & 8
Cambridge Preston
238.7kV
Galt
238.7kV
Courtice Steel
M20D
M21D
Milton
523.5kV
500kV
M570V
V586M
B560V
M571V
M585M
V586M
M573T
M572T
Claireville
523.3kV
244.5kV
2724.0MW
816.7MVAr
Essa
524.7kV
244.0kV
Nobel
542.0kV
541.9kV
522.4kV
522.5kV
OTTO HOLDEN GS
DES JOACHIMS GS
D5H
FLOW SOUTH
2514.8MW
-271.7MVAr
E8V
E9V
408.8MW/-180.2MVAr
400.8MW/-182.6MVAr
N21W
N22W
KEY
Transmission Facilities
500kV Facilities
230kV Facilities
115kV Facilities
Longwood
546.0kV
245.8kV
Longwood: Tertiary Reactors
543.8MW/-191.0MVAr
L24L
L26L
Buchanan
243.8kV
115kV
242.5MVAr
W44LC
W45LC
N582L
M31W
M32W
M33W
D5W
D4W
Negative BLIP
1492.7MW
Burlington
243.6kV
245.7kV
122.1kV
Trafalgar
Q25BM
Q23BM
Richview
245.1kV
245.3kV
R21T
R19T
R17T
R14T
Manby
FETT
QFW
1489.8MW
Middleport
532.5kV
533.2kV
247.0kV
245.5kV
N581M
N580M
Nanticoke
537.4kV
249.9kV
4 units
0.0MW 155.1MVAr
0.0MW 155.1MVAr
0.0MW 132.0MVAr
0.0MW 132.0MVAr
GENERATION
Lennox 0MW
Darlington 2490MW
Pickering 2668MW
Portlands GS 459MW
Sithe-Goreway GS 615MW
Halton Hills GS 600MW
Calpine 1000.0MW
St Clair 500.0MW
Brighton Beach 526.0MW
Windsor (115kV) 192.4MW
TransAlta 370.8MW
Imperial Oil 0.0MW
C23Z & C24Z
101MW
Port Alma Wind Project
WT1T
99MW
Erie Shores Wind Project
Load Flow Results: Primary Demand: 28400MW
With Eight Bruce Units & 725MW of Wind-turbine Generation in Bruce Area
With a new 500kV Double-circuit Line: Bruce to Milton TS
With Four Nanticoke Units on-condense
Contingency Condition:
Breaker-failure condition at Milton TS that results in the simultaneous loss of a 500kV Bruce x Milton & a 500kV Milton x Claireville circuit
MICHIGAN IMPORTS: 1500.6MW
NEW YORK IMPORTS at Niagara: 1012.6MW
Losses on the Ontario System: 1294.7MW
DIAGRAM 8
24th March 2007



Load Flow Results: *Primary Demand: 28400MW*

With Eight Bruce Units & 725MW of Wind-turbine Generation in Bruce Area
With a new 500kV Double-circuit Line: Bruce to Milton TS
With Four Nanticoke Units on-condense

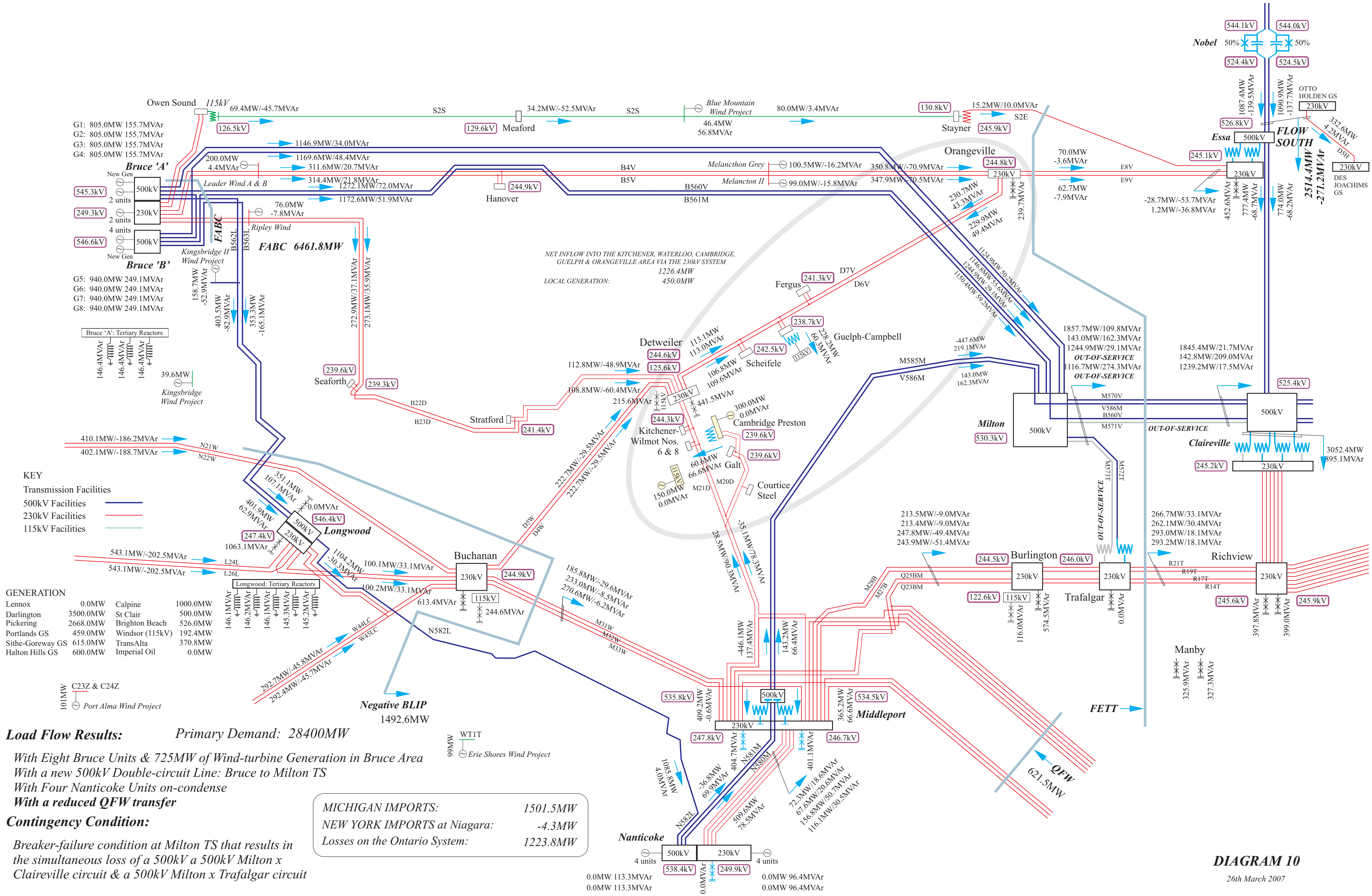
MICHIGAN IMPORTS:	*1500.5MW*
NEW YORK IMPORTS at Niagara:	*996.4MW*
Losses on the Ontario System:	*1258.4MW*

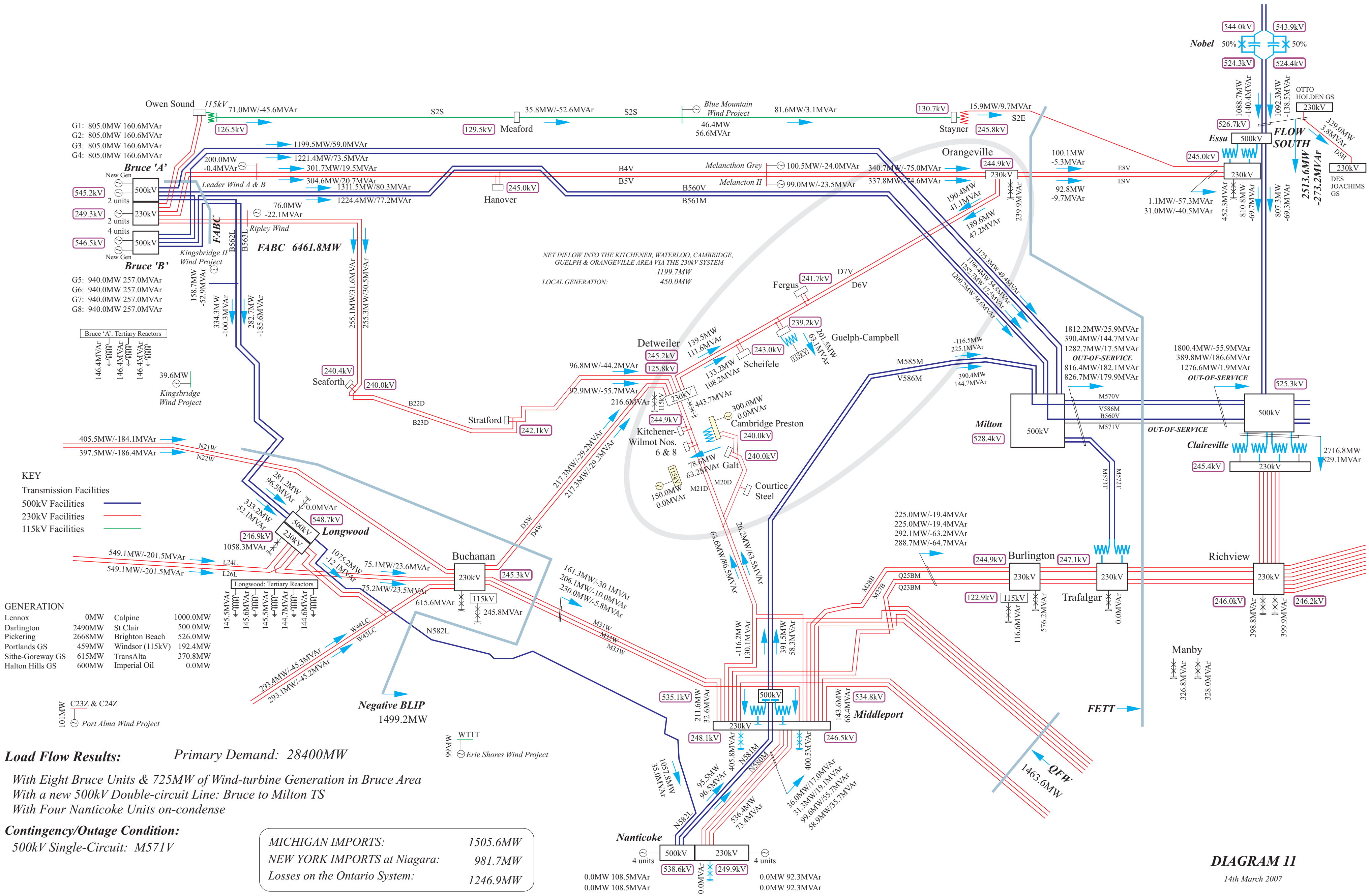
Contingency Condition:

