

Independent Electricity Market Operator (IMO)

Connection Assessment

For

**Temporary Generation Resources in
Ontario for the Summer/Autumn 2003**

Applicant:

Ontario Electricity Financial Corporation

CAA ID: 2003-095

Final Report

Prepared by:
Long Term Forecasts & Assessments Department
Consistent Information Set Department

July 10, 2003
(Revised August 6, 2003)

Connection Assessment Report

Project: Temporary Generation Resources in Ontario for the Summer/Autumn 2003
Applicant: OEFC
CAA ID: 2003-095

ACKNOWLEDGEMENT

The Independent Electricity Market Operator (IMO) wishes to acknowledge the assistance of Acres International Ltd. in completing this assessment.

DISCLAIMERS

IMO

This report has been prepared solely for the purpose of assessing whether the connection applicant's proposed connection with the IMO-controlled grid would have an adverse impact on the reliability of the integrated power system and whether the IMO 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 IMO by the connection applicant and the transmitter(s) at the time the assessment was carried out. The IMO assumes no responsibility for the accuracy or completeness of such information, including the results of studies carried out by the transmitter(s) at the request of the IMO. 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 IMO-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(s) 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 IMO in accordance with Chapter 4, section 6 of the Market Rules. The IMO assumes no responsibility to any third party for any use, which it makes of

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Independent Electricity Market Operator (IMO)

Connection Assessment & Approval Process

Project:

**Temporary Generation Resources in
Ontario for the Summer/Autumn 2003**

Applicant:

Ontario Electricity Financial Corporation

CAA ID: 2003-095

Addendum Report

- OEM/PEI McMaster and Kingston Projects

Prepared by:

Long Term Forecasts & Assessments Department
Consistent Information Set Department

July 7, 2003

Connection Assessment Report - Addendum - OEM/PEI McMaster and Kingston Projects

Project: Temporary Generation Resources in Ontario for the Summer/Autumn 2003
Applicant: OEFC
CAA ID: 2003-095

1. Introduction

In their original response to OEFC's Request for Proposal for temporary generation resources in Ontario for the summer and autumn of 2003, Ontario Energy Management/Peninsula Engineering (OEM/PEI) proposed to install 4x5 MW of natural temporary generation connected to McMaster TS in Hamilton, and 4x5 MW connected to Frontenac TS in Kingston. Both projects were assessed by the IMO to have no adverse impact to the IMO-controlled grid.

Subsequently, OEM/PEI revised their proposals for the two sites. The proposal for the McMaster location is currently for the installation of 3x7.9 MW units, and for the Kingston location, 1x18 MW. Because of these changes, the IMO is required to reassess these projects on their impact to the IMO-controlled grid and their adherence to the requirements of the Market Rules. The details and results of the latest reassessment are documented in this addendum report.

2. Project Assessment

2.1. McMaster 13.8 kV-3X7.9 MW

a) Project Description and Connection Arrangement

In its latest plan, OEM/PEI proposes to install 23.7 MW of new temporary generation near the McMaster TS site in the City of Hamilton. This generation capacity will be derived from three commercially available Alstom Tempest gas turbine generating sets operating at 13.8 kV. These units will be connected to the McMaster 13.8 kV bus through individual 15 kV 1200A 500 MVA circuit breakers. Step-up transformers are not required for these gensets.

The general arrangement and basic provisions of the proposed connection are considered adequate – isolating devices are provided, and the breakers appear to have adequate ratings. Notwithstanding the general acceptability of the connection facilities, the final design and specification of the proposed connection facilities, including those required for relaying & protection, control, metering, monitoring and communication, must meet the minimum

standards specified in the OEB's Distribution and Transmission Codes, and specific facilities requirements of the asset owner of McMaster TS (a direct customer station), and the requirements of the Market Rules.

b) Generator Data Verification

The generator data for these 10.5 MVA rated generators as provided by the proponent was reviewed. The rated power factor was 0.8, which meets the Market Rules requirements for reactive power generating capability.

Other technical data were reviewed and found to be in the acceptable range. As well, generator V-curves were developed using this data and they almost verify the information provided. Thus, the generator data is judged adequate for these units.

Dynamic testing of the performance of the units' exciter and governor models was not carried-out, as these embedded units are just marginally larger than the 10 MVA unit size that requires performance testing, and considering the temporary nature of these units.

c) Local Area Impact

The McMaster proposal is on a direct customer site. That Direct Customer is responsible for ensuring that the short circuit, thermal loading and voltage impacts on its local system are acceptable with the incorporation of the new generation.

Loadflow simulations were performed for the proposed generation addition at McMaster TS. The load modeled at the station was 17.2 MW. The addition of 23.7 MW of generation displaced the load and provided about 7 MW of power injection into the 115 kV system supplying the McMaster station. As a result, the McMaster step-down transformers were very lightly loaded; the 115 kV voltages at McMaster TS improved marginally (from 114.5 kV to 114.7 kV); and the flows on the two 115 kV supply circuits from Burlington TS decreased by about 7 MW (from about 130 MW to about 123 MW) each, measured at Burlington TS. Loss of the entire 23.7 MW of generation produced minimal changes at the 13.8 kV or 115 kV voltages at McMaster TS. Thus, it can be concluded that the connecting the proposed new generation at McMaster TS has no adverse impact on the IMO-controlled grid.

d) System Impact

Generation at the McMaster site feeds into a relatively large load pocket in the Hamilton area fed from Burlington TS. It will have a positive impact in reducing transfers into this load pocket.

Because the amount of generation added is small, a dynamic simulation was not performed.

e) Conclusions and Recommendations

Based on the above review, there will be no adverse impact on the IMO-controlled grid with the incorporation of the proposed generation subject to the review of short circuit impact on its system by the Direct Customer. Additionally, the proponent must come to an agreement with the Direct Customer on the final design and specification of the connection facilities prior to their installation and connection.

Being over 10 MW in aggregate output at each site, the IMO requires that the proponent provides detailed generator and connection data to the IMO when it is available.

Based on the above review, it is concluded that, subject to the requirements that the proponent must come to an agreement with the Direct Customer on the final design and specification of the connection facilities prior to their installation and connection, the incorporation of the proposed facilities will have no adverse impact on the existing IMO-controlled grid. It is therefore proposed to issue a Notification of Approval of the Connection Proposal for these Projects.

2.2. Kingston 13.8 kV-1X18 MW

a) Project Description and Connection Arrangement

In its latest plan, OEM/PEI proposes to install about 18 MW of new temporary generation in the City of Kingston. This generation capacity will be derived from a single commercially available Pratt Whitney gas turbine generator unit operating at 13.8 kV. This unit will be embedded in Utilities Kingston's distribution system fed from HydroOne's Frontenac TS. The proponent did not provide information concerning the arrangement and facilities required for connecting the new generator to the LDC's distribution system.

Being an embedded facility, the final design and specification of the proposed connection facilities, including those required for relaying & protection, control, metering, monitoring and communication, must meet the minimum standards specified in the OEB's Distribution Codes, and specific facilities requirements of the LDC, and the requirements of the Market Rules.

b) Generator Data Verification

Generator Data

Tables 1 and 2 below provide a summary of the generator information provided in the manufacturer's data sheets provided by the proponent of the project. Comments on the data are included.

Table 1 Pratt Whitney Generator Dynamic Data

Generator Data	Manufacturer's Values / Revised Values	Comments
Base MVA	23.5	
T'do	3.18	
T''do	0.08	
T'qo	0.61	
T''qo	0.4	High
H	7	Assumed
Damping		
Xd	2.91 / 2.14	High
Xq	2.78 / 1.9	High
X'd	0.35	Reasonable
X'q	0.34 / 0.37	Saturated value – Unsaturated value not provided
X''d	0.220	Reasonable
Xl	0.23 / 0.2	High – Should be lower than direct axis subtransient reactance
S(1.0)	0.28	High – Calculated from no load saturation curve
S(1.2)	1.67 / 1.1	Very high - Calculated from no load circuit saturation curve

Table 2 Pratt Whitney Generator Field Data

Parameters	Manufacturer's Values
Voltage (kV)	13.8
MVA	23.5
PF (p.u)	0.9
Rfd@75 C (Ohm)	0.45
Ifd base (A)	161
Efd base (Vdc)	73
Ifd rated (A)	508
Efd rated (Vdc)	228
Efdmax (Vdc)	292**
Efd rated (p.u)	3.12

Ceiling Factor (%)	400**
Short Circuit Ratio	0.46

** Assumed values

Simulation Results for Generator Data

Figure 1 shows the generator V-Curves based on manufacturer's data. The results computed by VCV, a utility in PSS/E program, do not agree with the generator excitation voltage (Efd) value at rated output, as shown Table 2. Also, the response ratio test revealed a negative value for short circuit ratio using manufacturer's data. This clearly shows that the generator dynamic parameters do not correspond to other generator data and ratings given in the data sheets. It is concluded that the some of the provided values may be erroneous.

Accordingly, the generator reactance and saturation parameters were revised to get a reasonable agreement with the designed values for short circuit ratio and generator field voltage, Efd, at rated output of the machine. Table 1 also shows the revised values for generator dynamic parameters and the corresponding V-curves are shown in Figure 2.

Excitation System Performance Assessment by Simulation Tests

The proponent has not provided the data for the proposed IEEE Type 2 excitation system model. A very conservative set of typical parameters has been used to verify and test the performance of the proposed excitation system. The following two simulation tests have been performed to verify response ratio/exciter ceiling field voltage and assess dynamic behavior after a step change applied to the voltage regulator reference. .

Response Ratio Test

Response ratio test was performed using ESTR command in the dynamics module of PSS/E. This test helps to validate the data for generator's saturation function S(1.2) and the ceiling factor for excitation system. The excitation field voltage value at rated power factor and rated MVA output obtained from the simulation test is compared with the manufacturer's value or with the available field test data. Figure 3 shows that ceiling value of the field voltage is within the capability of IEEE Type 2 excitation system with assumed parameters. The response ratio is 0.49, which is very close to the manufacturer's supplied value.

Open Circuit Step Response Test

Open circuit step response test was performed to examine the resulting exciter response from the typical data assumed. This has been accomplished using ESTR command in the dynamics module of PSS/E. The reference point of the exciter was raised by 5% and the terminal voltage and field voltage were plotted. The plots of Figures 4 and 5 reveal that the terminal voltage and the field voltage, after the step change in Vref, settle quickly to a steady state value. If the response was oscillatory then adjustment of some time constants and gains in the excitation system model would have been required to remove the oscillatory content

from the exciter response. It is concluded that the proposed IEEE Type 2 model with the assumed data will likely meet the requirements specified under market rules.

Governing System Performance Assessment by Simulation Tests

Governor response test was performed using GSTR command in the dynamics module of PSS/E. GAST model with conservative parameters was tested for its response. The machine was initialized at 0.8 pu load for the preparation of the test where the electrical load was suddenly increased to 90% of the unit rating. The results of this test are shown in Figure 6, which confirm that the response with the assumed data is satisfactory.

c) Local Area Impact

The Kingston proposal will be an embedded resource. The affected LDC, Utilities Kingston, is responsible for ensuring that the short circuit, thermal loading and voltage impacts on their distribution systems are acceptable with the incorporation of the new generation.

Due to its relative small size compared to the large load (78 MW) at Frontenac TS, the new generation is displacing part of the station's load and no adverse impact on the IMO-controlled grid is expected from this generator connection..

d) System Impact

Generation at the Kingston site feeds into Frontenac TS in the Kingston area, a relatively large load centers in Eastern Ontario. The generation from this site will have a positive impact in reducing transfers into this load pocket.

Because the amount of generation added is relatively small and load displacement in nature, a dynamic simulation was not performed.

e) Conclusions and Recommendations

Based on the above review, there will be no adverse impact on the IMO-controlled grid with the incorporation of the proposed generation subject to the review of short circuit impact on its system by the LDC or Direct Customer. Additionally, the proponent must come to an agreement with the Distributor or Direct Customer on the final design and specification of the connection facilities prior to their installation and connection.

Being over 10 MW in aggregate output at each site, the IMO requires that the proponent provides detailed generator and connection data to the IMO when it is available. The results of the generator data verification and performance tests indicated that some of the generator data provided may be erroneous, and model data was not provided for the exciter and governor systems of the generator. The response of the generator is adequate when generic data were assumed for these systems. The proponent should verify the generator and model

data when it is available and recertify the exciter and governor performance. Alternatively, the proponent may seek a formal exemption from the IMO to exempt these requirements

Based on the above review, it is concluded that, subject to the requirements that the proponent must come to an agreement with the Distributor or Direct Customer on the final design and specification of the connection facilities prior to their installation and connection, and re-verification of the performance of the generator, or seek formal exemption of these requirements from the IMO, the incorporation of the proposed facilities will have no adverse impact on the existing IMO-controlled grid. It is therefore proposed to issue a Notification of Approval of the Connection Proposal for these Projects.

3. Conclusions and Recommendations

The OEM/PEI revised temporary generator proposals for McMaster and Kingston have been reviewed. The salient results and conclusions are:

- Neither of the projects was shown to have an adverse impact on the IMO-controlled Grid. In fact, both, being load displacement in nature, have positive effects on the local networks they are connected to.
- For both projects, it is expected that the final design and specification of the connection facilities, including relaying & protection, control, metering, monitoring, and communication will meet the minimum standards specified in the OEB's Transmission or Distribution Code, the specific facility requirements of the host LDC or Direct Customer, and the requirements of the Market Rules.
- Full adherence to the Market Rules requires the provision of detailed model data to the IMO for both locations. Both submissions, in particular the larger Kingston unit, did not satisfy all of the data requirements to fully assess the performance characteristics of the generating units, especially with respect to their exciter and governor controls. Using generic data, however, the performance of the excitation and governor systems of the Kingston unit were shown to be adequate.

Given that these units are relatively small, and consisted of standard, commonly-used or "off-the-shelf" equipment, and will only be used at time of near-emergency conditions on the system, the IMO will accept the connection of these units for their intended purposes. Nevertheless, it is required that the proponent provide the required information to the IMO once it is available, and re-verification of the performance tests for the Kingston unit, or a formal exemption be sought from the IMO to exempt this data and generator performance requirements.

It is recommended that Notifications of Approval be granted for both projects, subject to the implementation of the requirements noted above.

Note that these generation proposals were approved on the basis that they will only remain connected and available for use until May 1, 2004. Proponents who decide to keep their

facilities operational after this date and participate in the IMO administered markets will have to complete the Connection Assessment and Approval, and the Facility Registration process.

Figure 2

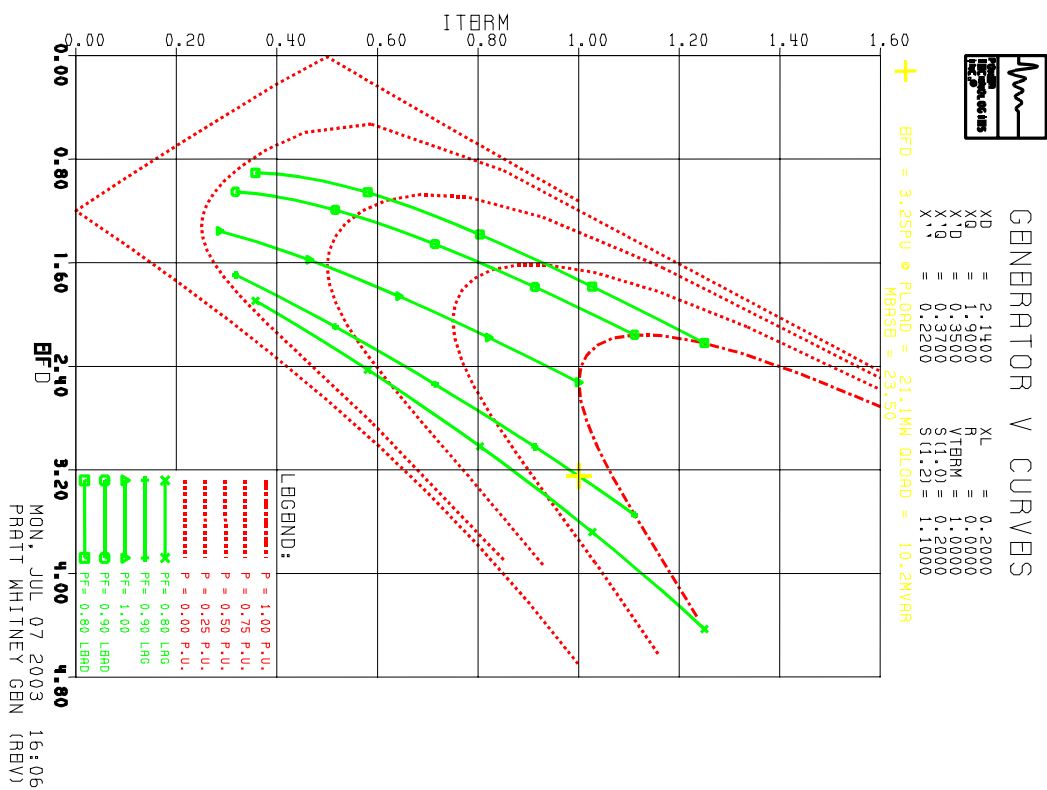


Figure 3

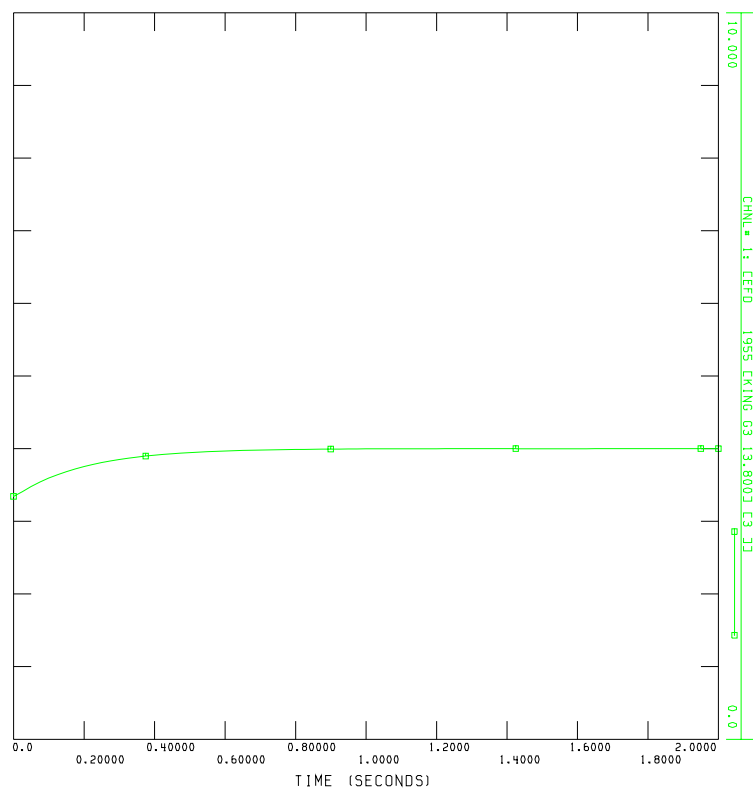
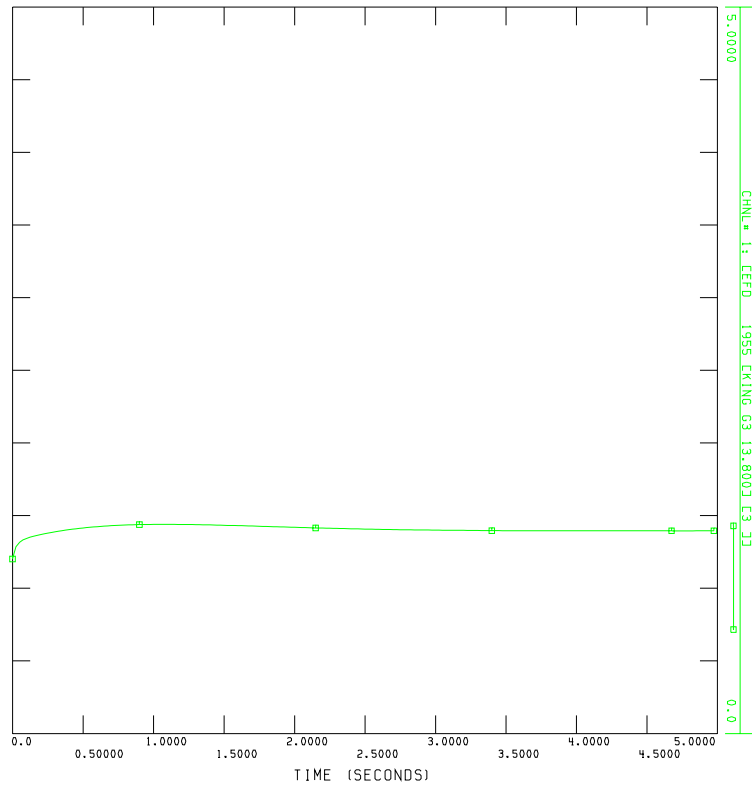


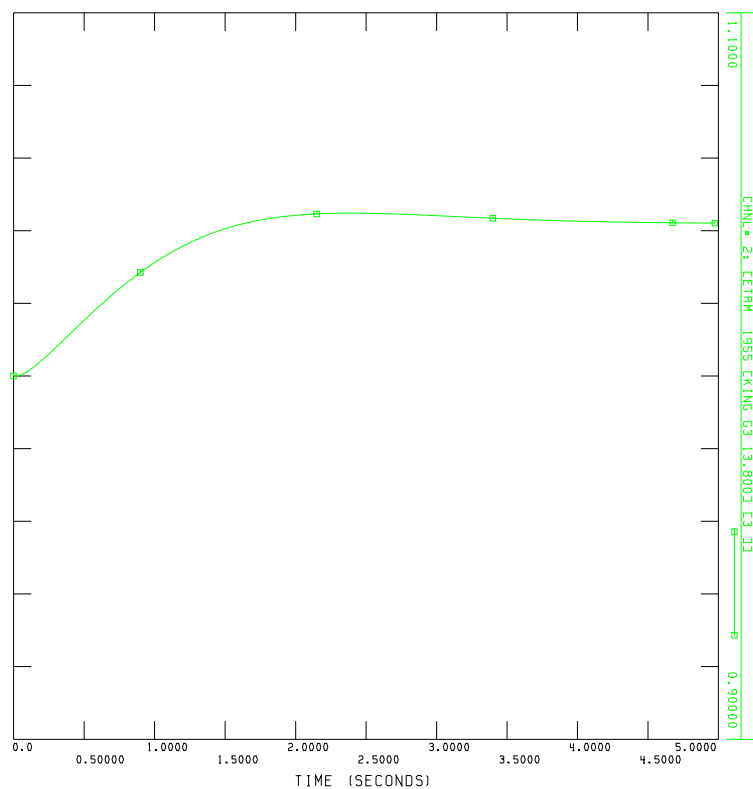
Figure 4



MON, JUL 07 2003 3:21
KING G3 EFD

EMERGENCY POWER INTERCONNECTION STUDIES: IMO - SUMMER 2003
KINGSTON PRATT WHITNEY - TURBO GENERATOR
OPEN CIRCUIT STEP RESPONSE TEST
PRATT WHITNEY UNIT
FILE: C:\My Documents\Projects\IMO-On tar 10\acres\ecocr-kingG3.out

Figure 5



EMERGENCY POWER INTERCONNECTION STUDIES: IMO - SUMMER 2003
KINGSTON PRATT WHITNEY - TURBO GENERATOR
OPEN CIRCUIT STEP RESPONSE TEST
PRATT WHITNEY UNIT
FILE: C:\My Documents\Projects\IMO-Ontario\acres\pocsr-KingG3.out

MON, JUL 07 2003 3:23
KING G3 ETERM

Figure 6

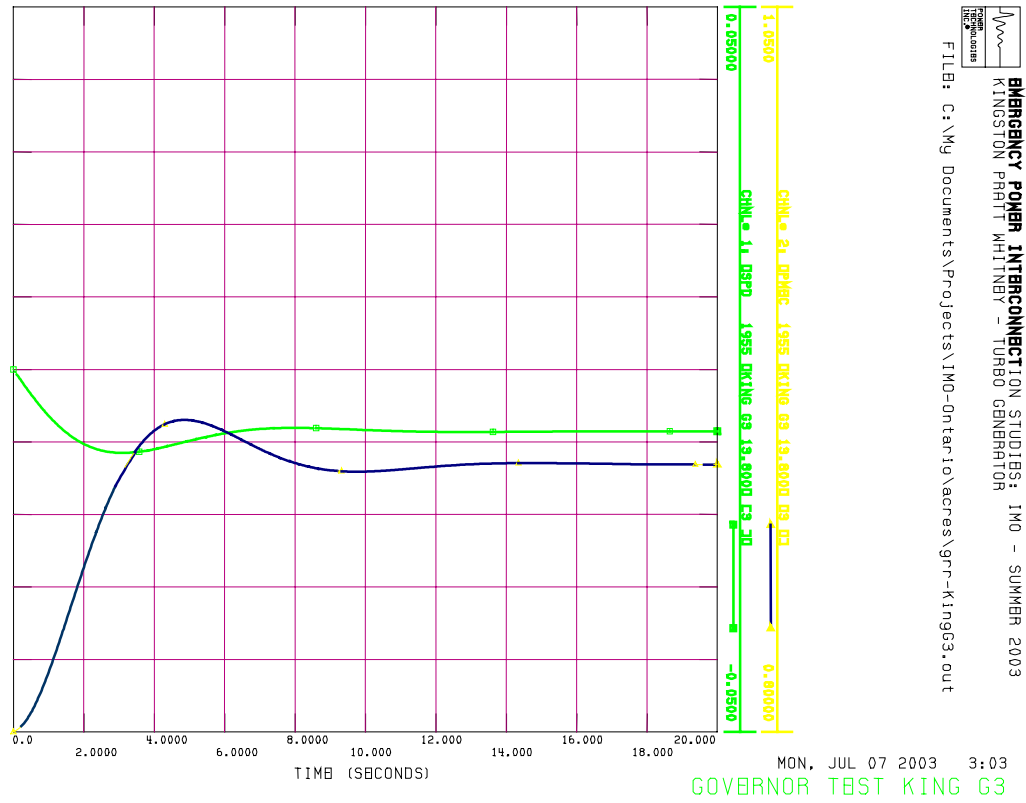


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Connection Assessment Report

Project: Temporary Generation Resources in Ontario for the Summer/Autumn 2003
 Applicant: OEFC
 CAA ID: 2003-095

Executive Summary

The Ontario Electricity Financial Corporation (OEFC) issued an RFP on April 28, 2003, inviting prospective respondents to submit proposals for the provision of all or part of 200 to 400 MW of temporary generation resources that would be available for service in the summer and autumn of 2003. The successful proposals would be contracted with OEFC to provide Firm Peaking Capacity that are new to Ontario and connected to the Ontario Electricity System during that period.

In response to this extremely tight timeline, the IMO developed an expedited process for conducting this Connection Assessment. As well, where information is not available, there was much reliance on the engineering judgement of the IMO staff and consultants on generator performance and system impact assessment.

On May 16, 2003, the IMO received from OEFC a list of screened proposals that required connection assessment and approval (CAA). In total, there were 8 respondents with 46 project proposals totalling about 875 MW of temporary generating resources. From all the proposals OEFC selected to negotiate contracts for the projects shown in the table below.

<u>Proponent</u>	<u># of Projects/ Sites</u>	<u>Aggregate MW Capacity</u>	<u>Comment</u>
Gasworks Energy	2/2	40 MW	1 MW size units
TransAlta	2/1	60 MW	2 units returning to service
Kingston Co-Gen	1/1	22.8 MW	A single unit
Toromont	8/8	115.1 MW	1 to 5 MW size units
Toronto Hydro Energy	3/2	20 MW	1 MW size units
TransCanada Pipeline	1/1	114 MW	23 MW size units

OEM/PEI	2/2	40 MW	5 MW size units
Total	19/17	411.9 MW	

Note that for a large number of the proposals, the MW capacity to be developed at a site is derived from the installation of multiple small generating units (typically 1 to 5 MW in size) of identical specifications and from the same manufacturer.

The IMO carried out the assessment between May 16 and May 23. A summary of the results, conclusions and recommendations with respect to the acceptability of connecting these projects was provided to OEFC on May 23, 2003.

The process that was employed in this assessment is as follows:

- identify the specific proposal from a site perspective;
- establish the point of connection for each;
- identify the point on the IMO-controlled grid that could be impacted by the generation development;
- review and verify data provided including simulations as necessary;
- review connection arrangement proposed;
- review and establish as required the local area impact as related to short circuit, facility loading, and voltage regulation and variations;
- review and study as required system impacts; and
- identify any other special requirements.

In addition, a “cluster” study was conducted for any location where a number of individual projects are being proposed and being connected to. In these cases, individual proposals may be acceptable, but collectively, there may be constraints on the total amount that is allowed in aggregate.

Results, conclusions and recommendations for the individual projects are documented in this assessment report.

A summary of the assessment results is contained in the attached spreadsheet Table A.

The salient results and conclusions are:

- None of the project proposals was shown to have an adverse impact on the IMO-controlled grid. In fact, some are beneficial to the local network and/or the bulk system in the vicinity of the installations:
- Initially, the concentration of proposals for connection to Markham TS#1 was a concern from the aspect of short circuit interrupting capability of existing equipment; to alleviate this problem OEFC has selected proposals which collectively met the distribution system capability indicated by Markham Hydro;

- In all cases, the design and specification of the actual connection facilities have not yet been finalized;
- In cases where the Market Rules require that detailed information on connection facilities and generators be provided to the IMO, the information is incomplete or not available.

The overall conclusion is that all of the projects covered under this assessment have no adverse impact on the reliability of the existing IMO-controlled grid subject to implementation of the requirements identified in Section 7 and detailed in Section 5 of this report. However, the facilities, as proposed, will require IMO Market Rule exemptions with respect to data submission, performance requirements, market participation, revenue metering, operational telemetry and operating schedules. The extent of the exemption requirements vary depending on the proposal. IMO staff expects to be able to recommend that these exemptions be granted, but the decision rests with a panel of independent directors of the IMO Board. **OEFC will need to begin this process as early as possible to facilitate a timely decision.**

The requirements identified in this assessment for incorporating the various project proposals under the Temporary Generation Program for the summer and autumn of 2003 are summarized below. More detailed discussions are provided in Section 5 for the individual projects.

General Requirements

- For all the projects, it is expected that the final design and specification of the connection facilities, including relaying & protection, control, metering, monitoring, and communication will meet the minimum standards specified in the OEB's Transmission or Distribution Code, the specific facility requirements of each respective Transmitter or LDC, and the requirements of the Market Rules. The proponent must come to an agreement with the Transmitter or Distributor on the final design and specification of the connection facilities prior to their installation and connection.
- The IMO assumes that all the facilities will provide protective relaying that is properly co-ordinated and acceptable to the host LDC or Transmitter.
- None of the facilities proposed to connect directly to a transmitter has been assessed from a customer impact perspective. The customer impact assessment is an OEB requirement on Transmitters. Connection of the facilities is subject to the acceptable resolution of any customer impact issues between the proponent and the Transmitter.
- The IMO assumes the proposals will satisfy applicable environmental regulations.

Specific Requirements to the Proposals Directly Connected to the IMO-Controlled Grid

- It is assumed that revenue metering satisfactory to the IMO will not be installed at any of these sites. In these cases IMO assumes that it will be able to estimate the aggregated load consumption of these facilities and charge OEFC for the additional energy demand.
- With respect to the TransAlta proposal, these facilities are proposed to connect behind an existing revenue meter used for other facilities already settled in the IMO market. In these cases there may be incorrect energy or congestion management settlement credits paid to these existing market participants.
- HydroOne indicates that all directly connected facilities (TCPL-Cobourg, Kingston Co-Gen and TransAlta) could have an adverse effect on the reliability of nearby connected customers. To mitigate this, all are expected to employ duplicate protective relaying, to be disconnected from the grid when not required, and to be capable of being put on potential via the disconnect at their point of interconnection.
- With respect to the TransAlta proposal, consisting of units G2 and G4, IMO advises the following:
 - The proposed TransAlta facilities are located near Sarnia. There is an existing transmission congestion point on the IMO-controlled grid in the vicinity of London. IMO advises that there is a very low, but not zero, probability of transmission congestion over the summer that could limit the utilization of this facility if it is selected.
 - IMO understands that the operation of TransAlta unit G4 is currently restricted by an environmental regulation.
- With respect to the TCPL-Cobourg proposal, the location is one that poses some challenges to provide adequate protections. Initial indications are that duplicate high-speed protections will be required at TCPL-Cobourg that must be time-co-ordinated with the existing 115kV line protections. Some setting changes at Port Hope may also be required. Protection studies are not yet complete and other requirements may also be identified. In addition to the protection issues, HydroOne has also confirmed that the summer design rating (30 degrees C, 4 km/hr wind) of the connection circuit is **about 95 MW**. The applicant has indicated that during these conditions the output of the turbines is reduced to 93 MW. With winds of at least 10 km/hr or temperatures less than 0 degrees C, no restriction is expected. IMO notes that the submitted one-line diagram for the proposal shows a 115 kV breaker where none currently exists, but there is no mention of a new breaker to be supplied.

Specifics to the Proposals Connected to LDCs

- With the exception of Toromont at Markham, each of the other sites is proposed to be less than 50 MVA in aggregate, and are judged not to have any adverse effect on the IMO-controlled grid.
- For all connections to distribution feeders, once final connection points are established, IMO requires that the selection of feeders for under-frequency load tripping be reviewed and modified where necessary to satisfy under-frequency load shedding requirements.
- IMO cautions that all of the proposals appear to connect to points on the distribution system that may not have been designed to accommodate a generation injection. This may pose varying challenges to the LDC to facilitate the connection, such as:
 - the short circuit interrupting capability of the LDCs equipment,
 - the allowable voltage change experienced by nearby customers if the generator were to trip, and
 - the compatibility and co-ordination of the generator's protective relaying with that of the host or LDC.

Equipment short circuit capability will limit the amount of generation to be select at a given site.

The allowable voltage dip following a generation loss could also significantly limit the amount of generation permitted at a station or on feeders. Typical values vary significantly depending on the connection point on the distribution system, and should be examined by the LDC.

Relaying requirements generally can be overcome, but may delay implementation if telecommunication is required.

- IMO makes special note of the proposals at Markham. Four projects (two Gasworks and two Toromont) totalling about 94.5 MW are proposed at or near Markham TS#1. This appears to be high for the distribution system, and needs to be evaluated by Markham Hydro. The proposals were also missing single-line diagrams therefore the IMO cannot comment on the amount of a generation trip and resulting voltage dip that could result from a single failure. The estimated peak load of this station is about 120 MW. Therefore, the generation will effectively reduce the net power injection from the IMO-controlled grid. Examination of the relaying is required to ensure acceptable operation under these conditions.
- IMO found no adverse thermal or voltage effects on the IMO-controlled grid with all of these proposals connected.
- With respect to the proposals by Toromont located at Casco London and Casco Port Colborne these are all connected in series with potential congestion points on the IMO-controlled grid. IMO advises that there is a very low, but not zero, probability of transmission congestion over the summer that could limit the utilization of these facilities if selected.

Full adherence to the Market Rules requires the provision of detailed generator model data to the IMO unless the proposed generation is embedded in the distribution system and has a net plant capacity of less than 10 MVA. Additionally, for units greater than 10 MVA or with plant capacity exceeding 50 MVA, verification of the performance characteristics of their generators, exciters, stabilizers and governors in conformance with those requirements specified under Chapter 4 of the Market Rules is required.

In general the submissions did not satisfy all of the data requirements to fully assess the performance characteristics of the generating units, especially with respect to their excitation and governor controls. Given that these units are small, and consist of standard, commonly-used or “off-the-shelf” equipment, IMO assumes their operating parameters will lie in a typical and acceptable range, and judges their performance to be acceptable. Nevertheless, it is required that the proponent provide the required information to the IMO once it is available or a formal exemption be sought from the IMO to exempt this requirement.

This assessment has investigated the impact of the various project proposals on the IMO-controlled grid and has identified IMO’s requirements for connection to ensure no negative effect on the reliability of that system.

It is recommended that Notifications of Approval be granted for all the projects, subject to the implementation of the requirements noted above and stipulated in Sections 7 and 8 of this report.

Note that these generation proposals were approved on the basis that they will only remain connected and available for use until April 30, 2004. Proponents who decide to keep their facilities operational after this date and participate in the IMO administered markets will have to complete the normal Connection Assessment and Approval process, and the Facility Registration process.

Connection Assessment Report

Project: Temporary Generation Resources in Ontario for the Summer/Autumn 2003

Applicant: OEFC

CAA ID: 2003-095

1 Introduction

The Ontario Electricity Financial Corporation (OEFC) issued an RFP on April 28, 2003, inviting prospective respondents to submit proposals for the provision of all or part of 200 to 400 MW of temporary generation resources that would be available for service in the summer and autumn of 2003. The successful proposals would be contracted with OEFC to provide Firm Peaking Capacity that are new to Ontario and connected to the Ontario Electricity System during that period.

Among the various requirements, the new temporary resources must meet the requirements for electrical connections established by relevant authorities, such as the IMO, with respect to the Market Rules, and the Ontario Energy Board (OEB), with respect to the Transmission System Code and the Distribution System Code. The IMO oversees and administers the Connection Assessment and Approval (CAA) process to ensure, among other responsibilities under the Market Rules, that new facilities connected to the IMO-controlled grid will not adversely impact that system. Project proponent must also work with the affected Transmitter or Distributor to establish an agreement on the design and specification of the connection facilities that would be in conformance with the appropriate Code and Market Rule requirements.

It should be noted that the timeline of the OEFC RFP is extremely ambitious. The key dates of the RFP are: RFP closing date of May 12, 2003; evaluation completion date of May 26, 2003; and an earliest anticipated date for in-service of June 15, 2003.

In response to this extremely tight timeline, the IMO developed an expedited process for conducting this Connection Assessment. As well, where information is not available, there was much reliance on the engineering judgement of the IMO staff and consultants on generator performance and system impact assessment.

On May 16, 2003, the IMO received from OEFC the list of screened proposals that required connection assessment. In total, there were 8 respondents with 46 project proposals totalling about 875 MW of temporary generating resources. The IMO carried out the assessment between May 16 and May 23. A summary of the results, conclusions and recommendations with respect to the acceptability of connecting these projects was provided to OEFC on May 23, 2003. Subsequently, OEFC has selected to negotiate contracts with only 19 project proposals totalling about 412 MW.

The purpose of this report is to document the connection process followed, the data received, assumptions used, and the results, conclusions, and recommendations of this CAA for those proposals which were selected by OEFC.

2 Connection Assessment and Approval Requirements

In accordance with Chapter 4, Section 6 of the Market Rules, anyone planning to establish or modify a connection to the IMO-controlled grid must obtain IMO approval through the CAA process. This process allows the IMO to assess the impact of new or modified connections to the IMO-controlled grid on the reliability of the integrated power system.

The procedural details and requirements of the CAA process are documented in the IMO Market Manual: Part 2.10 – Connection Assessment and Approval.

The Connection Assessment data requirements and performance standards for the proposed facilities are documented in Chapter 4 of the Market Rules – Grid Connection Requirements. Of particular relevance to this assessment is Appendix 4.2 – Generation Facility Requirements (Embedded and Non-Embedded) which outlines requirements related to: reactive power capabilities, voltage variations, frequency variations, voltage unbalance, connection equipment capability, protective systems and relaying systems, monitoring and telemetry, communication facilities, compliance monitoring, and generator controls (excitation system, AVR, power factor regulator, power system stabilizer, and speed governor).

In order for IMO to be able to carry out the assessment, the proponent is required to provide to the IMO detailed data on the proposed generating and connection facilities. The level of detail is governed by the MVA rating and the point of connection of the generation to the electrical network.

For this CAA, the proponents are required to complete Appendix D – IMO Required Information Form, which was included with the original issue of the RFP dated April 28, 2003, and as explained in Section 4.3.4 of that RFP.

In addition, Part 2 of the IMO Required Information Form Part 2 is required,

- for projects with connection point to the IMO-controlled grid, regardless of the generator MVA size;
- for each embedded single unit (connected to a distribution network) larger than 10 MVA;
- for each embedded group of units connected to a distribution system that is supplied off a single IMO-controlled grid connection point with an aggregated output larger than 10 MVA;

Since complete data was not supplied for this Project, the accompanying data sheets have been modified to identify those data that are essential for the IMO to be able to undertake the assessment. The data sheets also identify those data for which the IMO will use

appropriate values should the Applicant not provide suitable data. For illustrative purposes, some typical generator model data are shown in Appendix III.

Whenever it is necessary for the IMO to use typical (generally conservative) values for the assessment of the connection application, then it will be the responsibility of the Applicant to ensure that the equipment that is eventually installed meets or exceeds these values.

3 Assessment Process Employed

This assessment covers a large number of project proposals and categories - both embedded and directly connected; and of large and small installations. Normally, the developer of a generation project would have worked closely with the Transmitter or Distributor to define the required connection facilities prior to requesting a Connection Assessment from the IMO. Thus, the IMO would be assessing near-complete design and arrangements that have met the requirements of the Transmitter or Distributor.

In this application, however, because of the tight timeline, much of the preliminary development work has not yet been completed prior to proceeding with the Connection Assessment application. As a result, some aspects of the project proposals are still in the conceptual phase where alternatives are still being considered, and detailed specifications for the connection facilities are not available. This difficulty was recognized by the IMO in this assessment.

Considering:

- the temporary and “emergency” nature of the proposed generation installations;
- that most of the generation facilities being proposed use commercially available equipment that is widely used in the industry; and
- that many of the proposals are small, and a large number are load displacement in nature embedded in the distribution system;

some allowance and relaxation of the standard data and performance requirements have been granted in this assessment to these projects based on the experience and common sense engineering judgment of the IMO. However, the reliability of the IMO-controlled grid will not be compromised as a result of any generation additions.

The process that was employed in this assessment is as follows:

- identify the specific proposal from a site perspective;
- establish the point of connection for each;
- identify the point on the IMO-controlled grid that could be impacted by the generation development;
- review and verify data provided including simulations as necessary and possible;
- review connection arrangement proposed;
- review and establish as required the local area impact as related to short circuit, facility loading, and voltage regulation and variations;
- review and study as required system impacts; and
- identify any other special requirements.

In addition, a “cluster” study is conducted for any location where a number of individual projects are being proposed and being connected to. In these cases, individual proposals may be acceptable, but collectively, there may be constraints on the total amount that is allowed in aggregate.

Results, conclusions and recommendations for the individual projects are documented in this assessment report.

4 Project Proposals under this Application

As commented earlier, OEFC selected 19 project proposals, which were from 7 interested parties and totaling about 412 MW of nominal temporary generating capacity, for this connection assessment. These project proposals are summarized in the following table.

<u>Proponent</u>	<u># of Projects/ Sites</u>	<u>Aggregate MW Capacity</u>	<u>Comment</u>
Gasworks Energy	2/2	40 MW	1 MW size units
TransAlta	2/1	60 MW	2 units returning to service
Kingston Co-Gen	1/1	22.8 MW	A single unit
Toromont	8/8	115.1 MW	1 to 5 MW size units
Toronto Hydro Energy	3/2	20 MW	1 MW size units
TransCanada Pipeline	1/1	114 MW	23 MW size units
OEM/PEI	2/2	40 MW	5 MW size units
Total	19/17	411.9 MW	

Note that for a large number of the proposals, the MW capacity to be developed at a site is derived from the installation of multiple small generating units (typically 1 to 5 MW in size) of identical specifications and from the same manufacturer.

5 Assessment of Individual Project Proposals

The following sections provide a discussion of the salient aspects, results, conclusions and recommendations from the assessment of the individual projects. Note that a number

of projects (from the same proponent) have been grouped because of their many similarities. The findings and conclusions for the group would apply to them all individually. Also, the aspects of the “Markham Cluster” are covered in the discussions.

5.1 GasWorks Energy

Gasworks Energy proposes to install about 40 MW of temporary generation at 2 selected sites: Markham Amber MS and Markham John MS, under this CAA. At each site, the planned generation capacity is derived from an assembly of small commercially 1 MW available generation units.

5.1.1 Markham Amber MS 13.8 kV-20X1 MW and Markham John MS 13.8 kV-20X1 MW

a) Project Description and Connection Arrangement

Gasworks Energy proposes these two projects in the Markham area. The two projects have the following common features:

- Use of the 1 MW GE JES320 reciprocating genset
- Embedded in the distribution system of the host LDC, Markham Hydro
- Load displacement in nature
- 20 MW of aggregate output at each site

Generator voltage is 480V for these installations. Each site will use ten 0.48/13.8 kV 2.5 MVA step-up transformers to allow connection to the LDC’s 13.8 kV system at the respective MS.

b) Generator Data Verification

The generating units, proposed for both Markham Amber and John sites, are rated at 1319 kVA and deliver 1056 kW at 0.8 power factor. The table below shows some of the machine reactance parameters and time constants that are provided as part of the technical specifications for JES320 type GE generator. The values of these parameters are in the reasonable range, as found in the industry. The response tests for excitation and governing systems were not required in this case since the net installed output at the sites is less than 50 MVA.

Generator data for GE JES320 type machines.

GENERATOR DATA DESCRIPTION	Value	Comments
Rated output (kVA)	1319	At ISO conditions
Rated voltage (V)	480	
Rated power factor	0.8	Meets the MR requirements for reactive power generating capability

GENERATOR DATA DESCRIPTION	Value	Comments
Rated output (kW) at p.f. = 0.8	1056	
Rated Speed (rpm)	1800	
T'do	3.16	
T''do	-	Not provided
T'qo	-	Not provided
T''qo	-	Not provided
H	0.626	Combined Moment of Inertia = 1103.87 lbs-ft ²
D	0.00	Assumed
Xd	2.02	
Xq	-	Not provided
X'd	0.15	
X'q	-	Not provided
X''d	0.11	
Xl	-	Not provided
S(1.0)	-	Not provided
S(1.2)	-	Not provided

c) Local Area Impact

Being embedded resources, the LDC is responsible for ensuring acceptability of short circuit, thermal loading and voltage effect with their incorporation into their distribution system. Due to their load displacement nature, the local area impact is not expected to be adverse, and possibly positive.

There are four individual project proposals associated with this application that identified Markham TS#1, Markham Amber MS, Markham John MS, and Markham District Energy as the connection points. It is neither valid nor appropriate to assess each project independently of each other. It is also inefficient to consider all possible combinations of potential developments. Instead, a worst case scenario considering the total sum output of all these proposals for TS#1 was studied. The details and results of the loadflow studies performed for this "Markham Cluster", which has about 94.5 MW of total generation connected to TS#1 are documented in Appendix I.

The results of the loadflow studies show that the added generation provided improved voltage support to TS#1. The total peak demand at the station was about 120 MW. A generation injection of 94.5 MW on the TS#1 28 kV bus resulted in a load displacement, and a reduction in the power flow over the TS#1 transformers.

It was also found that, based on the system condition assumed, the proposed imbedded generation had positive impact on this system because it reduced the power flows from

both the Cherrywood and Richview terminals on these circuits (see Figures 5.1.2a and 5.1.2b).

In terms of voltage impact, a worst case contingency of losing all the added generation at TS#1 resulted in less than a 1% voltage decline on the 230 kV system and about 5.3% on the TS#1 28kV bus. Both are considered acceptable as compared to the 10% decline allowed for a single contingency, especially considering the unlikely event of losing all the added generation in a single contingency at this station.

Thus, from both thermal loading and voltage impact perspectives, all the proposed generation at TS#1 can be incorporated without adverse impact on the IMO-controlled grid. This conclusion would apply to each individual project proposals for connection to TS#1.

However, the above conclusion does not apply to short circuit impact in the local area. Short circuit study results were not provided to the IMO as part of this CAA. In this case, the LDC would be performing the short circuit studies and assessing the impact on existing facilities. Again, this must be done from a “Markham Cluster” perspective. The interrupting capabilities of existing circuit breakers and/or short circuit withstanding capabilities of station equipment would limit the total amount of generation that may be added on the 28 kV buses of TS#1.

Thus, from a local area impact perspective, the new generation proposed by Gasworks Energy for connection into Markham TS #1 has no adverse impact to the system performance of the local area with respect to thermal and voltage considerations. Short circuit consideration, however, may limit the total amount of generation that may be installed there from a “cluster” perspective.

d) System Impact

Generation at both sites will reduce transfers into the GTA. For this reason and that the amount of generation added is small as compared to the size of demand in the GTA, dynamic simulation was not conducted.

e) Conclusions and Recommendations

Based on the above assessment, there will be no adverse impact on the IMO-controlled grid with the incorporation of the proposed generation, with the exception of short circuit consideration from a “Markham Cluster” perspective.

The proponent must come to an agreement with the Distributor on the final design and specification of the connection facilities prior to their installation and connection.

Markham Hydro, the LDC, must ensure that the generation added by this Project to Markham TS#1 will not result in the short circuit exceeding the capabilities of equipment at that station, and the impact on their distribution system is acceptable.

Subject to the requirements noted above, it is concluded that the incorporation of the proposed facilities will have no adverse impact on the existing IMO-controlled grid. It is therefore proposed to issue a Notification of Approval of the Connection Proposal for this Project.

5.2 TransAlta

TransAlta proposes to make available for temporary and emergency use 60 MW of temporary generation at its existing Sarnia site. This capacity is derived from a 50 MW unit (G2) and a 29 MW unit (G4) that are already installed. While the rated capability of G4 is 33.88 MVA, TransAlta offers only 10 MW for emergency use. The Connection Assessment for these units was performed in 2001. It concluded that, if they were to connect as proposed, they would not have an adverse impact on the IMO-controlled grid (copies of the Preliminary Assessment Report and System Impact Assessment Report can be found at http://www.theimo.com/imoweb/pubs/caa/caa_prelimAssess_TransAlta.pdf and http://www.theimo.com/imoweb/pubs/caa/caa_SIAReport-1.pdf on the IMO web site). As such, they were approved for connection in 2001. However, due to operational and environmental reasons, these units, G2 and G4, are not presently included in the Ontario available capacity.