Breaker-failure condition at Milton TS that results in the simultaneous loss of a 500kV a 500kV Milton x Claireville circuit & a 500kV Milton x Trafalgar circuit

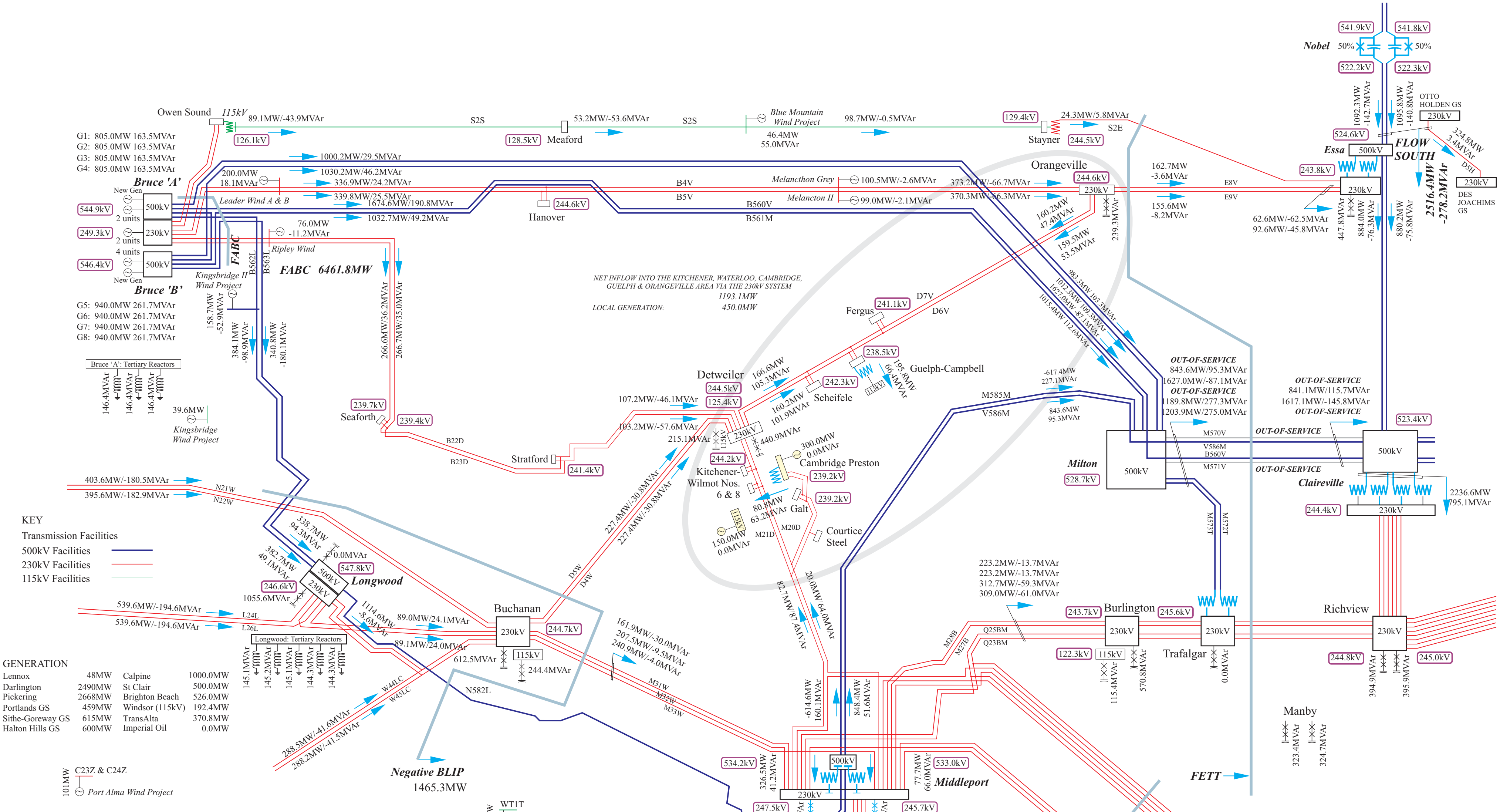
DIAGRAM 9

24th March 2007


Owen Sound
115kV
69.4MW/-45.7MVAr
126.5kV
S2S
34.2MW/-52.5MVAr
129.6kV
Meaford
S2S
Blue Mountain Wind Project
46.4MW
56.8MVAr
80.0MW/3.4MVAr
130.8kV
15.2MW/10.0MVAr
S2E
Stayner
245.9kV
G1: 805.0MW 155.7MVAr
G2: 805.0MW 155.7MVAr
G3: 805.0MW 155.7MVAr
G4: 805.0MW 155.7MVAr
Bruce 'A'
New Gen
545.3kV
500kV
2 units
249.3kV
230kV
2 units
4 units
546.6kV
500kV
New Gen
Bruce 'B'
G5: 940.0MW 249.1MVAr
G6: 940.0MW 249.1MVAr
G7: 940.0MW 249.1MVAr
G8: 940.0MW 249.1MVAr
Bruce 'A': Tertiary Reactors
146.4MVAr
146.4MVAr
146.4MVAr
1146.9MW/34.0MVAr
1169.6MW/48.4MVAr
200.0MW
4.4MVAr
311.6MW/20.7MVAr
Leader Wind A & B
314.4MW/21.8MVAr
1272.1MW/72.0MVAr
1172.6MW/51.9MVAr
76.0MW
-7.8MVAr
Ripley Wind
FABC
B562L
B563L
FABC 6461.8MW
Kingsbridge II Wind Project
158.7MW
-52.9MVAr
403.5MW
-82.9MVAr
353.3MW
-165.1MVAr
272.9MW/37.1MVAr
273.1MW/35.9MVAr
B4V
B5V
244.9kV
Hanover
B560V
B561M
Melancthon Grey
100.5MW/-16.2MVAr
Melancthon II
99.0MW/-15.8MVAr
Orangeville
244.8kV
350.8MW/-70.9MVAr
347.9MW/-70.5MVAr
230kV
239.7MVAr
230.7MW
43.3MVAr
229.9MW
49.4MVAr
70.0MW
-3.6MVAr
62.7MW
-7.9MVAr
E8V
E9V
-28.7MW/-53.7MVAr
1.2MW/-36.8MVAr
544.1kV
544.0kV
Nobel
50%
50%
524.4kV
524.5kV
1087.4MW
-139.5MVAr
1090.9MW
-137.7MVAr
OTTO HOLDEN GS
230kV
526.8kV
Essa
500kV
FLOW SOUTH
332.6MW
4.2MVAr
D5H
245.1kV
230kV
DES JOACHIMS GS
452.6MVAr
777.4MW
-68.7MVAr
774.0MW
-68.2MVAr
2514.4MW
-271.2MVAr
NET INFLOW INTO THE KITCHENER, WATERLOO, CAMBRIDGE, GUELPH & ORANGEVILLE AREA VIA THE 230kV SYSTEM
1226.4MW
LOCAL GENERATION:
450.0MW
Fergus
241.3kV
D7V
D6V
238.7kV
Guelph-Campbell
228.2MW
60.3MVAr
115kV
242.5kV
Scheifele
Detweiler
244.6kV
125.6kV
113.1MW
113.0MVAr
112.8MW/-48.9MVAr
108.8MW/-60.4MVAr
106.8MW
109.6MVAr
215.6MVAr
230kV
441.5MVAr
244.3kV
300.0MW
0.0MVAr
Cambridge Preston
239.6kV
Kitchener-Wilmot Nos. 6 & 8
239.6kV
60.6MW
66.6MVAr
Galt
150.0MW
0.0MVAr
M21D
M20D
Courtice Steel
239.6kV
Seaforth
239.3kV
B22D
B23D
Stratford
241.4kV
1124.9MW 50.2MVAr
1146.8MW 55.6MVAr
1244.9MW 29.1MVAr
1150.4MW 59.2MVAr
-447.6MW
219.1MVAr
M585M
V586M
143.0MW
162.3MVAr
1857.7MW/109.8MVAr
143.0MW/162.3MVAr
1244.9MW/29.1MVAr
OUT-OF-SERVICE
1116.7MW/274.3MVAr
OUT-OF-SERVICE
Milton
530.3kV
500kV
M570V
V586M
B560V
M571V
OUT-OF-SERVICE
1845.4MW/21.7MVAr
142.8MW/209.0MVAr
1239.2MW/17.5MVAr
525.4kV
500kV
Claireville
3052.4MW
895.1MVAr
245.2kV
230kV
M573T
M572T
OUT-OF-SERVICE
39.6MW
Kingsbridge Wind Project
410.1MW/-186.2MVAr
402.1MW/-188.7MVAr
N21W
N22W
351.1MW
107.1MVAr
401.9MW
62.9MVAr
0.0MVAr
546.4kV
500kV
230kV
Longwood
247.4kV
1063.1MVAr
543.1MW/-202.5MVAr
543.1MW/-202.5MVAr
L24L
L26L
Longwood: Tertiary Reactors
146.1MVAr
146.2MVAr
146.1MVAr
145.3MVAr
145.2MVAr
1104.2MW
-30.3MVAr
100.1MW/33.1MVAr
100.2MW/33.1MVAr
Buchanan
230kV
244.9kV
613.4MVAr
115kV
244.6MVAr
D5W
D4W
222.7MW/-29.5MVAr
222.7MW/-29.5MVAr
185.8MW/-29.6MVAr
233.0MW/-8.5MVAr
270.6MW/-6.2MVAr
M31W
M32W
M33W
N582L
W44LC
W45LC
292.7MW/-45.8MVAr
292.4MW/-45.7MVAr
Negative BLIP
1492.6MW
213.5MW/-9.0MVAr
213.4MW/-9.0MVAr
247.8MW/-49.4MVAr
243.9MW/-51.4MVAr
Q25BM
Q23BM
244.5kV
Burlington
230kV
122.6kV
115kV
116.0MVAr
574.5MVAr
246.0kV
230kV
Trafalgar
0.0MVAr
266.7MW/33.1MVAr
262.1MW/30.4MVAr
293.0MW/18.1MVAr
293.2MW/18.1MVAr
Richview
R21T
R19T
R17T
R14T
230kV
245.6kV
245.9kV
397.8MVAr
399.0MVAr
Manby
325.9MVAr
327.3MVAr
M28B
M27B
28.5MW/90.3MVAr
-35.1MW/78.3MVAr
-446.1MW
137.4MVAr
143.2MW
66.4MVAr
535.8kV
409.2MW
-0.6MVAr
500kV
365.2MW
66.6MVAr
534.5kV
Middleport
230kV
247.8kV
246.7kV
404.7MVAr
401.1MVAr
N581M
N580M
FETT
QFW
621.5MW
1085.8MW
4.0MVAr
-36.8MW
69.9MVAr
509.6MW
78.5MVAr
72.3MW/18.6MVAr
67.6MW/20.6MVAr
156.8MW/50.7MVAr
116.1MW/30.5MVAr
N582L
Nanticoke
4 units
500kV
230kV
4 units
538.4kV
249.9kV
0.0MVAr
0.0MW 113.3MVAr
0.0MW 113.3MVAr
0.0MW 96.4MVAr
0.0MW 96.4MVAr
KEY
Transmission Facilities
500kV Facilities
230kV Facilities
115kV Facilities
GENERATION
Lennox 0.0MW
Darlington 3500.0MW
Pickering 2668.0MW
Portlands GS 459.0MW
Sithe-Goreway GS 615.0MW
Halton Hills GS 600.0MW
Calpine 1000.0MW
St Clair 500.0MW
Brighton Beach 526.0MW
Windsor (115kV) 192.4MW
TransAlta 370.8MW
Imperial Oil 0.0MW
101MW
C23Z & C24Z
Port Alma Wind Project
99MW
WT1T
Erie Shores Wind Project
Load Flow Results:
Primary Demand: 28400MW
With Eight Bruce Units & 725MW of Wind-turbine Generation in Bruce Area
With a new 500kV Double-circuit Line: Bruce to Milton TS
With Four Nanticoke Units on-condense
With a reduced QFW transfer
Contingency Condition:
Breaker-failure condition at Milton TS that results in the simultaneous loss of a 500kV a 500kV Milton x Claireville circuit & a 500kV Milton x Trafalgar circuit
MICHIGAN IMPORTS: 1501.5MW
NEW YORK IMPORTS at Niagara: -4.3MW
Losses on the Ontario System: 1223.8MW
DIAGRAM 10
26th March 2007