This Connection Assessment concluded that:

- The IMO understands that TransAlta unit 2 may be in an extended maintenance state. TransAlta is required to confirm that this unit can be made operational in the target timeframe.
- The operation of TransAlta unit 4 is currently restricted by an environmental regulation. TransAlta is required to provide evidence that the environmental restrictions have been lifted.

The proposed TransAlta facilities are located near Sarnia. There is an existing transmission congestion point on the IMO-controlled grid in the vicinity of London. IMO advises that there is a very low, but not zero, probability of transmission congestion over the summer that could limit the utilization of this facility if it is selected.

Based on this review and the Connection Assessment that was completed in 2001, it is concluded that, subject to the requirements listed above, the incorporation of the proposed facilities will have no adverse impact on the existing IMO-controlled grid. It is therefore proposed to issue a Notification of Approval of the Connection Proposal for these Projects.

5.3 Kingston Co-Gen

Kingston Co-Gen Limited Partnership (KCLP) proposes to install 22.8 MW of temporary generation at its existing generating plant located near Kingston, Ontario.

5.3.1 Kingston Co-Gen 230kV-1X22.8 MW

a) Project Description and Connection Arrangement

The KCLP proposal is to install 22.8 MW of temporary generating capacity at its existing 110 MW combined-cycle generating plant near Kingston, Ontario. The new generating capacity will be derived from a portable GE TM 2500 generating system operating at 13.8 kV. The new generator will be connected to the IMO-controlled grid at an existing 230 kV bus in the KCLP plant via a 13.8/230 kV 25 MVA transformer and a 230 kV circuit breaker. That bus is currently used to connect the existing 98 MW G1 generating unit and the line tap to 230 kV circuit X1H. The proposed single line arrangement is shown in Figure 5.3.1a.

The proponent did not provide with this application other relevant information related to the connection facilities, such the impedances, tap ratios and winding configurations of the step-up transformers and the ratings of the 230kV circuit breakers.

The general arrangement and basic provisions of the proposed connection are considered adequate – the transformers have adequate MVA ratings, and isolating devices are provided on the 230 kV side of the connection. Notwithstanding the general acceptability of the connection arrangement, that the final design and specification of the proposed connection facilities, including those required for relaying & protection, control, metering, monitoring, and communication, must meet the minimum standards specified in the OEB’s Transmission Code, the specific facility requirements of the Transmitter (HydroOne, in this case), and the performance requirements, where applicable, covered under Chapter 4 of the Market Rules.

b) Generator Data Verification

The following table shows the reactances and time constants for the proposed generating unit. They are in the reasonable range.

Generator Data for Gas Turbine Unit

GENERATOR DATA DESCRIPTION	Value	Comments
Rated output (kVA)	32,235	
Rated voltage (kV)	13.8	
Rated power factor	0.85	Meets the MR requirements for reactive power generating capability
Rated output (kW) at p.f. = 0.85	27,400	
Rated Speed (rpm)	3600	
T’do	7.64	

GENERATOR DATA DESCRIPTION	Value	Comments
T ^{'do}	0.05	
T ^{'qo}	2.33	
T ^{''qo}	0.05	
H	0.233	Combined Moment of Inertia = 423 kg-m ² is low
D	0.00	Assumed
X _d	2.57	
X _q	2.35	
X' _d	0.248	
X' _q	0.41	
X'' _d	0.172	
X _l	0.16	
S(1.0)	0.14	
S(1.2)	0.83	

Appendix 4.2 of the Market Rules requires that generating unit 10 MVA or larger be operated with a speed governor which has a permanent speed droop that can be set between 3% and 7% and the intentional dead band shall not be wider than +36 mHz.

The governor model for the new generator provided by the proponent is shown in Figure 5.3.1c. The governor droop for the Kingston Co-Gen new unit based on the information provided is set to 4%.

Dynamic simulations were performed with this model to verify the transient response of the governor in isolation of the rest of the system, to a load change of 10%. The results are shown in Figure 5.3.1b and indicate that the governor response as modeled is well damped. Based on this test, the response performance of the governor system of this new unit meets the requirements of the Market Rules.

Information on the excitation model used by the new generator was not provided by the proponent. A response test for the excitation system was conducted assuming that the new generator would have the same type of exciter models (EXST1) as the existing G2 unit at the KCLP Kingston plant. The results of that test are shown in Figure 5.3.1d. Performance was shown to be adequate. If the new generator is to have exciter models greatly different from that assumed, than its performance will have to be re-verified.

c) Local Area Impact

The impact to the short circuits, thermal loading and voltages in the Kingston-Lennox area as the result of incorporating the proposal generation was assessed.

The short circuit assessment was conducted by HydroOne. They concluded that there will be no appreciable change in short circuit level at the surrounding major stations - Lennox, Hinchinbrooke and Kingston-Gardiner TSs, and the interrupting capability of the existing circuit breakers at these stations will be adequate for the higher level of short circuit currents.

With regard to thermal loading, loadflows depicting a 2003 Summer Peak condition with the new generation added at the KCLP plant were simulated. The results show that the addition of the 22.8 MW of new generation increased the loading on X1H from the KCLP tap to Hinchinbrook, the most affected section of that circuit, by about 6 MW, from 144 MW to 150 MW. There is ample capability on this circuit to carry the increased transfer. The increases on the other three Lennox X Hinchinbrook 230 kV circuits were negligible. The higher loading on the KCLP to X1H line tap (from 84 to 107 MW) was well within its rating (1050 A or about 417 MVA in the summer). Contingency loadflow tests were judged not to be necessary since the affected Lennox X Hinchinbrook circuits were lightly loaded, and the addition of the new generation was shown to have minimal impact on the loading of these circuits.

Local voltage impact was assessed using contingency loadflows. Tests were conducted simulating the sudden loss of the new generation and G1 (a total of about 107 MW) at KCLP. Results for this case show that the resulting impact on the 230 kV voltage in the area was negligible.

Thus, from a local area impact perspective, the 22.8 MW of new generation proposed by KCLP at its Kingston plant has no adverse impact to the system performance of the local area.

d) System Impact

The 22.8 MW of new generation will be injected into Hinchinbrook and Lennox. This will most likely increase the flow into the GTA from the east by approximately that amount assuming that it displaces flows on the transmission interfaces west of the GTA. There is currently no congestion associated with this westbound transfer. Thus, the impact of the new generation on the system is considered minimal. For this reason and that the amount of generation added is small as compared to what is existing there, dynamic simulation was not conducted.

e) Conclusions and Recommendations

Based on the above assessment, there will be no adverse impact on the IMO-controlled grid with the incorporation of the proposed generation.

Because this unit will be connected directly to the BES and its rating is greater than 10 MVA, full adherence to the Market Rules requires the provision of detailed generator

model data to the IMO, and verification of the performance of their exciters and stabilizers in conformance with those requirements specified under Chapter 4 of the Market Rules. These requirements as related to the exciter model data have not been met by this Project proposal. However, in view of the facts that these generators will be employed under system emergency situations and the individual generators are commercially available units widely used throughout the industry, the risk of poor design and negative performance impact on the system is considered to be small. Nevertheless, the proponent must provide the required information to the IMO once it is available or a formal exemption must be sought from the IMO to exempt this requirement.

Additionally, the proponent must come to an agreement with the Transmitter, HydroOne in this case, on the final design and specification of the connection facilities prior to their installation and connection.

Subject to the requirements noted above, it is concluded that the incorporation of the proposed facilities will have no adverse impact on the existing IMO-controlled grid. It is therefore proposed to issue a Notification of Approval of the Connection Proposal for this Project.

5.4 Toromont

Toromont proposes the installation of about 115.1 MW of temporary generation at 8 sites across Ontario under this CAA. At each site, the planned generation capacity is derived from an assembly of small commercially available generation units with sizes ranging from 1.25 to 5.2 MW.

5.4.1 Beare Rd 4 kV-9x1.25 MW; Kodak 28 kV-2X1.25 MW; and Markham District 28kV-2X1.25 MW

a) Project Description and Connection Arrangement

These three project proposals have the following common features:

- Use of the 1.25 MW Cat XQ1250 Module
- Embedded in the distribution system of the host LDC
- Load displacement in nature
- Less than 10 MW in aggregate output except for the Beare Rd installation which is 11.25 MW

b) Generator Data Verification

Generator and detailed connection data are required for aggregate generation installation of 10 MVA or greater. This was not provided by the proponent for the Bear Road project.

c) Local Area Impact

Being embedded resources, the LDCs affected are responsible for ensuring that the short circuit, thermal loading and voltage impacts on their distribution systems are acceptable with the incorporation of the new generation. Being load displacement in nature, the local areas should not be adversely impacted.

d) System Impact

Generation at all three sites will reduce transfer into the GTA. For this reason and that the amount of generation added is small compared to the size of demand in the GTA, dynamic simulation was not conducted.

e) Conclusions and Recommendations

Based on this review, it is concluded that, subject to the requirement that the proponent must come to an agreement with the Distributors on the final design and specification of the connection facilities prior to their installation and connection, the incorporation of the proposed facilities will have no adverse impact on the existing IMO-controlled grid. Being greater than 10 MW in net capacity, there is also the requirement for the developer of the generation at the Beare Road site to provide the IMO with detailed generator model information of the units there. It is therefore proposed to issue a Notification of Approval of the Connection Proposal for these Projects.

5.4.2 Casco London 28kV-2X5.2 MW; Casco Port Colborne 28 kV-2X5.2 MW; Maple Lodge 28 kV-3X5.2 MW; and Regents Plastics 28 kV-2X5.2 MW

a) Project Description and Connection Arrangement

These four project proposals have the following common features:

- Use of the 5.2 MW Cat XQ5200 Mobile Power Unit
- Embedded in the distribution system of the host LDC
- Load displacement in nature
- Greater than 10 MW but less than 20 MW in aggregate output at each site

b) Generator Data Verification

The proponent did not provide any dynamic data for the generators. The power factor of the machines meets the Market Rules requirements.

c) Local Area Impact

Being embedded resources, the LDCs affected are responsible for ensuring that the short circuit, thermal loading and voltage impacts on their distribution systems are acceptable with the incorporation of the new generation. Being load displacement in nature, the local areas should not be adversely impacted.

Note that the generation at Casco Port Colborne will reduce the net power flow into the Allanburg 115 kV pocket, alleviating the loading of Allanburg 230/115 kV autotransformers that are known to be approaching their maximum loading capability. Thus, the generation addition at this site has a positive impact on the local system performance from this perspective.

d) System Impact

Generation at the Maple Lodge feeds into Brampton TS and will have a positive impact of reducing transfers into the GTA. Generation at Regents Plastics feeds into Barrie TS and will reduce transformer loading at that station. Thus, generation additions at these sites have positive impact on the system performance. On the other hand, generation at Casco London will increase transfers into the London Area from the west, while Casco Port Colborne will add to the Queenston Flow West transfers. Both interfaces are known congested points on the bulk system. Therefore, under some infrequent system conditions, generating units on these two sites may not be dispatched due to congestion on the respective transmission interfaces. Because of the amount of generation added is small, dynamic simulation was not performed.

e) Conclusions and Recommendations

Based on the above review, it is concluded that, subject to the requirements that the proponent must come to an agreement with the Distributors on the final design and specification of the connection facilities prior to their installation and connection, the incorporation of the proposed facilities will have no adverse impact on the existing IMO-controlled grid. It is therefore proposed to issue a Notification of Approval of the Connection Proposal for these Projects.

5.4.3 Markham TS#1 28kV-10X5.2 MW

a) Project Description and Connection Arrangement

Toromont proposes to install 52 MW of new generation on a site next to Markham Hydro's TS#1. This generation capacity will be derived from an assembly of ten commercially available Caterpillar 5.2 MW XQ5200 modules at 13.8 kV. The units will be connected to the TS#1 28 kV buses via either two 12 MVA 13.8/28 kV step-up transformers as listed in the summary table included in the application, or one 52 MVA 13.8/28 kV unit listed in the description of facilities on Site #6G also as part of the application. The latter would be more appropriate considering the rated output of the generator. Note that information related to the impedances, tap ratios and winding configurations of the step-up transformers, and the ratings of the circuit breakers was not provided by the proponent.

The final design and specification of the connection facilities, including those required for relaying & protection, control, metering, monitoring, and communication, must meet the minimum standards specified in the OEB's Distribution Code, the specific facilities

requirements of the LDC (Markham Hydro, in this case) and the requirements of the Market Rules.

b) Generator Data Verification

The proponent did not provide the required technical model data for its generators. Assessment of the generator performance as required by the Market Rules for generator installation of greater than 50 MVA could not be performed.

c) Local Area Impact

As discussed earlier, there are a number of individual project proposals associated with this Connection Assessment that identified Markham TS#1 as the connection point. It is neither valid nor appropriate to assess each project independently of each other. It is also inefficient to consider all possible combinations of potential developments. Instead, a worst case scenario considering the total sum output of all proposals for TS#1 was studied. The details and results of the loadflow studies performed for this “Markham Cluster”, which has about 94.5 MW of total generation connected to TS#1, are documented in Appendix I.

The results of the loadflow studies show that the added generation provided voltage support to TS#1, reduced loading on the supply transformers and 230 kV circuits, and generally had no adverse impact on the local system. This conclusion would apply to all the individual projects proposing to connect to TS#1.

However, the above conclusion does not apply to short circuit impact in the local area. Short circuit study results were not provided to the IMO as part of this CAA. In this case, the LDC, Markham Hydro, would be performing the short circuit studies and assessing the impact on existing facilities. Again, this must be done from a “Markham Cluster” perspective. The interrupting capabilities of existing circuit breakers or short circuit withstanding capabilities of station equipment would limit the total amount of generation that may be added on the 28 kV buses of TS#1.

d) System Impact

The 52 MW of generation injection onto the Markham bus will reduce the system flow into the GTA. The impact of the new generation on the system is positive as it reduces 230 kV line loading, MVA flows through the heavily loaded Cherrywood and Claireville 500/230 kV autotransformers, and provides reactive support to the area. For this reason and that the amount of generation added is small compared to the size of demand in the GTA, dynamic simulation was not conducted.

e) Conclusions and Recommendations

Based on the above assessment, there will be no adverse impact on the IMO-controlled grid with the incorporation of the proposed generation, with the exception of short circuit consideration from a “Markham Cluster” perspective.

Because these units have an aggregate output of greater than 50 MVA, full adherence to the Market Rules requires the provision of detailed generator model data to the IMO, and verification of the performance of their exciters and stabilizers in conformance with those requirements specified under Chapter 4 of the Market Rules. These requirements have not been met by this Project proposal. However, in view of the facts that these generators will be employed under system emergency situations and the individual generators are commercially available units widely used throughout the industry, the risk of poor design and negative performance impact on the system is considered to be small. Nevertheless, it is required that the proponent provide the required information to the IMO once it is available or a formal waiver be sought from the IMO to exempt this requirement.

Additionally, the proponent must come to an agreement with the Distributor on the final design and specification of the connection facilities prior to their installation and connection.

Markham Hydro, the LDC, must ensure that the generation added by this Project to Markham TS#1 will not result in the short circuit exceeding the capabilities of equipment at that station.

Subject to the requirements noted above, it is concluded that, the incorporation of the proposed facilities will have no adverse impact on the existing IMO-controlled grid. It is therefore proposed to issue a Notification of Approval of the Connection Proposal for this Project.

5.5 Toronto Hydro Energy Services

Toronto Hydro Energy Services proposes to install 20 MW of new temporary generation at three sites in Scarborough in northeast Toronto. At each site, the planned generation capacity is derived from an assembly of small 1 MW commercially available generation units.

5.5.1 Scarborough Site #1 13.8 kV-6X1 MW; Scarborough Site #2 13.8kV-6X1 MW; and Scarborough Site #3 13.8 kV-8X1 MW

a) Project Description and Connection Arrangement

These three project proposals have the following common features:

- Use of the 1 MW GE Jenbacher JES320 genset
- Embedded in the distribution system of the host LDC, Toronto Hydro
- Load displacement in nature
- Less than 10 MW in aggregate output at each site

b) Generator Data Verification

Only one type of generator (GE JES320) is proposed for all three sites in Toronto. It is rated at 1319 kVA and is capable of delivering 1056 kW at 0.8 power factor. The table below shows some machine reactance parameters and time constants. They are in the reasonable range.

Generator data for GE JES320 type machines

GENERATOR DATA DESCRIPTION	Value	Comments
Rated output (kVA)	1319	At ISO conditions
Rated voltage (V)	480	
Rated power factor	0.8	Meets the MR requirements for reactive power generating capability
Rated output (kW) at p.f. = 0.8	1056	
Rated Speed (rpm)	1800	
T'do	3.16	
T''do	-	Not provided
T'qo	-	Not provided
T''qo	-	Not provided
H	0.626	Combined Moment of Inertia = 1103.87 lbs-ft ²
D	0.00	Assumed
Xd	2.02	
Xq	-	Not provided
X'd	0.15	
X'q	-	Not provided
X''d	0.11	
Xl	-	Not provided
S(1.0)	-	Not provided
S(1.2)	-	Not provided

c) Local Area Impact

Being embedded resources, the LDCs affected are responsible for ensuring that the short circuit, thermal loading and voltage impacts on their distribution systems are acceptable with the incorporation of the new generation. Being load displacement in nature, the local areas should not be adversely impacted.

d) System Impact

Generation at these sites feeds into either Scarborough TS or Malvern TS in northeast Toronto. Both TSs serve large load centers. The generation from these three sites will have a positive impact in reducing transfers into these load pockets.

Because the amount of generation added is small, dynamic simulation was not performed.

e) Conclusions and Recommendations

Based on the above review, it is concluded that, subject to the requirements that the proponent must come to an agreement with the Distributors on the final design and specification of the connection facilities prior to their installation and connection, the incorporation of the proposed facilities will have no adverse impact on the existing IMO-controlled grid. It is therefore proposed to issue a Notification of Approval of the Connection Proposal for these Projects.

5.6 TransCanada Pipeline

TransCanada Pipeline (TCPL) proposes to install 114 MW of temporary generation near the Town of Cobourg in Eastern Ontario.

5.6.1 TCPL-Cobourg 115kV-5X22.8 MW

a) Project Description and Connection Arrangement

TCPL proposes to install 114 MW of temporary generating capacity at a site near its existing TCPL #136 Station. The new generating capacity will be derived from five turbine units rated at 22.8 MW each operating at 13.8 kV. The single line diagram provided by the proponent shows the five generators will be connected together to a common 13.8 kV bus. The total output is then stepped up to 115 kV through one 13.8/115 kV transformer and connected to the 115 kV bus at the TCPL #136 Station. A new 115 kV circuit breaker will be provided to enable switching and isolation of the generators.

TCPL #136 Station is connected to 115 kV circuit P4S, Dobbin to Sidney TS, about 34 km from Sidney TS, as shown in Figure 5.7.1a. Circuit P4S is about 100 km long – 45 km from Dobbin to Port Hope, and 55 km from Port Hope to Sidney.

The proponent has not provided with this application other relevant information related to the connection facilities, such as the MVA rating of the transformer, impedances (assumed to be 10% on 36 MVA base in the loadflow studies), tap ratios (assumed to be 115/13.8 kV in the loadflow studies) and winding configurations of the step-up transformers and the ratings of the 115 kV circuit breaker.

The general arrangement and basic provisions of the proposed connection are considered adequate – the transformers have adequate MVA ratings, and isolating devices are provided on the 115 kV side of the connection. It is assumed that each generator will also have its own unit breaker on the 13.8 kV side. Notwithstanding the general acceptability

of the connection arrangement, it is required that the final design and specification of the proposed connection facilities, including those required for relaying & protection, control, metering, monitoring, and communication, must meet the minimum standards specified in the OEB's Transmission Code, the specific facility requirements of the Transmitter (HydroOne, in this case), and the performance requirements, where applicable, covered under Chapter 4 of the Market Rules.

b) Generator Data Verification

TCPL provided a partial list of the required generator data with the application. The following are noted with regard to that information:

- The 0.8 power factor rating of the generators exceeds the Market Rules requirement for reactive capability at their terminal; however, high impedance step-up transformers could reduce some of this capability;
- Terminal voltage droop compensation will be required for optimizing reactive sharing of these units since they are bused together;
- The inertial constant given for the generators appears to be much smaller than for most machines (~1/4 of hydraulic units and ~1/10 of nuclear units)
- Generator data is missing saturation parameters S(1.0) and S(1.2); conservative values (0.2 and 0.6) were assumed in the dynamic simulation;
- Generator open circuit/short circuit curves are missing although mentioned in the submission;
- Generator capability curve provided as well as Z_{source};
- "V Curves" (i.e. I_{term} vs E_{fd}) calculated for model used is attached in Appendix II
- Exciter model time constants and saturation values, as submitted by the applicant, were retained in the dynamic simulation; however, gain and ceiling settings were replaced with more appropriate values;
- The governor model is not available; a typical turbine model was assumed for the dynamic simulation
- The dynamic model employed for the simulation is included in Appendix II.

Appendix 4.2 of the Market Rules requires that generating unit 10 MVA or larger be equipped with an excitation system with voltage response time not longer than 50 msec, and a ceiling voltage at least twice the rated field voltage.

Dynamic simulations were performed with the excitation model shown in Appendix II. The results show that the exciter, as modeled, did not meet the Market Rules requirements for speed of response. The excitation test response curves are also included in Appendix II.

Similarly, Appendix 4.2 of the Market Rules requires that generating unit 10 MVA or larger be operated with a speed governor which has a permanent speed droop that can be set between 3% and 7% and the intentional dead band shall not be wider than +36 mHz.

Dynamic simulations were performed with the governor model shown in Appendix II. The results show that the governor, as modeled, produced noticeable oscillatory response for a 20% load change test. The governor test response curves are also included in Appendix II. Tuning of the control parameters will be required to improve damping.

c) Local Area Impact

The impact to the short circuits, thermal loading and voltages in the Sydney-Port Hope Area as the result of incorporating the proposal generation was assessed.

The short circuit assessment was conducted by HydroOne using actual transformer data provided by TCPL. The results show that with the new generation at TCPL and maximum system conditions the short circuit levels in the area are within the interrupting capability of the station breakers. At Sidney TS however, where breakers are rated for 6.8 kA asymmetrical current, the short circuit currents are very close to the breaker ratings, but the equipment was considered to be adequate.

With regard to thermal loading, a loadflow depicting a 2001 Summer Peak condition with the new generation added at TCPL was simulated. The results show that the addition of the 114 MW of new generation could overload the TCPL tap to P4S. HydroOne has confirmed that the summer design rating (30 degrees C, 4 km/hr wind) of the connection circuit could limit the generation to about 95 MW. The applicant has indicated that during these conditions the output of the turbines is reduced to 93 MW. With winds of at least 10 km/hr or temperatures less than 0 degrees C, no restriction is expected. It was assumed that other connection equipment between the generators and the TCPL 115 kV bus would not be limiting.

Beyond the TPCL Station, under summer peak conditions, power flows will be from Dobbin to Sidney on P3S and P4S. The new TCPL generation will tend to unload P4S from Dobbin to Port Hope as well as B1S and Q6S into Sidney, and tend to load P4S from the TCPL site to Sidney. Distribution of flow on the 83 MVA 115/44 kV transformers at Port Hope on P3S and P4S will be unbalanced. For a maximum injection of 137 MW at TPCL, the following flow changes are observed on the critical 230/115 kV autotransformers in Eastern Ontario: Cataraqui (-41 MW); Dobbin (-84 MW); Merviale (-9 MW); and Hawthorne (-2 MW). Except for the tap to TCPL, no thermal overloads were observed in the pre-fault or post-contingency tests. The flow summaries without the TCPL proposal and following the loss of P3S with the TCPL proposal are included in Appendix II.

In terms of voltage impact, the new generation tends to improve reactive support and voltage regulation in the area.

d) System Impact

The 114 MW of new generation will be mostly injected into Dobbin and Cataraqui (Lennox) buses. This will most likely increase the flow into the GTA from the east by approximately that amount assuming that it displaces flows on the transmission interfaces

west of the GTA. There is currently no congestion associated with this transfer. Thus, the impact of the new generation on the system is considered minimal. Thus, dynamic simulation was not performed in terms of bulk system impact.

However, the 110 MW is considered to be a relatively large amount of generation injected into the Sidney-Port Hope 115 kV system. Thus, transient stability tests were conducted for contingencies on this system. The results show that the most severe contingency for the TCPL generators is a 3-phase fault at Sidney on P3S, although the fault at the Dobbin end is nearly as severe. The TCPL units were stable for this contingency, although, the period of TCPL unit oscillation is observed to be much higher than typical due to their low inertia. The exciter and governor models assumed for the TCPL units only made the damping worse. Better data and settings should resolve this issue. The dynamic response plots for this test are included in Appendix II.

e) Other Considerations

The method for isolating the TCPL units from faults on P4S was not included in the application. Note that there is no transfer tripping on P4S, and distance relays at Dobbins, Sidney and port Hope trip local breakers to clear P4S faults.

f) Conclusions and Recommendations

Based on the above assessment, overall, there will be no adverse impact on the IMO-controlled grid with the incorporation of the proposed generation. However a number of deficiencies were noted in the assessment that require remedy from the proponent. They include:

- Verifying the exciter and governor models and improving their response;
- Verifying by the Transmitter that the proposal will not exceed fault capabilities once the final technical specifications for the connection facilities are known;
- Verification by the Transmitter that TCPL will be isolated from faults is required.

It must be noted that the generation output is not to exceed 93 MW during the summer.

Because this unit will be connected directly to the BES and its rating is greater than 10 MVA, full adherence of the Market Rules requires the provision of detailed generator model data to the IMO, and verification of the performance of their exciters and stabilizers in conformance with those requirements specified under Chapter 4 of the Market Rules. These requirements as related to the exciter and governor performance have not been met by this Project proposal. However, in view of the facts that these generators will be employed under system emergency situations the risk of negative performance impact on the system is considered to be small. Nevertheless, it is required that the proponent provide the required information to the IMO once it is available or a formal waiver be sought from the IMO to exempt this requirement.

Additionally, the proponent must come to an agreement with the Transmitter, HydroOne in this case, on the final design and specification of the connection facilities prior to their installation and connection.

Subject to the requirements noted above, it is concluded that the incorporation of the proposed facilities will have no adverse impact on the existing IMO-controlled grid. It is therefore proposed to issue a Notification of Approval of the Connection Proposal for this Project.

5.7 OEM/PEI

Ontario Energy Management/Peninsula Engineering (OEM/PEI) proposes to install 40 MW of temporary generation resources in Hamilton and Kingston. At each site, the planned generation capacity is derived from a single or an assembly of 5 MW commercially available generation units.

5.7.1 McMaster 13.8 kV-4X5 MW; and Kingston 4 kV-4X5 MW

a) Project Description and Connection Arrangement

These three project proposals have the following common features:

- Use of the 5.2 MW Solar Taurus 60 Mobile Power Plant
- Embedded in the distribution system of the host customer or LDC system
- Load displacement in nature
- 20 MW in aggregate output at each site

b) Generator Data Verification

The following table shows the machine reactance and time constants, which are in the reasonable range.

Generator Data for 5.3 MW Units

GENERATOR DATA DESCRIPTION	Value	Comments
Rated output (kVA)	6,625	
Rated voltage (kV)	13.8	
Rated power factor	0.8	Meets the MR requirements for reactive power generating capability
Rated output (kW) at p.f. = 0.85	5,300	
Rated Speed (rpm)	1800	
T'_{do}	5.54	
T''_{do}	0.05	
T'_{qo}	-	Not Provided
T''_{qo}	-	Not Provided
H	0.893	Generator Only

GENERATOR DATA DESCRIPTION	Value	Comments
D	0.00	Assumed
Xd	1.976	
Xq	1.032	
X'd	0.288	
X'q	1.032	Appears a typo error
X''d	0.182	
Xl	-	Not Provided
S(1.0)	-	Not Provided
S(1.2)	-	Not Provided

c) Local Area Impact

The Kingston proposal will be an embedded resource. The affected LDC, Utilities Kingston, is responsible for ensuring that the short circuit, thermal loading and voltage impacts on their distribution systems are acceptable with the incorporation of the new generation.

The McMaster proposal is connected to a customer transformer station. That customer is responsible for ensuring that the short circuit, thermal loading and voltage impacts on their system are acceptable with the incorporation of the new generation.

Due to their small size and load displacement in nature, no adverse impact on the IMO-controlled grid is expected from these two generation proposals.

d) System Impact

Generation at the McMaster site feeds into 115 kV McMaster TS in the Hamilton area. The Kingston site feeds into Frontenac TS in the Kingston area. Both serve relatively large load centers. The generation from these sites will have a positive impact in reducing transfers into the respective load pockets.

Because the amount of generation added is small, a dynamic simulation was not performed.

e) Conclusions and Recommendations

Based on the above review, there will be no adverse impact on the IMO-controlled grid with the incorporation of the proposed generation subject to the review of short circuit impact on its system by the LDC or Direct Customer. Additionally, the proponent must come to an agreement with the Distributor or Direct Customer on the final design and specification of the connection facilities prior to their installation and connection.

Being over 10 MW in aggregate output at each site, the IMO requires that the proponent provides detailed generator and connection data to the IMO when it is available.

Based on the above review, it is concluded that, subject to the requirements that the proponent must come to an agreement with the Distributor or Direct Customer on the final design and specification of the connection facilities prior to their installation and connection, the incorporation of the proposed facilities will have no adverse impact on the existing IMO-controlled grid. It is therefore proposed to issue a Notification of Approval of the Connection Proposal for these Projects.

6 Summary of Connection Assessment Results and Conclusions

A summary of the assessment results is contained in the attached spreadsheet Table A.

The salient results and conclusions are:

- None of the project proposals was shown to have an adverse impact on the IMO-controlled grid. In fact, some are beneficial to the local network and/or the bulk system in the vicinity of the installations;
- The concentration of proposals for connection to Markham TS#1 is a concern from the aspect of short circuit interrupting capability of existing equipment;
- In all cases, the design and specification of the actual connection facilities have not yet been finalized;
- In cases where the Market Rules require that detailed information on connection facilities and generators be provided to the IMO, the information is incomplete or not available.

The overall conclusion is that all of the projects covered under this Connection Assessment have no adverse impact on the reliability of the existing IMO-controlled grid subject to implementation of the requirements identified in the following Section 7 and detailed earlier in Section 5. However, the facilities, as proposed, will require IMO Market Rule exemptions with respect to data submission, performance requirements, market participation, revenue metering, operational telemetry and operating schedules. The extent of the exemption requirements vary depending on the proposal. IMO staff expect to be able to recommend that these exemptions be granted, but the decision rests with the independent members of the IMO Board. **OEFC will need to begin this process as early as possible to facilitate a timely decision.**

7 IMO Connection Requirements

This section summarizes the requirements identified in this Connection Assessment for incorporating the various project proposals under the Temporary Generation Program for

the summer and autumn of 2003. More detailed discussions are provided in Section 5 for the individual projects.

General Requirements

- For all the projects, it is expected that the final design and specification of the connection facilities, including relaying & protection, control, metering, monitoring, and communication will meet the minimum standards specified in the OEB's Transmission or Distribution Code, the specific facility requirements of each respective Transmitter or LDC, and the requirements of the Market Rules. The proponent must come to an agreement with the Transmitter or Distributor on the final design and specification of the connection facilities prior to their installation and connection.
- The IMO assumes that all the facilities will provide protective relaying that is properly co-ordinated and acceptable to the host LDC or Transmitter.
- None of the facilities proposed to connect directly to a transmitter has been assessed from a customer impact perspective. The customer impact assessment is an OEB requirement on Transmitters. Connection of the facilities is subject to the acceptable resolution of any customer impact issues between the proponent and the Transmitter.
- The IMO assumes the proposals will satisfy applicable environmental regulations.

Specific Requirements to the Proposals Directly Connected to the IMO-Controlled Grid

- It is assumed that revenue metering satisfactory to the IMO will not be installed at any of these sites. In these cases IMO assumes that it will be able to estimate the aggregated load consumption of these facilities and charge OEFC for the additional energy demand.
- With respect to the TransAlta proposal, these facilities are proposed to connect behind an existing revenue meter used for other facilities already settled in the IMO market. In these cases there may be incorrect energy or congestion management settlement credits paid to these existing market participants.
- HydroOne indicates that all directly connected facilities (TCPL-Cobourg, Kingston Co-Gen, TransAlta, and Gasworks-Hawthorne) could have an adverse effect on the reliability of nearby connected customers. To mitigate this, all are expected to employ duplicate protective relaying, to be disconnected from the grid when not required, and to be capable of being put on potential via the disconnect at their point of interconnection.
- With respect to the TransAlta proposal, consisting of units G2 and G4, IMO advises the following:

- The proposed TransAlta facilities are located near Sarnia. There is an existing transmission congestion point on the IMO-controlled grid in the vicinity of London. IMO advises that there is a very low, but not zero, probability of transmission congestion over the summer that could limit the utilization of this facility if it is selected.
 - IMO understands that the operation of TransAlta unit 4 is currently restricted by an environmental regulation.
- With respect to the Gasworks Hawthorne proposal, HydroOne confirms that the existing breakers have adequate interrupting capability for the new proposal **until the 2nd quarter of 2004**. At that time, HydroOne plans to make transmission additions that will need to make use of the capability taken up by the new generation. Initial indications from HydroOne are that the generation would also require duplicate protections to mitigate potential degradation to customer reliability.
 - With respect to the TCPL-Cobourg proposal, the location is one that poses some challenges to provide adequate protections. Initial indications are that duplicate high-speed protections will be required at TCPL-Cobourg that must be time-co-ordinated with the existing 115kV line protections. Some setting changes at Port Hope may also be required. Protection studies are not yet complete and other requirements may also be identified. In addition to the protection issues, HydroOne has also confirmed that the summer design rating (30 degrees C, 4 km/hr wind) of the connection circuit is **about 95 MW**. The applicant has indicated that during these conditions the output of the turbines is reduced to 93 MW. With winds of at least 10 km/hr or temperatures less than 0 degrees C, no restriction is expected. IMO notes that the submitted one-line diagram for the proposal shows a 115 kV breaker where none currently exists, but there is no mention of a new breaker to be supplied.

Specifics to the Proposals Connected to LDCs

- With the exception of Toromont at Markham, each of the other sites is proposed to be less than 50 MVA in aggregate, and are judged not to have any adverse effect on the IMO-controlled grid.
- For all connections to distribution feeders, once final connection points are established, IMO requires that the selection of feeders for under-frequency load tripping be reviewed and modified where necessary.
- IMO cautions that all of the proposals appear to connect to points on the distribution system that may not have been designed to accommodate a generation injection. This may pose varying challenges to the LDC to facilitate the connection, such as:
 - the short circuit interrupting capability of the LDCs equipment,
 - the allowable voltage change experienced by nearby customers if the generator were to trip, and
 - the compatibility and co-ordination of the generator's protective relaying with that of the host or LDC.

Equipment short circuit capability will limit the amount of generation to be select at a given site.

The allowable voltage dip following a generation loss could also significantly limit the amount of generation permitted at a station or on feeders. Typical values vary significantly depending on the connection point on the distribution system, and should be examined by the LDC.

Relaying requirements generally can be overcome, but may delay implementation if telecommunication is required.

- IMO makes special note of the proposals at Markham. Four projects (two Gasworks and two Toromont) totalling about 94.5 MW are proposed at or near Markham TS#1. This appears to be high for the distribution system, and needs to be evaluated by Markham Hydro. The proposals were also missing single-line diagrams therefore the IMO cannot comment on the amount of a generation trip and resulting voltage dip that could result from a single failure. The estimated peak load of this station is about 120 MW. Therefore, the generation will effectively reduce the net power injection from the IMO-controlled grid. Examination of the relaying is required to ensure acceptable operation under these conditions.
- IMO found no adverse thermal or voltage effects on the IMO-controlled grid with all of these proposals connected.
- With respect to the proposals by Toromont located at Casco London, Casco Port Colborne, Niagara-on-the-Lake, and St. Catherine, these are all connected in series with potential congestion points on the IMO-controlled grid. IMO advises that there is a very low, but not zero, probability of transmission congestion over the summer that could limit the utilization of these facilities if selected.

8 IMO Compliance Requirements

Full adherence to the Market Rules requires the provision of detailed generator model data to the IMO unless the proposed generation is embedded in the distribution system and has a net plant capacity of less than 10 MVA. Additionally, for units greater than 10 MVA or with plant capacity exceeding 50 MVA, verification of the performance characteristics of their generators, exciters, stabilizers and governors in conformance with those requirements specified under Chapter 4 of the Market Rules is required.

In general the submissions did not satisfy all of the data requirements to fully assess the performance characteristics of the generating units, especially with respect to their excitation and governor controls. Given that these units are small, and consist of standard, commonly-used or “off-the-shelf” equipment, IMO assumes their operating parameters will lie in a typical and acceptable range, and judges their performance to be acceptable. Nevertheless, it is required that the proponent provide the required

information to the IMO once it is available or a formal exemption be sought from the IMO to exempt this requirement.

9 Notification of Approval

This Connection Assessment has assessed the impact of the various project proposals on the IMO-controlled grid and has identified IMO's requirements for connection to ensure no negative effect on the reliability of that system.

It is recommended that Notifications of Approval be granted for all the projects, subject to the implementation of the requirements stipulated in Sections 7 and 8 of this report.

Note that these generation proposals were approved on the basis that they will only remain connected and available for use until April 30, 2004. Proponents who decide to keep their facilities operational after this date and participate in the IMO administered markets will have to complete the normal Connection Assessment and Approval process, and the Facility Registration process.

FIGURES AND TABLES

Figure 5.1.2a: “Markham Cluster” System Diagram Before Generation Addition

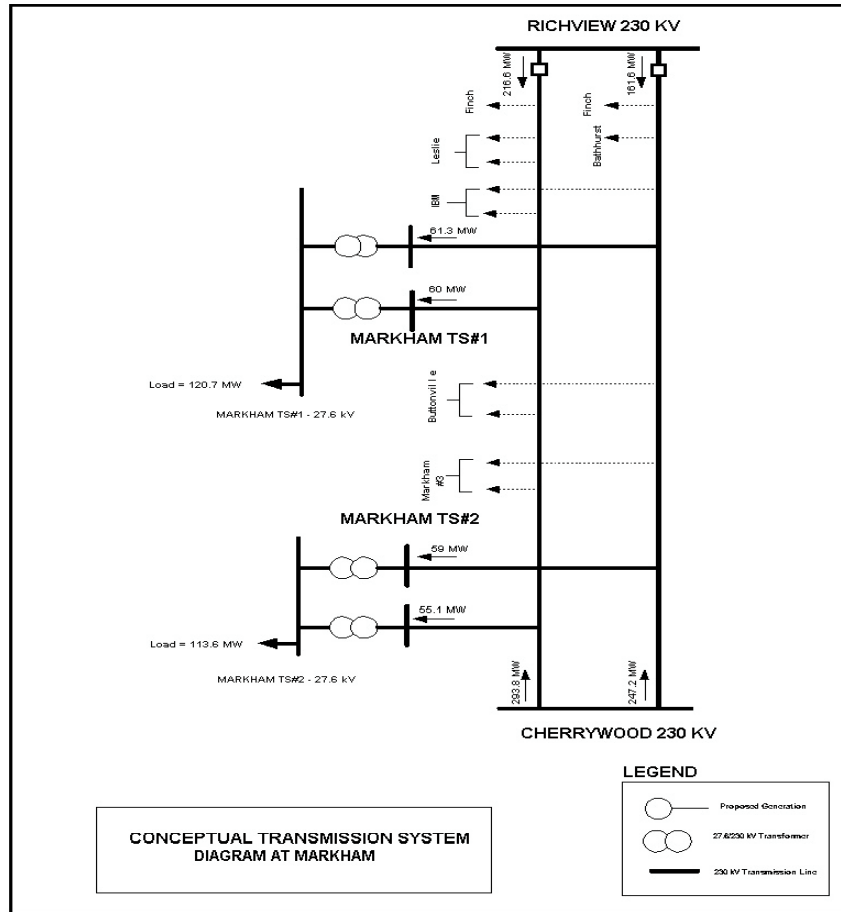


Figure 5.1.2b: “Markham Cluster” System Diagram After Generation Addition

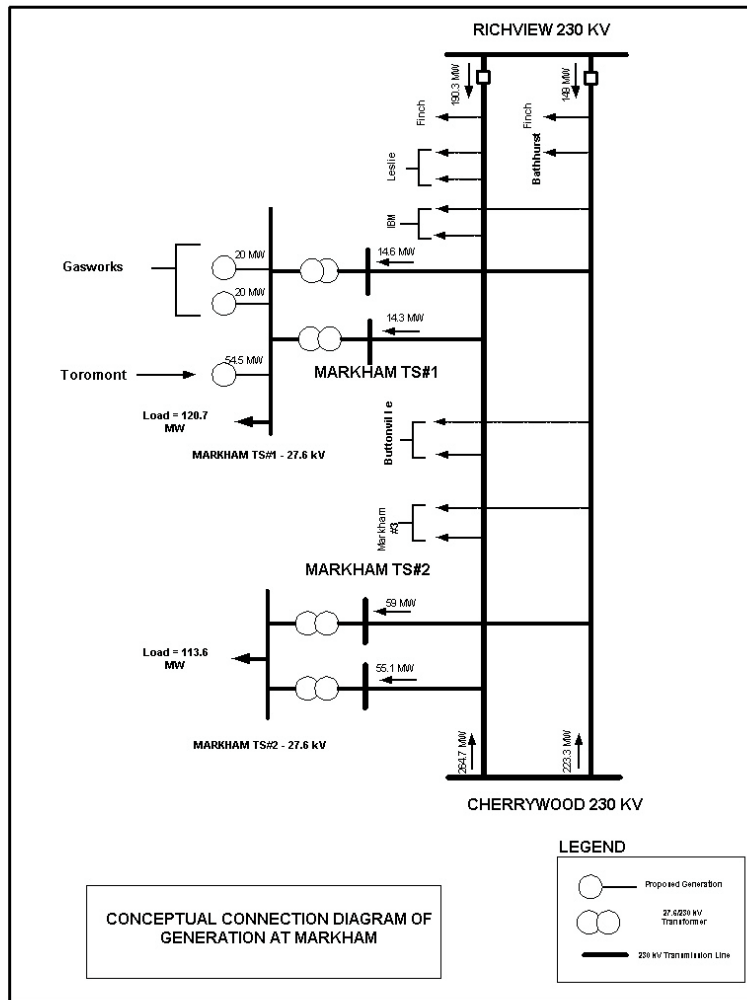


Figure 5.3.1a: Kingston Co-Gen Connection Diagram (Assumed)

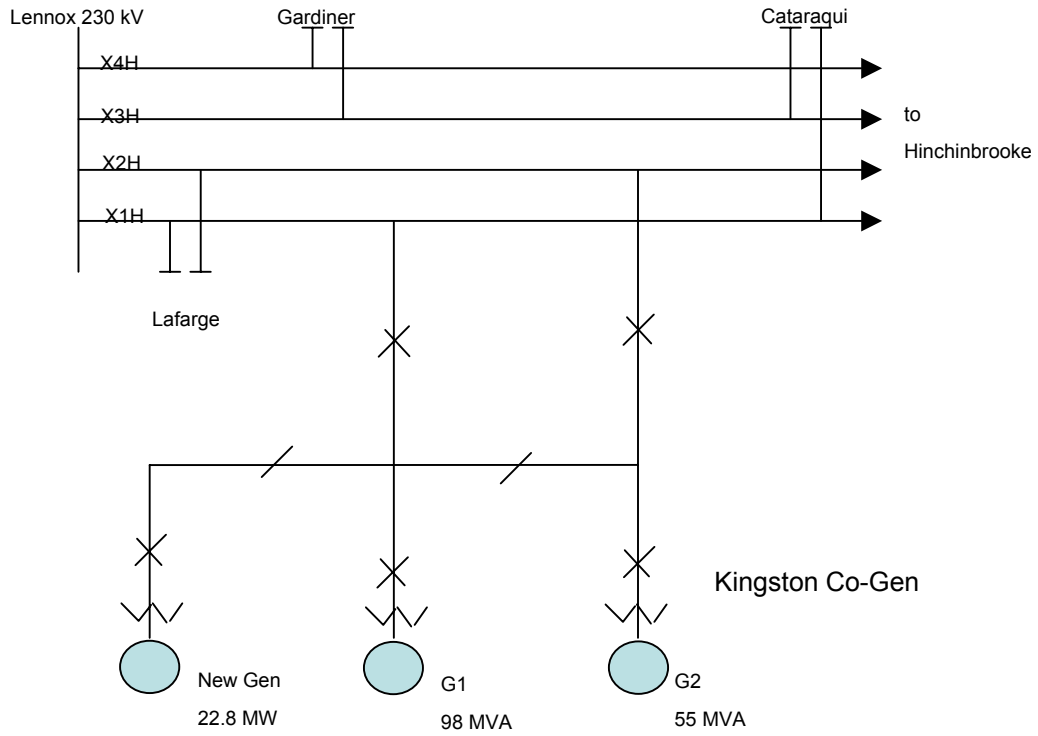


Figure 5.3.1b: Kingston Co-Gen Governor Response Test Results

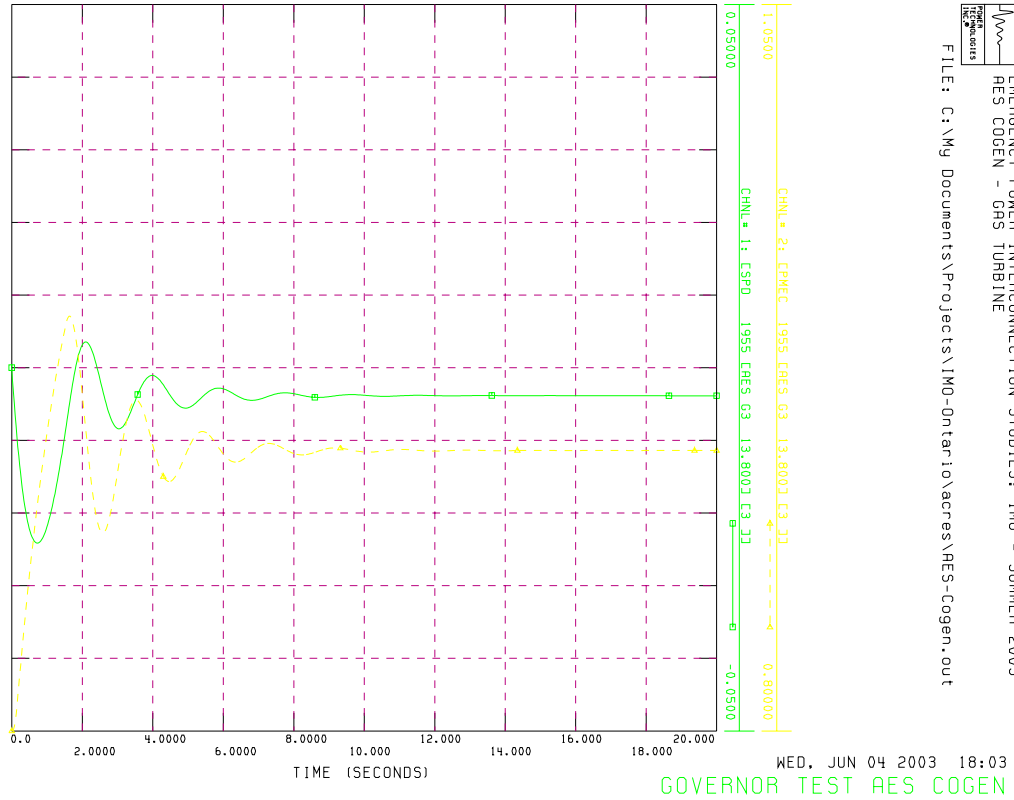


Figure 5.3.1c: Kingston Co-Gen GAST Governor Model

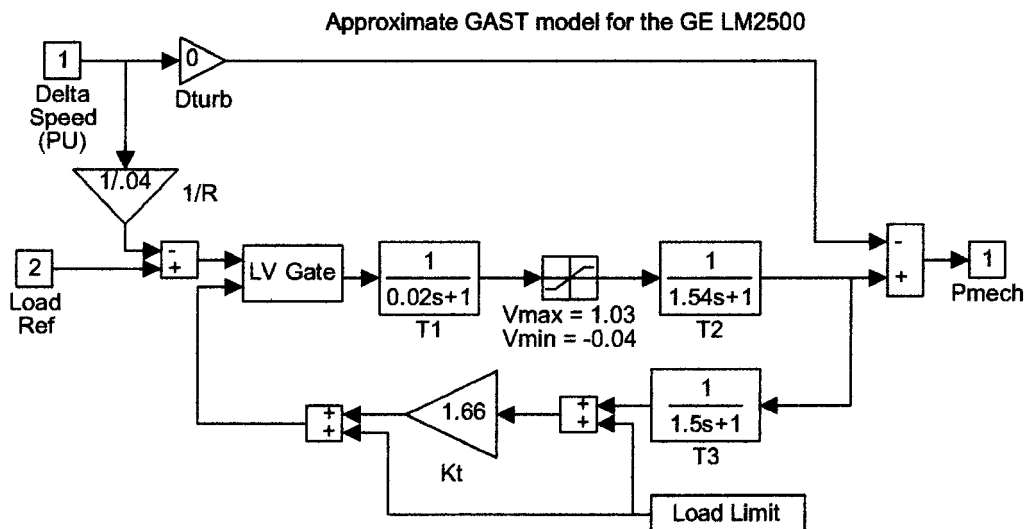
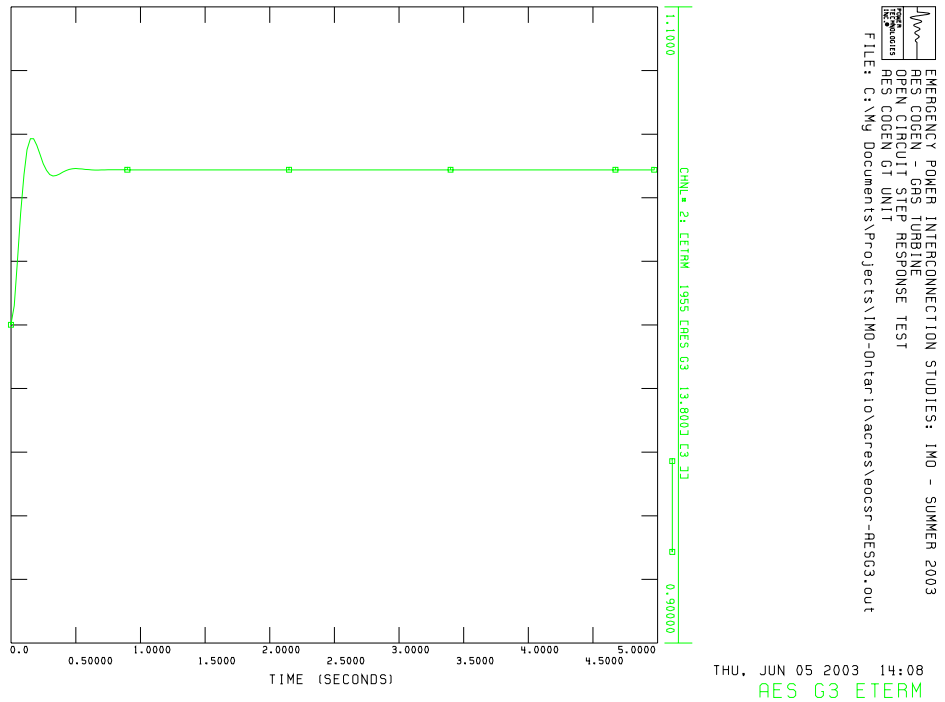
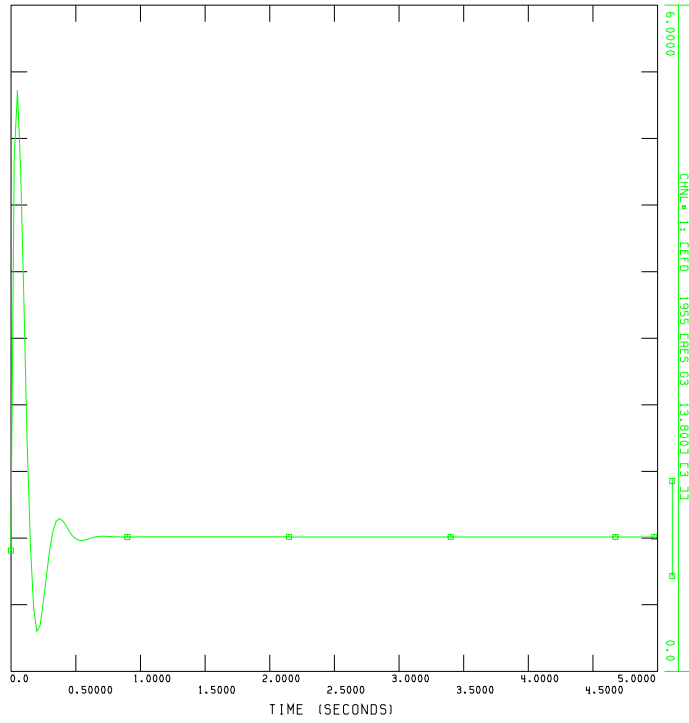