Load Flow Results:
Primary Demand: 28400MW
With Eight Bruce Units & 725MW of Wind-turbine Generation in Bruce Area
With a new 500kV Double-circuit Line: Bruce to Milton TS
With Four Nanticoke Units on-condense
Contingency/Outage Condition:
500kV Single-Circuit: M571V
MICHIGAN IMPORTS: 1505.6MW
NEW YORK IMPORTS at Niagara: 981.7MW
Losses on the Ontario System: 1246.9MW
DIAGRAM 11
14th March 2007
KEY
Transmission Facilities
500kV Facilities
230kV Facilities
115kV Facilities
GENERATION
Lennox 0MW
Darlington 2490MW
Pickering 2668MW
Portlands GS 459MW
Sithe-Goreway GS 615MW
Halton Hills GS 600MW
Calpine 1000.0MW
St Clair 500.0MW
Brighton Beach 526.0MW
Windsor (115kV) 192.4MW
TransAlta 370.8MW
Imperial Oil 0.0MW
G1: 805.0MW 160.6MVAr
G2: 805.0MW 160.6MVAr
G3: 805.0MW 160.6MVAr
G4: 805.0MW 160.6MVAr
Bruce 'A'
Bruce 'B'
G5: 940.0MW 257.0MVAr
G6: 940.0MW 257.0MVAr
G7: 940.0MW 257.0MVAr
G8: 940.0MW 257.0MVAr
Bruce 'A': Tertiary Reactors
FABC 6461.8MW
NET INFLOW INTO THE KITCHENER, WATERLOO, CAMBRIDGE, GUELPH & ORANGEVILLE AREA VIA THE 230kV SYSTEM
1199.7MW
LOCAL GENERATION: 450.0MW
Owen Sound
Meaford
Blue Mountain Wind Project
Stayner
Orangeville
Hanover
Melancthon Grey
Melancthon II
Leader Wind A & B
Ripley Wind
Kingsbridge II Wind Project
Kingsbridge Wind Project
Nobel
Essa
FLOW SOUTH
2513.6MW
-273.2MVAr
OTTO HOLDEN GS
DES JOACHIMS GS
Fergus
Guelph-Campbell
Scheifele
Detweiler
Seaforth
Stratford
Cambridge Preston
Kitchener-Wilmot Nos. 6 & 8
Galt
Courtice Steel
Milton
OUT-OF-SERVICE
Claireville
Longwood
Longwood: Tertiary Reactors
Buchanan
Burlington
Trafalgar
Richview
Manby
Middleport
Nanticoke
Negative BLIP
1499.2MW
FETT
QFW
1463.6MW
C23Z & C24Z
Port Alma Wind Project
WT1T
Erie Shores Wind Project



Load Flow Results: *Primary Demand: 28400MW*

With Eight Bruce Units & 725MW of Wind-turbine Generation in Bruce Area
With a new 500kV Double-circuit Line: Bruce to Milton TS
With Four Nanticoke Units on-condense

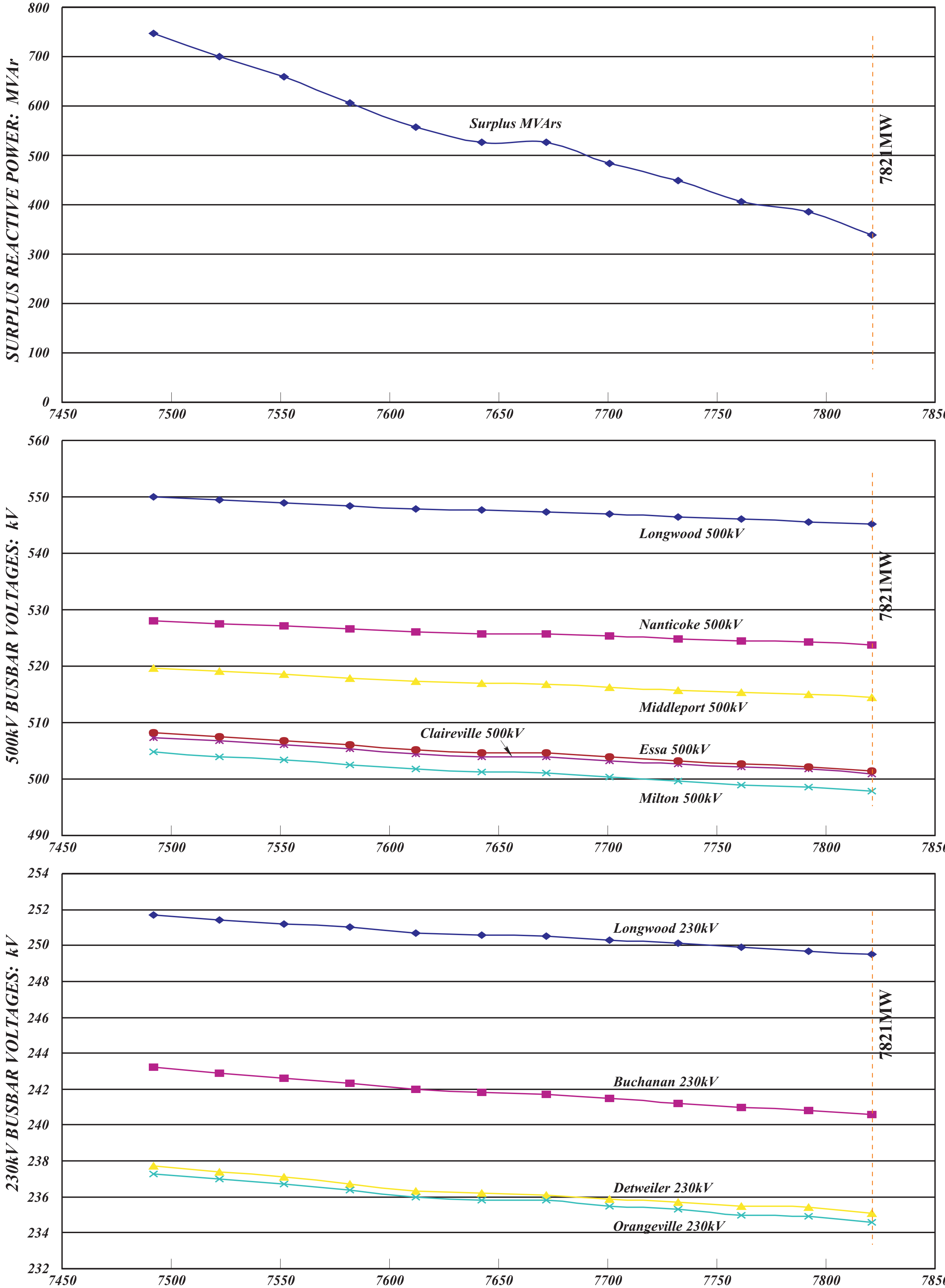
Contingency Condition:

500kV Single-Circuit: M570V with circuit M571V out-of-service pre-contingency [or vice versa]

MICHIGAN IMPORTS:	*1470.0MW*
NEW YORK IMPORTS at Niagara:	*952.8MW*
Losses on the Ontario System:	*1284.5MW*

DIAGRAM 12

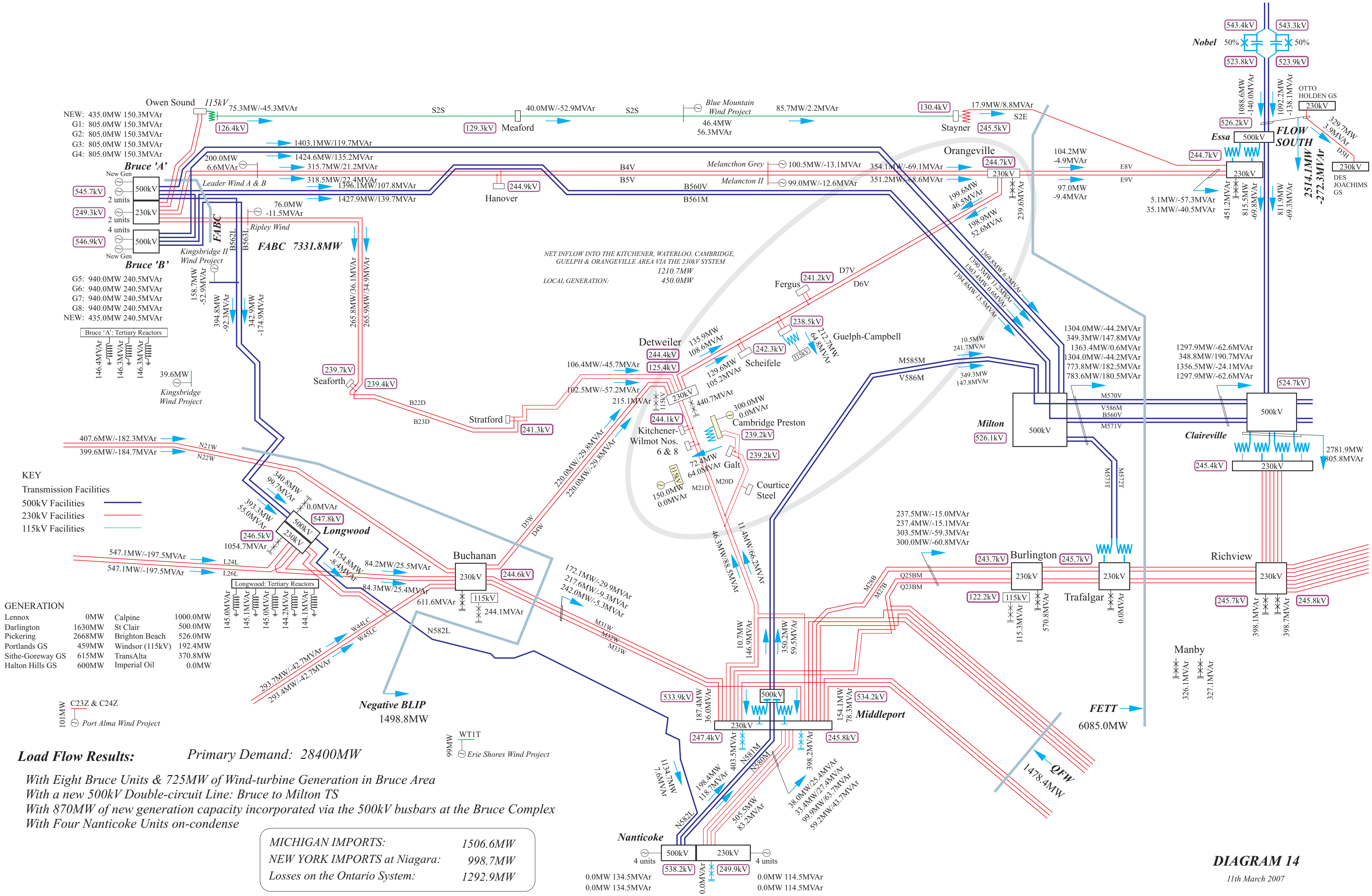
14th March 2007



PV-Curves for the arrangement with a new 500kV line to Milton TS

DIAGRAM 13

11th March 2007



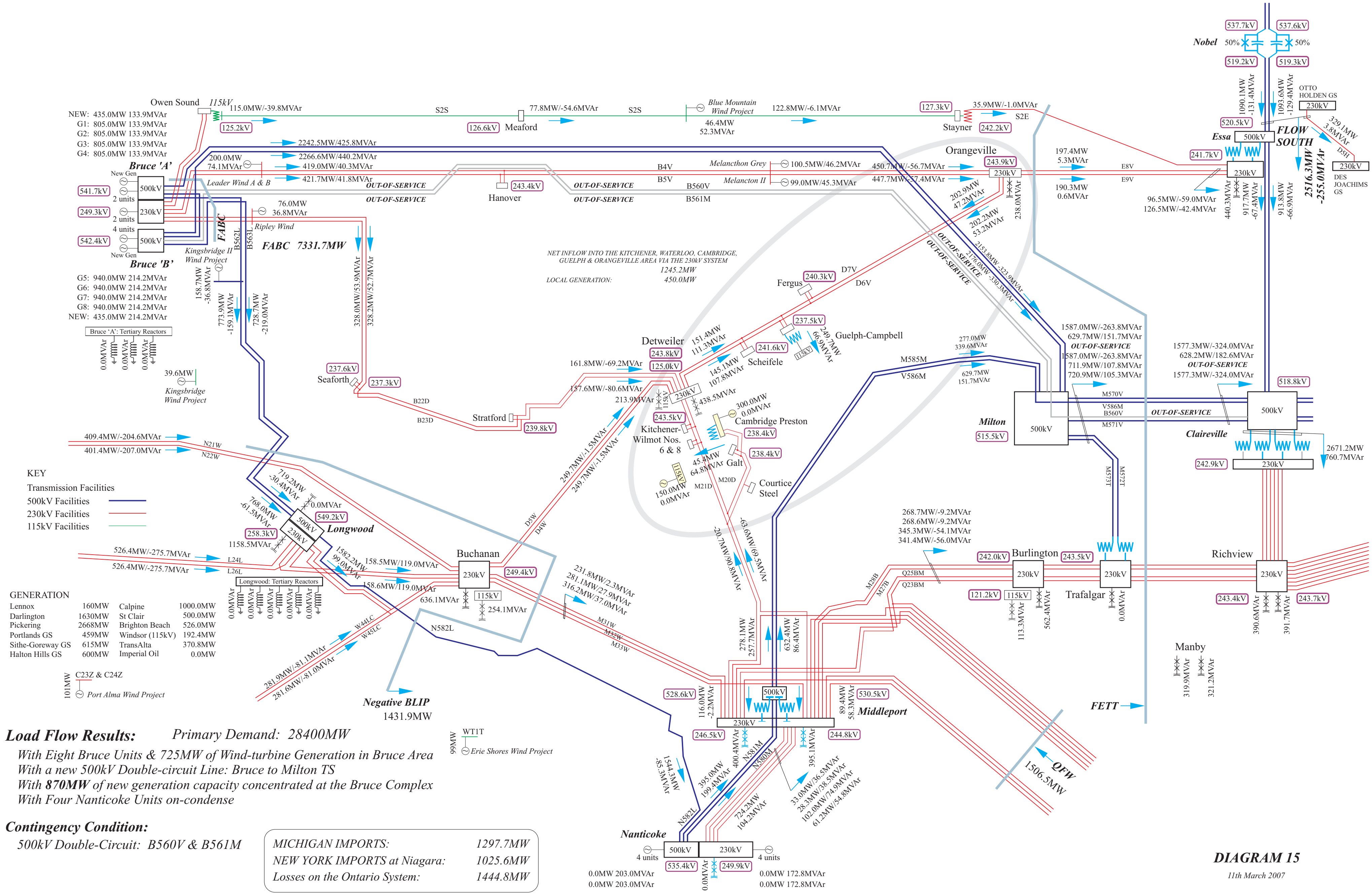
Load Flow Results: *Primary Demand: 28400MW*

With Eight Bruce Units & 725MW of Wind-turbine Generation in Bruce Area
With a new 500kV Double-circuit Line: Bruce to Milton TS
With 870MW of new generation capacity incorporated via the 500kV busbars at the Bruce Complex
With Four Nanticoke Units on-condense