Figure 5.3.1d Kingston Co-Gen Exciter Response Test Results

i. Open Circuit Step Response Test – Terminal Voltage



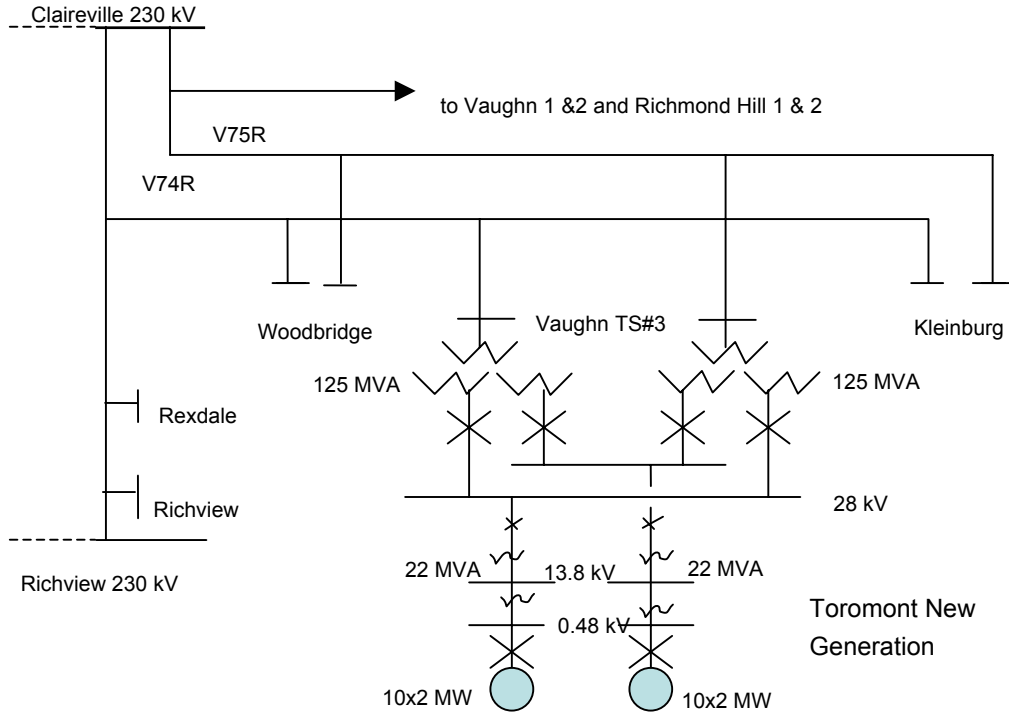
ii. Open Circuit Step Response Test – Field Voltage



EMERGENCY POWER INTERCONNECTION STUDIES: IMO - SUMMER 2003
AES COGEN - GAS TURBINE
OPEN CIRCUIT STEP RESPONSE TEST
AES COGEN GT UNIT
FILE: C:\My Documents\Projects\IMO-01tar-10\acres\ecocr-AESG3.out

THU, JUN 05 2003 14:15
AES G3 EFD

Figure 5.4.6a: Toromont – Vaughn TS#3 Connection Diagram (Assumed)



Proposal #	Section # in CAA Report	Proponent	General Location	Description	Rated MW	Connection Point	Impacted BES TS	Connection Category	Conn. Facilities
1.3	5.1.3	GasWorks Energy	Markham Amber MS	20X1MW (gas)	20.0	Markham Amber MS 13.8 kV	Markham TS#1 230kV	LDC embedded@13.8kV; load displ	10XTrf (.48/13.8kV, 2.5MVA)
1.4	5.1.3	GasWorks Energy	Markham John MS	20X1MW (gas)	20.0	Markham John MS 13.8kV	Markham TS#1 230kV	LDC embedded@13.8kV; load displ	10XTrf (.48/13.8kV, 2.5MVA)
				Subtotal==>	40.0				
2.1	5.2.1	TransAlta	Sarnia	1X50MW (gas)	50.0	Dow Chemical 230kV bus	Dow Chemical 230kV	BES direct @230kV	1XTrf(14.4/230kV; ?MVA; existing)
2.2	5.2.2	TransAlta	Sarnia	1X29MW (gas)	10.0	Dow Chemical 230kV bus	Dow Chemical 230kV	BES direct @230kV	1XTrf(14.4/230kV; ?MVA; existing)
				Subtotal==>	60.0				
3.1	5.3.1	Kingston Cogen	Kingston	1X22MW (gas)	22.8	AES Kingston 230kV bus	AES Kingston 230kV	BES direct @230kV	1XTrf(13.8/230kV; ?MVA)
				Subtotal==>	22.8				
4.1	5.4.1	Torontom	Bear Rd	9X1.25 MW (gas)	11.3	THES 4.16kV system	Malvern TS 230 kV (likely)	LDC embedded@27.6kV; load displ	1XTrf(4/28kV; 8MVA)
4.2	5.4.2	Torontom	Casco London	2X5.2 MW (gas)	10.4	London Hydro 27.6kV system	N/A	LDC embedded@27.6kV; load displ	1XTrf(13.8/28kV; 13MVA)
4.3	5.4.2	Torontom	Casco Pt Col	2X5.2 MW (gas)	10.4	Port Colborne 27.6kV system	Port Colborne 115kV	LDC embedded@27.6kV; load displ	1XTrf(13.8/28kV; 12MVA)
4.4	5.4.1	Torontom	Kodak	2X1.25 MW (gas)	2.5	THES 27.6 system	N/A	LDC embedded@27.6kV; load displ	1XTrf(13.8/28kV; 6MVA)
4.5	5.4.2	Torontom	Maple Lodge	3X5.2 MW (gas)	15.6	Brampton Hydro 27.6kV system	Brampton TS	LDC embedded@27.6kV; load displ	1XTrf(13.8/28kV; 20MVA)
4.6	5.4.3	Torontom	Markham #1	10X5.2MW (gas)	52.0	Markham TS#1 28kV bus	Markham TS#1 230kV	LDC direct@28kV; load displ	1XTrf(13.8/28kV; 52MVA)
4.7	5.4.1	Torontom	Markham Dis	2X1.25MW (gas)	2.5	Markham Hydro 27.6kV system	Markham TS#1 230kV	LDC embedded@27.6kV; load displ	1XTrf(13.8/28kV; 5MVA)
4.8	5.4.2	Torontom	Regents Plast	2X5.2MW (gas)	10.4	Barrie Hydro 27.6kV system	Barrie TS 115kV	LDC embedded@27.6kV; load displ	1XTrf(13.8/28kV; 13MVA)
				Subtotal==>	115.1				
5.1	5.5.1	Toronto Hydro	Scarborough Site 1	6X1MW (gas)	6.0	THES 13.8kV system	Scarborough TS 230kV (likely)	LDC embedded@13.8kV;load displ	3XTrf. 48/13.8kV; 3.75MVA)
5.2	5.5.1	Toronto Hydro	Scarborough Site 1	6X1MW (gas)	6.0	THES 13.8kV system	Scarborough TS 230kV (likely)	LDC embedded@13.8kV;load displ	3XTrf. 48/13.8kV; 3.75MVA)
5.3	5.5.1	Toronto Hydro	Scarborough Site 2	8X1MW (gas)	8.0	THES 13.8kV system	Malvern TS 230 kV (likely)	LDC embedded@13.8kV;load displ	4XTrf. 48/13.8kV; 3.75MVA)
				Subtotal==>	20.0				

7.1	5.7.1	Trans Canada	Cobourg	5X22.8MW Subtotal=>	114.0 114.0	TCPL #36 Station	Sidney TS, Dobbin TS	Connected to the IMO-controlled Grid	x Trf(13.8;13.8/115 kV; 72/96/120MV)
8.1	5.8.1	PEI/OEM	McMaster	4X5MW (gas)	20.0	McMaster TS 13.8kV bus	McMaster TS 115kV	LDC direct @13.8kV;load displ	ET @13.8; no TRF req'd
8.2	5.8.1	PEI/OEM	Kingston	4X5MW (gas) Subtotal=>	20.0 40.0	Kingston 4 or 44kV system	Frontenac TS 115kV (likely)	LDC embedded@4 or 44kV;load displ	Data not provided
				Grand Total=>	411.9				

Proposal #	Data Verification: Gen Data	Data Verification: Exciter Data	Data Verification: Governor Data	SCCT Assessment	Local Area Impact: Fac. Loading	Local Area Impact: Voltages
1.1	Partial dynamic data provided; available data is in reasonable range. Pf = 0.8, meets the MR requirement	Response test not required	Response test not required	LDC to review and authorize	>> see Note 1 concerning the Markham cluster	>> see Note 1 concerning the Markham cluster
1.2	Partial dynamic data provided; available data is in reasonable range. Pf = 0.8, meets the MR requirement	Response test not required	Response test not required	LDC to review and authorize	>> see Note 1 concerning the Markham cluster	>> see Note 1 concerning the Markham cluster
2.1	Generator reactances and time constants are in acceptable range. Inertia H is low. Efd base value does not calculate right. Pf = 0.85 meets the MR requirement	Data not provided; req'd response test not conducted	Data not provided; req'd response test not conducted	HON1 to review and authorize	>> not studied; IMO indicated that this was done as part of the earlier CAA for TransAlta Sarnia Area Project	>> not studied; IMO indicated that this was done as part of the earlier CAA for TransAlta Sarnia Area Project
2.2	Generator dynamic parameters are in their acceptable range. Pf = 0.85 meets the MR requirement	Data not provided; req'd response test not conducted	Data not provided; req'd response test not conducted	HON1 to review and authorize	>> not studied; IMO indicated that this was done as part of the earlier CAA for TransAlta Sarnia Area Project	>> not studied; IMO indicated that this was done as part of the earlier CAA for TransAlta Sarnia Area Project
3.1	Data not Provided	Data not provided; req'd response test not conducted	Data not provided; req'd response test not conducted	adequate based on HON1 assessment	>> minimal impact on 230kV line loading; XIH prefault loading increased from 24% to 25%; circuit outage not studied as outage will take out the unit	>> new unit will improve voltage control in the Lennox area; negligible voltage change for the loss of new unit plus G1 (84MW)
4.1	Dynamic Data not Provided. Pf = 0.8; meets the MR requirement	Response test not required	Response test not required	LDC to review and authorize	>> load displacement generation; reduces loading of supply transformer and HV circuits	>> load displacement generation; provides reactive support and improves local voltages; dV will be minor due to small unit size
4.2	Dynamic Data not Provided. Pf = 0.8; meets the MR requirement	Response test not required	Response test not required	LDC to review and authorize	>> load displacement generation; reduces loading of supply transformer and HV circuits	>> load displacement generation; provides reactive support and improves local voltages; dV will be minor due to small unit size
4.3	Dynamic Data not Provided. Pf = 0.8; meets the MR requirement	Response test not required	Response test not required	LDC to review and authorize	>> load displacement generation; reduces loading of supply transformer and HV circuits	>> load displacement generation; provides reactive support and improves local voltages; dV will be minor due to small unit size
4.4	Dynamic Data not Provided. Pf = 0.8; meets the MR requirement	Response test not required	Response test not required	LDC to review and authorize	>> load displacement generation; reduces loading of supply transformer and HV circuits	>> load displacement generation; provides reactive support and improves local voltages; dV will be minor due to small unit size
4.5	Dynamic Data not Provided. Pf = 0.8; meets the MR requirement	Response test not required	Response test not required	LDC to review and authorize	>> load displacement generation; reduces loading of supply transformer and HV circuits	>> load displacement generation; provides reactive support and improves local voltages; dV will be minor due to small unit size
4.6	Dynamic Data not Provided. Pf = 0.8; meets the MR requirement	Data not provided; req'd response test not conducted	Data not provided; req'd response test not conducted	LDC to review and authorize	>> see Note 1 concerning the Markham cluster	>> see Note 1 concerning the Markham cluster
4.7	Dynamic Data not Provided. Pf = 0.8; meets the MR requirement	Response test not required	Response test not required	LDC to review and authorize	>> see Note 1 concerning the Markham cluster	>> see Note 1 concerning the Markham cluster
4.8	Dynamic Data not Provided. Pf = 0.8; meets the MR requirement	Response test not required	Response test not required	LDC to review and authorize	>> load displacement generation; reduces loading of supply transformer and HV circuits	>> load displacement generation; provides reactive support and improves local voltages; dV will be minor due to small unit size
5.1	Partial generator data available, which is in acceptable range. Pf = 0.8	Response test not required	Response test not required	LDC to review and authorize	>> load displacement generation; reduces loading of supply transformer and HV circuits	>> load displacement generation; provides reactive support and improves local voltages; dV will be minor due to small unit size
5.2	Partial generator data available, which is in acceptable range. Pf = 0.8	Response test not required	Response test not required	LDC to review and authorize	>> load displacement generation; reduces loading of supply transformer and HV circuits	>> load displacement generation; provides reactive support and improves local voltages; dV will be minor due to small unit size
5.3	Partial generator data available, which is in acceptable range. Pf = 0.8	Response test not required	Response test not required	LDC to review and authorize	>> load displacement generation; reduces loading of supply transformer and HV circuits	>> load displacement generation; provides reactive support and improves local voltages; dV will be minor due to small unit size

6.1	Missing saturation , open circuit, short circuit curves.	Exciter model provided; gain and ceiling replaced	Governor model missing; typical model assumed	Short-circuit studies performed by transmitter show that all breakers in the area have adequate interrupting capability	>> generation is not to exceed 93 MW during summer	>>no impact on the IMO-controlled grid; Transmitter to verify short circuit levels with 'as built' data
7.1	Data not Provided	Response test not required	Response test not required	LDC to review and authorize	>> load displacement generation; reduces loading of supply transformer and HV circuits	>> load displacement generation; provides reactive support and improves local voltages; dV will be minor due to small unit size
7.2	Data not Provided	Response test not required	Response test not required	LDC to review and authorize	>> load displacement generation; reduces loading of supply transformer and HV circuits	>> load displacement generation; provides reactive support and improves local voltages; dV will be minor due to small unit size

Proposal #	Interface Impact	Dynamic Assessm	Other Considerations	Summary of Salient Results	Conclusions and Recommendations
1.3	>> will reduce flows into the GTA	>> not conducted; load displacement in nature; will generally reduce circuit loading and improve voltages; units are closely connected to a strong 230kV system in Toronto	>> design and specification of the connection facs. must need req't of TSC or DSC; and metering, and other data provision to the IMO must meet the req't in the MR	>> SCCT concern	>> ACCEPTABLE subject to SCCT acceptability
1.4	>> will reduce flows into the GTA	>> not conducted; load displacement in nature; will generally reduce circuit loading and improve voltages; units are closely connected to a strong 230kV system in Toronto	>> design and specification of the connection facs. must need req't of TSC or DSC; and metering, and other data provision to the IMO must meet the req't in the MR	>> SCCT concern	>> ACCEPTABLE subject to SCCT acceptability
2.1	>> not studied; IMO indicated that this was done as part of the earlier CAA for TransAlta Sarnia Area Project; will increase congestion in Sarnia Area	>> not studied; IMO indicated that this was done as part of the earlier CAA for TransAlta Sarnia Area Project	>> existing registered facility?	>> subject to previous CAA results; missing gen.data; registered fac?; located in congested Sarnia area	>> ACCEPTABLE subject to acceptability of earlier results; provision of data or a waiver by the IMO; is a qualified facility; in congested area - under some conditions, unit may not be dispatched
2.2	>> not studied; IMO indicated that this was done as part of the earlier CAA for TransAlta Sarnia Area Project; will increase congestion in Sarnia Area	>> not studied; IMO indicated that this was done as part of the earlier CAA for TransAlta Sarnia Area Project	>> existing registered facility?	>> subject to previous CAA results; missing gen.data; registered fac?; located in congested Sarnia area	>> ACCEPTABLE subject to acceptability of earlier results; provision of data or a waiver by the IMO; is a qualified facility; in congested area - under some conditions, unit may not be dispatched
3.1	>> will increase flows into Toronto from the east; no congestion concern	>> not studied as the new unit only adds 18% (23MW) to the existing plant; the Lennox 230kV system is very strong and the units are closely connected to this system	>> design and specification of the connection facs. must need req't of TSC or DSC; and metering, and other data provision to the IMO must meet the req't in the MR	>> missing gen.data	>> ACCEPTABLE subject to provision of data or a waiver by the IMO
4.1	>> will reduce flows into the GTA	>> not conducted; load displacement in nature; will generally reduce circuit loading and improve voltages; unit size is relatively small	>> design and specification of the connection facs. must need req't of TSC or DSC; and metering, and other data provision to the IMO must meet the req't in the MR	>> generally meets MR req'ts	>> ACCEPTABLE
4.2	>> will reduce flows into the GTA	>> not conducted; load displacement in nature; will generally reduce circuit loading and improve voltages; unit size is relatively small	>> design and specification of the connection facs. must need req't of TSC or DSC; and metering, and other data provision to the IMO must meet the req't in the MR	>> generally meets MR req'ts	>> ACCEPTABLE
4.3	>> will increase flows through QFW	>> not conducted; load displacement in nature; will generally reduce circuit loading and improve voltages; unit size is relatively small	>> design and specification of the connection facs. must need req't of TSC or DSC; and metering, and other data provision to the IMO must meet the req't in the MR	>> located in congested Niagara area	>> ACCEPTABLE. Located in a congested area - under some conditions, units may not be dispatched
4.4	>> will reduce flows into the GTA	>> not conducted; load displacement in nature; will generally reduce circuit loading and improve voltages; unit size is relatively small	>> design and specification of the connection facs. must need req't of TSC or DSC; and metering, and other data provision to the IMO must meet the req't in the MR	>> generally meets MR req'ts	>> ACCEPTABLE
4.5	>> reduces flows into the GTA	>> not conducted; load displacement in nature; will generally reduce circuit loading and improve voltages; unit size is relatively small	>> design and specification of the connection facs. must need req't of TSC or DSC; and metering, and other data provision to the IMO must meet the req't in the MR	>> generally meets MR req'ts	>> ACCEPTABLE
4.6	>> reduces flows into the GTA	>> not conducted; load displacement in nature; will generally reduce circuit loading and improve voltages; units are closely connected to a strong 230kV system in Toronto	>> design and specification of the connection facs. must need req't of TSC or DSC; and metering, and other data provision to the IMO must meet the req't in the MR	>> SCCT concern; missing gen.data	>> ACCEPTABLE subject to SCCT acceptability; and provision of data or a waiver by the IMO
4.7	>> reduces flows into the GTA	>> not conducted; load displacement in nature; will generally reduce circuit loading and improve voltages; unit size is relatively small	>> design and specification of the connection facs. must need req't of TSC or DSC; and metering, and other data provision to the IMO must meet the req't in the MR	>> SCCT concern	>> ACCEPTABLE subject to SCCT acceptability
4.8	>> will reduce flows into the Barrie area	>> not conducted; load displacement in nature; will generally reduce circuit loading and improve voltages; unit size is relatively small	>> design and specification of the connection facs. must need req't of TSC or DSC; and metering, and other data provision to the IMO must meet the req't in the MR	>> generally meets MR req'ts	>> ACCEPTABLE
5.1	>> will reduce flows into the GTA	>> not conducted; load displacement in nature; will generally reduce circuit loading and improve voltages; units are closely connected to a strong 230kV system in Toronto	>> design and specification of the connection facs. must need req't of TSC or DSC; and metering, and other data provision to the IMO must meet the req't in the MR	>> generally meets MR req'ts	>> ACCEPTABLE
5.2	>> will reduce flows into the GTA	>> not conducted; load displacement in nature; will generally reduce circuit loading and improve voltages; units are closely connected to a strong 230kV system in Toronto	>> design and specification of the connection facs. must need req't of TSC or DSC; and metering, and other data provision to the IMO must meet the req't in the MR	>> generally meets MR req'ts	>> ACCEPTABLE
5.3	>> will reduce flows into the GTA	>> not conducted; load displacement in nature; will generally reduce circuit loading and improve voltages; units are closely connected to a strong 230kV system in Toronto	>> design and specification of the connection facs. must need req't of TSC or DSC; and metering, and other data provision to the IMO must meet the req't in the MR	>> generally meets MR req'ts	>> ACCEPTABLE

7.1	>>will increase the flow east to GTA by an amount equivalent >> with typical governor data the performance was to the generator's output, but no congesion is likely to occur,acceptable	>> design and specification of the connection facs. mus need req't of TSC or DSC; and metering, and other data provision to the IMO and performance must meet the req't in the MR	>> missing exciter and governor data (assumed models and data)	>> ACCEPTABLE subject to meeting tranmitter's protection requirements and IMO generator data provision and performance requirements.
8.1	>> will reduce flows into the Hamilton Area	>> not conducted; load displacement in nature; will generally reduce circuit loading and improve voltages; unit size is relatively small	>> design and specification of the connection facs. mus need req't of TSC or DSC; and metering, and other data provision to the IMO must meet the req't in the MR	>> missing gen.data
8.2	>> will reduce flows into the Kingston Area and increase flows into the Troonto Area from the east; both interfaces are not congested	>> not conducted; load displacement in nature; will generally reduce circuit loading and improve voltages; unit size is relatively small	>> design and specification of the connection facs. mus need req't of TSC or DSC; and metering, and other data provision to the IMO must meet the req't in the MR	>> missing gen.data

APPENDIX I

Load Flow Study of Proposed Generators in Markham

1. General

There are only two proponents whose proposals to connect generation in Markham need to be analyzed. The names of the proponents and the salient details of their projects are as follows;

1. Gasworks Energy Corp.

Gasworks Energy Corp is planning to install generation at the distribution level two locations in Markham. The sites, installed capacity, connection voltage and type, as supplied by Gasworks are as follows;

i) Location – Markham Amber MS
Number of Units and Capacity – 20 @ 1 MW
Transformer(s) Rating – 0.48/13.8 kV, 10 x 2.5 MVA
Connection Voltage – 13.8 kV

iii) Location - Markham John MS
Number of Units and Capacity – 20 @ 1 MW
Transformer(s) Rating – 0.48/13.8 kV, 10 x 2.5 MVA
Connection Voltage – 13.8 kV

2. TOROMOMT

Toromont has also proposed two natural gas fuelled power plants in the Markham area. The salient features of the projects are as follows;

i) Location – Markham Hydro TS#1
Number of Units and Capacity – 10 @ 5.2 MW
Transformer(s) Rating – 13.8/27.6 kV,
Connection Voltage – 27.6 kV

ii) Location –Markham District
Number of Units and Capacity – 2 @ 1.25 MW
Transformer(s) Rating – 13.8/27.6 kV,
Connection Voltage – 27.6 kV

2. Assumptions

In the load flow studies, the following assumptions have been made.

- i) All the generation projects have been assumed to be connected directly to the low voltage bus of the transmission substation in order to assess the effect on the transmission network. No distribution lines have been modeled.

- ii) In the absence of complete connection information of some of the projects, the contingency of all the units connected at one substation has been considered as a first contingency in order to simulate the worst case scenario.

3. Load Flow Analysis

The proposed generation in Markham area will be connected to Markham TS#1 substation. The total generation connected at this substation is as follows;

Markham TS#1

Gasworks = 20 MW
Gasworks = 20 MW
Toromont = 52 MW
Torormont = 2.5 MW

Total = 94.5 MW

The load flow studies have been carried assuming all the generation connected to TS#1 and TS#2 substations is operating in order to simulate the maximum possible impact of these projects on the transmission system. A conceptual diagram of the system modeled in load flow studies is shown in Figure 5.1.2a

Markham TS#1

The summer peak load at Markham TS#1 substation is approximately 120 MW. Therefore a connection of 94.5 MW of generation would result in a reduction of the power being injected from the transmission system to about 30 MW. With the addition of 94.5 MW of generation, all the power flows and system voltages remain within normal ranges.

The addition of the 94.5 MW of embedded generation power will result in a reduction in the power flowing over the Cherrywood – Richview 230 kV circuits C11R and C12R to which Markham TS#1 is connected. Load flow study results are shown in Figure 5.1.2b.

Outage of all the units connected at TS#1 results in a voltage deviation of less than 1% on the 230 kV side, which is well within the criteria of 10%.

The generation can be connected at TS#1 without any significant impact on the taps of the 230/27.6 kV transformer.

4. Conclusions

Load flow analysis shows that there is no significant impact on the IMO-controlled grid of connecting 94.5 MW of generation at Markham TS#1 substation. Due to their load displacement nature, the proposed generation will result in a reduction in the power flowing over the Cherrywood – Richview 230 kV transmission interface.

Contingency analysis reveals that all the voltages and branch loadings remain within limits on the transmission system.

APPENDIX II

Detailed Assessment Results for TCPL - Cobourg

Proposed 114MW Generation Addition near Cobourg by TCPL

Description

- Five gas turbines @22.8 MW each about 34 km from Sidney on P4S
- Connected at existing TCPL #136 installation (figure attached)
- P4S is about 100 km long, 45km N-S to Port Hope then 55km E-W to Sidney

Summary

- TCPL tap under hot windless conditions can't accommodate 114MW. Four units would be a better fit
- proposal improves voltages near Dobbin and Sydney
- units are stable for faults at Dobbin and Sidney at maximum possible unit power (27.5MW) if the TCPL reach for undelayed faults clearing is extend to include all of circuit P3S

Evaluation

Loadflow Submission

- single line provided that shows generators bused together with a three winding step up transformer
- assume missing $Z_{xy} = Z_{hx} + Z_{hy}$
- assume transformer impedances provided are based on the winding self cooled MVA rating
- transformer taps missing (assume 115/13.8)
- generator capability curve provided as well as Z_{sorce}
- proposal includes a new 115kV breaker
- connection equipment between generators and transformers and between transformer and IMO control grid is assumed to have negligible impedance and will not impose thermal restrictions

```
rdch / add nanticoke generation to account for increase phope load and to get swing machine down
1
1377,'TCPL#136', 118.0000,1, 0.000, 0.000, 1, 103,1.09597, -49.2784, 1
1764,'TCPLcogn', 13.8000,1, 0.000, 0.000, 1, 103,1.09597, -49.2784, 1
2712,'PT HOPBY', 44.0000,1, 0.000, 0.000, 1, 103,1.05100, -44.8137, 1
2713,'PT HOPJQ', 44.0000,1, 0.000, 0.000, 1, 103,1.05972, -45.0534, 1
0 / END OF BUS DATA, BEGIN LOAD DATA port hope load only 40 MW in case change to 110 MW,
2712,'1 ',1, 1, 103, 55.0, 27.0, 0.000, 0.000, 0.000, 0.000, 1
2713,'1 ',1, 1, 103, 55.0, 27.0, 0.000, 0.000, 0.000, 0.000, 1
0 / END OF LOAD DATA, BEGIN GENERATOR DATA
6328,'1 ', 100.000, 248.158, 349.000, -186.000,1.11000, 5105, 588.000, 0.00000, 0.21500,
0.00000, 0.00000,1.00000,1, 34.9, 0.000, 0.000, 1,1.0000
1764 1 27.4 0 12 -7 1.03 1377 32.235 0.0 0.172 0.0 0.0 1.000 1 12 27.4 0.0 / 5 identical cogen units
1764 2 27.4 0 12 -7 1.03 1377 32.235 0.0 0.172 0.0 0.0 1.000 1 12 27.4 0.0
1764 3 27.4 0 12 -7 1.03 1377 32.235 0.0 0.172 0.0 0.0 1.000 1 12 27.4 0.0
1764 4 27.4 0 12 -7 1.03 1377 32.235 0.0 0.172 0.0 0.0 1.000 1 12 27.4 0.0
1764 5 27.4 0 12 -7 1.03 1377 32.235 0.0 0.172 0.0 0.0 1.000 1 12 27.4 0.0
0 / END OF GENERATOR DATA, BEGIN BRANCH DATA
1104, 1301,'T2', 0.00373, 0.12118, 0.00000, 70.00, 110.20, 0.00,,,,, 0 / open dobbin t2
368, 442,'1 ', 0.00775, 0.02573, 0.00417, 161.90, 175.00, 218.80,,,,, 0 / open d6-x6
1377, 1764,'T1', 0.00000, 0.16028, 0.00000, 60.00, 84.00, 0.00,0.97460 / 5.77% and 5.66%
1377, 1764,'T2', 0.00000, 0.15722, 0.00000, 60.00, 84.00, 0.00,0.97460 / on 36MVA base
```

Thermal Considerations

- connection to P4S cannot accommodate all active power let alone any reactive power under hot windless conditions
- transformer rating 72/90/120MVA is not adequate to accept full power at 0.9 power factor
- ratings of P3S and P4S are tabulated below

ckt	sec	stations	temp	w	time	preload	cont	15m	volt	preload%
P3S	6	PORTHOPE DALEJ	35	5	day	702.	935.	1052.	118.	75
P3S	3	SIDNEY DALEJ	35	5	day	240.	321.	420.	118.	75
P3S	2	PORTHOPJ DALEJ	35	5	day	596.	795.	880.	118.	75
P3S	1	DOBBIN PORTHOPJ	35	5	day	561.	749.	844.	118.	75
P4S	2	DALEJ VERNONVJ	35	5	day	350.	467.	518.	118.	75
P4S	6	TCCOBORG VERNONVJ	35	5	day	362.	483.	511.	118.	75
P4S	5	PORTHOPE DALEJ	35	5	day	705.	940.	1057.	118.	75
P4S	3	HILTONJ VERNONVJ	35	5	day	369.	492.	545.	118.	75
P4S	4	HILTONJ SIDNEY	35	5	day	369.	492.	545.	118.	75
P4S	7	IPLHILTN HILTONJ	35	5	day	149.	199.	256.	118.	75
P4S	1	DOBBIN DALEJ	35	5	day	536.	715.	806.	118.	75

Powerflow Considerations

- under summer peak conditions power flow will be from Dobbin to Sidney on P3S and P4S
- TCPL generation will tend to unload P4S from Dobbin to Port Hope as well as B1S and Q6S into Sidney
- TCPL generation will tend to load P4S from the TCPL site to Sidney
- distribution of flow on the 83 MVA 115/44kV transformers at Port Hope on P3S and P4S will be unbalanced. Without TCPL the load at Port Hope is about equally distributed between P3S and P4S. With TCPL on at full output, P4S will supply about 2/3 of the Port Hope load.
- except for the tap to TCPL no thermal overloads observed
- Catarqui (-41), Dobbin (-84), Merivale (-9), Hawthorne (-2) for 137MW injection at TCPL
- flow summaries without with TCPL proposal and following loss of P3S with TCPL are attached
- outage distribution factors are tabulated at the end of this report

Short Circuit Considerations

- vintage breakers and Dobbin (10.5kA) and Sidney (6.3kA) are low rated
- all ambient short circuit ratings should be checked
- an accurate check must await confirmation of step-up transformer impedance

Voltage Considerations

- these 0.8pf units exceed MR requirement for reactive capability at their terminal
- voltages improve slightly (1 kV) without any reactive contribution from the new units
- droop compensation will be required for good reactive sharing

Protection Considerations

- no communication on P4S or P3S for transfer trips, distance relaying trips local breakers
- instantaneous zone 1 protections reaches about 80% from Dobbin, Port Hope, and Sidney
- delayed zone 2 protections reaches about 120% from Dobbin Port Hope, and Sidney
- instantaneous zone 1 reach is 85% from Sidney on B1S (145 kms) and 80% on Q4S (89 kms)
- delayed fault clearing of 400ms makes TCPL units unstable for P3S faults
- when undelayed TCPL protection reach include all of P3S, TCPL units are stable
- this extended undelayed reach will cause tripping of TCPL for faults on B1S and Q6S

Dynamic Submission

- conservative values were assumed for missing saturation constants $S(1.0)=0.2$, $S(1.2)=0.6$
- generator open circuit/short circuit curves are missing although mentioned in the submission
- exciter model time constants and saturation values retained while atypical gain and ceiling replaced
- typical gas turbine model was implement for missing governor model
- dynamic models used for simulations are listed below

```

** GENROU ** BUS   NAME   BSKV MACH   C O N S   S T A T E S
                1764 TCPLCOGN 13.8   1   167414-167427 60188-60193

                MBASE   Z S O R C E   X T R A N   GENTAP
                32.2   0.00000+J 0.17200   0.00000+J 0.00000   1.00000

T'DO T''D0 T'Q0 T''Q0   H   DAMP   XD   XQ   X'D   X'Q   X''D   XL
7.60 0.050 2.33 0.050   0.94 0.00 2.5700 2.3500 0.2480 0.4100 0.1720 0.1610

                S(1.0) S(1.2)
                0.2000 0.6000

```

```

** IEEET2 ** BUS   NAME   BSKV MACH   C O N S   S T A T E S   VAR
                1764 TCPLCOGN 13.8   1   167484-167497 60218-60222 10159

TR   KA   TA   VRMAX   VRMIN   KE   TE   KF   TF1   TF2
0.022 400.00 0.100 7.000   0.000   1.000 1.000 0.017 0.600 1.000

                E1   S(E1)   E2   S(E2)   KE VAR
                5.2000 2.0800 7.0000 6.5800   1.0000

```

```

** GAST ** BUS   NAME   BSKV MACH   C O N S   S T A T E S   VAR
                1764 TCPLCOGN13.8   1   167554-167562 60243-60245 10164

R   T1   T2   T3   LOAD LIM   KT   VMAX   VMIN   DT
0.050 0.400 0.100 3.000 1.000 2.000 1.000 -0.050 0.000

```

Exciter Submission

```

TR   KA   TA   VRMAX   VRMIN   KE   TE   KF   TF1   TF2
0.022 3751 0.100 61.00 0.000 1.000 1.000 0.017 0.600 1.000

                E1   S(E1)   E2   S(E2)   KE VAR
                n/a 2.0800 n/a 6.5800   1.0000

```

Dynamic Verification

- the inertia constant is much smaller than for most machines (~1/4 hydraulic, 1/10 nuclear)
- v-curves calculated for model used, (curve attached)
- exciter does not meet market rule requirement for speed of response (curve attached)
- typical governor data produces quite oscillatory response for a 20% load change (curve attached)

Dynamic Performance

- damping ratio is low
- period of TCPL unit oscillation much higher than typically observed due to small H
- exciter and governor models make damping worse, better data and settings may improve damping
- TCPL is unstable for P3S faults with delayed clearing (400ms) at Dobbin and Sydney
- TCPL would be stable for P3S faults if transfer tripping with typical communication delays is installed
- TCPL is stable with delayed clearing (400ms) of faults at Sidney on Circuits B1S and Q6S

Dynamic Switching Decks

- LLG criteria for this part of the IMO controlled grid, use more severe 3P in this expedited analysis for a screen

```
text Solid 3 phase fault at Dobbin (3p_p15c_p)
text Assume Dobbin 3~ (no indication in CB binder) and Cherrywood 3~ (verified)
text Assume slow communication (33 ms)
text Refine these assumptions if limiting
text time = prim + trip aux (+ comm) + btm + brk
text time = 25 + 4 + (+33) + 4 + 50
psas
1

apply fault at bus 'dobbin 220' Y 0 -1000000 MVA
run for 0.083 seconds print=0 plot=9
clear fault
trip line from bus 'dobbin 220' to bus 'cherydk2 220' ckt 1
apply fault at bus 'cherydk2 220' Y 0 -1250 MVA
run for 0.033 seconds print=0 plot=9
clear
end

text Solid 3 phase fault near Sydney (3p_p3s_s)
text Assume Dobbin 5~ and Sidney 5~
text no communications
text assume zone 2 timer is 400ms at Dobbin
text zone 2 timer is 800ms at Port Hope
text zone 2 timer is 400ms at Sidney
text refine these assumptions if limiting
text time = prim + trip aux (+ delay) + btm + brk
text time = 25 + 4 + (+ 400) + 4 + 83
psas
1

apply fault at bus 'sidney 118' Y 0 -1000000 MVA
run for 0.116 seconds print=0 plot=9
clear fault
trip line from bus 'sidney 118' to bus 'dale jp3 118' ckt 1
apply fault at bus 'dale jp3 118' Y 0 -1000000 MVA
run for 0.184 seconds print=0 plot=9
run for 0.216 seconds print=0 plot=9
clear fault
disconnect bus 'phopejp3 118'
disconnect bus 'dale jp3 118'
end

text Solid 3 phase fault near Sydney (3p_p3s'_s after TT)
text Assume Dobbin 5~ and Sidney 5~
text assume communications
text refine these assumptions if limiting
text time = prim + trip aux (+ communication) + btm + brk
text time = 25 + 4 + (+ 33) + 4 + 83
psas
1

apply fault at bus 'sidney 118' Y 0 -1000000 MVA
run for 0.116 seconds print=0 plot=9
clear fault
trip line from bus 'sidney 118' to bus 'dale jp3 118' ckt 1
apply fault at bus 'dale jp3 118' Y 0 -1000000 MVA
run for 0.033 seconds print=0 plot=9
clear fault
disconnect bus 'phopejp3 118'
disconnect bus 'dale jp3 118'
end

text Solid 3 phase fault near Odessa (3p_q6s_q) psas
text Assume Catarqui 5~ and Sidney 5~ 1
text no communications
text zone 2 timer is 400ms at Sidney
text assume zone 2 timer is 400ms at Catarqui
text refine these assumptions if limiting
text time = pri + aux (+ delay) + btm + brk
text time = 25 + 4 + (+ 400) + 4 + 83
apply fault at bus 'odessa j 118' Y 0 -1000000 MVA
run for 0.116 seconds print=0 plot=9
disconnect bus 'westbkq6 118'
print=0 plot=9
clear fault
disconnect bus 'kosa 118'
disconnect bus 'kosa 13.8'
disconnect bus 'odessa j 118'
disconnect bus 'selbjq6s 118'
end
```

Outage Distribution Factors

Base Case Factors
 ----Outaged Lines & Generator Buses-----

Monitored Lines		Outaged Elements 1 P3S_P									
		MW	1 P3S_P	2 P4S_P	3 DOB_T1	4 DOB_T5	5 P3S_S	6 P4S_S	7 B1S_S	8 Q6S_S	9 TCPL
		37		12	-46	-23	-2	-69	7	-10	-137
1 DOBBIN	PHOPEJP3	37	-1.000	0.656	0.073	0.040	0.502	-0.104	-0.274	-0.347	-0.204
2 DOBBIN	DALE JP4	12	0.656	-1.000	0.073	0.040	-0.104	0.502	-0.274	-0.347	-0.384
3 DOBBIN	DOBBIN	-46	0.228	0.228	-1.000	0.920	-0.264	-0.263	0.363	0.460	0.389
4 DOBBIN	DOBBIN	-23	0.116	0.116	0.854	-1.000	-0.134	-0.134	0.185	0.234	0.198
5 SIDNEY	DALE JP3	-2	0.434	-0.090	-0.073	-0.040	-1.000	0.602	0.274	0.347	0.056
6 SIDNEY	HILTON J	-69	-0.090	0.434	-0.073	-0.040	0.602	-1.000	0.274	0.347	-0.469
7 SIDNEY	LODGERM	7	-0.120	-0.120	0.051	0.028	0.139	0.138	-1.000	0.306	0.142
8 SIDNEY	MILLTWNJ	-10	-0.224	-0.224	0.095	0.052	0.259	0.259	0.452	-1.000	0.270
9 VERNONVJ	TCPL#136	-137	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-1.000

Outaged Elements 1 P3S_P
 ----Outaged Lines & Generator Buses-----

Monitored Lines		Outaged Elements 1 P3S_P									
		MW	1 P3S_P	2 P4S_P	3 DOB_T1	4 DOB_T5	5 P3S_S	6 P4S_S	7 B1S_S	8 Q6S_S	9 TCPL
		0		36	-37	-19	14	-72	3	-18	-137
1 DOBBIN	PHOPEJP3	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2 DOBBIN	DALE JP4	36	0.000	-1.000	0.123	0.066	0.288	0.438	-0.469	-0.623	-0.518
3 DOBBIN	DOBBIN	-37	0.000	0.663	-1.000	0.934	-0.191	-0.290	0.311	0.413	0.343
4 DOBBIN	DOBBIN	-19	0.000	0.337	0.877	-1.000	-0.097	-0.148	0.158	0.210	0.175
5 SIDNEY	DALE JP3	14	0.000	0.342	-0.042	-0.023	-1.000	0.562	0.160	0.213	-0.032
6 SIDNEY	HILTON J	-72	0.000	0.658	-0.081	-0.044	0.712	-1.000	0.309	0.410	-0.450
7 SIDNEY	LODGERM	3	0.000	-0.348	0.043	0.023	0.100	0.152	-1.000	0.377	0.166
8 SIDNEY	MILLTWNJ	-18	0.000	-0.652	0.080	0.043	0.188	0.285	0.531	-1.000	0.316
9 VERNONVJ	TCPL#136	-137	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-1.000

Outaged Elements 5 P3S_S
 ----Outaged Lines & Generator Buses-----

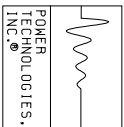
Monitored Lines		Outaged Elements 5 P3S_S									
		MW	1 P3S_P	2 P4S_P	3 DOB_T1	4 DOB_T5	5 P3S_S	6 P4S_S	7 B1S_S	8 Q6S_S	9 TCPL
		36		12	-45	-23	0	-70	7	-10	-137
1 DOBBIN	PHOPEJP3	36	-1.000	0.617	0.037	0.020	0.000	0.311	-0.142	-0.190	-0.176
2 DOBBIN	DALE JP4	12	0.781	-1.000	0.082	0.044	0.000	0.689	-0.314	-0.421	-0.390
3 DOBBIN	DOBBIN	-45	0.145	0.254	-1.000	0.936	0.000	-0.663	0.302	0.405	0.375
4 DOBBIN	DOBBIN	-23	0.074	0.129	0.881	-1.000	0.000	-0.337	0.154	0.206	0.191
5 SIDNEY	DALE JP3	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6 SIDNEY	HILTON J	-70	0.219	0.383	-0.119	-0.064	0.000	-1.000	0.456	0.611	-0.435
7 SIDNEY	LODGERM	7	-0.076	-0.133	0.041	0.022	0.000	0.348	-1.000	0.389	0.150
8 SIDNEY	MILLTWNJ	-10	-0.143	-0.250	0.078	0.042	0.000	0.652	0.544	-1.000	0.285
9 VERNONVJ	TCPL#136	-137	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-1.000

Outaged Elements 2 P4S_P
 ----Outaged Lines & Generator Buses-----

Monitored Lines		Outaged Elements 2 P4S_P									
		MW	1 P3S_P	2 P4S_P	3 DOB_T1	4 DOB_T5	5 P3S_S	6 P4S_S	7 B1S_S	8 Q6S_S	9 TCPL
		45		0	-43	-22	-3	-64	6	-12	-137
1 DOBBIN	PHOPEJP3	45	-1.000	0.000	0.123	0.066	0.438	0.288	-0.469	-0.623	-0.456
2 DOBBIN	DALE JP4	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3 DOBBIN	DOBBIN	-43	0.663	0.000	-1.000	0.934	-0.290	-0.191	0.311	0.413	0.302
4 DOBBIN	DOBBIN	-22	0.337	0.000	0.877	-1.000	-0.148	-0.097	0.158	0.210	0.154
5 SIDNEY	DALE JP3	-3	0.658	0.000	-0.081	-0.044	-1.000	0.712	0.309	0.410	0.091
6 SIDNEY	HILTON J	-64	0.342	0.000	-0.042	-0.023	0.562	-1.000	0.160	0.213	-0.635
7 SIDNEY	LODGERM	6	-0.348	0.000	0.043	0.023	0.152	0.100	-1.000	0.377	0.188
8 SIDNEY	MILLTWNJ	-12	-0.652	0.000	0.080	0.043	0.285	0.188	0.531	-1.000	0.356
9 VERNONVJ	TCPL#136	-137	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-1.000

Outaged Elements 6 P4S_S
 ----Outaged Lines & Generator Buses-----

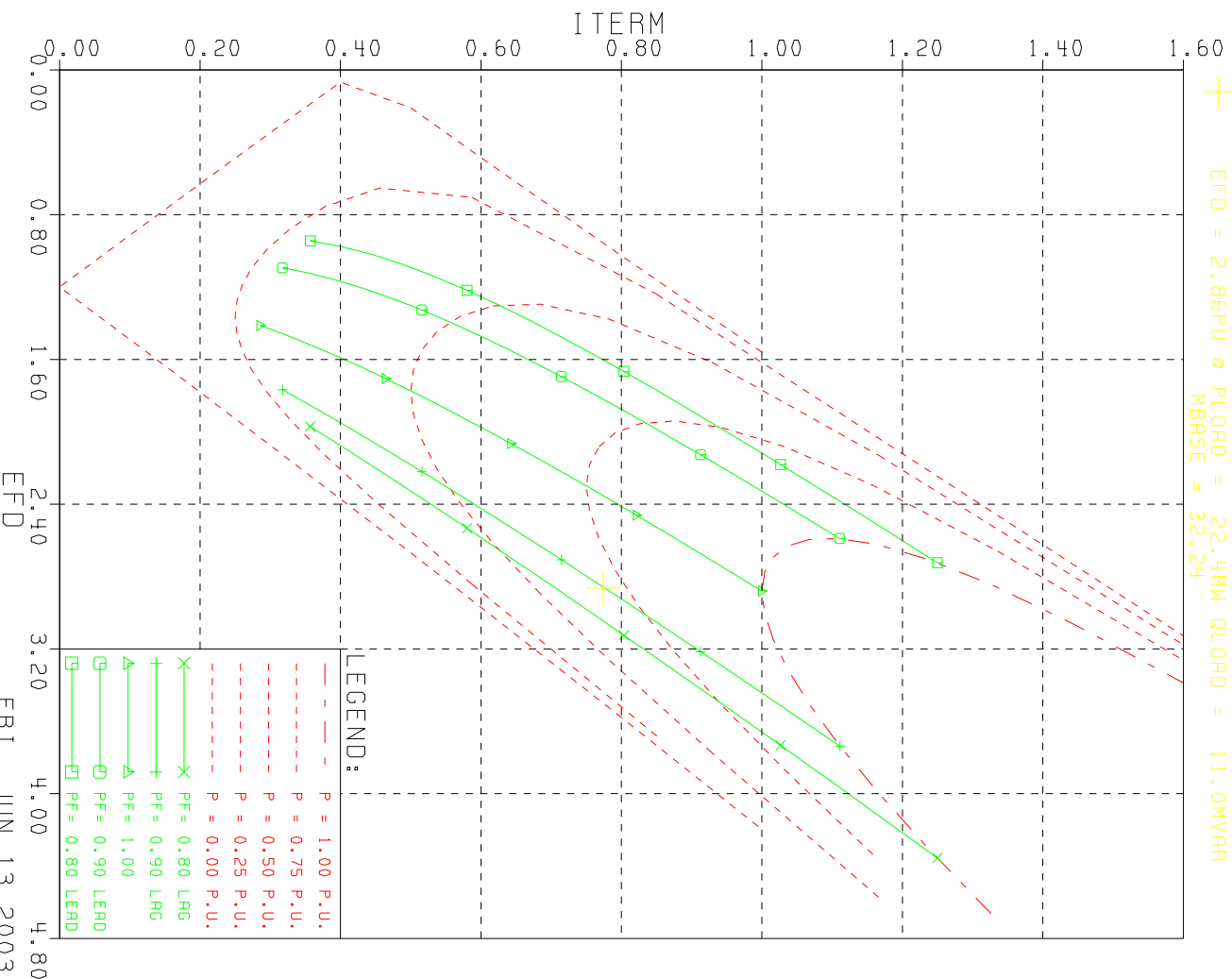
Monitored Lines		Outaged Elements 6 P4S_S									
		MW	1 P3S_P	2 P4S_P	3 DOB_T1	4 DOB_T5	5 P3S_S	6 P4S_S	7 B1S_S	8 Q6S_S	9 TCPL
		44		-22	-28	-14	-43	0	-2	-27	-137
1 DOBBIN	PHOPEJP3	44	-1.000	0.781	0.082	0.044	0.689	0.000	-0.314	-0.421	-0.155
2 DOBBIN	DALE JP4	-22	0.617	-1.000	0.037	0.020	0.311	0.000	-0.142	-0.190	-0.619
3 DOBBIN	DOBBIN	-28	0.254	0.145	-1.000	0.936	-0.663	0.000	0.302	0.405	0.513
4 DOBBIN	DOBBIN	-14	0.129	0.074	0.881	-1.000	-0.337	0.000	0.154	0.206	0.261
5 SIDNEY	DALE JP3	-43	0.383	0.219	-0.119	-0.064	-1.000	0.000	0.456	0.611	-0.226
6 SIDNEY	HILTON J	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7 SIDNEY	LODGERM	-2	-0.133	-0.076	0.041	0.022	0.348	0.000	-1.000	0.389	0.077
8 SIDNEY	MILLTWNJ	-27	-0.250	-0.143	0.078	0.042	0.652	0.000	0.544	-1.000	0.149
9 VERNONVJ	TCPL#136	-137	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-1.000