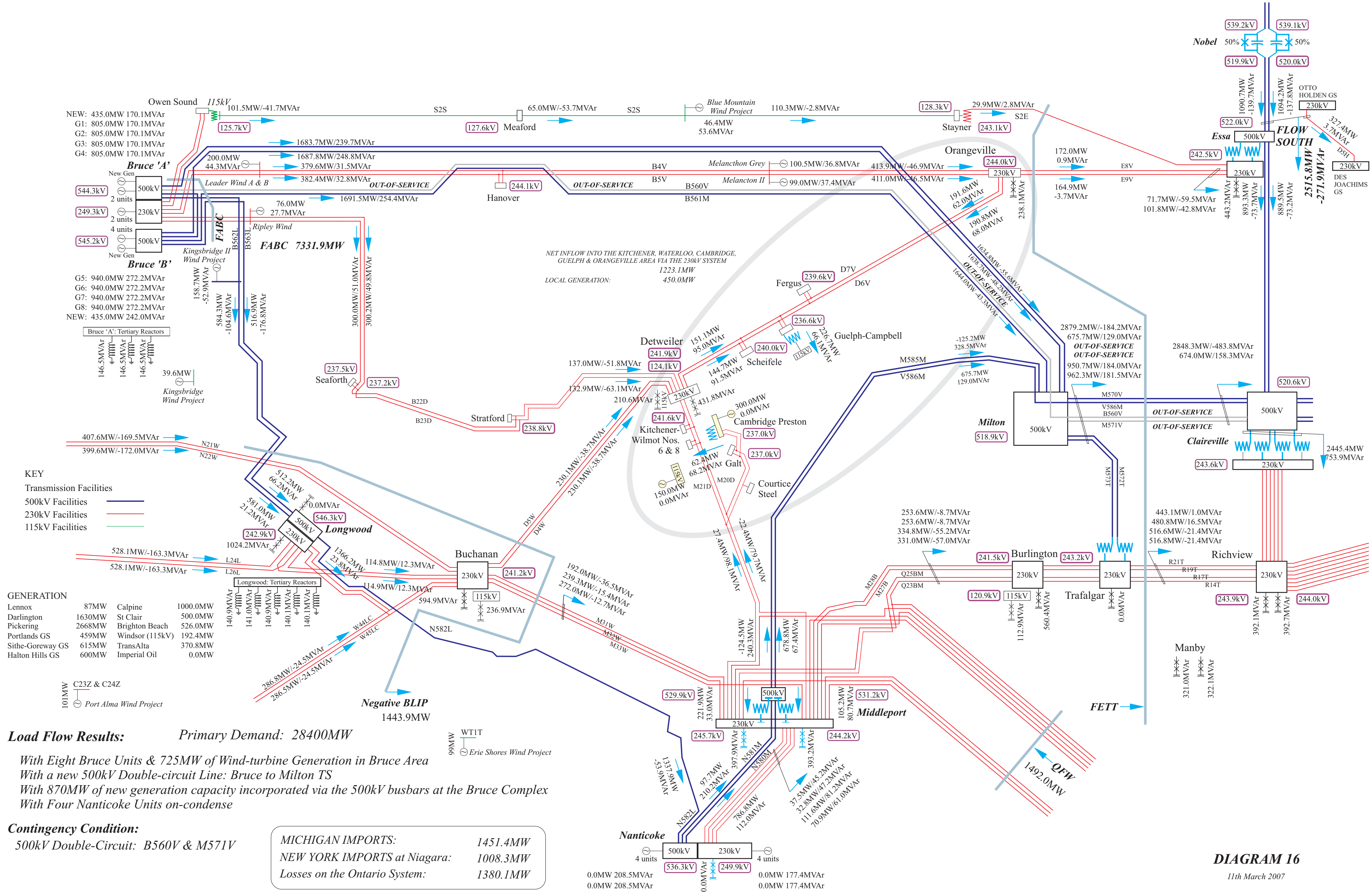
MICHIGAN IMPORTS:	*1506.6MW*
NEW YORK IMPORTS at Niagara:	*998.7MW*
Losses on the Ontario System:	*1292.9MW*

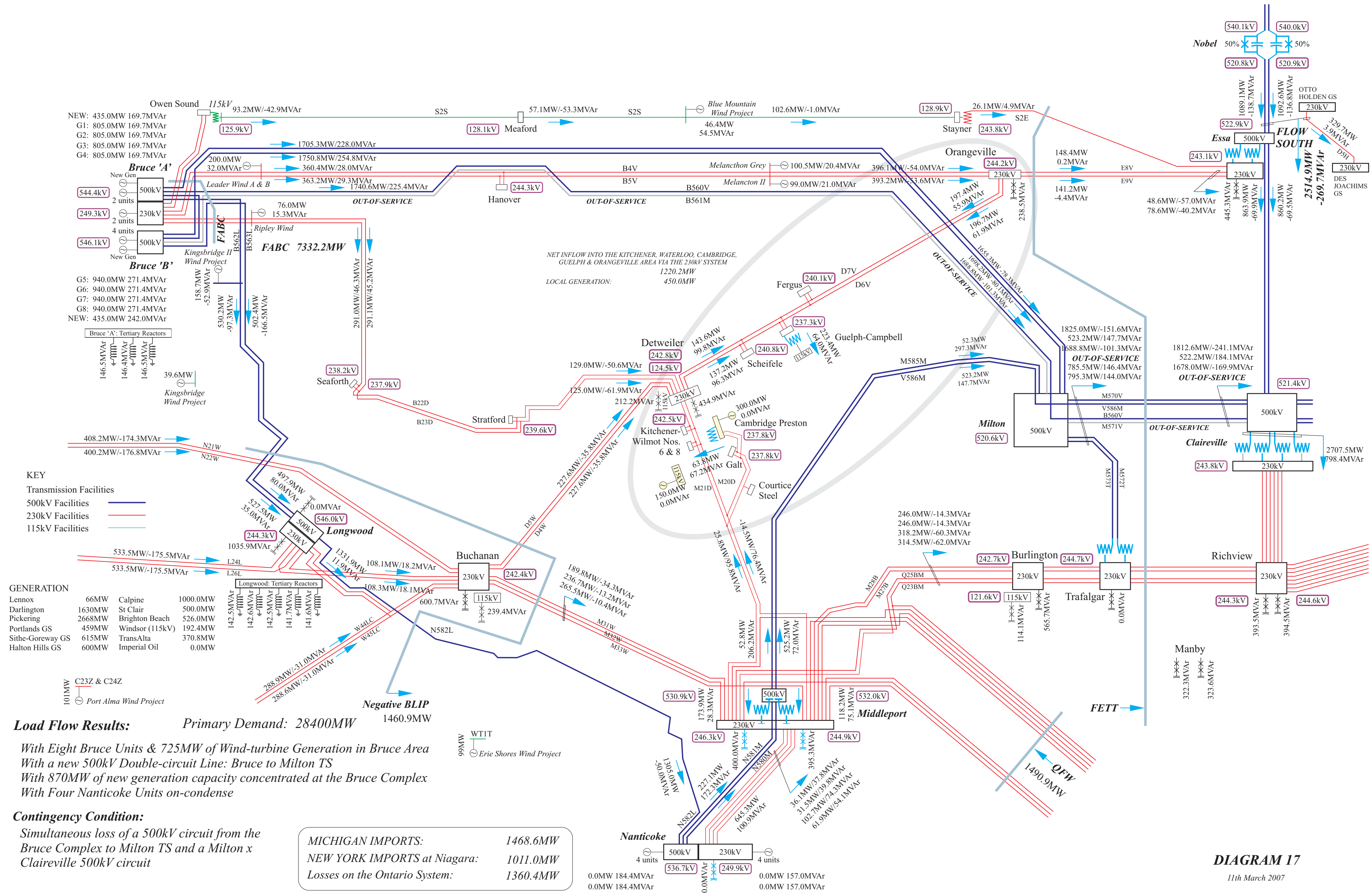
DIAGRAM 14

11th March 2007



Load Flow Results: Primary Demand: 28400MW
With Eight Bruce Units & 725MW of Wind-turbine Generation in Bruce Area
With a new 500kV Double-circuit Line: Bruce to Milton TS
With 870MW of new generation capacity concentrated at the Bruce Complex
With Four Nanticoke Units on-condense
Contingency Condition:
500kV Double-Circuit: B560V & B561M
MICHIGAN IMPORTS: 1297.7MW
NEW YORK IMPORTS at Niagara: 1025.6MW
Losses on the Ontario System: 1444.8MW
DIAGRAM 15
11th March 2007
KEY
Transmission Facilities
500kV Facilities
230kV Facilities
115kV Facilities
GENERATION
Lennox 160MW
Darlington 1630MW
Pickering 2668MW
Portlands GS 459MW
Sithe-Goreway GS 615MW
Halton Hills GS 600MW
Calpine 1000.0MW
St Clair 500.0MW
Brighton Beach 526.0MW
Windsor (115kV) 192.4MW
TransAlta 370.8MW
Imperial Oil 0.0MW
Bruce 'A'
NEW: 435.0MW 133.9MVAr
G1: 805.0MW 133.9MVAr
G2: 805.0MW 133.9MVAr
G3: 805.0MW 133.9MVAr
G4: 805.0MW 133.9MVAr
Bruce 'B'
G5: 940.0MW 214.2MVAr
G6: 940.0MW 214.2MVAr
G7: 940.0MW 214.2MVAr
G8: 940.0MW 214.2MVAr
NEW: 435.0MW 214.2MVAr
FABC 7331.7MW
FLOW SOUTH 2516.3MW -255.0MVAr
Negative BLIP 1431.9MW
QFW 1506.5MW
FETT
NET INFLOW INTO THE KITCHENER, WATERLOO, CAMBRIDGE, GUELPH & ORANGEVILLE AREA VIA THE 230kV SYSTEM 1245.2MW
LOCAL GENERATION: 450.0MW
Owen Sound
Meaford
Stayner
Hanover
Orangeville
Essa
Nobel
Fergus
Guelph-Campbell
Detweiler
Scheifele
Seaforth
Stratford
Cambridge Preston
Kitchener-Wilmot Nos. 6 & 8
Galt
Courtice Steel
Milton
Claireville
Longwood
Buchanan
Burlington
Trafalgar
Richview
Manby
Middleport
Nanticoke
OTTO HOLDEN GS
DES JOACHIMS GS
Leader Wind A & B
Ripley Wind
Kingsbridge II Wind Project
Kingsbridge Wind Project
Blue Mountain Wind Project
Melancthon Grey
Melancthon II
Port Alma Wind Project
Erie Shores Wind Project