GENERATOR V CURVES

XD = 2.5700
 XQ = 2.3500
 X'D = 0.2480
 X'q = 0.4100
 X'' = 0.1720
 PLOAD = 22.4MW
 QLOAD = 11.0MVAR
 MBASE = 32.24

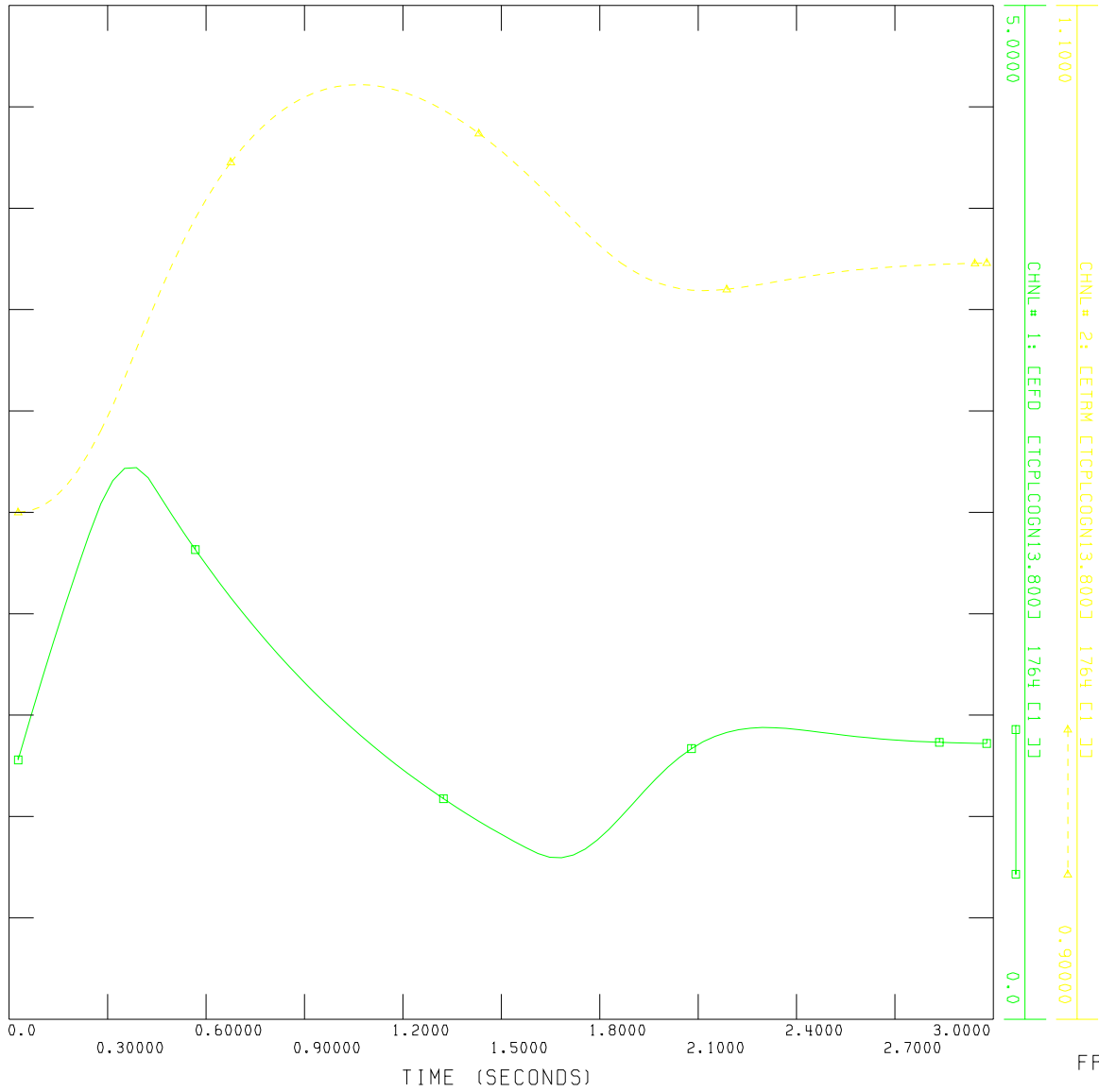
XL = 0.1610
 R = 0.0000
 VTERM = 1.0000
 S(1.0) = 0.2000
 S(1.2) = 0.6000





ASSESSMENT OF TCPL RT COBBOURG 5x22.8MW

FILE: tcp1estr.bin



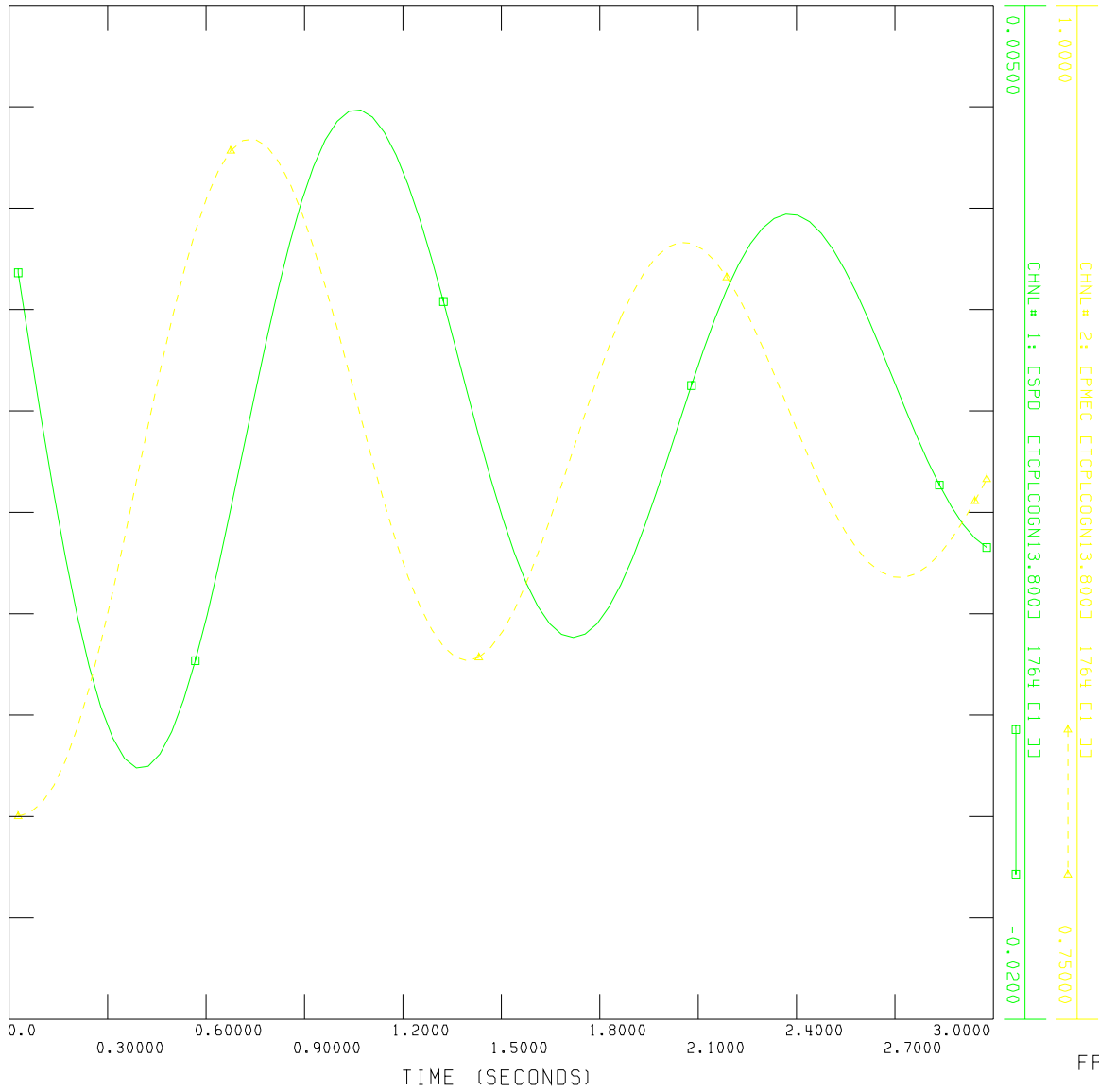
FRI, JUN 13 2003 16:33

TCPL RESPONSE



ASSESSMENT OF TCPL RT COBBOURG 5x22.8MM

FILE: tcp1gstr.bin



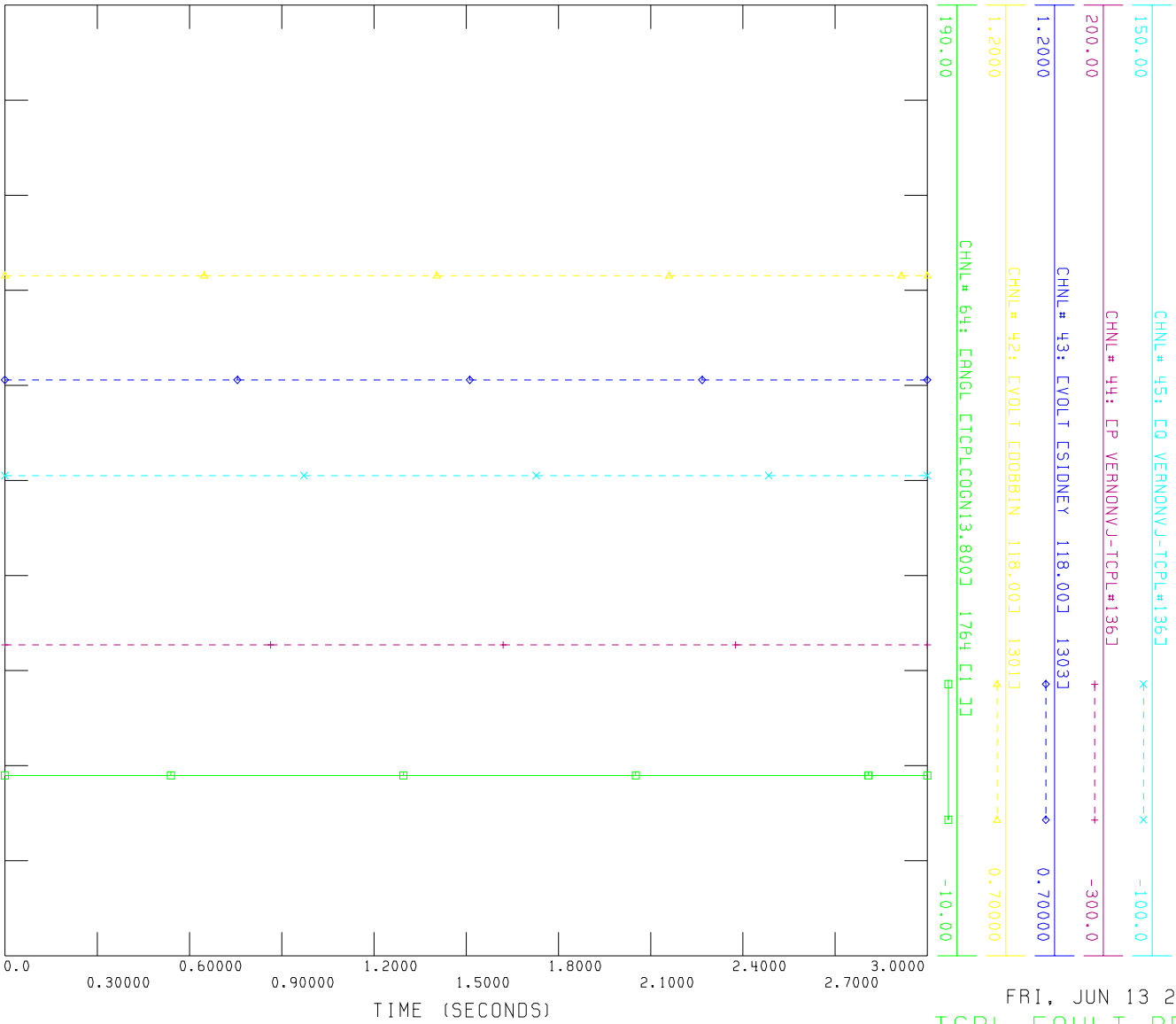
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TCPL RESPONSE



ASSESSMENT OF TCPL RT COBOLURG 5*22.8MW

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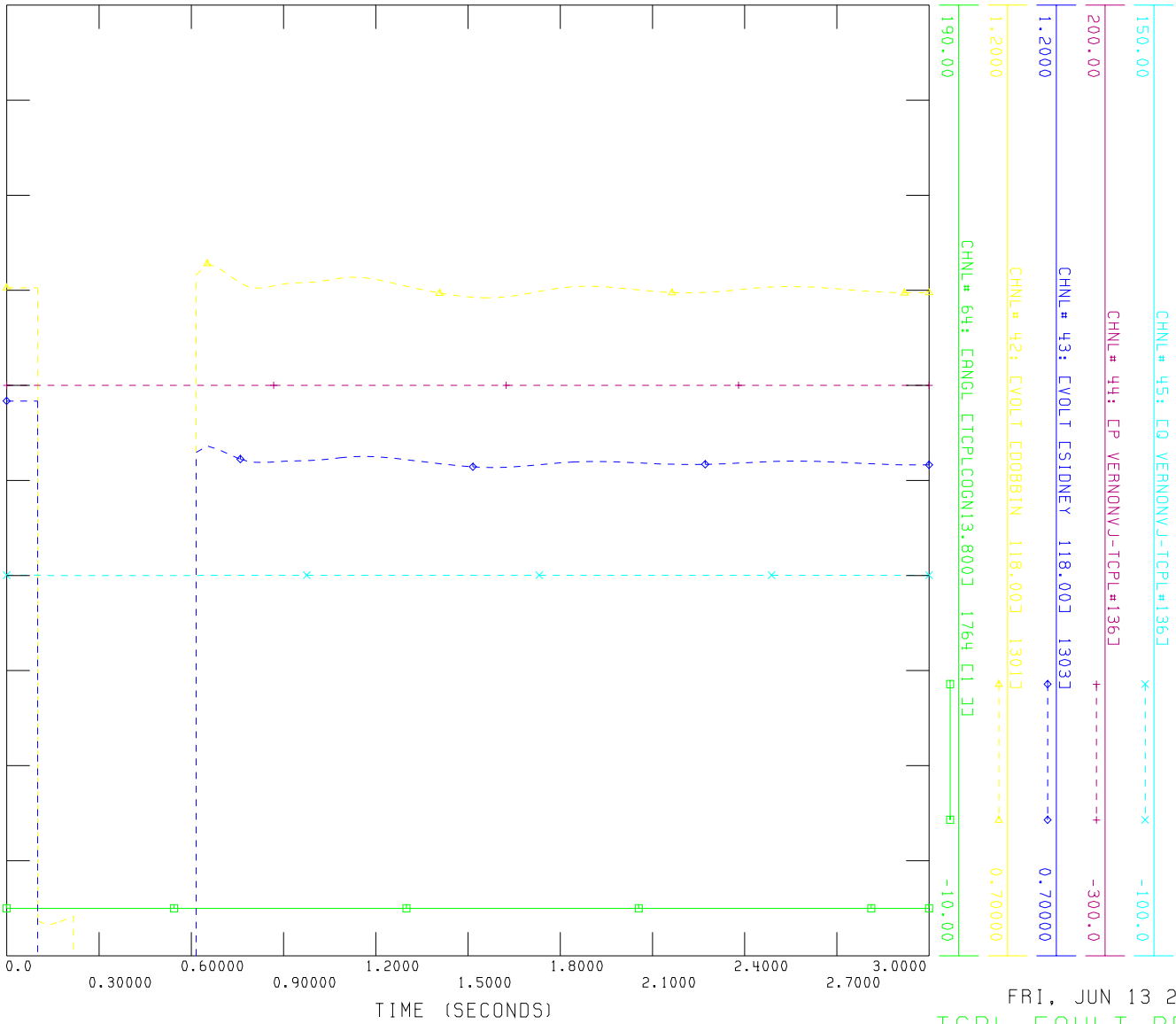


FRI, JUN 13 2003 16:02
TCPL FAULT RESPONSE



ASSESSMENT OF TCPL RT COBOLURG 5*22.8MW

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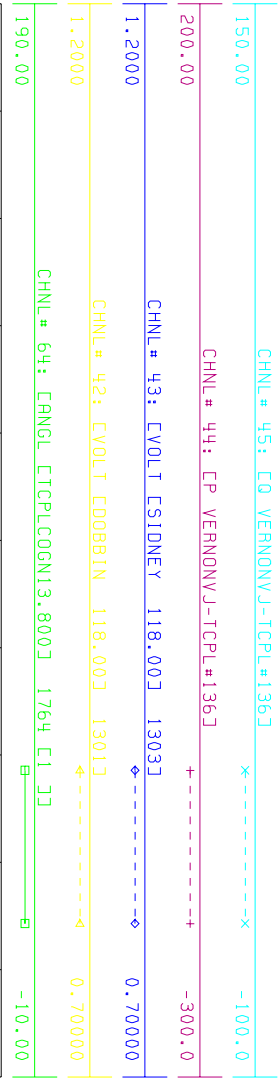


FRI, JUN 13 2003 16:19
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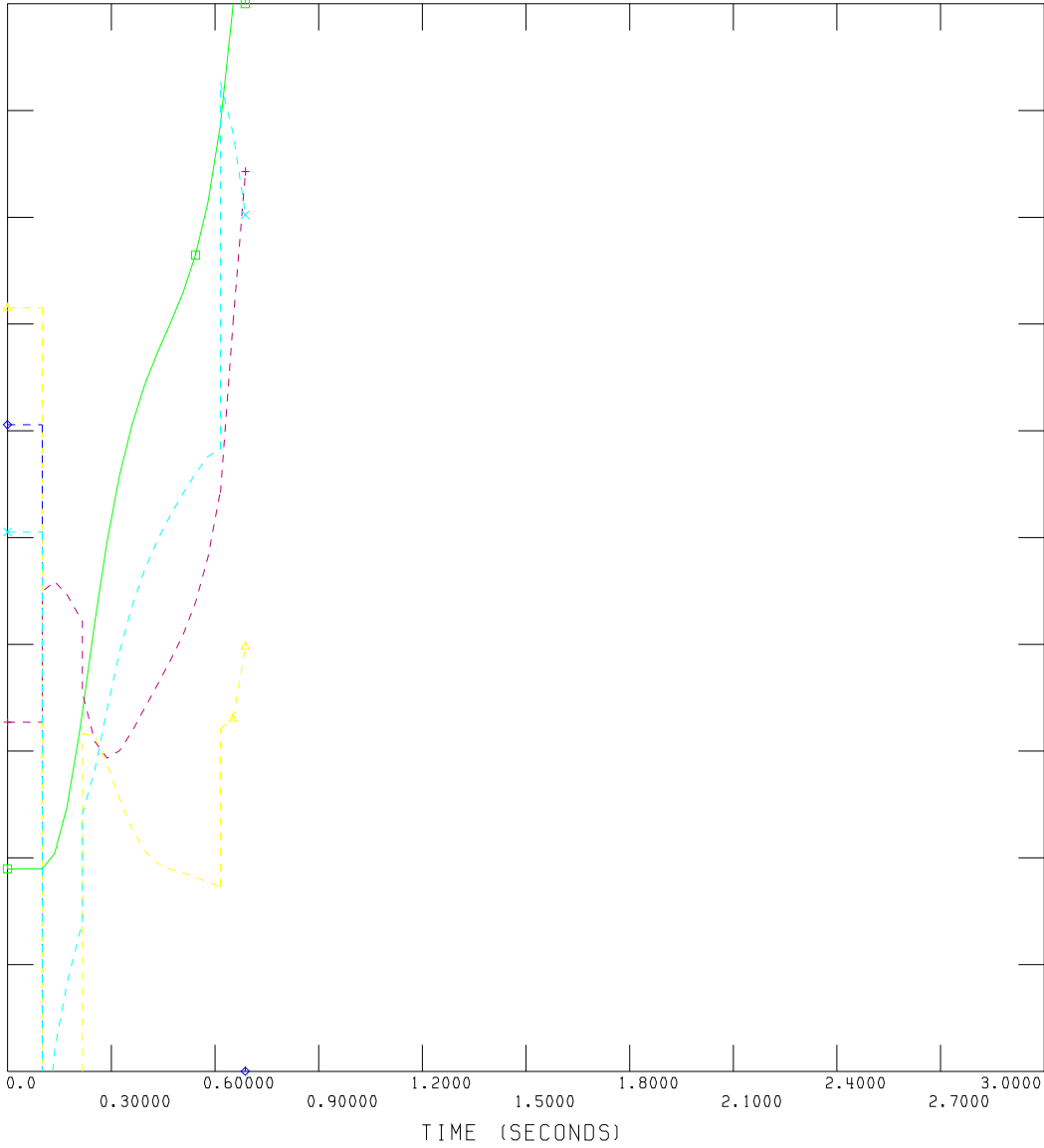


ASSESSMENT OF TCPL RT COBOLURG 5*22.8MW

FILE: 3p_p3s_ptcplddtcpl1.bin



FRI, JUN 13 2003 16:21
TCPL FAULT RESPONSE



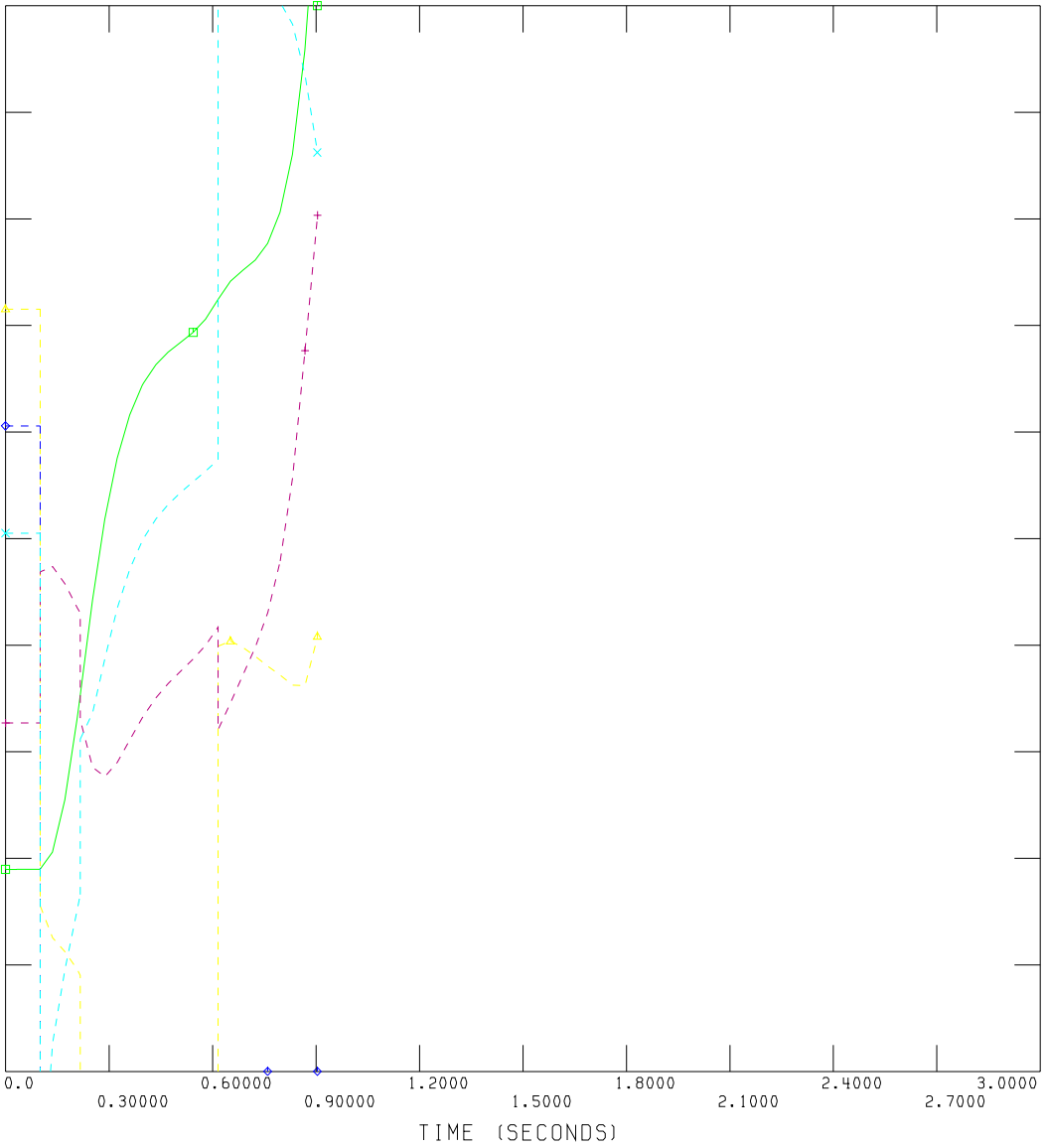


ASSESSMENT OF TCPL RT COBOURG 5*22.8MW

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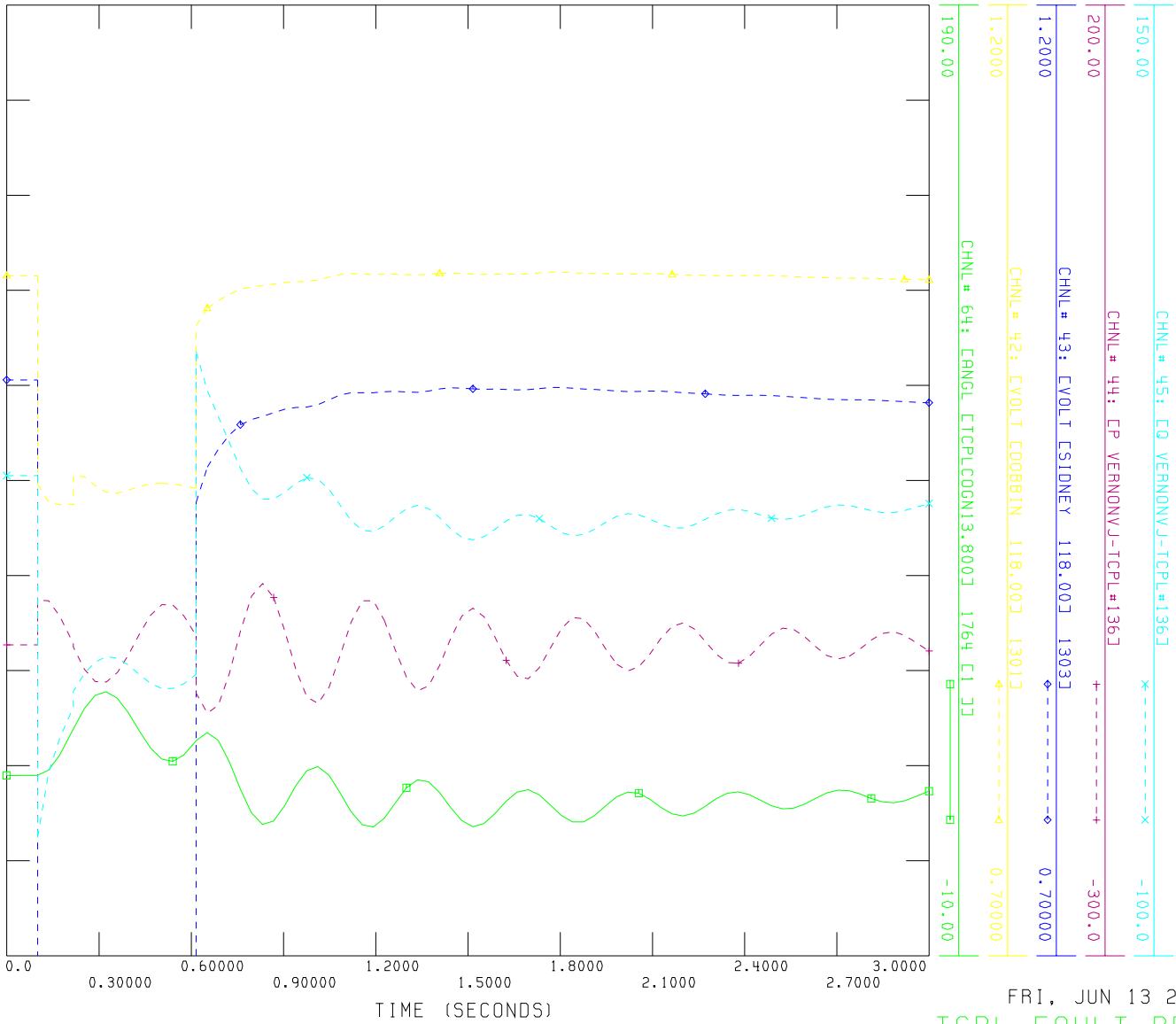
FRI, JUN 13 2003 16:22
TCPL FAULT RESPONSE





ASSESSMENT OF TCPL RT COBURG 5x22.8MW

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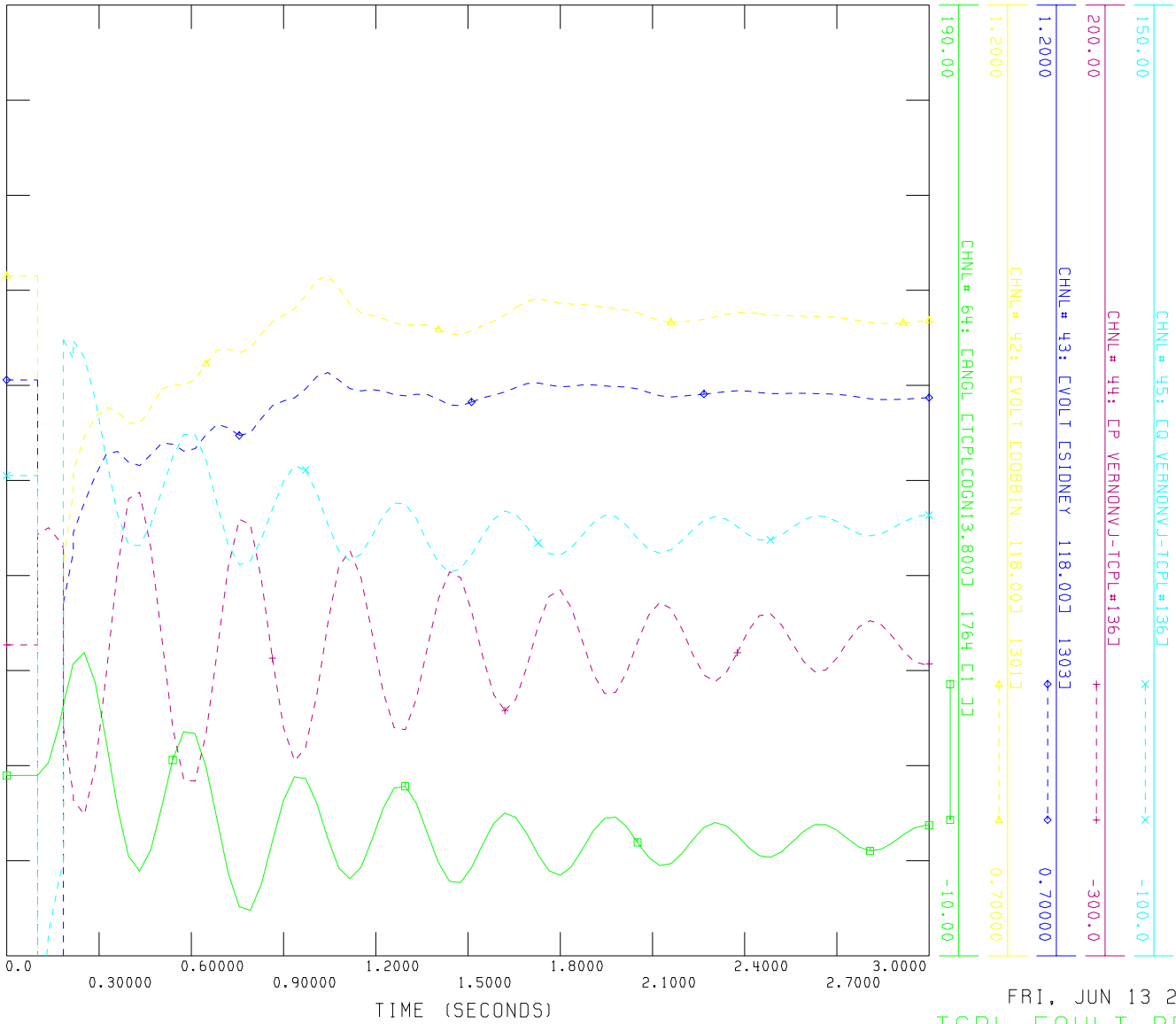


FRI, JUN 13 2003 16:24
TCPL FAULT RESPONSE



ASSESSMENT OF TCPL RT COBOLURG 5*22.8MW

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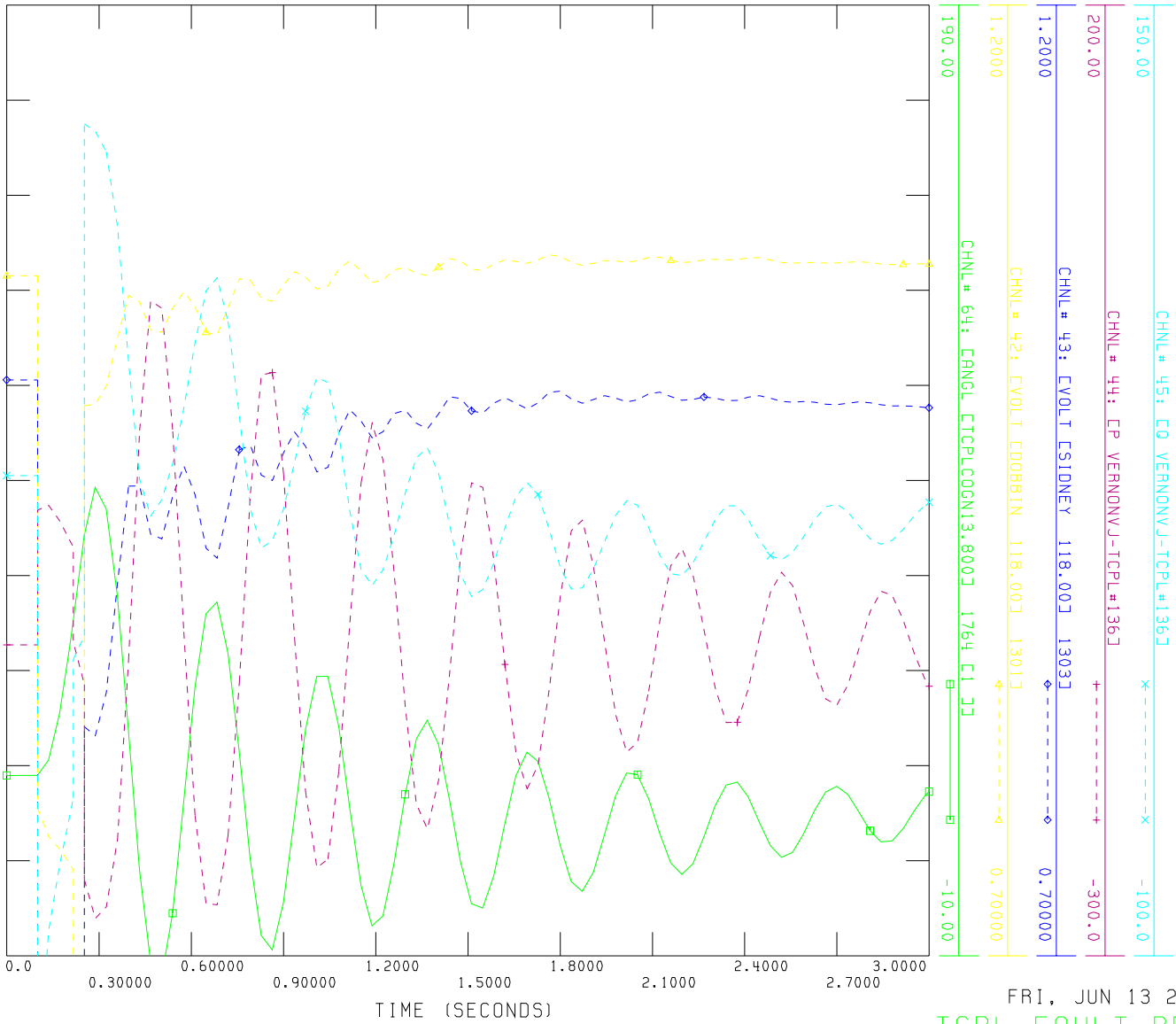


FRI, JUN 13 2003 16:26
TCPL FAULT RESPONSE



ASSESSMENT OF TCPL RT COBOLURG 5*22.8MW

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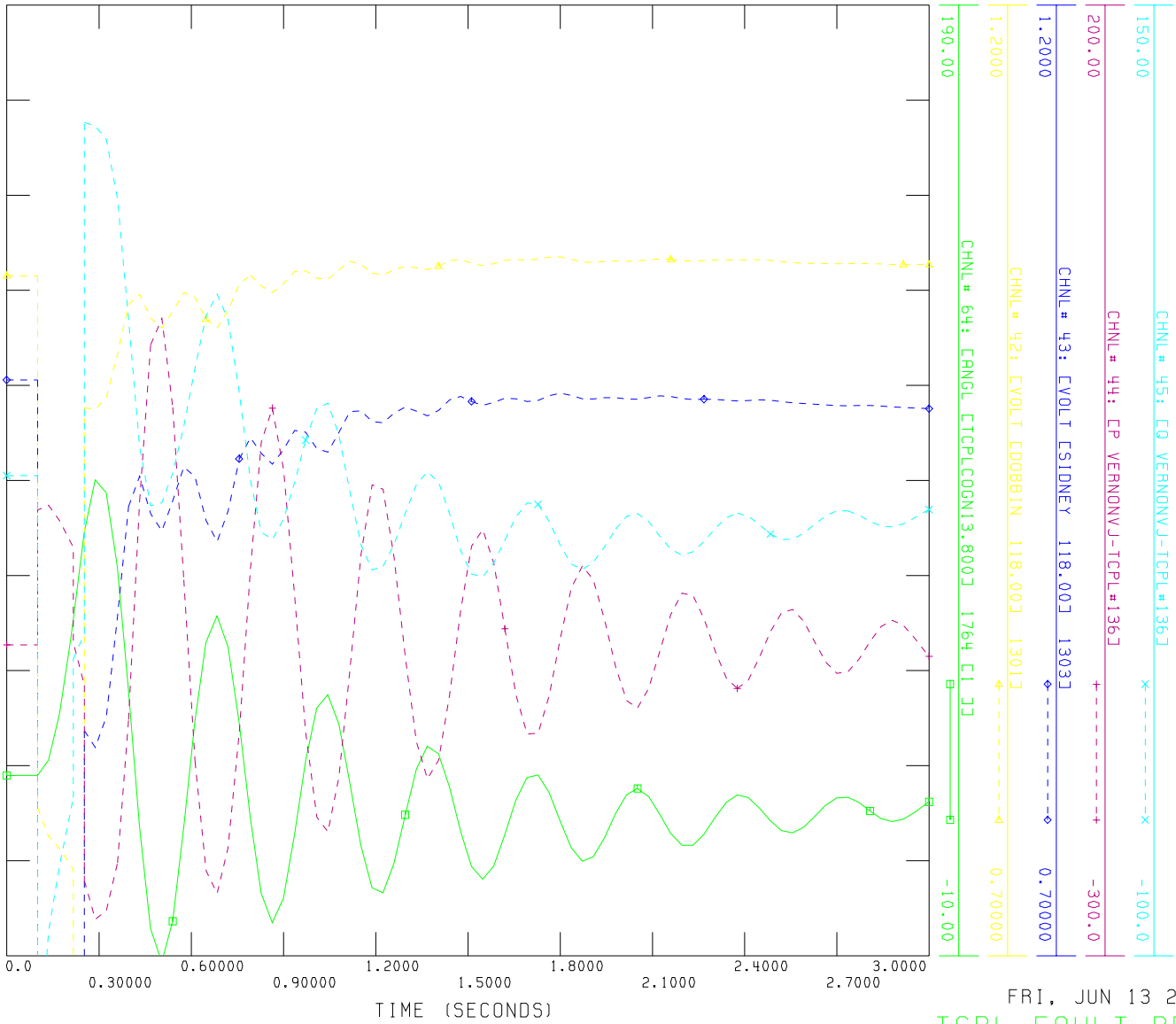


FRI, JUN 13 2003 16:28
TCPL FAULT RESPONSE



ASSESSMENT OF TCPL AT COBOURG 5*22.8MW

FILE: 3p_p3s'_stcplddtcplnogov.bin

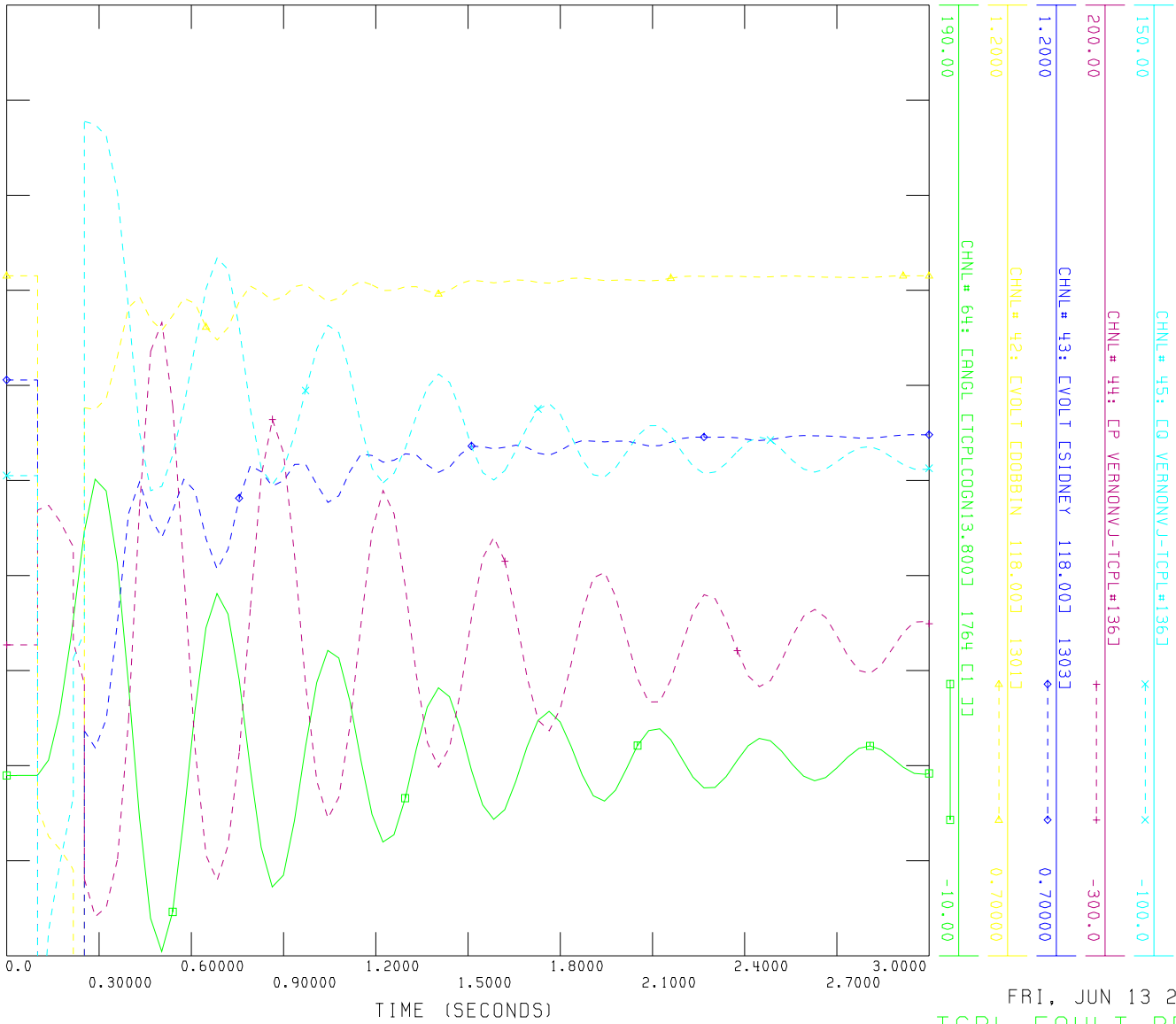


FRI, JUN 13 2003 16:29
TCPL FAULT RESPONSE



ASSESSMENT OF TCPL AT COBURG 5*22.8MM

FILE: 3p_p3s'_stcp1ddtcplnoexcorgov.bin



APPENDIX III

Typical Models/Parameters Used in System Studies

Synchronous generators are usually represented by either salient pole or round rotor machine models. The salient pole generators are installed at hydro or diesel power plants and generally have a slower speed rating. The high speed thermal systems usually have round rotor machines. The salient pole machine model GENSAL and the round rotor machine model GENROU along with the typical parameters are provided in this note.

These days the two most common type of excitation systems are static and brushless. Typical models to represent these excitation systems and the parameters are also given.

As the proposals consist of gas turbine and diesel plants, therefore the most commonly used models to represent the governor controls of these type of plants are provided.

1. Generator Parameters of Salient Pole Machines Using GENSAL Model

$T'd_0 = 5.0 \text{ s}$
 $T''d_0 = 0.02 \text{ s}$
 $T''q_0 = 0.09 \text{ s}$
 $H = 2.2 \text{ MJ/MVA}$
 $D = 0$
 $X_d = 1.01 \text{ pu}$
 $X_q = 0.63 \text{ pu}$
 $X'd = 0.33 \text{ pu}$
 $X''d = 0.3 \text{ pu}$
 $X_l = 0.12 \text{ pu}$
 $S(1.0) = 0.19 \text{ pu}$
 $S(1.2) = 0.59 \text{ pu}$

2. Generator Parameters of Round Rotor Machines Using GENROU Model

$T'd_0 = 5.0 \text{ s}$
 $T''d_0 = 0.05 \text{ s}$
 $T'q_0 = 0.7 \text{ s}$
 $T''q_0 = 0.1 \text{ s}$
 $H = 1.5 \text{ s}$
 $D = 0$
 $X_d = 1.8 \text{ pu}$
 $X_q = 1.8 \text{ pu}$
 $X'd = 0.2 \text{ pu}$
 $X'q = 0.2 \text{ pu}$
 $X''d = 0.15 \text{ pu}$
 $X_l = 0.068 \text{ pu}$
 $S(1.0) = 0.1$
 $S(1.2) = 0.5$

3. Representation of Static Excitation System Using EXST1 Model

$T_r = 0$ s
 $V_{\max} = 3$
 $V_{\min} = -3$
 $T_c = 1$
 $T_b = 1$
 $K_a = 200$
 $T_a = 0.02$ s
 $V_{r\max} = 7$
 $V_{r\min} = -7$
 $K_c = 0$
 $K_f = 0.02$
 $T_f = 0.15$ s

4. Representation of Brushless Excitation System Using ESAC8B Model

$T_r = 0$ s
 $K_p = 170$
 $K_i = 130$
 $K_d = 60$
 $T_d = 0.03$
 $K_a = 1$
 $T_a = 0$ s
 $V_{r\max} = 10$
 $V_{r\min} = 0$
 $T_e = 1$ s
 $K_e = 1$
 $E_1 = 3.38$
 $S(E_1) = 1.36$
 $E_2 = 4.5$
 $S(E_2) = 1.5$

5. Representation of Gas Turbines Using GAST Model

$R = 0.05$
 $T_1 = 0.1$ s
 $T_2 = 0.05$ s
 $T_3 = 3.0$ s
 $A_T = 1$
 $K_T = 2$
 $V_{\max} = 0.9$
 $V_{\min} = 0.05$
 $D_{\text{turb}} = 0$

6. Representation of Diesel Governor Using DEGOV1 Model

$$T1 = 0.1905 \text{ s}$$

$$T2 = 0.0476 \text{ s}$$

$$T3 = 0.018 \text{ s}$$

$$K = 1.0$$

$$T4 = 5.1 \text{ s}$$

$$T5 = 0.322 \text{ s}$$

$$T6 = 0$$

$$Td = 0.002 \text{ s}$$

$$Tmax = 0.8$$

$$Tmin = 0$$

$$\text{Droop} = 0.05$$

$$Te = 0.05 \text{ s}$$