Nobel
Essa
FLOW SOUTH
2515.8MW
-271.9MVAr
OTTO HOLDEN GS
DES JOACHIMS GS
Owen Sound
Meaford
Blue Mountain Wind Project
Stayner
Orangeville
Hanover
Melancthon Grey
Melancthon II
Bruce 'A'
Bruce 'B'
NEW: 435.0MW 170.1MVAr
G1: 805.0MW 170.1MVAr
G2: 805.0MW 170.1MVAr
G3: 805.0MW 170.1MVAr
G4: 805.0MW 170.1MVAr
G5: 940.0MW 272.2MVAr
G6: 940.0MW 272.2MVAr
G7: 940.0MW 272.2MVAr
G8: 940.0MW 272.2MVAr
NEW: 435.0MW 242.0MVAr
Bruce 'A': Tertiary Reactors
Leader Wind A & B
Ripley Wind
Kingsbridge II Wind Project
Kingsbridge Wind Project
FABC
FABC 7331.9MW
OUT-OF-SERVICE
NET INFLOW INTO THE KITCHENER, WATERLOO, CAMBRIDGE, GUELPH & ORANGEVILLE AREA VIA THE 230kV SYSTEM 1223.1MW
LOCAL GENERATION: 450.0MW
Fergus
Guelph-Campbell
Detweiler
Scheifele
Seaforth
Stratford
Kitchener-Wilmot Nos. 6 & 8
Cambridge Preston
Galt
Courtice Steel
Milton
Claireville
Longwood
Longwood: Tertiary Reactors
Buchanan
Burlington
Trafalgar
Richview
Manby
Middleport
Nanticoke
Negative BLIP
1443.9MW
FETT
QFW
1492.0MW
KEY
Transmission Facilities
500kV Facilities
230kV Facilities
115kV Facilities
GENERATION
Lennox 87MW
Darlington 1630MW
Pickering 2668MW
Portlands GS 459MW
Sithe-Goreway GS 615MW
Halton Hills GS 600MW
Calpine 1000.0MW
St Clair 500.0MW
Brighton Beach 526.0MW
Windsor (115kV) 192.4MW
TransAlta 370.8MW
Imperial Oil 0.0MW
Port Alma Wind Project
Erie Shores Wind Project
Load Flow Results:
Primary Demand: 28400MW
With Eight Bruce Units & 725MW of Wind-turbine Generation in Bruce Area
With a new 500kV Double-circuit Line: Bruce to Milton TS
With 870MW of new generation capacity incorporated via the 500kV busbars at the Bruce Complex
With Four Nanticoke Units on-condense
Contingency Condition:
500kV Double-Circuit: B560V & M571V
MICHIGAN IMPORTS: 1451.4MW
NEW YORK IMPORTS at Niagara: 1008.3MW
Losses on the Ontario System: 1380.1MW
DIAGRAM 16
11th March 2007



Load Flow Results: Primary Demand: 28400MW

With Eight Bruce Units & 725MW of Wind-turbine Generation in Bruce Area
With a new 500kV Double-circuit Line: Bruce to Milton TS
With 870MW of new generation capacity concentrated at the Bruce Complex
With Four Nanticoke Units on-condense

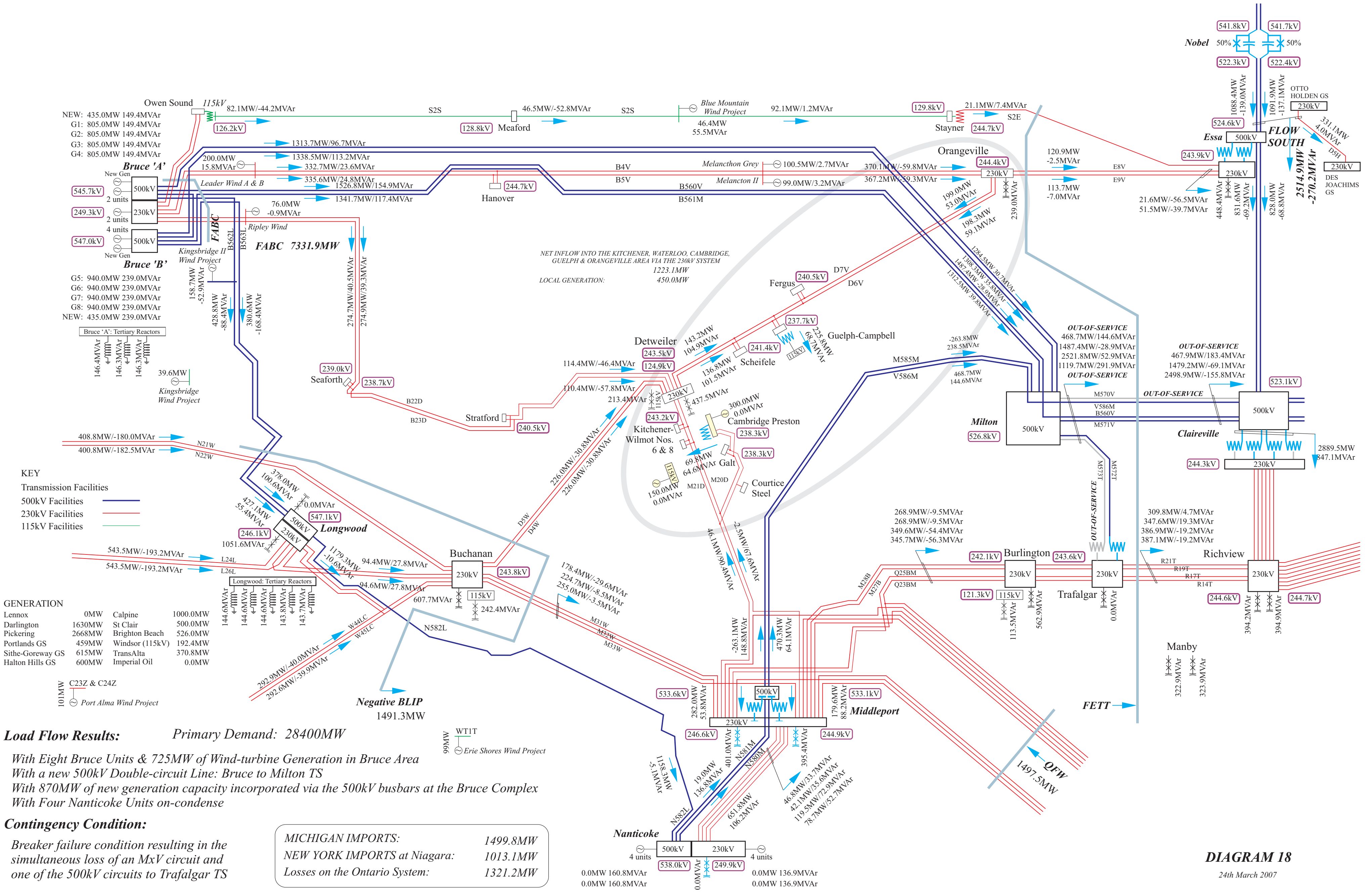
Contingency Condition:

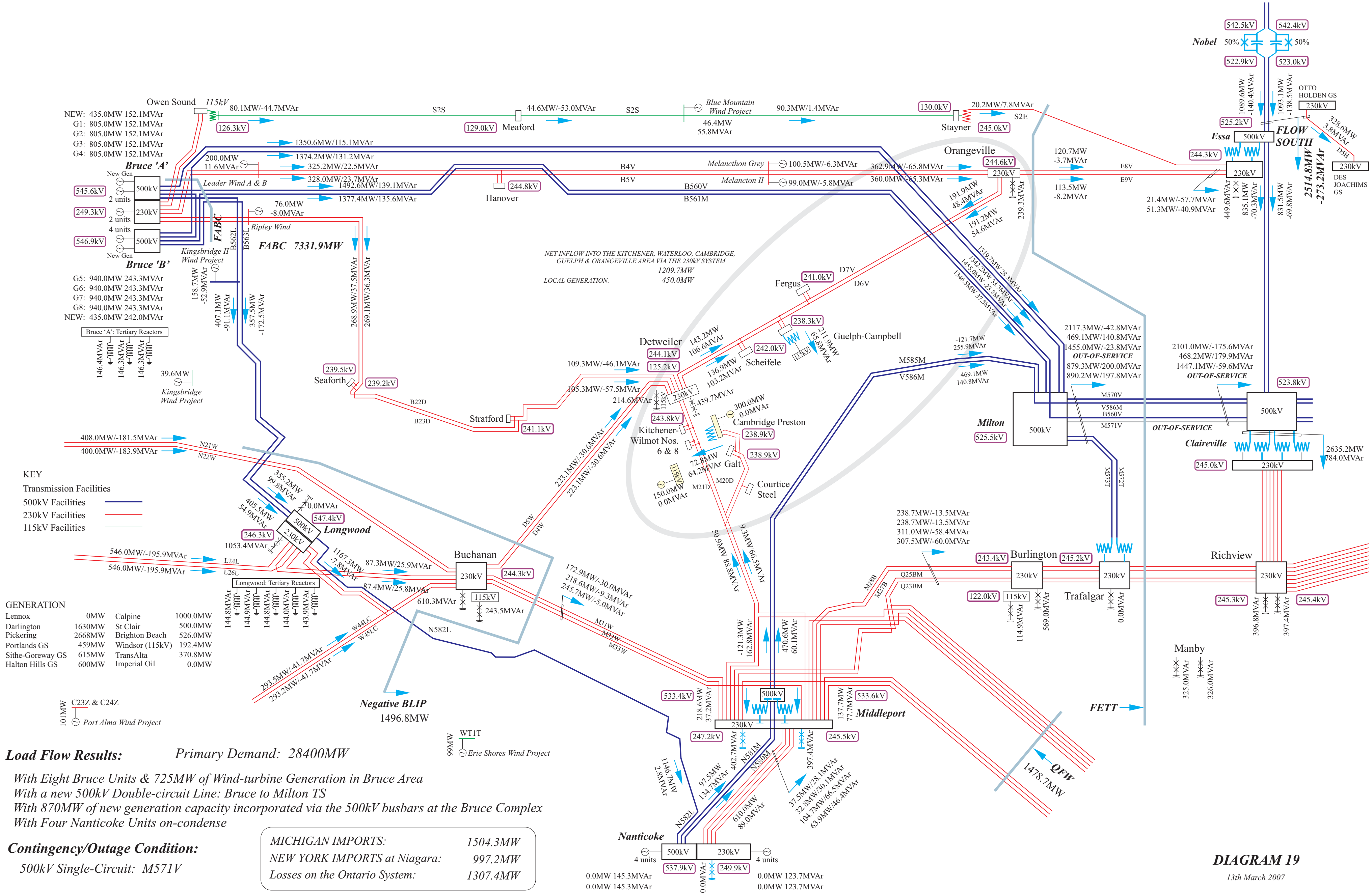
Simultaneous loss of a 500kV circuit from the Bruce Complex to Milton TS and a Milton x Claireville 500kV circuit

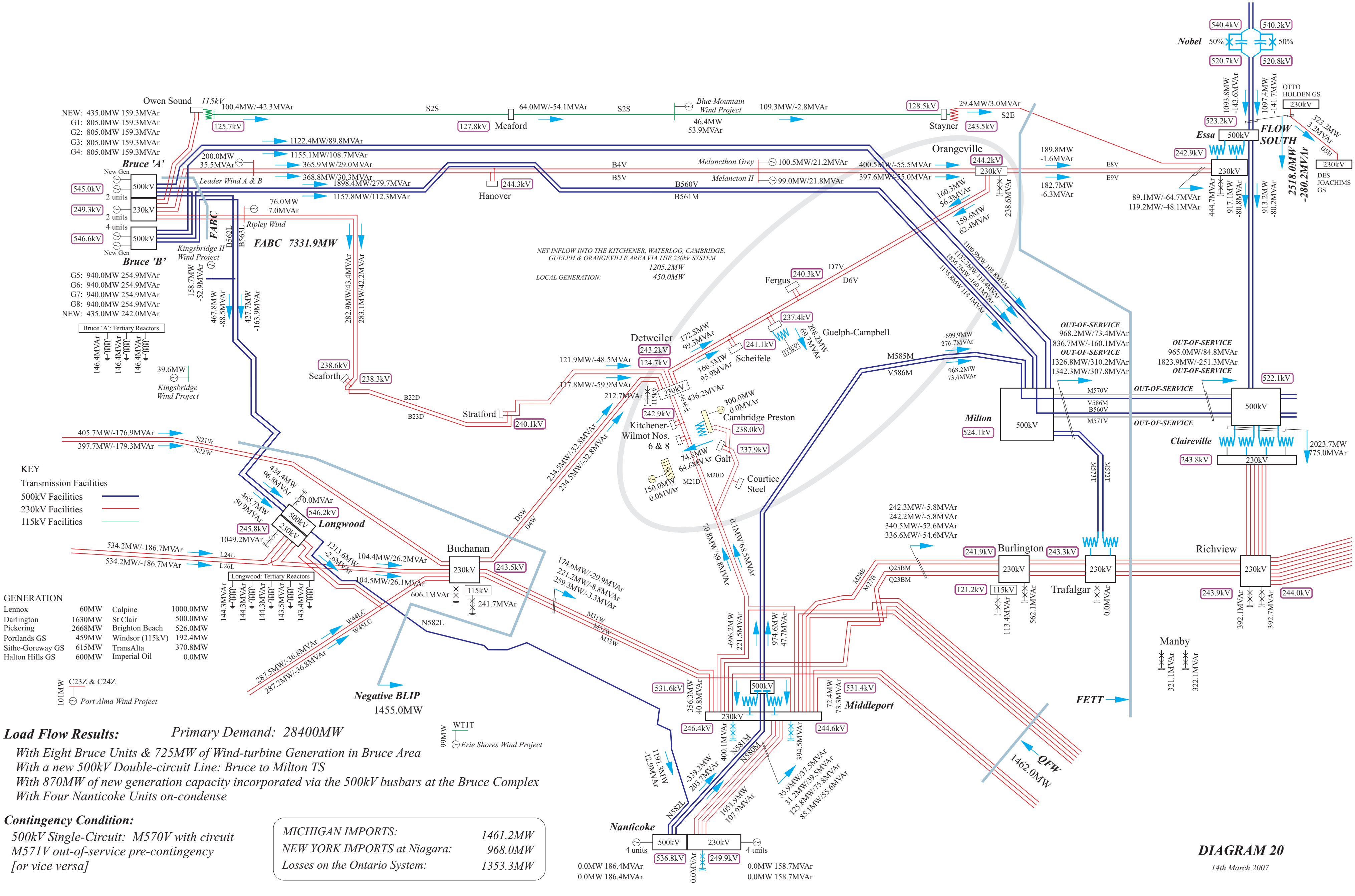
MICHIGAN IMPORTS:	1468.6MW
NEW YORK IMPORTS at Niagara:	1011.0MW
Losses on the Ontario System:	1360.4MW

DIAGRAM 17

11th March 2007


Owen Sound
115kV
82.1MW/-44.2MVAr
S2S
46.5MW/-52.8MVAr
Meaford
Blue Mountain Wind Project
92.1MW/1.2MVAr
46.4MW
55.5MVAr
Stayner
21.1MW/7.4MVAr
S2E
NEW: 435.0MW 149.4MVAr
G1: 805.0MW 149.4MVAr
G2: 805.0MW 149.4MVAr
G3: 805.0MW 149.4MVAr
G4: 805.0MW 149.4MVAr
Bruce 'A'
Bruce 'B'
G5: 940.0MW 239.0MVAr
G6: 940.0MW 239.0MVAr
G7: 940.0MW 239.0MVAr
G8: 940.0MW 239.0MVAr
NEW: 435.0MW 239.0MVAr
Bruce 'A': Tertiary Reactors
1313.7MW/96.7MVAr
1338.5MW/113.2MVAr
332.7MW/23.6MVAr
335.6MW/24.8MVAr
1526.8MW/154.9MVAr
1341.7MW/117.4MVAr
Leader Wind A & B
Ripley Wind
Kingsbridge II Wind Project
Kingsbridge Wind Project
FABC
FABC 7331.9MW
Hanover
B4V
B5V
B560V
B561M
Melancthon Grey
100.5MW/2.7MVAr
Melancton II
99.0MW/3.2MVAr
Orangeville
370.1MW/-59.8MVAr
367.2MW/-59.3MVAr
E8V
E9V
Nobel
Essa
FLOW SOUTH
2514.9MW
-270.2MVAr
OTTO HOLDEN GS
DES JOACHIMS GS
NET INFLOW INTO THE KITCHENER, WATERLOO, CAMBRIDGE, GUELPH & ORANGEVILLE AREA VIA THE 230kV SYSTEM 1223.1MW
LOCAL GENERATION: 450.0MW
Fergus
D7V
D6V
Guelph-Campbell
Detweiler
Scheifele
Seaforth
Stratford
B22D
B23D
Kitchener-Wilmot Nos. 6 & 8
Cambridge Preston
Galt
Courtice Steel
M20D
M21D
Milton
M585M
V586M
OUT-OF-SERVICE
Claireville
2889.5MW
847.1MVAr
N21W
N22W
Longwood
Longwood: Tertiary Reactors
L24L
L26L
Buchanan
D5W
D4W
W44LC
W45LC
N582L
Negative BLIP
1491.3MW
M31W
M32W
M33W
Burlington
Trafalgar
Richview
Manby
Q25BM
Q23BM
R21T
R19T
R17T
R14T
FETT
QFW
1497.5MW
Middleport
Nanticoke
KEY
Transmission Facilities
500kV Facilities
230kV Facilities
115kV Facilities
GENERATION
Lennox 0MW
Darlington 1630MW
Pickering 2668MW
Portlands GS 459MW
Sithe-Goreway GS 615MW
Halton Hills GS 600MW
Calpine 1000.0MW
St Clair 500.0MW
Brighton Beach 526.0MW
Windsor (115kV) 192.4MW
TransAlta 370.8MW
Imperial Oil 0.0MW
C23Z & C24Z
Port Alma Wind Project
WT1T
Erie Shores Wind Project
Load Flow Results:
Primary Demand: 28400MW
With Eight Bruce Units & 725MW of Wind-turbine Generation in Bruce Area
With a new 500kV Double-circuit Line: Bruce to Milton TS
With 870MW of new generation capacity incorporated via the 500kV busbars at the Bruce Complex
With Four Nanticoke Units on-condense
Contingency Condition:
Breaker failure condition resulting in the simultaneous loss of an MxV circuit and one of the 500kV circuits to Trafalgar TS
MICHIGAN IMPORTS: 1499.8MW
NEW YORK IMPORTS at Niagara: 1013.1MW
Losses on the Ontario System: 1321.2MW
DIAGRAM 18
24th March 2007


Load Flow Results:
Primary Demand: 28400MW
With Eight Bruce Units & 725MW of Wind-turbine Generation in Bruce Area
With a new 500kV Double-circuit Line: Bruce to Milton TS
With 870MW of new generation capacity incorporated via the 500kV busbars at the Bruce Complex
With Four Nanticoke Units on-condense
Contingency/Outage Condition:
500kV Single-Circuit: M571V
MICHIGAN IMPORTS: 1504.3MW
NEW YORK IMPORTS at Niagara: 997.2MW
Losses on the Ontario System: 1307.4MW
DIAGRAM 19
13th March 2007
KEY
Transmission Facilities
500kV Facilities
230kV Facilities
115kV Facilities
GENERATION
Lennox 0MW
Darlington 1630MW
Pickering 2668MW
Portlands GS 459MW
Sithe-Goreway GS 615MW
Halton Hills GS 600MW
Calpine 1000.0MW
St Clair 500.0MW
Brighton Beach 526.0MW
Windsor (115kV) 192.4MW
TransAlta 370.8MW
Imperial Oil 0.0MW
Bruce 'A'
NEW: 435.0MW 152.1MVAr
G1: 805.0MW 152.1MVAr
G2: 805.0MW 152.1MVAr
G3: 805.0MW 152.1MVAr
G4: 805.0MW 152.1MVAr
Bruce 'B'
G5: 940.0MW 243.3MVAr
G6: 940.0MW 243.3MVAr
G7: 940.0MW 243.3MVAr
G8: 940.0MW 243.3MVAr
NEW: 435.0MW 242.0MVAr
FABC 7331.9MW
NET INFLOW INTO THE KITCHENER, WATERLOO, CAMBRIDGE, GUELPH & ORANGEVILLE AREA VIA THE 230kV SYSTEM 1209.7MW
LOCAL GENERATION: 450.0MW
Negative BLIP 1496.8MW
FLOW SOUTH 2514.8MW -273.2MVAr
QFW 1478.7MW
FETT
Owen Sound
Meaford
Stayner
Orangeville
Hanover
Nobel
Essa
Detweiler
Guelph-Campbell
Scheifele
Fergus
Seaforth
Stratford
Kitchener-Wilmot Nos. 6 & 8
Cambridge Preston
Galt
Courtice Steel
Longwood
Buchanan
Milton
Claireville
Burlington
Trafalgar
Richview
Manby
Middleport
Nanticoke
OTTO HOLDEN GS
DES JOACHIMS GS
Blue Mountain Wind Project
Leader Wind A & B
Ripley Wind
Kingsbridge II Wind Project
Kingsbridge Wind Project
Melancthon Grey
Melancthon II
Port Alma Wind Project
Erie Shores Wind Project
OUT-OF-SERVICE



Load Flow Results: Primary Demand: 28400MW

With Eight Bruce Units & 725MW of Wind-turbine Generation in Bruce Area
With a new 500kV Double-circuit Line: Bruce to Milton TS
With 870MW of new generation capacity incorporated via the 500kV busbars at the Bruce Complex
With Four Nanticoke Units on-condense

Contingency Condition:

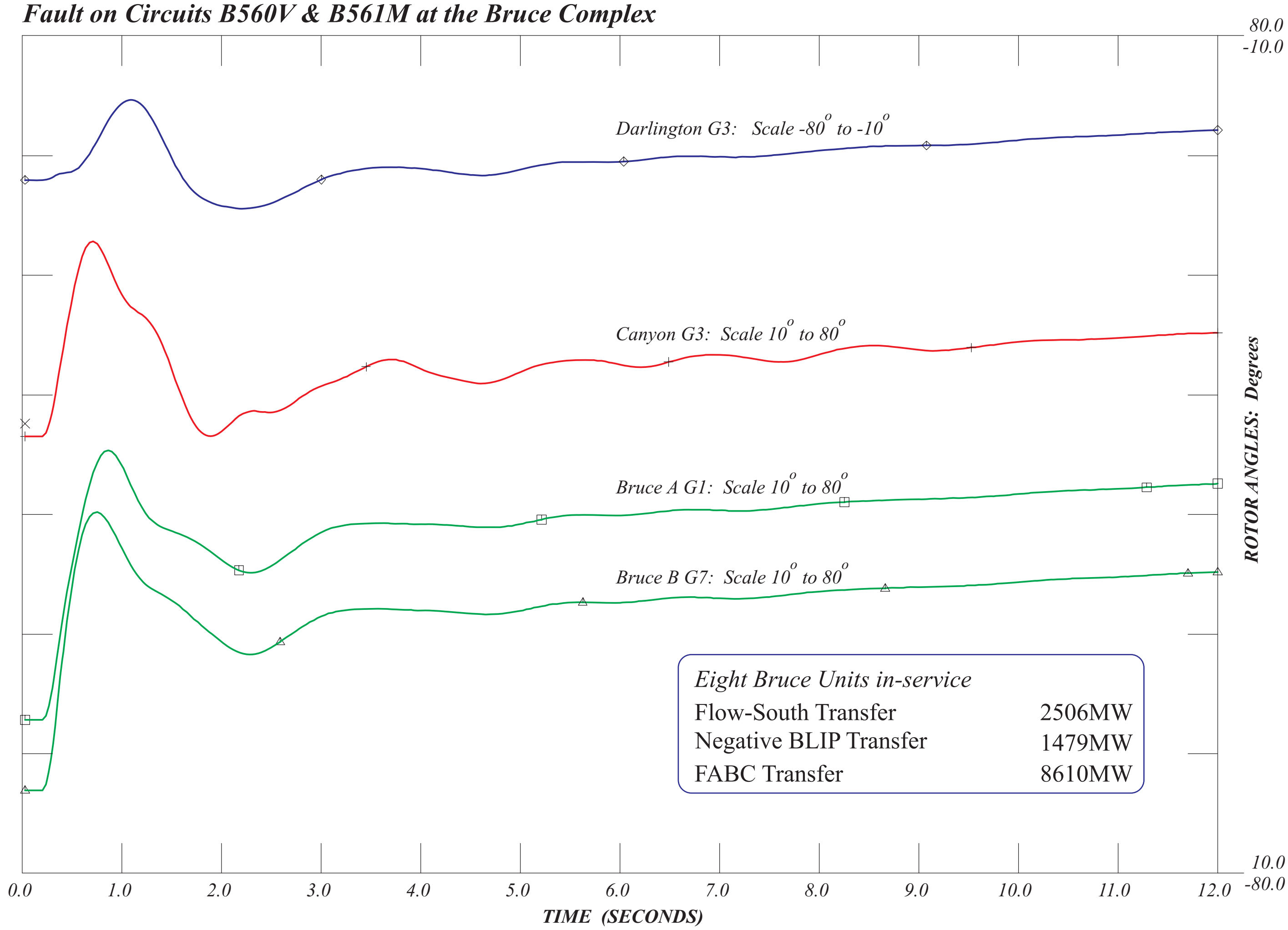
500kV Single-Circuit: M570V with circuit M571V out-of-service pre-contingency [or vice versa]

MICHIGAN IMPORTS:	1461.2MW
NEW YORK IMPORTS at Niagara:	968.0MW
Losses on the Ontario System:	1353.3MW

DIAGRAM 20

14th March 2007

Generator Rotor Angle Responses to a Line-Line-Ground Fault on Circuits B560V & B561M at the Bruce Complex



Busbar Voltages in Response to a Line-Line-Ground Fault on Circuits B560V & B561M at the Bruce Complex

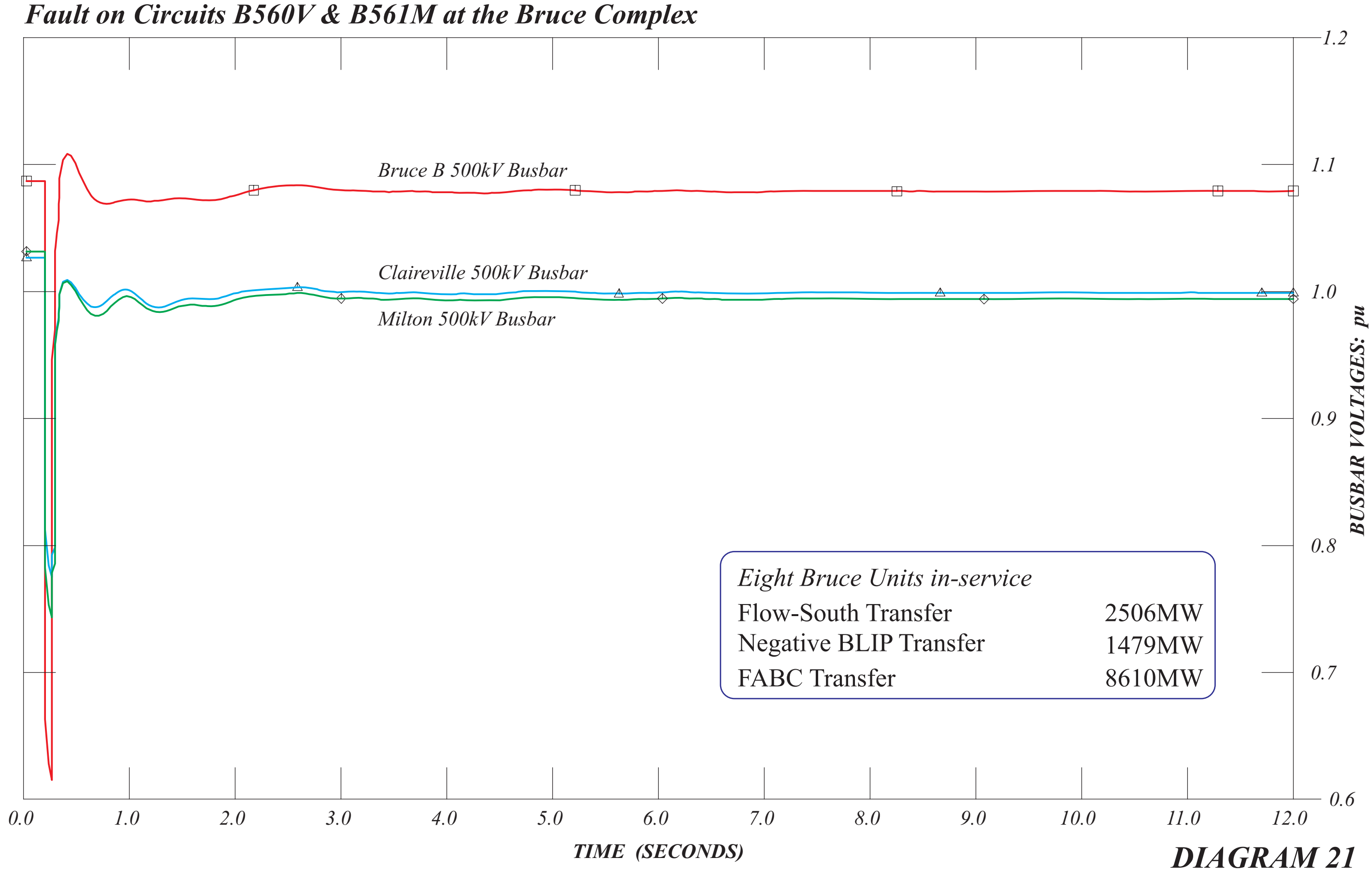


DIAGRAM 21

24th March 2007